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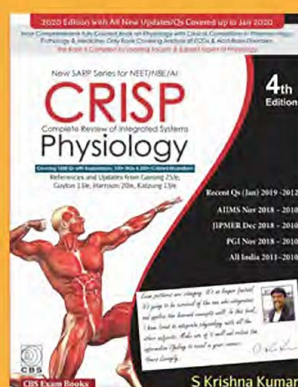
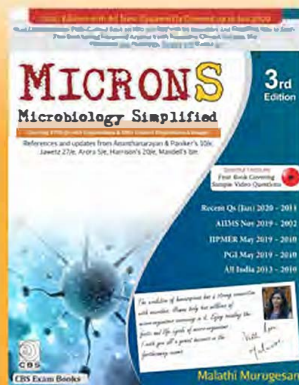


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K Raviraj MBBS MD (Anatomy)

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Revise

Anatomy

New SARP Series for NEET/NBE/AI

In 15 Days

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Dedication

The book is dedicated to my parents and my dear wife

K Raviraj



From the Publisher's Desk

Dear Readers,

I extend my warm welcome and convey my heartfelt thanks for appreciating the CBS Exam Books for another successful year. It has been an amazing journey so far and I am highly grateful for your support and cooperation to help us achieve various milestones in this whole span of time. The mission with which we started in the year 2015 was to bring nothing but the best of everything to our target audience and today I can proudly say that we have maintained that standard and are committed to continue the same in future as well.

Every single title under the banner of CBS Exam Books has been developed and nurtured like an infant. The authors and our entire team work day and night to bring the best in everything for you. Be it content, presentation, social media contests and offers, we strive to meet your expectations with every passing year. Your trust has motivated us to maintain and upgrade ourselves during this period. I am extremely thankful to all our authors who are the real pillars of the complete series of CBS Exam Books. The contributions of our esteemed authors have laid the foundations of CBS Exam Books.

At this juncture, I can recall these lines by Drake,

“Sometimes it's the journey that teaches you a lot about your destination”.

We have grown and changed with the passage of time to upgrade our ways of providing our readers with maximum benefits and help them manage their time and efforts in effective manner. Previous year was the year of great achievements. Let me show you a glimpse of our successful journey:

- Most of the titles of CBS Exam Books received wide acceptance and recognition by the readers of proving their usefulness and supremacy. To mention a few, SARP Anatomy, CRISP, Surgery Sixer, Complete Review of Pathology, Conceptual Review of Pharmacology, SOCH, Forensic Medicine, Complete Review of Medicine, Conceptual Review of PSM, MICRONS, My PGMEET Notes, AIIMS MedEasy, and PRIMES. With your constant support and our consistent efforts, I am sure that we will together witness an exponential acceptance of all CBS Exam Books in coming future as well.
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A book is incomplete if it does not have the right readers. We value you and your feedback. Please share your feedback and suggestions directly with me at bhupesharora@cbspd.com. We promise to deliver in our books, what you desire to see.

I would like to sum up with these eternal lines of Robert Frost:

Woods are lovely dark and deep,
But I have promises to keep.
And miles to go before I sleep,
And miles to go before I sleep!
Wishing you success in all your endeavors!



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Preface

The world is growing more and more competitive in almost all the fields, and the field of medicine is no exception. Almost every budding media dreams of becoming a specialist or a super specialist as soon as possible, for which he has to prepare for various entrance examinations like NEET PG, AIIMS, PGI Chandigarh, JIPMER, etc. The time available is very short, yet the young doctors are expected to master all the major nonclinical and clinical subjects in order to survive the competition and come out with flying colors.

Of all the subjects, aspirants generally find difficult to study nonclinical subjects like anatomy, physiology, etc. as these subjects are taught in first year of MBBS curriculum. However, without mastering these subjects, scoring high marks in competitive entrance examinations is almost impossible.

In this fourth edition, content has been modified as per the requirements of competitive examinations. Throughout the book anatomy is integrated with all other clinical subjects like Surgery, Obstetrics and Gynecology, Medicine, Pediatrics, etc. so that aspirants can have solid foundation on anatomy in relation to the other subjects. For the first time, real-time Cadaveric images have been added. The question bank has been updated till January 2020. As usual, book has been kept simple and easy to follow to help readers save a lot of time so that they can concentrate on other subjects as well. Hope those who are preparing for PG entrance examinations will find this book easy, relevant and concise.

As the saying goes, to err is human, therefore comments, suggestions and corrections are always welcome.

Wish you all the very best!

K Raviraj • VD Agrawal

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- ❑ I also extend my sincere thanks to Mr Dheena Dhalayan BE (ECE)
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- ❑ Dr Rajmohan MD General Medicine, Dr Anand MD Pulmonology, Dr Aishwarya MS ENT
- ❑ Dr Dileep MD Anatomy, Dr Vinnarasi MD Anatomy, Dr Gajapriya MD Anatomy, Dr Soorya Sridhar MD Anatomy

I would like to thank **Mr Satish Kumar Jain** (Chairman) and **Mr Varun Jain** (Managing Director), M/s CBS Publishers and Distributors Pvt Ltd for providing me the platform in bringing out the book. I have no words to describe the role, efforts, inputs and initiatives undertaken by **Mr Bhupesh Arora**, (Vice President – Publishing & Marketing, PGMEE and Nursing Division) for helping and motivating me.

I sincerely thank the entire CBS team for bringing the book colorful with utmost care and attractive presentation. I thank Dr Mrinalini Bakshi (Editorial Head & Content Strategist) for her editorial support and Ms Nitasha Arora (Production Head & Content Strategist), Dr Anju Dhir (Project Manager & Senior Scientific Coordinator), Mr Shivendu Bhushan Pandey (Senior Editor), Mr Ashutosh Pathak (Senior Proof Reader) and all the production team members, Mr Chaman Lal, Mr Prakash Gaur, Mr Phool Kumar, Mr Bunty Kashyap, Mr Chander Mani, Ms Tahira Parveen, Ms Babita Verma, Ms Manorama Gupta, Mr Raju Sharma, Mr Manoj Chaudhary, Mr Vikram Chaudhary, Mr Manoj Malakar and Mr Rahul Negi for devoting laborious hours in designing and typesetting of the book.

K Raviraj

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Latest Exam Questions 2020-2019

1. Recent Pattern Questions 2020
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5. JIPMER May 2019
6. PGI May 2019

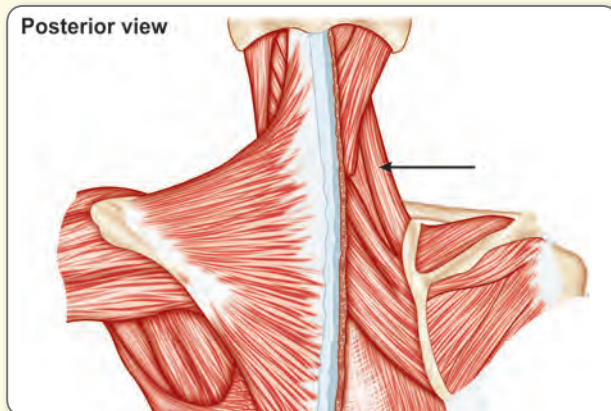


RECENT PATTERN QUESTIONS 2020

1. The upward extension of thyroid swelling is prevented by which is attached to thyroid cartilage?

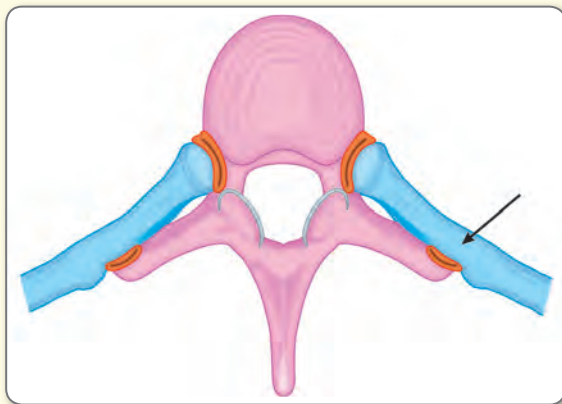
- Pretracheal fascia
- Ligament of Berry
- Thyrohyoid membrane
- Sternothyroid

2. Nerve supply to marked muscle



- Dorsal scapular
- Suprascapular
- From the dorsal rami of C1
- Subscapular

3. Identify the type of joint in the given picture (image showing costotransverse joint between rib and vertebrae):



- Syndesmosis
- Synarthrosis
- Synovial joint
- Symphysis

4. Meiosis occurs in:

- Adrenal
- Ovary
- Prepubertal testis
- Hypothalamus

5. A patient presented with clinical features of ataxia, incoordination. Which of the following artery is affected?

- Posterior cerebral
- Middle cerebral
- Internal carotid
- Superior cerebellar

6. The reason for the long left recurrent laryngeal nerve is due to the persistence of which arch artery?

- 3rd arch
- 4th arch
- 6th arch
- 2nd arch

7. Where is the highest oxygen concentration in fetal circulation?

- SVC
- IVC
- Right ventricle
- Aorta

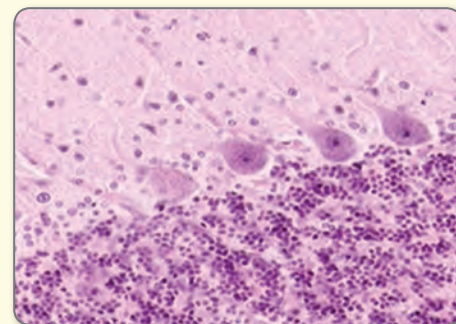
8. Ligation of the common hepatic artery will impair blood supply in:

- R gastric and R gastroepiploic artery
- R gastric and L gastric artery
- R gastroepiploic and short gastric vessels
- R gastric and short gastric vessels

9. A patient presented with weakness of the right side of the face with the loss of pain and temperature. Pain and temperature sensation of the left leg is lost. The lesion is most likely located at?

- Medial medulla
- Lateral pons
- Medial pons
- Lateral medulla

10. Identify the cell marked in the histological image of the cerebellum shown below:



- Purkinje cells
- Basket cells
- Golgi cells
- Granular cell

11. Tumor of the uncinate process of pancreas affects which of the following vessel?

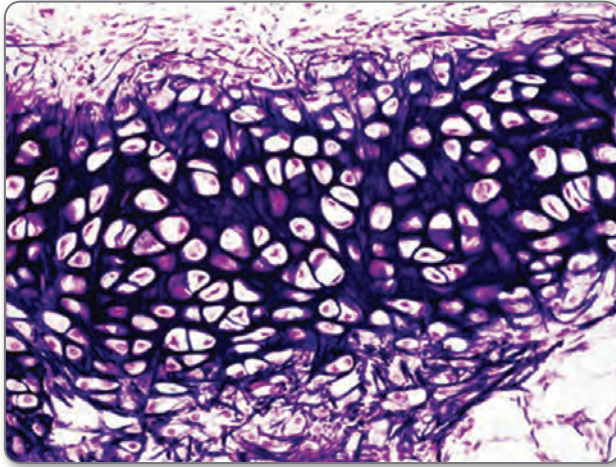
- Superior mesenteric artery
- Portal vein
- Common hepatic artery
- Inferior mesenteric artery

12. A man was brought to the emergency after meeting with an accident and injured his perineum. He gets an urge to micturate but is unable to pass urine. This is because of: (On examination—blood was seen at the tip of urethra and swelling of penis and scrotum)

- Penile urethra rupture
- Bulbar urethra
- Membranous urethra
- Urinary bladder



13. Illustration showing histology of cartilage. Identify the type of cartilage



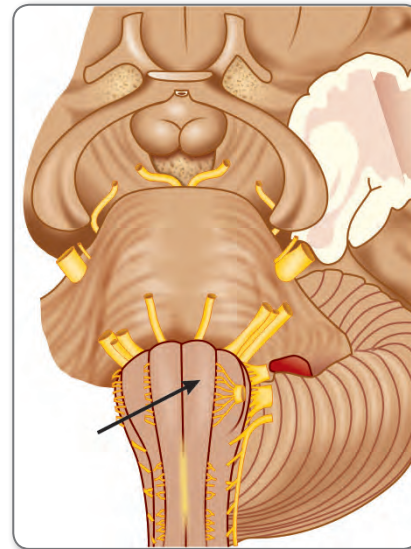
- a. Hyaline cartilage
 - b. Elastic cartilage
 - c. Articular cartilage
 - d. Fibrocartilage
14. Fertilization occurs in which part of the fallopian tube?
- a. Ampulla
 - b. Isthmus
 - c. Interstitial
 - d. Infundibular
15. Remnants of Wolffian ducts in a female are in:
- a. Pouch of Douglas
 - b. Broad ligament
 - c. Uterovesical pouch
 - d. Iliac fossa
16. Episiotomy posteriorly beyond perineal body injuring the structure immediately posterior to it. Which structure is injured?
- a. External anal sphincter
 - b. Ischiocavernosus
 - c. Bulbospongiosus
 - d. Urethral sphincter
17. In a preterm baby with respiratory distress syndrome, which of the following type of cell is deficient:
- a. Alveolar capillary endothelial cell
 - b. Bronchial mucosal epithelial cell
 - c. Type 1 alveolar cell
 - d. Type 2 alveolar cell
18. A 65-year-old lady presents with a cerebrovascular accident involving inferior frontal gyrus. Which function area would mostly be affected?
- a. Visual
 - b. Auditory
 - c. Sensory speech
 - d. Motor speech

19. Boy met with motor bike accident. CT brain shows injury to posterior end of superior temporal gyrus. He is likely to suffer from:

- a. Fluent aphasia
- b. Non fluent aphasia
- c. Conduction aphasia
- d. Global aphasia

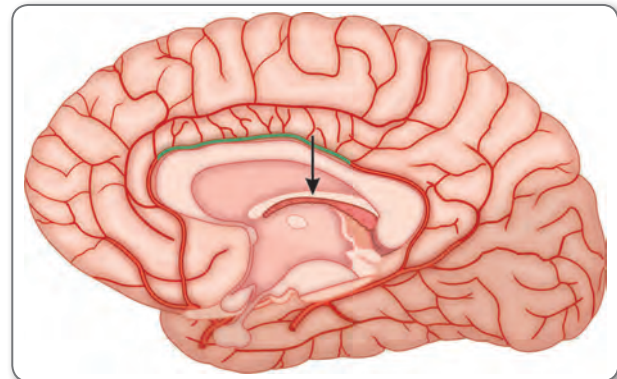
AIIMS NOVEMBER 2019

20. Lesion on the marked structure in the given specimen would present which of the following feature:



- a. Ataxia
- b. Vertigo
- c. Ipsilateral facial nerve palsy
- d. Contralateral hemiplegia

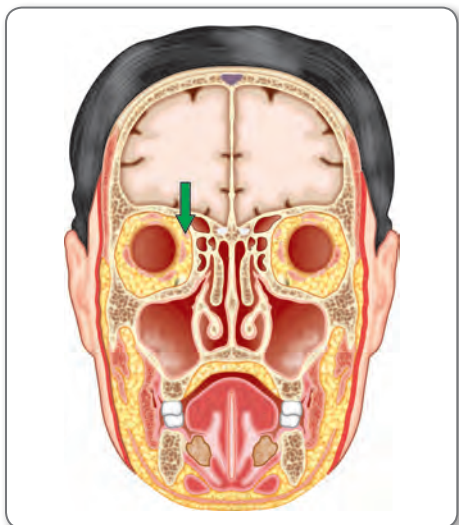
21. Blood supply of the marked structure in the given specimen is derived from which of the following artery?



- a. Middle cerebral artery
- b. Internal carotid artery
- c. Anterior cerebral artery
- d. Vertebral artery



22. Which of the following nerve supplies in the marked structure in the given below figure?



- a. CN 2
- b. CN 4
- c. CN 3
- d. CN 6

23. Identify the marked structure in the given dissection specimen:



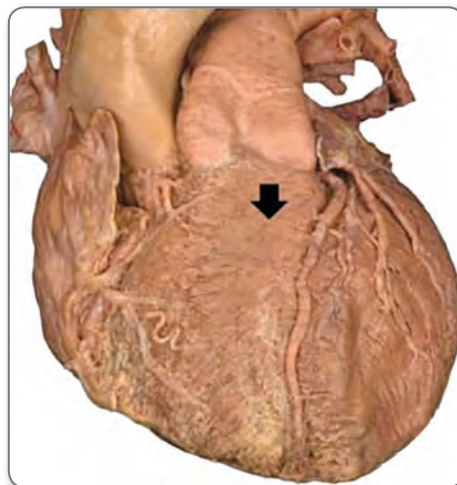
- a. Ulnar Nerve
- b. Ulnar Artery
- c. Radial Artery
- d. Median Nerve

24. The marked structure given in the specimen is derived from which embryonal derivatives:



- a. Endocardial cushion
- b. Septum primum
- c. Left venous valve
- d. Bulboventricular flange

25. All of the following artery supplies the marked part the specimen; except:



- a. Marginal artery
- b. Anterior interventricular artery
- c. Diagonal artery
- d. Right coronary artery

26. Which part of brachial plexus does not give branches?

- a. Roots
- b. Trunks
- c. Cords
- d. Division

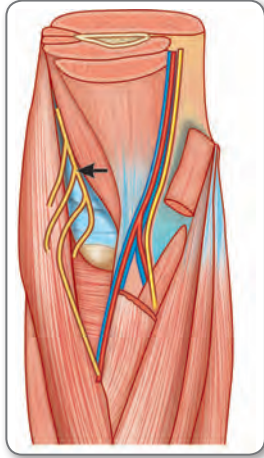
27. Which of the following muscles do not contribute to the marked tendon:



- a. 2nd Dorsal interossei
- b. 2nd Palmar interossei
- c. Lumbricals
- d. Extensor digitorum



28. Lesion of the marked structure lead to which of the following deformity?



- a. Claudication
- b. Ape thumb deformity
- c. Wrist drop
- d. Claw hand

29. Lesion of the marked structure leads to:



- a. Loss of sensation of tip of index finger dorsal side
- b. Loss of sensation over hypothenar muscles
- c. Loss of sensation at the tip of radial bone
- d. Loss of sensation from 4th Interdigital cleft

30. A patient undergoes surgery at the lateral part of the skull. Post-operative complication of the patient is aspirations without voice change. It occurs due to damage of:

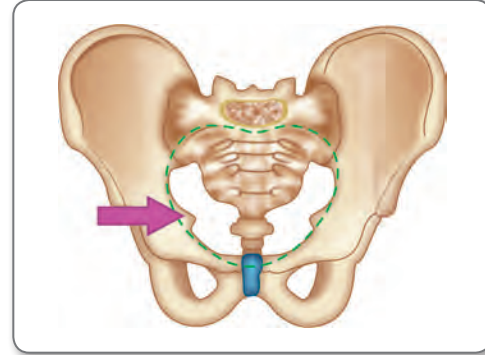
- a. Vagus nerve
- b. Recurrent laryngeal nerve
- c. Glossopharyngeal nerve
- d. SLN

31. Which of the following viscera related to marked area of left the kidney:



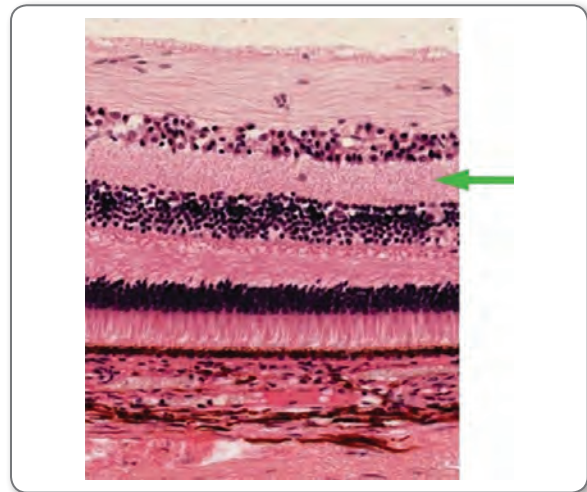
- a. Second part of duodenum
- b. Liver
- c. Stomach
- d. Spleen

32. Which of the following structure is crossed the marked structure:



- a. Sciatic
- b. Obturator
- c. Inferior rectal
- d. Pudental

33. Identify the marked layer in the given histological section:



- a. Inner plexiform layer
- b. Outer plexiform layer
- c. Inner limiting layers
- d. Outer limiting layer

AIIMS MAY 2019

34. All of the following are branches of External carotid artery (ECA) supplying the nasal septum except:

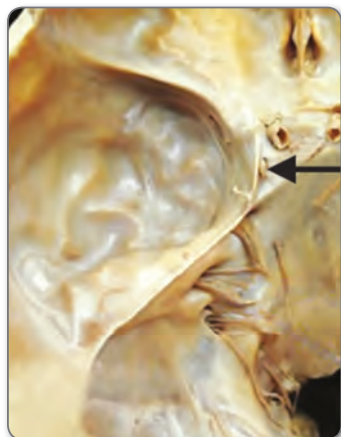
- a. Anterior ethmoidal artery
- b. Sphenopalatine artery
- c. Greater palatine artery
- d. Superior labial artery

35. True/False regarding carotid sheath:

- a. Ansa cervicalis lies on the posterior wall of carotid sheath
- b. Carotid sheath is formed by investing layer of deep cervical fascia.
- c. Carotid sheath contains IX, X, and XI cranial nerves
- d. Sympathetic chain lies in between Internal carotid arteries and internal jugular vein
- e. CCA divided at the lower level of thyroid cartilage.



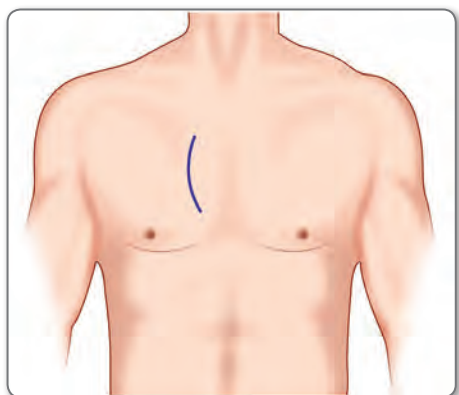
36. Which of the following muscle is not supplied by the marked nerve?



- a. Superior rectus
- b. Superior oblique
- c. Medial rectus
- d. Levator palpebrae superioris (LPS)

37. Video-Based Question: In this video the person started the superficial marking of thorax from 3rd costal cartilage to 6th Sternocostal joint and a marking point was given. The question was asked to identify the marked point.

For video, scan this QR Code

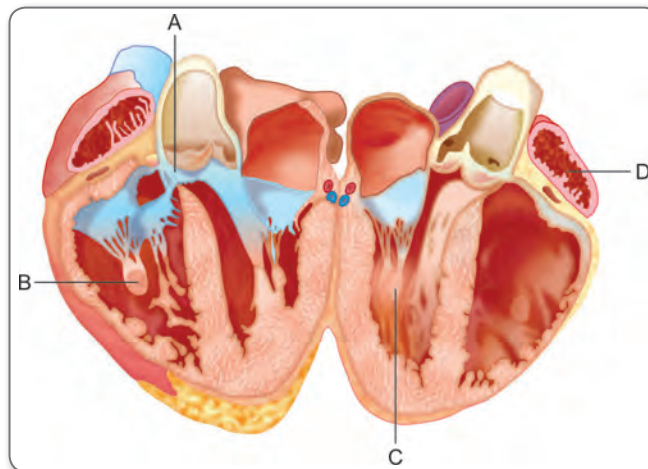


- a. Thoracic duct
- b. Right atrium
- c. Inferomedial bronchopulmonary segments
- d. Hilum

38. Find out the wrong statement about levator ani muscle function and support.

- a. Supports pelvic viscera
- b. Converge Downwards and medially
- c. Parts iliococcygeus and pubococcygeus
- d. Attached to pelvic brim

39. In the given cut section of heart, match the marked (A, B, C & D) structures.



1. Musculi pectinati
2. Anterior papillary muscle of Left ventricle
3. Anterior papillary muscle of right ventricle
4. Anterior leaflet of mitral valve.
5. Membranous part of ventricular septum

- a. A-5, B-2, C-1, D-4
- b. A-1, B-2, C-5, D-3
- c. A-5, B-3, C-2, D-1
- d. A-1, B-2, C-4, D-5

40. Correct sequence of structure in spermatogenesis event:

1. Spermatozoa
 2. Spermatogonia
 3. Spermatocytes
 4. Spermatid
- a. 3 → 2 → 4 → 1
 - b. 2 → 3 → 4 → 1
 - c. 2 → 3 → 1 → 4
 - d. 2 → 4 → 3 → 1

41. Sequential arrangement of 8th nerve pathway from periphery to centre:

1. Cochlear nerve
 2. Superior olivary nucleus
 3. Medial geniculate body
 4. Cochlear nuclei
 5. Lateral lemniscus
 6. Inferior colliculus
- a. 1 → 3 → 2 → 4 → 5 → 6
 - b. 1 → 4 → 2 → 5 → 6 → 3
 - c. 1 → 3 → 4 → 2 → 6 → 5
 - d. 1 → 4 → 2 → 3 → 6 → 5

42. Action of the muscle attached to the marked area?



- a. Flexion
- b. Adduction
- c. Abduction
- d. Extension



43. Structure that divides liver anatomically based on Couinaud classification system is:

- a. Portal veins b. Hepatic artery
c. Bile duct d. Cystic duct

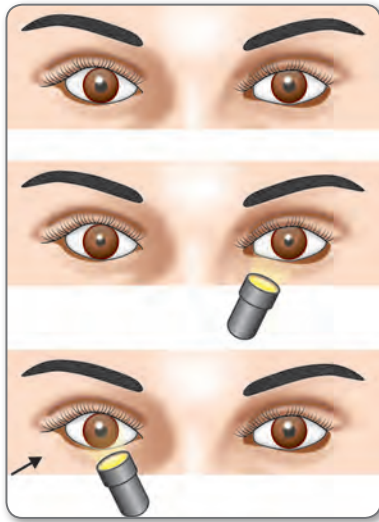
44. 2nd dorsal interossei attached to which of the following finger:

- a. Index finger b. Little finger
c. Middle finger d. Ring finger

45. A 57-year-old person underwent parotidectomy. After that he complains of loss of sensation while shaving. Which nerve is affected most?

- a. Auriculotemporal b. Greater auricular
c. Mandibular d. Facial

46. Which of the following is correct regarding the image given



- a. It is called as Argyll Robertson pupil
b. This test is named after Sir Marcus gun, a physician of us
c. The vision is normal in right eye
d. Seen in optic neuritis, the pupil can paradoxically dilate in both eyes

JIPMER DECEMBER 2019

47. Which cartilage of larynx doesn't ossify?

- a. Thyroid b. Cricoid
c. Cuneiform d. Arytenoid lower part

48. Patient when standing on right side, opposite side the hip drops. Which nerve is affected?

- a. Right superior gluteal b. Left superior gluteal
c. Right inferior gluteal d. Left inferior gluteal

49. Parasympathetic cranial nerve

- a. III, V, IX, X b. III, VII, IX, X
c. III, VII, X, XI d. I, II, III, IV

50. Which of the following site is anastomosis between internal and external carotid artery

- a. Angle of mandible b. Angle of mouth
c. Medial canthus of eye d. Condyle of mandible

51. Which of the following helps to differentiate between high and low radial nerve palsy

- a. Brachialis
b. Extensor carpi radialis longus
c. Extensor carpi radialis brevis
d. Extensor digitorum

52. Patient using crutches with history of restricted abduction of shoulder and extension of elbow. Which part of brachial plexus affected?

- a. Posterior cord b. Lateral cord
c. Medial cord d. Upper trunk

53. Levator palpebrae superioris supplied by

- a. III nerve b. VII nerve
c. II nerve d. IV nerve

54. Hyperextension of knee prevented by

- a. ACL b. PCL
c. Arcuate ligament
d. Oblique popliteal ligament

55. Ligamentum teres of femur which is false

- a. Stabilize the hip joint
b. Supply blood supply to femur head
c. Relaxed on abduction
d. Become stretched on adducting with semi flexed hip

56. Middle cranial fossa injury and structures passing through foramen ovale damaged. Which of the following lost?

- a. Sensory supply of forehead
b. Sensory supply over zygomatic arch
c. Chewing movement
d. Ability to blow up the cheeks

57. Injury at carotid triangle and patient presents with weak voice which nerve is affected

- a. Ansa cervicalis
b. RLN
c. Internal laryngeal nerve
d. External laryngeal nerve

58. Female patient history of trauma presents with left foot drop, power in left TA, Extensor digitorum longus, extensor hallucis longus power 0/5, power in tibialis posterior, gastrocnemius -4/5. Likely the site of injury:

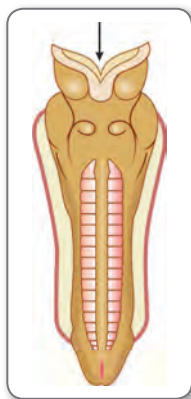
- a. Supracondylar fracture of left femur
b. Neck of fibula fracture
c. Left hip posterior dislocation
d. Left ankle fracture

59. Tympanic membrane is supplied by all except:

- a. Vagus b. Glossopharyngeal
c. Trigeminal d. Vestibulocochlear



60. When does the marked structure (Black arrow) close in utero?



- a. 30 days b. 25 days
c. 12 days d. 7 days
61. Dorsal artery of penis passes beneath which layer?
a. Colles' fascia b. Buck's fascia
c. Dartos layer d. Tunica albuginea
62. Deltoid ligament contains which of the following?
a. Tibiotalar ligament b. Talofibular ligament
c. Talonavicular ligament d. Calcaneocuboid
63. True statement regarding Kugel's anastomotic artery is:
a. Arising directly from arch of aorta
b. From left anterior descending coronary artery
c. From left circumflex artery
d. Artery connected to coronary sinus
64. A sportsperson presents with laceration of wrist but with no vascular injury. On examination, a structure lateral to flexor digitorum superficialis is found to be injured. What action he most likely cannot perform?
a. Opposition of thumb b. Adduction of 2nd digit
c. Abduction of 2nd digit d. Flexion of thumb
65. Which structure is not passing through the gap between superior and middle constrictor muscle of pharynx?
a. Glossopharyngeal nerve
b. Stylopharyngeus muscle
c. Internal laryngeal nerve
d. Stylohyoid ligament
66. Structure forming the posterior 1/3rd of vertebral canal is:
a. Posterior 1/3rd of vertebral body
b. Posterior 1/3rd of intervertebral disc
c. Posterior longitudinal ligament
d. Ligamentum flavum
67. While doing excision of cervical lymph nodes, inadvertent injury to which nerve causes drooping of shoulder?
a. Suprascapular nerve b. Spinal accessory nerve
c. Supraclavicular nerve d. Nerve to serratus anterior

68. All are neural crest derivatives except:
a. Sympathetic ganglia b. Muscles of ciliary body
c. C cells of thyroid gland d. Odontoblasts

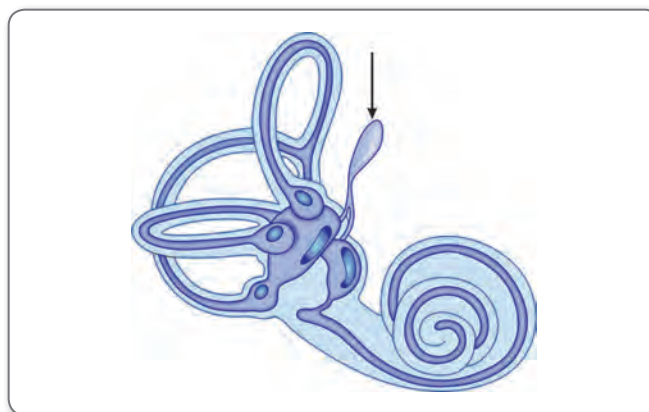
69. True about superior oblique origin and insertion:
a. Originate from lesser wing of sphenoid and inserted into sclera in front of equator
b. Originate from common tendinous ring (ring of Zinn) and inserted into sclera behind the equator
c. Originate from greater wing of sphenoid and inserted into sclera in front of equator
d. Originate from the body of sphenoid and inserted into the sclera behind the equator

70. Persistence of omphalomesenteric duct is:
a. Gastroschisis b. Omphalocele
c. Meckel's diverticulum d. Ectopia vesicae

71. Which of the following is a derivative of second arch?
a. Malleus
b. Stapes
c. Maxilla
d. Mandible

72. Crystalline lens is derived from:
a. Surface ectoderm
b. Neuroectoderm
c. Mesoderm
d. Endoderm

73. Identify the marked part in the given diagram:



- a. Utricle b. Saccule
c. Endolymphatic sac d. Semicircular canal

74. Which of the following sinuses open into Bulla ethmoidalis?
a. Anterior ethmoidal sinus
b. Posterior ethmoid sinus
c. Middle ethmoid sinus
d. Maxillary sinus

75. Which of the following structures not affected during tonsillectomy procedures?
a. Glossopharyngeal nerve
b. Para tonsillar vein
c. Tonsillar branch of facial artery
d. External carotid artery



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LATEST EXAM QUESTIONS 2020-2019

New SARP Series Anatomy

76. Which of the following test(s)/sign(s) is/are used to detect ulnar nerve injury:

- a. Pen test
- b. Card test
- c. Froment's sign
- d. Egawa test
- e. Pointing index finger

77. Trigeminal nerve supplies all of the following muscle(s) except:

- a. Tensor tympani
- b. Tensor veli palatini
- c. Levator veli palatini
- d. Anterior belly of digastric
- e. Mylohyoid

78. Remnant(s) of omphalomesenteric duct is/are:

- a. Urachal sinus
- b. Umbilical fistula
- c. Vitelline cyst
- d. Median umbilical ligament
- e. Meckel's diverticulum

79. Which of the following muscle(s) is/are transacted/divided in standard posterolateral thoracotomy procedure:

- a. Trapezius
- b. Serratus anterior
- c. Erector spinae
- d. Rhomboid
- e. Latissimus dorsi

80. Blood supply of pectoralis major muscle include(s):

- a. Superior thoracic artery
- b. Internal mammary artery
- c. Lateral thoracic artery
- d. Thoracodorsal artery
- e. Pectoral branch of the thoracoacromial artery

81. Structure(s) attached to medial condyle of femur is/are:

- a. Lateral head of gastrocnemius
- b. Capsular ligament of knee
- c. Popliteus
- d. Tibial collateral ligament
- e. Fibular collateral ligament

82. Which of the following statement(s) is/are correct about anatomy of liver:

- a. Accessory right hepatic artery is present in 15% cases
- b. Mainly supplied by hepatic artery and portal vein
- c. Caudate lobe is situated at the level of T10
- d. Caudate lobe has its own biliary drainage through both right and left systems
- e. Caudate lobe is supplied by both portal vein and hepatic artery

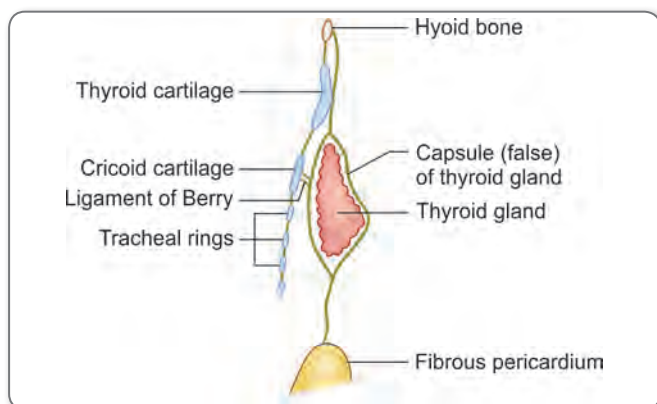


Answers with Explanations

RECENT PATTERN QUESTIONS 2020

1. Ans. (a) Pretracheal fascia

Pretracheal layer extends inferiorly from the base of the skull posteriorly and the hyoid bone and thyroid cartilage anteriorly and laterally and provides fascial sheaths of varying thickness for the thyroid gland, larynx, trachea, pharynx and esophagus. Inferiorly, it continues into the superior mediastinum along the great vessels and fuses with the fibrous pericardium. Ligament of berry attached to cricoid cartilage.



2. Ans. (a) Dorsal scapular

- Marked muscle—levator scapulae
- Supplied by c3, 4 also by c5 (dorsal scapular nerve)

3. Ans. (c) Synovial joint

Majority of joints in thoracic cage (interchondral, sternocostal, costovertebral, costotransverse) is plane type of synovial.

4. Ans. (b) Ovary

Meiosis Occurs in Gonads

- PGC reach the testis and go to dormant phase until puberty
- So, meiosis occurs in testis only after puberty

5. Ans. (d) Superior cerebellar

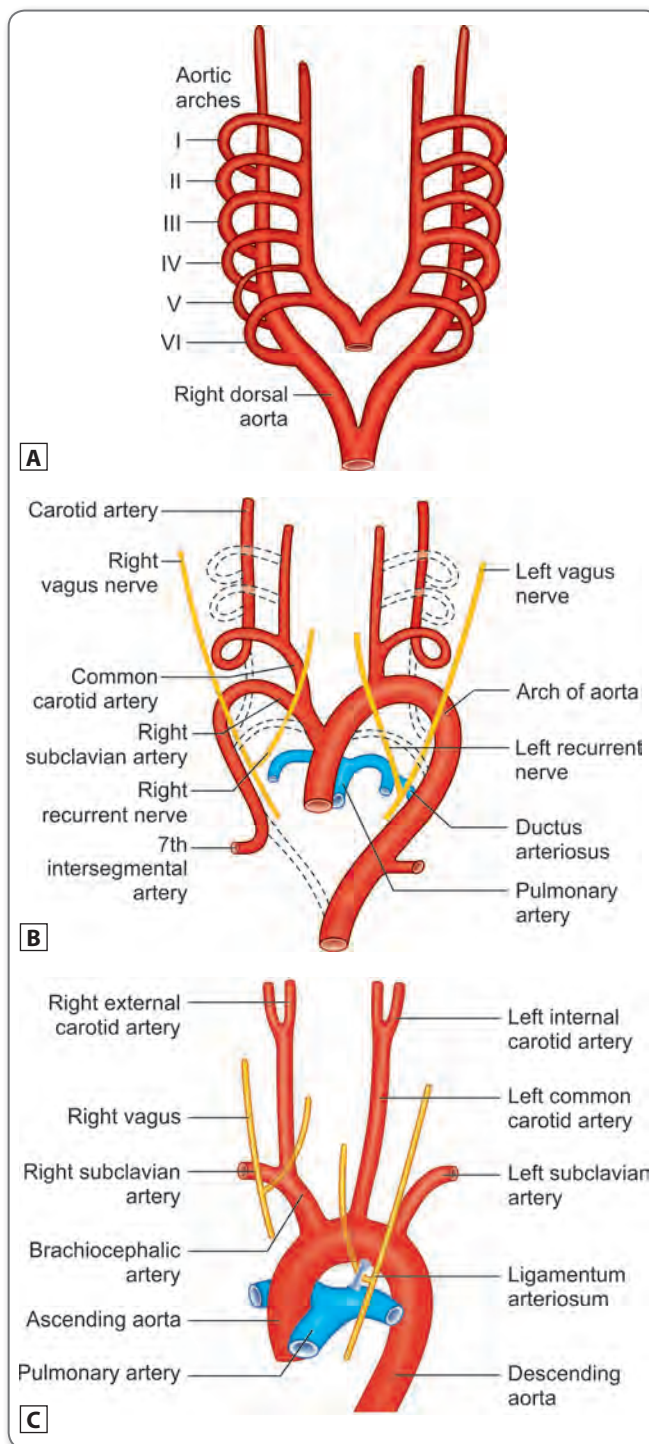
Ataxia, Incoordination due to Cerebellar Lesion

- Cerebellum supplied by superior cerebellar
- Posterior inferior cerebellar artery
- Anterior inferior cerebellar artery

6. Ans. (c) 6th arch

- The course of the recurrent laryngeal nerves different on the right and left sides.
- RLN is nerve of sixth pharyngeal arches.
- RLN hook around the sixth aortic arch and ascend again to the larynx, which accounts for their recurrent course.

- Right side - the distal part of the sixth aortic arch and the fifth aortic arch disappear, the recurrent laryngeal nerve moves up and hooks around the right subclavian artery.
- On the left, the nerve does not move up, (have long course than right side) since the distal part of the sixth aortic arch persists as the ductus arteriosus, which later forms the ligamentum arteriosum.





7. Ans. (b) IVC

Oxygenated blood is carried by left umbilical vein that drains into IVC

8. Ans. (a) R gastric and R gastroepiploic artery

- Right gastric artery is branch of common hepatic artery
- Right gastroepiploic artery is branch of gastroduodenal which is branch of common hepatic artery
- Left gastric—branch from celiac trunk
- Short gastric—from splenic artery

9. Ans. (b) Lateral pons

Remember Rule of 4

1. Weakness of face—palsy of facial muscles—7th nerve affected – same side—7th nerve from pons
2. Loss of pain and temperature from face – trigeminal nerve affected – lesion in lateral side and ipsilateral
3. Loss of pain and temperature in body (UL, LL) – spinothalamic tract affected—lesion in contralateral side and also lateral side (4s)
4. So, answer is right lateral pons

10. Ans. (a) Purkinje cells

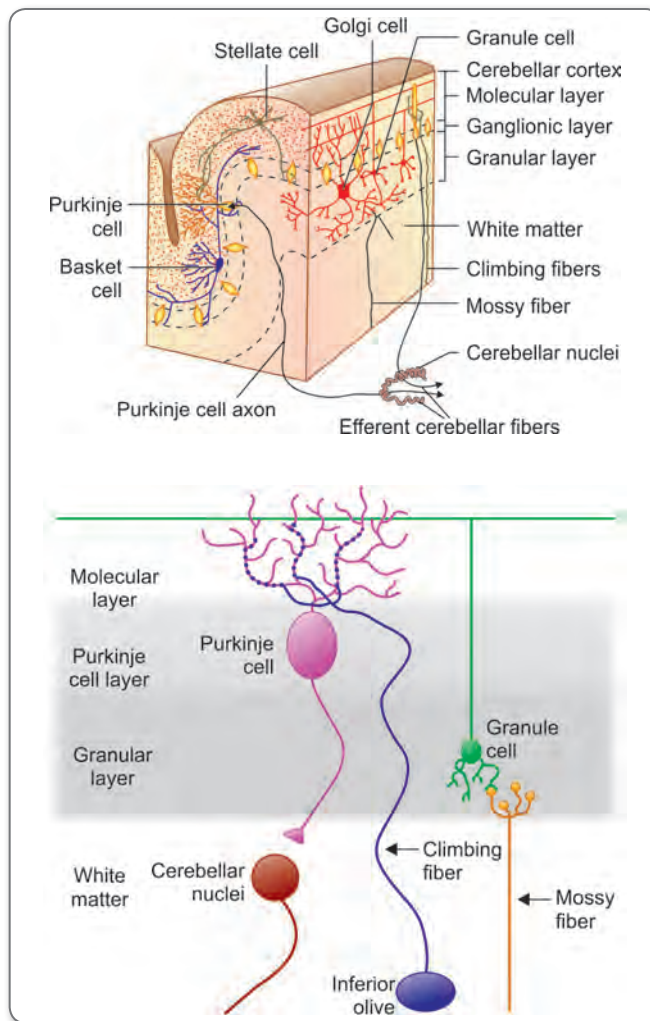
Purkinje cells—flask shaped cells

Layers of Cerebellar Cortex

- **Outer molecular layer:** Basket and stellate cells and dendrites from Purkinje cell
- **Intermediate Purkinje layer:** Flask-shaped Purkinje cell.
- **Inner granular layer:** Contains granule cell and few Golgi cells.

Cerebellar Pathway

- Afferents by climbing fibers and mossy fibers (both are excitatory)
- Climbing fibers originate from **inferior olivary nucleus** and synapse with **Purkinje cell**
- Mossy fibers form the bulk of the afferents and each fiber ends by dividing into 30–40 terminal rosette. Each rosette anastomose with Golgi cell and granule cell. One granule cell synapse with thousands of Purkinje, So mossy fiber synapse with thousands and thousands of Purkinje cell
- Axons of Purkinje cells (inhibitory) end by synapsing with the neurons of intracerebellar nuclei
- Axons from these nuclei in turn project into contralateral thalamus and then into contralateral cerebrum
- Cerebrum in turn control the contralateral spinal cord via corticospinal tract
- Few Purkinje neurons from flocculonodular lobe pass directly to vestibular nuclei



11. Ans. (a) Superior mesenteric artery

Superior mesenteric artery passing anterior to uncinat process

- Behind the head of pancreas—3 veins—IVC, Right and left renal vein
 - Behind the neck of pancreas—2 veins—superior mesenteric vein and portal vein
 - Behind the body—splenic vein
- Infront of uncinat process – superior mesenteric vein

12. Ans. (b) Bulbar urethra

Rupture of bulbar urethra leads to extravasation of urine in

- Penis
- Scrotum
- Superficial perineal pouch
- Anterior abdominal wall

13. Ans. (b) Elastic cartilage

Given cartilage is elastic cartilage

Classification

Based on visibility and nature of fibers in the ground substance.

- **Hyaline:** Contains thin invisible bundles of collagen fibers
 - Chondrocytes in islands or groups



- Collagen fibers not seen, matrix and collagen fibers refractive index are same

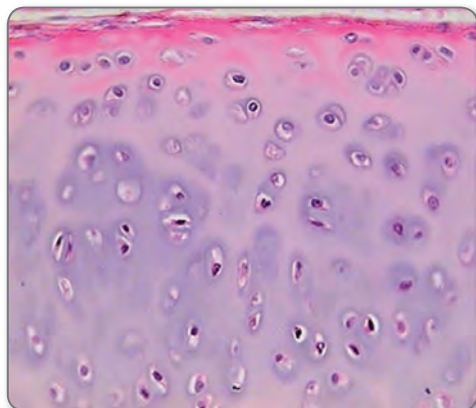


Fig. Hyaline cartilage

- Elastic:** With branching elastic fibers
 - Same as that of hyaline
 - But elastic fibers seen using some special stains

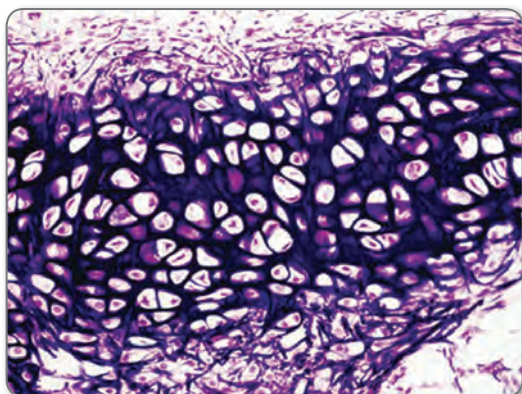


Fig. Elastic cartilage

- Fibrocartilage:** Contains thick bundles of collagen fibers
 - Cartilages arranged in rows
 - Bundles of collagen fibers seen

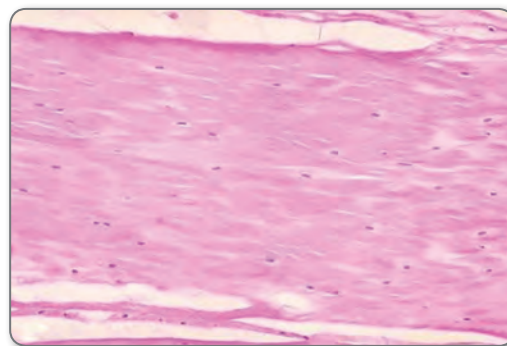


Fig. Fibrocartilage

Table 1: Comparison of types of cartilages

	Hyaline cartilage	Elastic cartilage	Fibrocartilage
Perichondrium	Present, comprising of an outer fibrous layer and inner chondrogenic vascular layer	Present, comprising of an outer fibrous layer and inner chondrogenic vascular layer	Absent
Fibers	Thin collagen fibers	Elastic fibers branching and anastomosing	Thick bundles of collagen fibers
Cells	Chondroblasts and chondrocytes	Chondroblasts and chondrocytes	Fibroblasts and chondrocytes

14. Ans. (a) **Ampulla**

- Fertilization in ampulla of fallopian tube

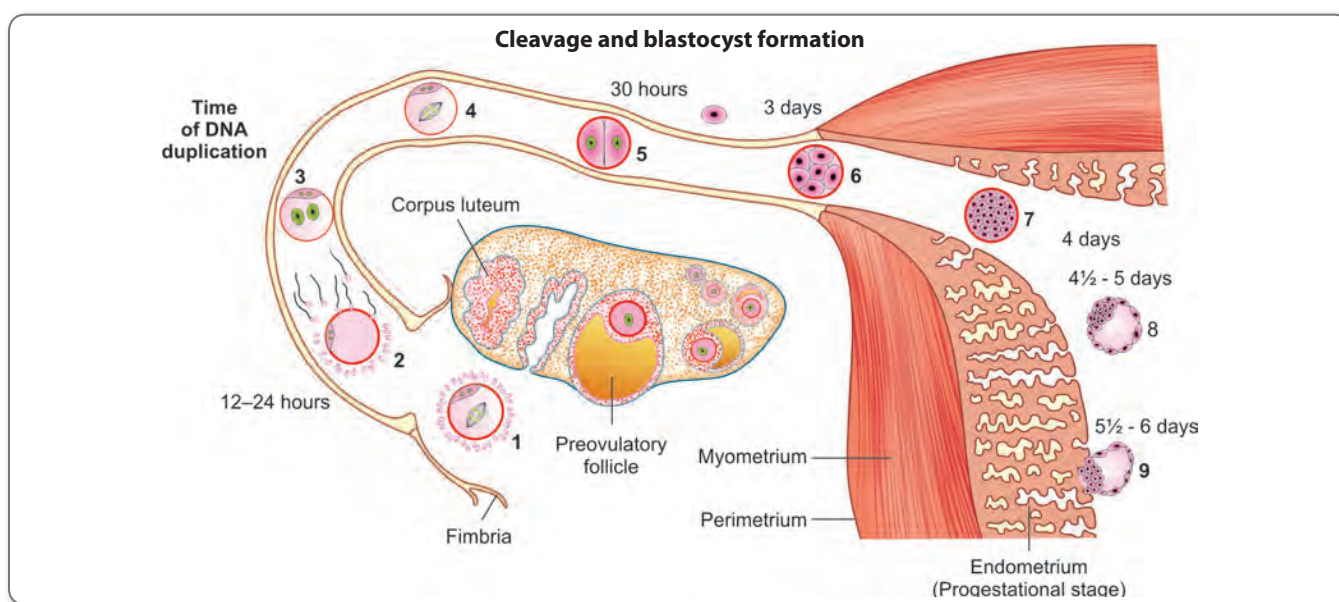


Fig. Cleavage and formation of blastocyst



- Zygote formed 12–24 hours after ovulation
- Two-cell stage formed 24 hours after fertilization
- 8-16 (morula) formed 3 days after fertilization
- **Advanced morula:** 32 cell stage formed 4 days after fertilization enters uterine cavity.

15. Ans. (b) Broad ligament

Gartner's duct remnant of mesonephric duct in female. Located in broad ligament
The broad ligament contains the following structures:

- One tube
 - Uterine tube
- Two ligaments
 - Round ligament of uterus
 - Ligament of ovary
- Two arteries
 - Uterine artery
 - Ovarian artery
- Two plexuses of nerves
 - Uterovaginal plexus
 - Ovarian plexus
- Three embryological remnants
 - Epoophoron and its duct (Gartner's duct)
 - Paröophoron
 - Vesicular appendices

- Other structures
 - Lymph vessels and lymph nodes
 - Fibroareolar tissue
 - Uterovaginal and ovarian nerve plexuses

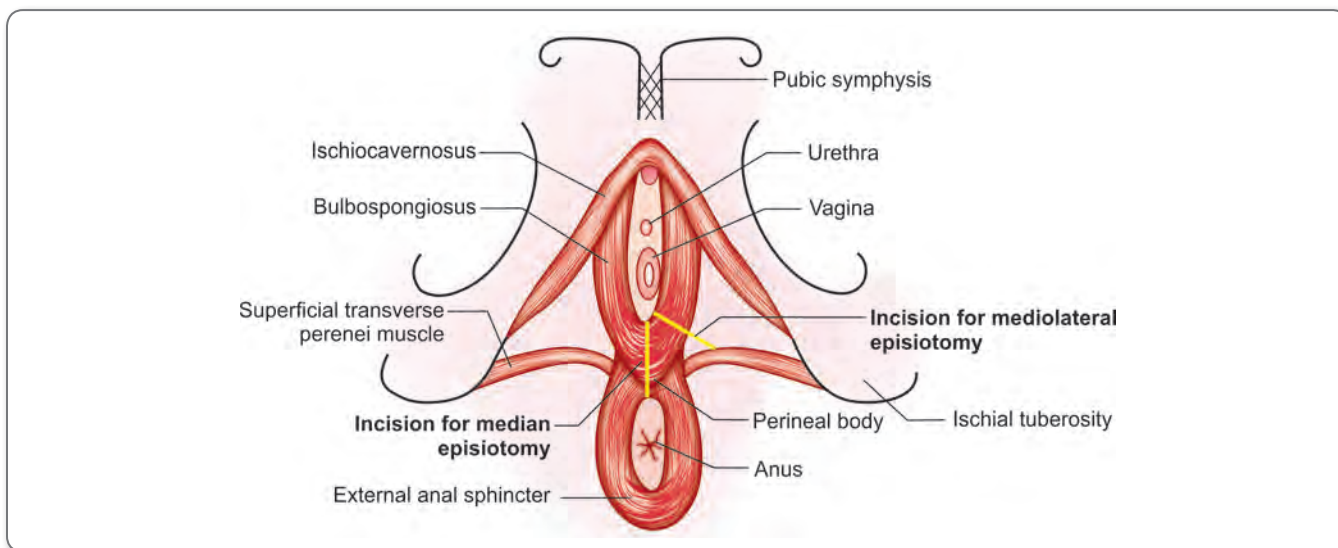
16. Ans. (a) External anal sphincter

Behind perineal body – external anal sphincter is located
The perineal body is a wedge-shaped mass of fibromuscular tissue situated in midline at the junction of urogenital triangle and anal triangle between the lower ends of vagina and anal canal.

The 10 muscles of the perineum converge and interlace in the perineal body. These are as follows:

1. Two superficial transverse perineal muscles.
2. Two deep transverse perineal muscles.
3. Two Bulbospongiosus muscles.
4. Two levator ani muscles.
5. One sphincter ani externus.
6. One longitudinal muscle coat of anal canal.

Median episiotomy: This incision begins at the frenulum of labia minora and proceeds backward in the midline up to the external anal sphincter. It cuts through the skin, vaginal wall, perineal body, and superficial transverse perineal muscle. Inadvertently, it may cut the external anal sphincter



17. Ans. (d) Type 2 alveolar cell

Respiratory distress syndrome due to deficiency of surfactant

Type I pneumocytes

- Cover about 95% of the alveolar surface and form part of blood gas barrier
- Form tight junction with adjacent cells
- Not able to divide

Type II pneumocytes

- Secrete surfactant
- Free surface contains microvilli
- Able to divide and regenerate both alveolar pneumocytes

18. Ans. (d) Motor speech

Aphasia—Inability to Understand or Produce Speech

- **Broca's (motor) aphasia**
 - Lesion in motor area of speech—inferior frontal gyrus
 - Fluency affected
 - Comprehension—not affected
 - Repetition—poor
- **Wernicke's (sensory) aphasia**
 - Lesion in sensory area of speech
 - Fluency not affected



- Comprehension—affected
- Repetition—poor
- **Conduction aphasia**
 - Lesion in arcuate fasciculus (interconnects Broca's and Wernicke's area)
 - Fluency and Comprehension not affected
 - Repetition—poor

19. Ans. (a) Fluent aphasia

Posterior part of superior temporal gyrus—Wernicke's area
Wernicke's area – sensory area of speech

- Fluency not affected
- Comprehension and repetition affected

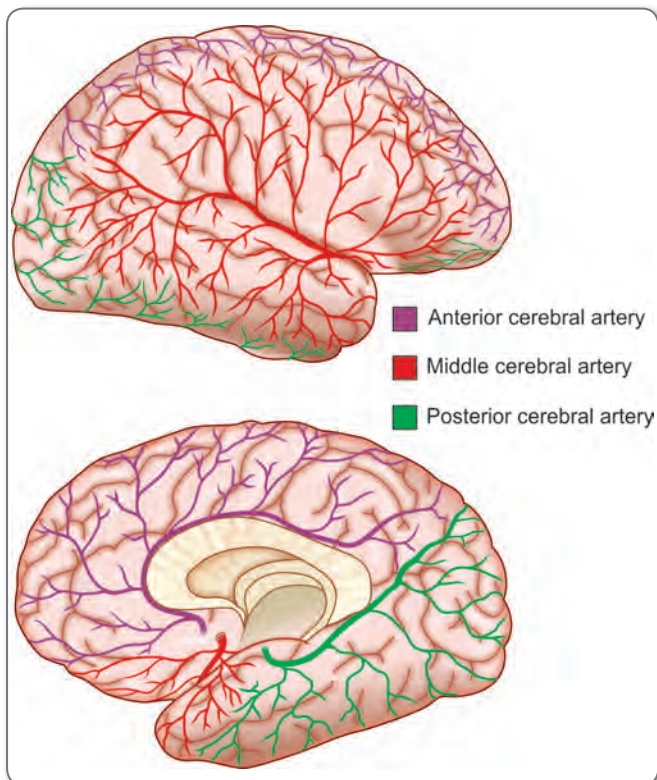
AIIMS NOVEMBER 2019

20. Ans. (d) Contralateral hemiplegia

- **Marked structure pyramid:** Corticospinal tract passing—affected in medial medullary syndrome
- Medial medullary syndrome is due to lesion in anterior spinal artery
- Features of medial medullary syndrome
- **Pyramid affected:** Contralateral hemiplegia
- **Hypoglossal nerve affected:** Ipsilateral deviation of tongue
- **Medial lemniscus affected:** Contralateral loss of vibration, stereognosis
- Lesion leads to contralateral hemiplegia
- **Ataxia and vertigo:** Seen in lateral medullary syndrome

21. Ans. (c) Anterior Cerebral Artery

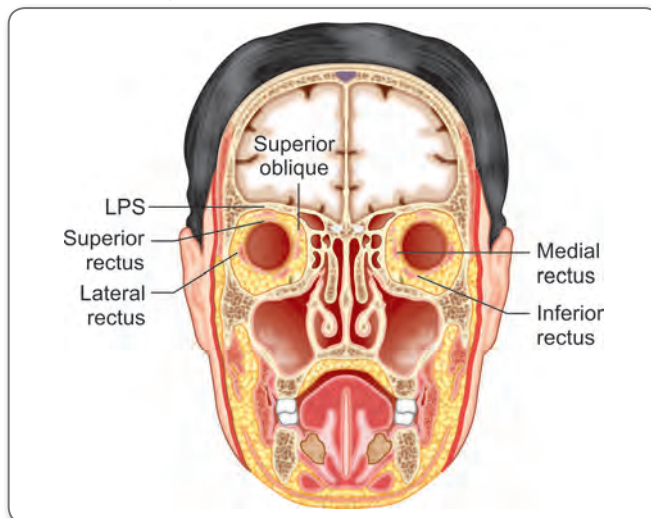
Marked part is fornix
Most of medial surface supplied by ant cerebral artery



Fornix is supplied by anterior cerebral > internal carotid & posterior cerebral artery

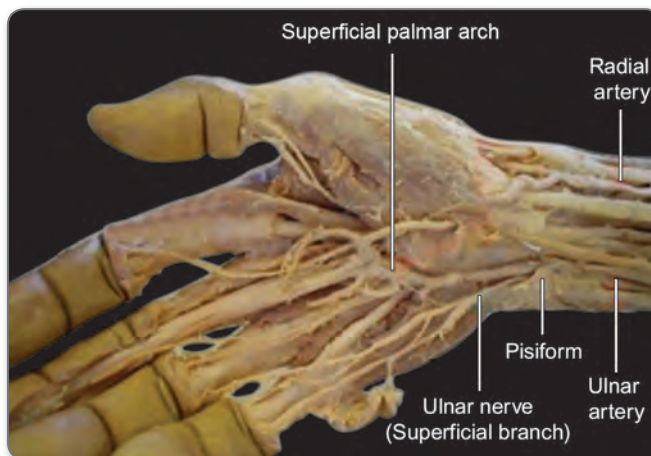
22. Ans. (b) CN 4

Marked muscle—superior oblique
Supplied by 4th nerve



23. Ans. (a) Ulnar nerve

Marked structure is ulnar nerve—medial most structure ulnar artery lateral to ulnar nerve



24. Ans. (a) Endocardial cushion

The membranous part of the IV septum – marked structure - derived from an extension of tissue from the right side of the endocardial cushion to the muscular part of the IV septum. This tissue merges with the aorticopulmonary septum and the thick muscular part of the IV septum

Endocardial cushions develop in the atrioventricular and conotruncal regions. In these locations, they assist in formation of the atrial and ventricular (membranous portion) septa, the atrioventricular canals and valves, and the aortic and pulmonary channels.

25. Ans. (c) Diagonal artery

Marked part – RIGHT VENTRICLE
Diagonal artery supplies the left ventricle



Diagonal branches of the left anterior descending coronary artery supply blood flow to the anterior and anterolateral walls of left ventricle

- Right marginal artery from right coronary artery supplies right ventricle
- Anterior inter ventricular artery supplies both right and left ventricle
- Right coronary artery gives anterior atrial and ventricular rami supplies right atrium and right ventricle

26. Ans. (d) Division

Division not give any branches

Branches of supraclavicular part of brachial plexus

Branches of roots Dorsal scapular nerve (C5)
Long thoracic nerve (C5, C6, C7)
muscular branches to longus colli and scaleni

Branches of upper trunk Nerve to subclavius (C5, C6)
Suprascapular nerve (C5, C6)

Branches of infraclavicular part of brachial plexus

- **Lateral cord**
 - Musculocutaneous nerve (C5, C6)
 - Lateral pectoral nerve (C5, C6)
 - Lateral root of median nerve (C5, C6)
- **Medial cord**
 - Medial cutaneous nerve of arm (C8, T1)
 - Medial cutaneous nerve of forearm (C8, T1)
 - Medial root of median nerve (C8, T1)
 - Medial pectoral nerve (C8, T1)
 - Ulnar nerve (C7, C8, T1)
- **Posterior cord**
 - Upper subscapular nerve (C5, C6)
 - Lower subscapular nerve (C5, C6)
 - Nerve to latissimus dorsi (C6, C7, C8)
 - Axillary nerve (C5, C6)
 - Radial nerve (C5, C6, C8, T1)

27. Ans. (b) 2nd Palmar interossei

- Palmar interosseous—unipennate arise from their own metacarpal bone
- Dorsal interosseous—bipennate arise from adjacent metacarpal bone
- Palmar interosseous do not attach to third finger, because middle finger in midline does not require adduction
- Though thumb possesses adductor pollicis, it is supplemented by 1st palmar interosseous
- Dorsal interosseous attach to middle three fingers on both sides not attach to little finger and thumb as they possess separate abductor.

28. Ans. (c) Wrist drop

- Marked structure radial nerve
- Lesion of radial nerve leads to wrist drop
- Claw hand due to ulnar nerve injury
- Ape thumb due to median nerve

29. Ans. (a) Loss of sensation of tip of index finger dorsal side

Marked structure—median nerve in the cubital fossa
Sensory supply of median nerve is shown in the figure



Palmar digital branches

The median nerve usually divides into four or five digital branches

It often divides first into a lateral ramus, providing digital branches to the thumb and the radial side of the index finger, and a medial ramus, supplying digital branches to adjacent sides of the index, middle and ring fingers

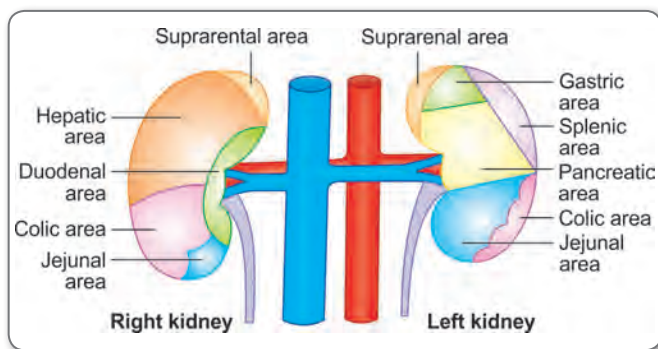
Distal to the base of the proximal phalanx, each proper digital nerve also gives off a dorsal branch to supply the skin over the back of the middle and distal phalanges.

30. Ans. (c) Glossopharyngeal nerve

- Vagus nerve supplies larynx muscle – lesion of vagus nerve results in voice change
- Recurrent laryngeal nerve lesion result in hoarseness of voice
- Superior laryngeal nerve – gives external laryngeal nerve which supplies cricothyroid – tensor of vocal cord – so voice change in superior laryngeal nerve lesion
- Glossopharyngeal nerve – involved in gag reflex – so lesion in glossopharyngeal nerve results in aspiration without voice change

31. Ans. (c) Stomach

Given kidney is left side – which is related to stomach.

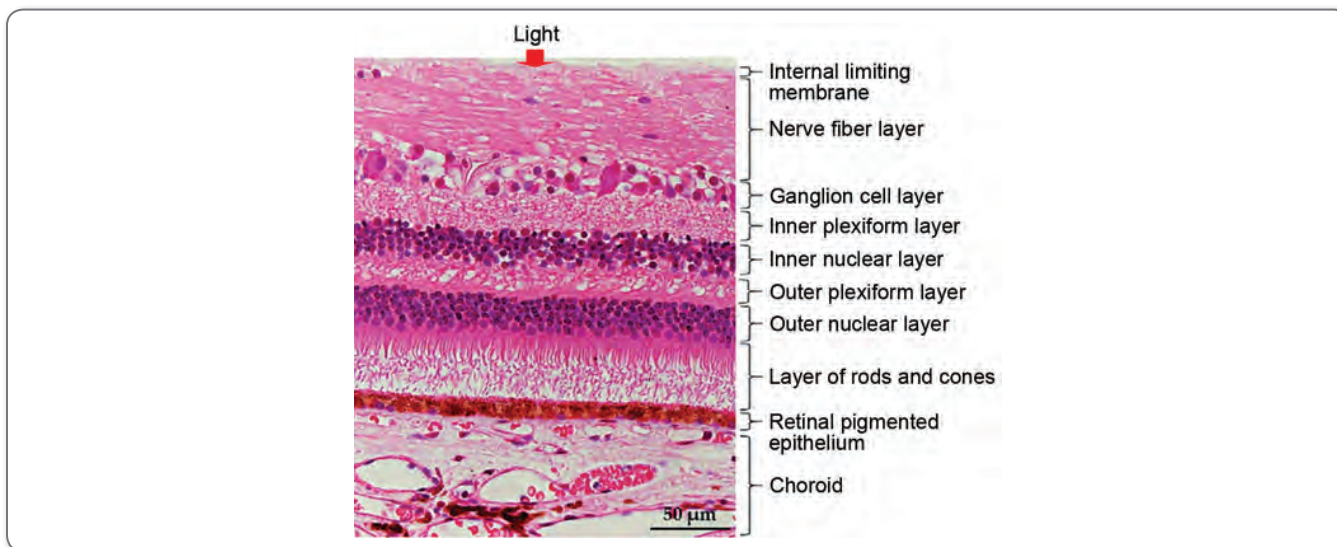


32. Ans. (d) Pudendal

- The pudendal nerve gives rise to the inferior rectal and perineal nerves and to the dorsal nerves of the penis or clitoris. The course of its branches parallels the pudendal vessels
- The pudendal nerve occupies a very constant position over the ischial spine and is readily found. It may be 'blocked' by infiltration with a local anaesthetic applied via a needle passed through the lateral wall of the vagina to numb the perineal and anal skin.
- It may also be palpated over the ischial spine through the lateral wall of the rectum and motor terminal latencies may be measured



33. Ans. (b) **Outer plexiform layer**



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LATEST EXAM QUESTIONS 2020-2019

AIIMS MAY 2019

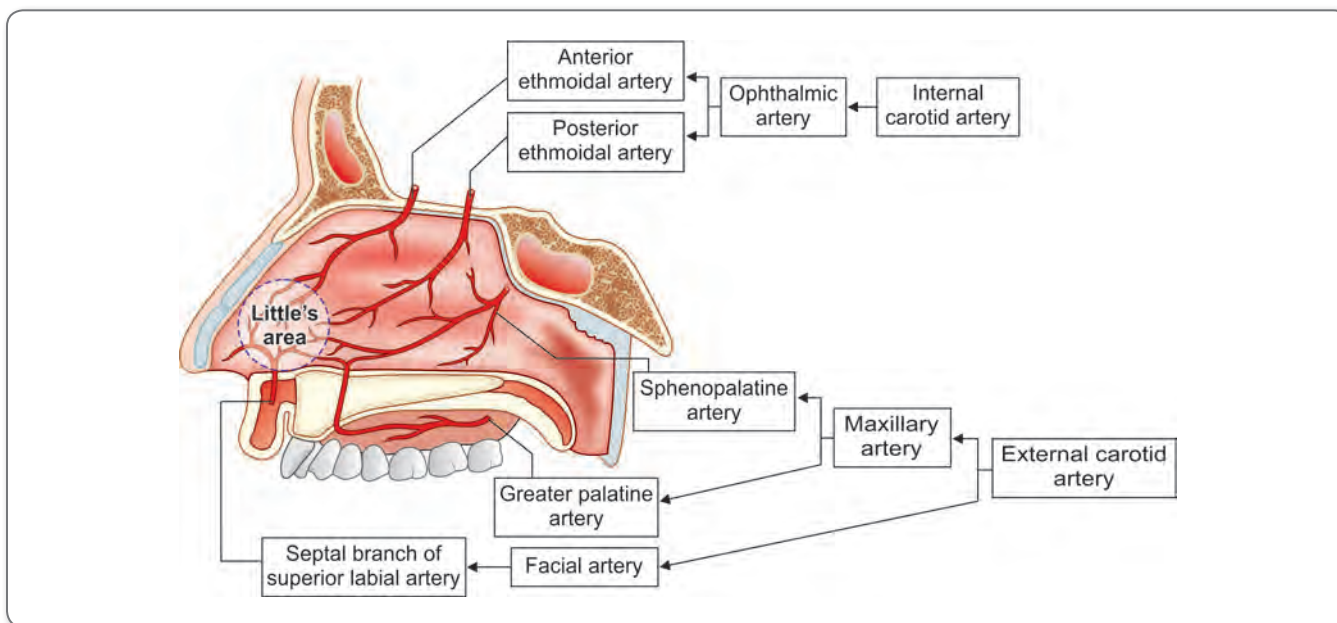
34. Ans. (a) **Anterior ethmoidal artery**

Anterior ethmoidal artery is branch of ophthalmic artery—branch of internal carotid

Little's area

Anteroinferior part of nasal septum is highly vascular and it is called Little's area or Kiesselbach area. Arteries converge in the little area

- Septal branch of sphenopalatine artery (branch of maxillary artery—branch of external carotid)
- Greater palatine artery (branch of maxillary artery—branch of external carotid)
- Anterior ethmoidal artery (branch of ophthalmic artery—branch of internal carotid artery)
- Superior labial artery (branch of facial artery—branch of external carotid)



New SARP Series Anatomy



35. Ans. (a) False, (b) True, (c) False, (d) False, (e) False

Key

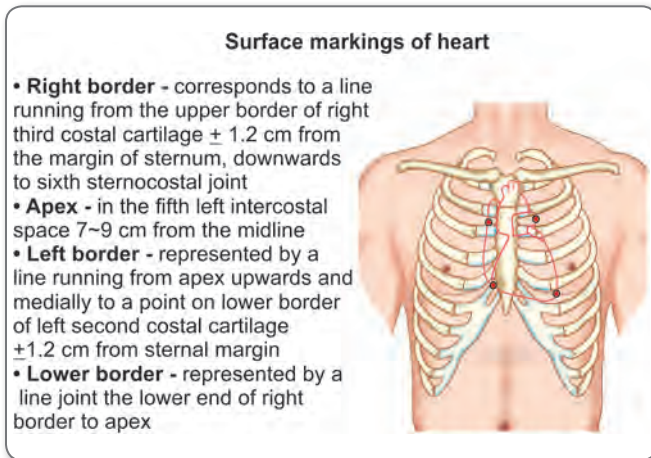
- (a) False – Ansa in anterior wall of sheath
- (b) True – All layers of deep fascia neck contribute to carotid sheath
- (c) False – Only vagus nerve in carotid sheath
- (d) False – sympathetic chain lies behind the carotid sheath
- (e) False – CCA divide at the upper border of thyroid cartilage

36. Ans. (b) **Superior oblique**

- **Marked structure**—oculomotor nerve
- **All extraocular muscles supplied by oculomotor nerve except superior oblique and lateral rectus**
- **Superior oblique supplied by trochlear nerve**
- **Lateral rectus supplied by abducens nerve**

37. Ans. (b) **Right atrium**

Surface anatomy of right atrium – right border shown in video



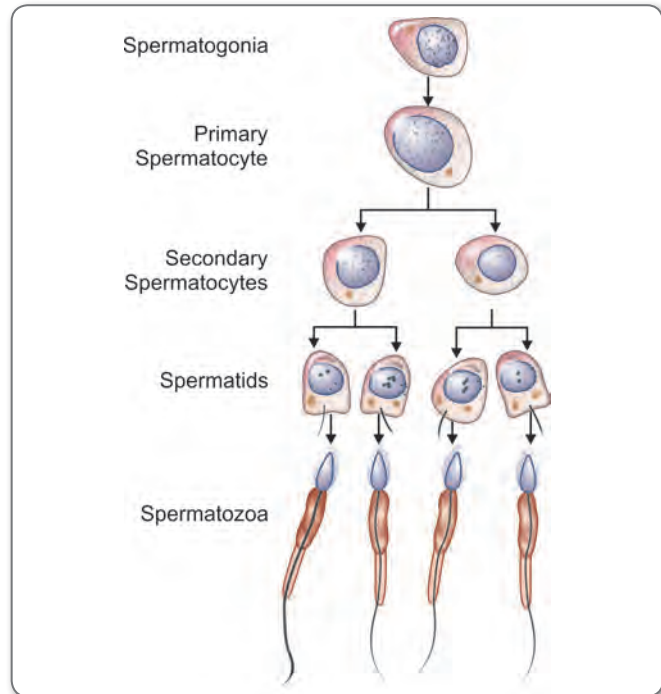
38. Ans. (d) **Attached to pelvic brim**

- **Levator ani does not attach to pelvic brim**
- **Arises from each side of the walls of the pelvis along the condensation of the obturator fascia (the tendinous arch of levator ani; see below)**
- **Function** – supports pelvic viscera
- **Consists of iliococcygeus and pubococcygeus**

39. Ans. (c) **A-5, B-3, C-2, D-1**

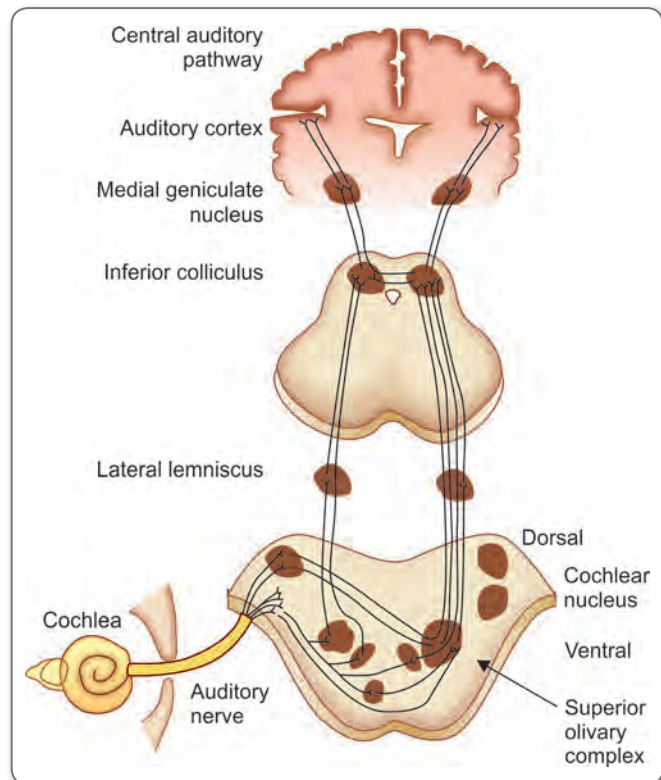
- A – Membranous part of ventricular septum
- B – Anterior papillary muscle of right ventricle
- C – Anterior papillary muscle of left ventricle
- D – Musculi pectinati

40. Ans. (b) **Spermatogonia \rightarrow Spermatocytes \rightarrow Spermatid \rightarrow Spermatozoa**



41. Ans. (b) **1 \rightarrow 4 \rightarrow 2 \rightarrow 5 \rightarrow 6 \rightarrow 3**

Eighth nerve – cochlear nucleus – superior olivary nucleus – lateral lemniscus – inferior colliculus – medial geniculate body – auditory cortex





42. Ans. (c) Abduction

- Lateral surface of greater trochanter receives gluteus medius
- Anterior surface of greater trochanter receives gluteus minimus
- Action abduction and medial rotation

43. Ans. (a) Portal vein > hepatic vein

[Ref: Gray's 41th edition]

Current understanding of the functional anatomy of the liver is based on Couinaud division of the liver into eight (subsequently nine, then later revised back to eight) functional segments, based on the distribution of portal venous branches in the parenchyma

44. Ans. (c) Middle finger

Dorsal interossei

First two attach to radial side of proximal phalanx of index and middle finger and blend with dorsal digital expansion 3rd and 4th to ulnar side of proximal phalanx of middle and ring finger and blend with dorsal digital expansion

45. Ans. (b) Great auricular nerve

Loss of sensation while shaving—great auricular nerve involvement which supplies angle of mandible and major part of auricle

Complications of Parotid Gland Surgery

Complication of parotid gland surgery include:

- Hematoma formation
- Infection
- **Deformity:** Unsightly scar and retromandibular hollowing
- Temporary facial nerve weakness
- Transection of the facial nerve and permanent facial weakness
- Sialocele
- Facial numbness
- Permanent numbness of the lobe associated with great auricular nerve transection
- Frey's syndrome

46. Ans. (d) Seen in optic neuritis, the pupil can paradoxically dilate in both eyes

- **Sir Marcus Gunn**—Scottish ophthalmologist not from US
- **Image given is Marcus Gunn pupil**—RAPD—seen in optic neuritis—when the light is thrown on right side (affected side)—it dilate paradoxically
- **Left eye is normal**—When light thrown on left side—both pupils constrict
- Optic neuritis seen in right eye, so Vision is affected in right eye

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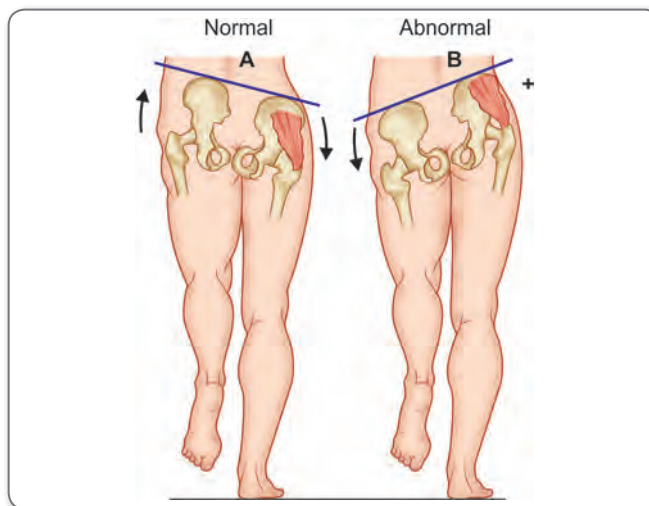
47. Ans. (c) Cuneiform

Only hyaline cartilages ossify

Hyaline cartilage – thyroid, cricoid, arytenoid except apex
Elastic cartilage – epiglottis, corniculate, cuneiform, apex of arytenoid

48. Ans. (a) Right superior gluteal

- Trendelenburg sign – sinking of pelvis on unsupported side, when the patient standing on paralysed side – due to superior gluteal nerve – paralysis of gluteus medius and minimus
- In this patient – right side patient standing – paralysed side – right side sup gluteal nerve paralysed – left side pelvis sinks



49. Ans. (b) III, VII, IX, X

Parasympathetic cranial nerve – III, VII, IX, X

50. Ans. (c) Medial canthus of eye

In the face, the artery passes tortuously, first upwards and forwards to a point 1.25 cm lateral to the angle of the mouth and then ascends along the side of the nose to the medial angle of the eye where it ends by anastomosing with the dorsal nasal branch of ophthalmic artery (internal carotid artery branch)

51. Ans. (b) Extensor carpi radialis longus

- Brachialis hybrid muscle – supplied by musculocutaneous nerve and radial nerve
- Extensor carpi radialis brevis and extensor digitorum supplied by posterior interosseous nerve – affected in low radial nerve palsy
- Extensor carpi radialis longus – supplied by radial nerve – above the elbow – affected in high radial nerve palsy

52. Ans. (a) Posterior cord

- Crutch palsy – radial nerve affected
- Loss of abduction of shoulder joint – deltoid muscle affected – axillary nerve – branch from posterior cord
- Extension of elbow lost – triceps muscle affected – radial nerve – branch of posterior cord

53. Ans. (a) III nerve

LPS supplied by III nerve

- All the extraocular muscle supplied by Oculomotor nerve except



XXX

LATEST EXAM QUESTIONS 2020-2019

New SARP Series Anatomy

- Superior oblique supplied by trochlear nerve
- Lateral rectus supplied by abducent nerve

54. Ans. (a) ACL

The most important factors of knee stability include:

- **Ligaments of the knee:** The knee joint is stabilized by four main ligaments:
 - **Anterior cruciate ligament (ACL):** The ACL has an important role in stabilization of knee extension movement by preventing the knee from hyperextending.
 - **Posterior cruciate ligament (PCL)**
 - **Medial collateral ligament (MCL)**
 - **Lateral collateral ligament (LCL)**

55. Ans. (a) Stabilize the hip joint

Mostly elongated and assumed to be taut when the hip joint is semi-flexed, laterally rotated, and adducted, the position where the capsular ligaments, as a whole, offer least stability to the joint ligament of the head of the femur is known primarily for lending the blood vessels to femoral head

56. Ans. (c) Chewing movement

Mandibular nerve affected

- Sensory supply of forehead – ophthalmic nerve
- Sensory supply over zygomatic arch – maxillary nerve
- Chewing movement – mandibular nerve
- Ability to blow up the cheeks – facial nerve

57. Ans. (d) External laryngeal nerve

Weak voice – patient not able to produce high pitch sound – Tensor muscle – cricothyroid – supplied by external laryngeal nerve affected

58. Ans. (b) Neck of fibula fracture

- Foot drop – loss of dorsiflexion – deep peroneal nerve affected
- Common peroneal nerve wind around the neck of fibula –
- So neck of fibula fracture is the answer

59. Ans. (d) Vestibulocochlear

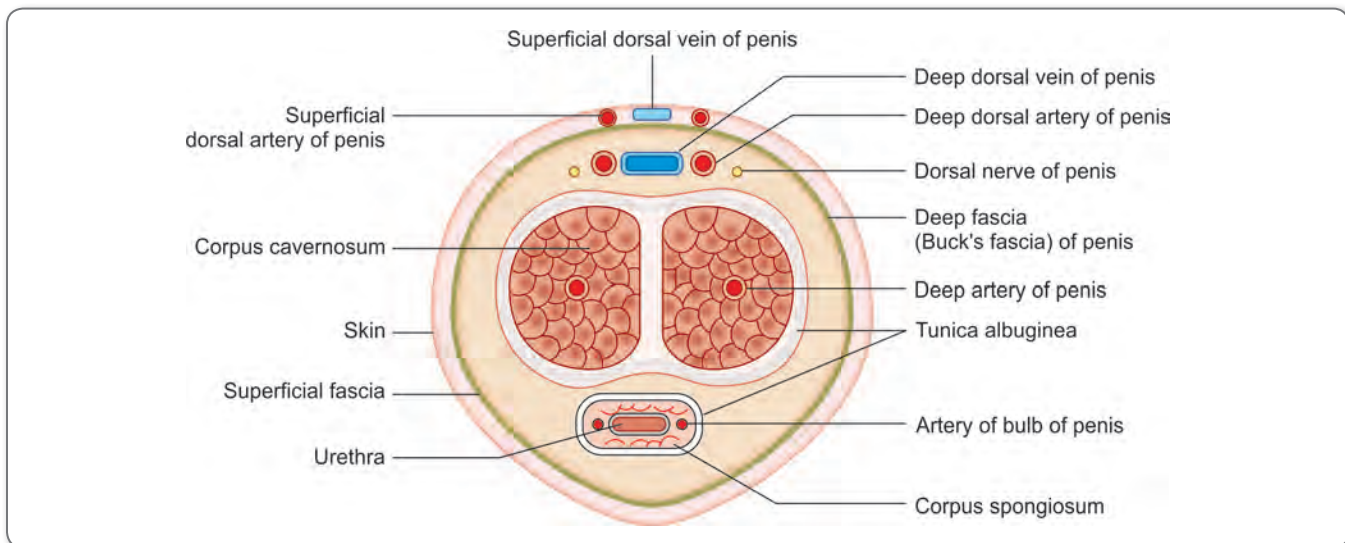
- Anterior half of the lateral surface is supplied by the auriculotemporal nerve (V3).
- Posterior half of the lateral surface by the auricular branch of vagus (CNX).
- Medial surface by tympanic branch of the glossopharyngeal (CNIX) through tympanic plexus

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60. Ans. (b) 25 days

- Marked part is cranial neuropore
- Cranial neuropore closes by 25th day
- Caudal neuropore closes by 28th day
- Remnant of cranial neuropore – lamina terminalis
- Remnant of caudal neuropore – terminal ventricle
- Anencephaly due to failure of fusion of cranial neuropore
- Rachischisis due to failure of fusion of caudal neuropore

61. Ans. (b) Buck's fascia



- Each deep artery of the penis runs lengthwise in corpus cavernosum and gives off numerous branches. These arteries give rise to minute arteries which directly open into the cavernous spaces.



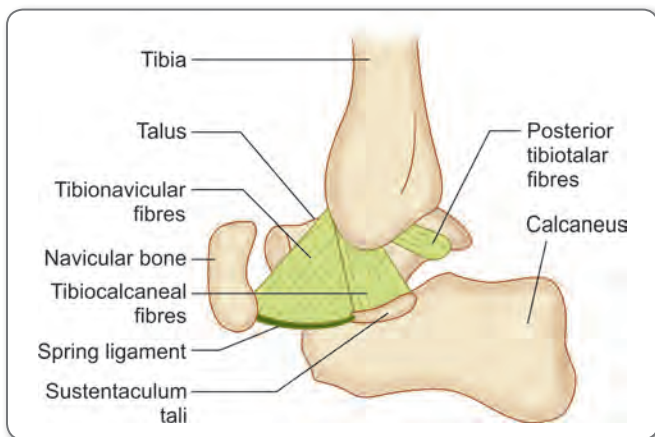
- The dorsal arteries run on the dorsum beneath the deep fascia and supply the glans penis and distal part of corpus spongiosum, prepuce, and frenulum of prepuce
- The arteries of bulb supply the bulb and proximal half of the corpus spongiosum. The superficial external pudendal arteries supply the skin and fascia of the penis

62. Ans. (a) Tibiotalar ligament

Deltoid ligament strengthens ankle joint on the medial aspect
So, all deltoid ligament parts contain tibia component (from medial malleolus)

Deltoid Ligament Parts

Tibionavicular (which blends with spring ligament)
Ant and post tibiotalar
Tibiocalcaneal (to sustentaculum tali of calcaneu)



63. Ans. (c) From left circumflex artery

Atrial branch of circumflex communicates with similar branch of right coronary.

Such anastomosing branch from circumflex artery is called Kugel's artery.

In 1927, MA Kugel described an atrial artery that arose from the proximal left circumflex artery (LCx) or from its branches, coursed through the lower part of the interatrial septum, and in most of his cases (66%) anastomosed directly or through its branches with the distal right coronary artery (RCA).

Portion of the LCx (8%). He called this artery "arteria anastomotica auricularis magna" because of its large caliber, the apparent importance of its anastomotic role, and its consistent occurrence at this site.

64. Ans. (a) Opposition of thumb

Nerve affected here – median nerve

Above 5 cm above the flexor retinaculum, nerve emerges on the lateral side of FDS

Opponens pollicis supplied by Median nerve

Flexion of interphalangeal joint of thumb is due to FPL (supplied by anterior interosseous nerve – branch of median nerve in forearm)

65. Ans. (c) Internal laryngeal nerve

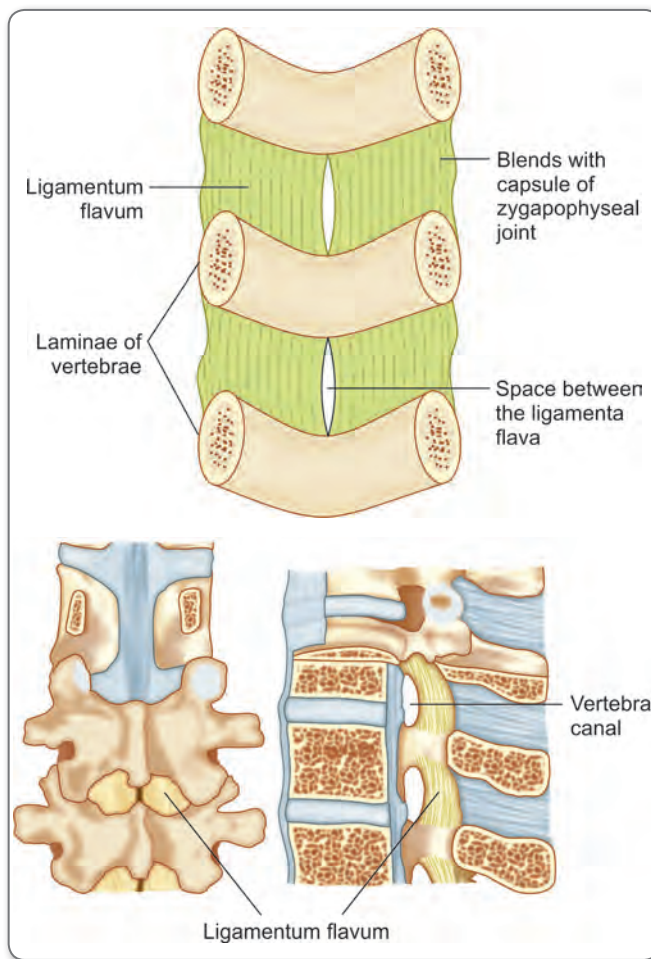
- Glossopharyngeal nerve, stylopharyngeus and stylohyoid ligament pass through a small gap between the middle and superior constrictors.
- Internal laryngeal nerve and the laryngeal branch of the superior thyroid artery pass between the middle and inferior constrictors

66. Ans. (d) Ligamentum flavum

Posterior one-third of canal is occupied by ligamentum flavum

Ligamentum Flavum

Connect the laminae of adjacent vertebrae. They extend from lower border of lamina above to the upper border of the lamina below in the vertebral canal. They are predominantly made up of yellow elastic tissue.



67. Ans. (b) Spinal accessory nerve

- Drooping of shoulder due to palsy of trapezius muscles which is innervated by spinal accessory nerve
- Actions of trapezius
- Elevation of scapula along with levator scapula
- Retraction of scapula along with rhomboids
- Overhead abduction of scapula along with serratus anterior



68. Ans. (b) **Muscles of ciliary body**

Table 1: Neural crest derivatives

Connective tissue and bones of the face and skull
Cranial nerve ganglia
Cells of the thyroid gland
Conotruncal septum in the heart
Odontoblasts
Dermis in face and neck
Spinal (dorsal root) ganglia
Sympathetic chain and preaortic ganglia
Parasympathetic ganglia of the gastrointestinal tract
Adrenal medulla
Schwann cells
Glial cells
Meninges (forebrain)
Melanocytes
Smooth muscle cells to blood vessels of the face and forebrain

69. Ans. (d) **Originate from the body of sphenoid and inserted into the sclera behind the equator**

Superior Oblique

Origin: From body of sphenoid superomedial to the optic canal.

Insertion: Into sclera behind the equator in posterior superior quadrant of the eyeball, between the superior rectus and lateral rectus. The tendon of superior oblique passes through a fibrocartilaginous pulley attached to the trochlear notch in the anterolateral part of the roof of the orbit.

70. Ans. (c) **Meckel's diverticulum**

- Persistent proximal part of the Vitellointestinal duct (**omphalomesenteric duct**)
- Present in 2% of population, situated in the anti-mesenteric border **2 inches** long. Length varies with age, not 2 inches always.
- **2 feet** from the ileocecal valve
- Outpouching connects to umbilicus via fibrous cord or fistula.
- Heterotrophic gastric tissue may ulcerate, perforate and produce gastrointestinal bleeding. Symptoms usually resemble appendicitis

71. Ans. (b) **Stapes**

Cartilage derivatives of second arch

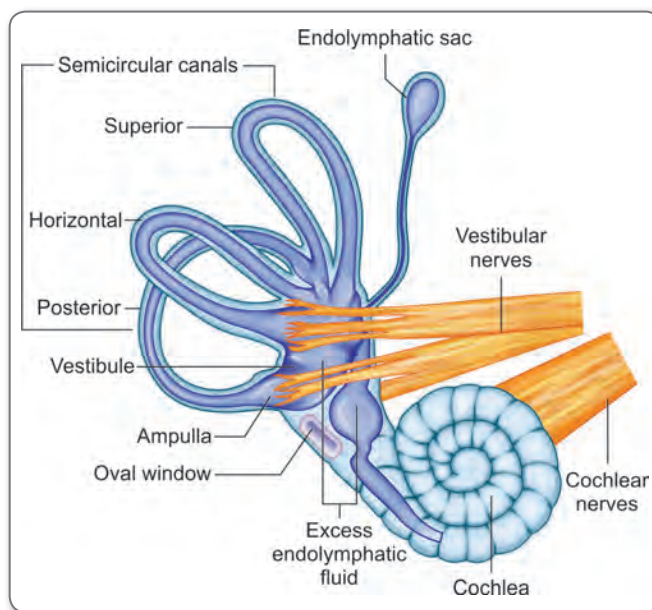
- Stapes
- Styloid
- Stylohyoid ligament

- Superior surface of hyoid
- Small horn of hyoid

72. Ans. (a) **Surface ectoderm**

- Eyeball derivatives from surface ectoderm
- Lens
- First layer of cornea
- Conjunctiva
- Lacrimal gland
- Tarsal gland

73. Ans. (c) **Endolymphatic sac**



74. Ans. (c) **Middle ethmoid sinus**

Bulla ethmoidal sinus receives – middle ethmoid sinus

In anteroinferior aspect of infundibulum via hiatus semilunaris – maxillary sinus

Maxillary sinus open into infundibulum > hiatus semilunaris

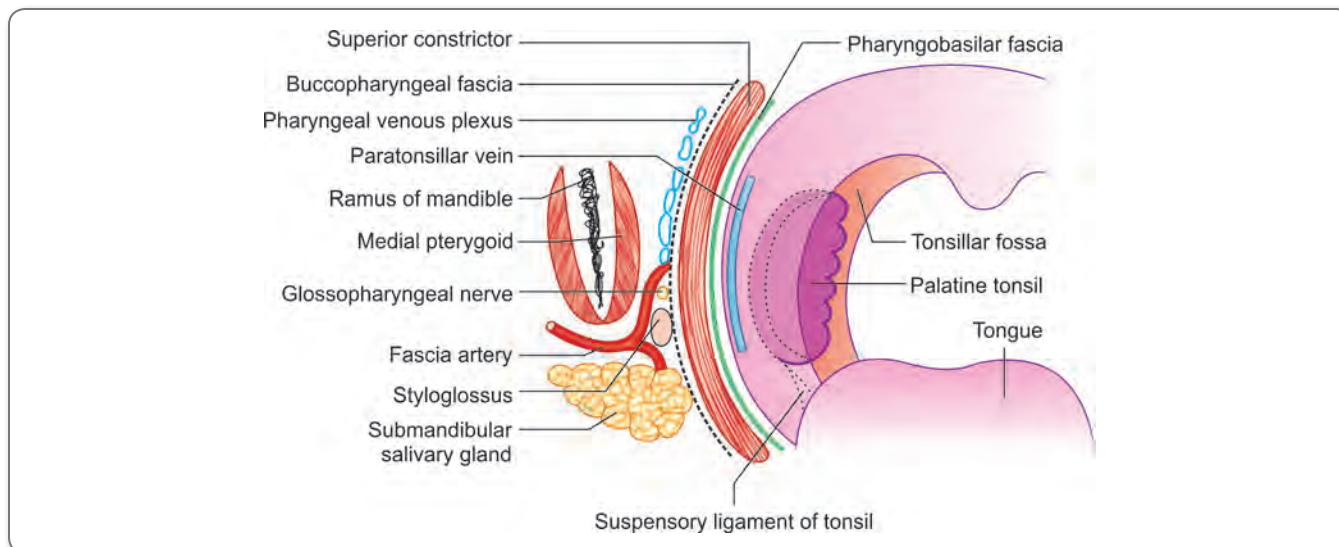
In the infundibulum from hiatus – anterior ethmoidal sinus and frontal sinus open

75. Ans. (d) **External carotid artery**

Lateral surface: It is covered by a well-defined fibrous tissue, which forms the tonsillar hemicapsule. Between the capsule and the bed of tonsil is the loose areolar tissue (peritonsillar space), which makes it easy to dissect the tonsil in this plane during tonsillectomy. It is also the site of collection of pus in peritonsillar abscess.

The superior constrictor separates this surface from the following structures (Fig.)

- Facial artery and two of its branches, the ascending palatine and tonsillar
- Styloglossus muscle and glossopharyngeal nerve.
- Styloid process (when elongated)
- Angle of mandible and medial pterygoid muscle
- Submandibular salivary gland



PGI MAY 2019

76. Ans. (b, c, d) **b. Card test, c. Froment's sign, d. Egawa test**

Tests to Detect Ulnar Palsy

- Book test (Froment test): Involvement of adductor pollicis. So subject is not able to hold paper between thumb and index finger. Hence, compensatory flexion of interphalangeal joint (positive Froment's sign) occurs to hold the book
- Card test (to test Palmar interossei)—adduction of fingers (PAD)
- Egawa test (to test dorsal interossei)—adduction of fingers (DAB)
- Ulnar claw hand (main en griffe)

77. Ans. (c) **Levator veli palatini**

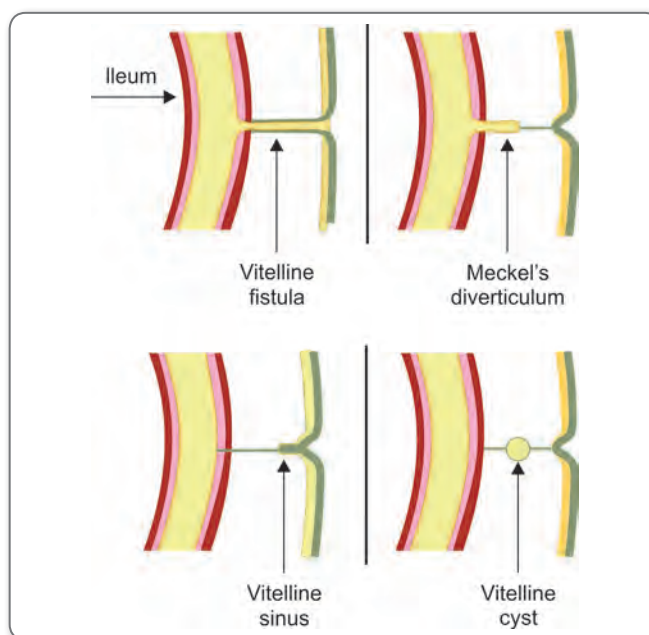
Muscles supplied by mandibular nerve:

- Muscles of mastication
- Tensor tympani
- Tensor veli palatini
- Mylohyoid
- Anterior belly of digastric

78. Ans. (b, c, e) **b. Umbilical fistula, c. Vitelline cyst, e. Meckel's diverticulum**

Vitelline Duct Anomalies

- In 2% of people, vitelline duct persists and forms Meckel's diverticulum of ileal diverticulum
- Both ends of vitelline duct forms fibrous cord and middle part forms fibrous cord – vitelline cyst
- Entire duct remains patent in which entire length establish communication between umbilicus and intestinal tract – umbilical fistula or vitelline fistula



Meckel's Diverticulum

Persistent proximal part of the Vitellointestinal duct

- Present in 2% of population, situated in the antimesenteric border
- Most common ectopic mucosa - gastric (most common is gastric 60%), pancreatic, colonic, Brunner's glands and endometriosis 2 inches long. Length varies with age, not 2 inches always.
- 2 feet from the Ileocecal valve
- Outpouching connects to umbilicus via fibrous cord or fistula.

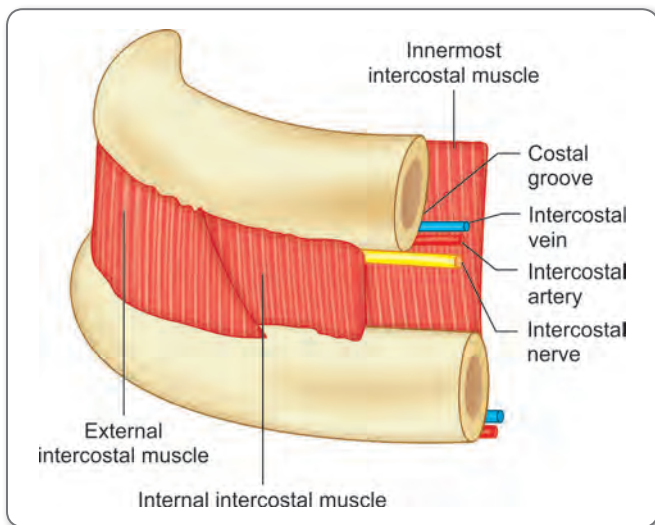


- Heterotrophic gastric tissue may ulcerate, perforate and produce gastrointestinal bleeding. Symptoms usually resemble appendicitis

79. Ans. (b, d, e) **b. Serratus anterior, d. Rhomboid, e. Latissimus dorsi**

While doing posterolateral thoracotomy following structures are cut:

- Skin
- Superficial fascia
 - Latissimus dorsi
 - Serratus anterior
 - Rhomboids major
 - Intercostal muscle
 - Endothoracic fascia
 - Parietal pleura
- While doing anterolateral thoracotomy following structures pierced:
 - Skin
 - Superficial fascia
 - ◆ Pectoralis major
 - ◆ Pectoralis minor
 - ◆ Serratus anterior
 - ◆ Intercostal muscle
 - ◆ Endothoracic fascia
 - ◆ Parietal pleura
- Muscles pierced during pleural tapping in midaxillary line:
 - Skin
 - Superficial fascia
 - ◆ Serratus anterior
 - ◆ External intercostal muscle
 - ◆ Internal intercostal muscle
 - ◆ Innermost intercostal muscle
 - ◆ Endothoracic fascia
 - ◆ Parietal pleura



80. Ans. (a, b, c, e) **a. Superior thoracic artery, b. Internal mammary artery, c. Lateral thoracic artery, e. Pectoral branch of the thoracoacromial artery**

Vascular Supply Pectoralis Major

- Supplied by one dominant vascular pedicle from the pectoral branch of the thoracoacromial artery
- Supplemented by deltoid and clavicular branches of the thoracoacromial artery,
- Perforating branches of the internal thoracic arteries and
- Superior and lateral thoracic arteries.

81. Ans. (d) **Tibial collateral ligament**

- The medial condyle has a bulging, convex medial aspect, which is easily palpable.
- Proximally, its adductor tubercle, which may only be a facet rather than a projection, receives the tendon of adductor magnus.
- The medial prominence of the condyle, the medial epicondyle, is anteroinferior to the tubercle.
- The medial epicondyle receives the tibial collateral ligament.

82. Ans. (a, b, c, d, e) **a. Accessory right hepatic artery is present in 15% cases, b. Mainly supplied by hepatic artery and portal vein, c. Caudate lobe is situated at the level of T10, d. Caudate lobe has its own biliary drainage through both right and left systems, e. Caudate lobe is supplied by both portal vein and hepatic artery**

- An accessory right hepatic artery arises from the superior mesenteric artery in 15% of cases.
- In this case they run behind the portal vein and bile duct in the lesser omentum and can be identified at surgery by pulsation behind the portal vein.
- The accessory right hepatic artery may be injured during resections of the pancreatic head because the artery lies in close proximity to the portal
- Liver is supplied by portal vein and hepatic artery
- The caudate lobe (lobus caudatus; spigelian lobe) is situated upon the posterior surface of the right lobe of the liver, opposite the tenth and eleventh thoracic vertebrae. It is bounded, below, by the port; on the right, by the fossa for the inferior vena cava; and, on the left by the fossa for the ductus venosus.
- Caudate lobe – 1st segment – supplied by both right and left branch of portal vein, right and left branch of hepatic artery
- Blood drain directly to IVC
- Bile drain to right and left hepatic duct

1



GENERAL ANATOMY



BONES

Skeleton is divided into axial skeleton and appendicular skeleton.

- **Axial Skeleton:** Forms central axis of body. It includes skull, hyoid bone, vertebral bones and thoracic cage (Ribs and sternum)
- **Appendicular Skeleton:** Bones of upper limb and lower limb.

CLASSIFICATION OF BONES

Based on Types of Development

Based on types, bones are classified into the following:

- **Cartilaginous bones:** Bones are formed by cartilage, which later ossify into bones, e.g. Long bones, skull base and vertebra
- **Membranous bones:** Bones are formed by membranes. These membranes are then transformed into bone, e.g. Clavicle, facial skeleton, skull vault and mandible

Based on Shape

Based on shape, bones are classified into the following:

- Long bones
- Short bones
- Flat bones
- Irregular bones

Long Bones

- Consists of two ends—epiphysis and intervening shaft—diaphysis
- Presence of medullary cavity
- Vertically placed
- Ossify by means of cartilage
- Typical long bones with two epiphysis, e.g. Humerus, radius, ulna, femur, tibia and fibula
- Miniature long bones with one epiphysis—metacarpals and phalanges
- Modified long bones with no medullary cavity—clavicle.

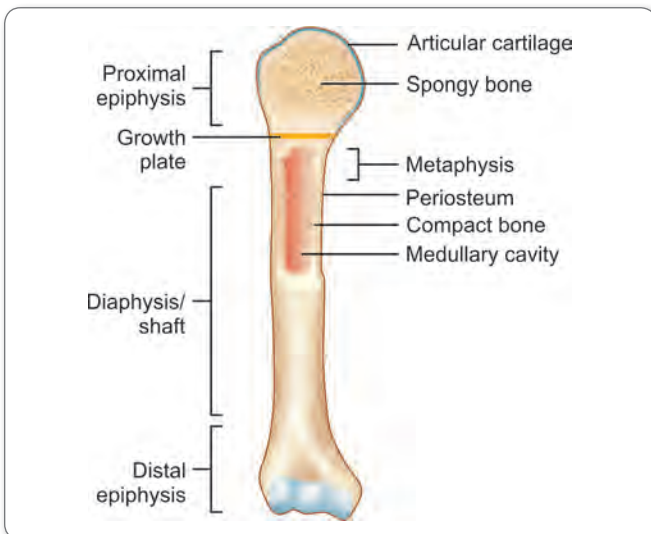


Fig. 1: Structure of long bone

Short Bones

Short in length and it can be of any shape. According to their shape, these bones are named—trapezium and cuboid.

Flat Bones

Flat in appearance and so there are two surfaces, i.e. in front and behind for these bones. E.g., Bones of thoracic cage, bones forming cranial vault.

Irregular Bones

These bones are irregular and not fit into any category of shape. For example, Hip bone.

Other Types of Bones

Pneumatic Bones

Contain large spaces lined by epithelium. E.g. – Maxilla, sphenoid and ethmoid.

Sesamoid Bones

- Bones formed in tendons and joint capsules
- Sesamoid bones reduce the friction
- No periosteum and ossify after birth
- No Haversian system and no medullary cavity

Sesamoid Bones in the Body

Muscle name	Sesamoid bone
Flexor carpi ulnaris	Pisiform
Quadriceps femoris	Patella
Adductor longus	Riders bone
Lateral head of gastrocnemius	Fabella
Peroneus longus	Os perineum
Peroneus brevis	Os vesalis

Macroscopic Classification of Bones

Classified into compact and cancellous bone

- **Compact Bone:** More bone tissue and less empty space. Dense in nature.
- **Spongy (cancellous) bone:** More space and less bone tissue.

Microscopic Classification of Bones

- **Lamellar bone:** Collagens are arranged in orderly manner in form of concentric sheets.
- **Woven bone:** Woven bones are arranged in random manner.

HIGH YIELD POINTS

Woven bones are formed during pathological conditions in adults, which are then replaced by lamellar bones.



REMEMBER

- **Haversian system:** Osteon fundamental functional unit of compact bone; consists of Haversian canal and surrounded by concentric lamellae
- **Volkman's canal:** Volkman's canal connects Haversian canal to each other and to surface of bone.

PARTS OF YOUNG GROWING BONE

There are four parts in young growing bones. These are as follows.

- Epiphysis
- Diaphysis
- Metaphysis
- Epiphyseal plates

Epiphysis

The ends of bones which ossify from secondary centers called epiphyses. The following are the types of epiphysis.

Types of Epiphysis

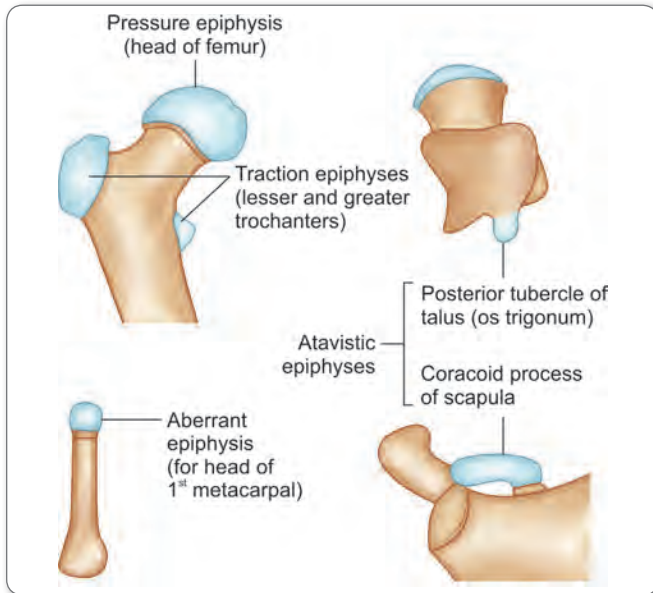


Fig. 2: Type of epiphysis

- **Pressure epiphysis:** Take part in joint formation. They transmit weight, e.g. Head of humerus, Lower end of radius, etc.
- **Traction epiphysis:** Non-articular and does not take part in weight transmission, e.g. Greater and lesser trochanter of femur, Greater and lesser tubercle of humerus and mastoid process.
- **Atavistic epiphysis:** Phylogenetically independent but fused to nearest bone for nutrition, e.g. Coracoid process of scapula, Os trigonum.
- **Aberrant Epiphysis (Aberrant - Not usual):** Not always present, e.g. Head of first metacarpal bones, Base of other metacarpal bones.

Diaphysis

Elongated shaft of long bone, which ossifies from primary center of ossification.

Metaphysis

- Epiphyseal end of diaphysis are called metaphysis
- Metaphysis is zone of active growth.

Epiphyseal Plate of Cartilage

These plates separate epiphysis from metaphysis

Epiphysis	Diaphysis
Articular ends	Shaft
Composed of spongy bone	Composed of compact bone
Surrounded by a thin layer of compact bone	With marrow cavity

BLOOD SUPPLY OF LONG BONES

Nutrient Artery

- Enters nutrient foramen, which is formed in middle of shaft and divides into ascending and descending branches
- Each branch divides into number of small parallel branches, which terminate in the adult metaphysis by anastomosing with epiphyseal, metaphyseal and periosteal arteries
- Nutrient artery supplies medullary cavity, inner 2/3rd of cortex and metaphysis
- Nutrient foramen is directed away from the growing end of the bone
- Growing ends of bones in upper limb are upper end of humerus and lower end of radius and ulna. In lower limb, lower end of femur and upper end of tibia
- Long bones are also supplied by periosteal arteries, metaphyseal arteries and epiphyseal arteries.

OSSIFICATION

- Bone formation process – ossification
- Intramembranous ossification – Bones laid down as mesenchymal condensation. Later, these mesenchyme transform into bones
- Intra cartilaginous ossification – Mesenchymal condensation pass through cartilaginous stage and then transform into bones
- Ossification takes place by centers of ossification
- **Centers of ossification may be primary and secondary:** Site of bone formation: One primary ossification center appears before birth (Exception: Primary center of tarsal and carpal bones) and one or more secondary ossification center appear after birth
- Primary centers forms diaphysis and secondary centers form epiphysis
- Fusion of epiphysis with diaphysis starts at puberty and completes by age of 25 years after which no more bone growth can takes place.

Primary center of ossification	Secondary center of ossification
Starts appearing at 8th week	After birth
Form diaphysis	Form epiphysis



Law of Ossification

- The secondary center which appears first, fuses last and that extremity of bone is growing end (growing end is in opposite direction to nutrient foramen)
- In upper limb, nutrient foramina are directed towards elbow. In lower limb, they are directed away from knee joint
- Fibula violates law of ossification.

Table 1: Ossification of various bones of body and the respective age

Age	Occurs in
Third month (Fetus)	Ossification begins in long bones
Fourth month (Fetus)	Most 1° ossification centers appear in diaphysis of long bones
From birth till 5 years of age	2° ossification centers appear in epiphyses
5–14 years	Rapid spreading of ossification from ossification centers
15–20 years	Bones of upper limb and scapulae ossified completely
18–23 years	Bones of lower limb and hip bones ossified completely
21–25 years	Sternum, clavicle and vertebrae ossified completely
By 23 years (Females) By 25 years (Males)	Nearly all bones Completely ossified

REMEMBER

Hilton's Law

The nerve supplying a muscle also gives a branch to joint and another branch to skin over the joint, e.g. Nerve to quadratus femoris: Hip joint: axillary nerve: shoulder joint.



Clinical Aspect

- TB and syphilis begin in the middle of shaft (Diaphysis)
- Metaphysis is the most common site of hematogenous osteomyelitis in children. Metaphysis is prone to traumatic necrosis and avascular necrosis.
- Epiphysis is involved in Perthe's disease
- *Hematogenous infection of bone most commonly involves → metaphysis of long bones*

JOINTS

- Joints are junction between two or more bones
- Joints classified into fibrous joints, cartilaginous joint and synovial joint
- Cartilaginous joints are divided into primary and secondary

Primary Cartilaginous—Synchondrosis

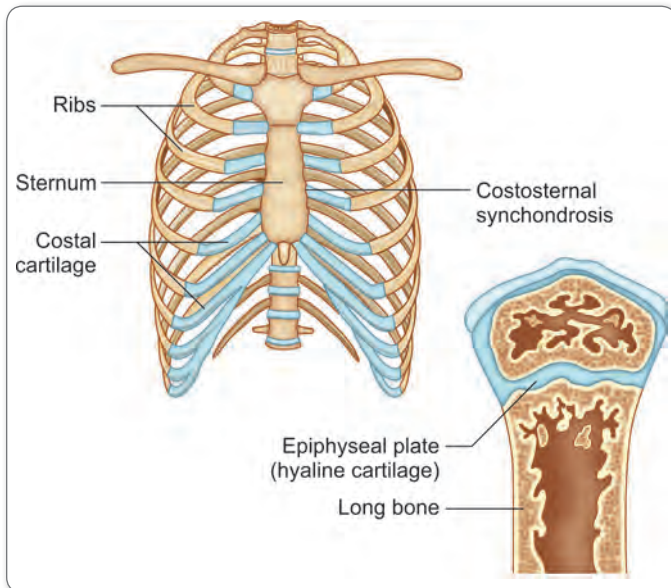


Fig. 3: Synchondroses

- Space between bones are occupied by hyaline cartilage
- It is then replaced by bone, hence it is temporary
- It is immovable, hence strong.

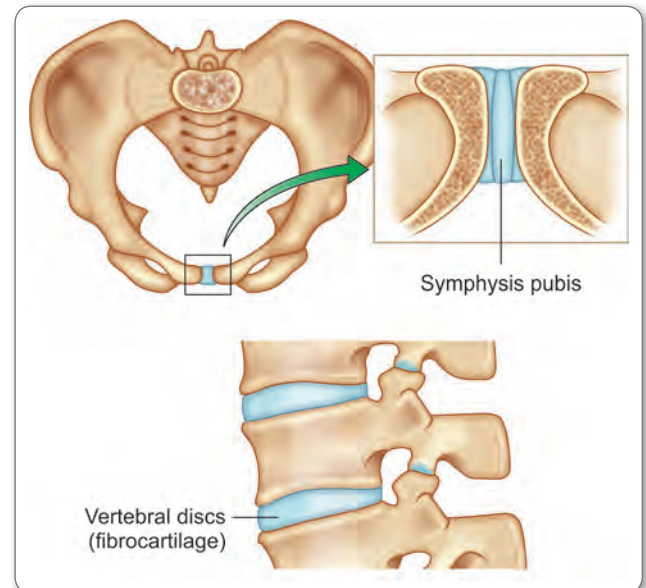


Fig. 4: Symphyses



Secondary Cartilaginous—Symphysis

- Articular surface covered by thin layer of hyaline cartilage and bones are united by fibrocartilage
- These are permanent and present throughout the life
- These joints are found in midlines

Fibrous Joints

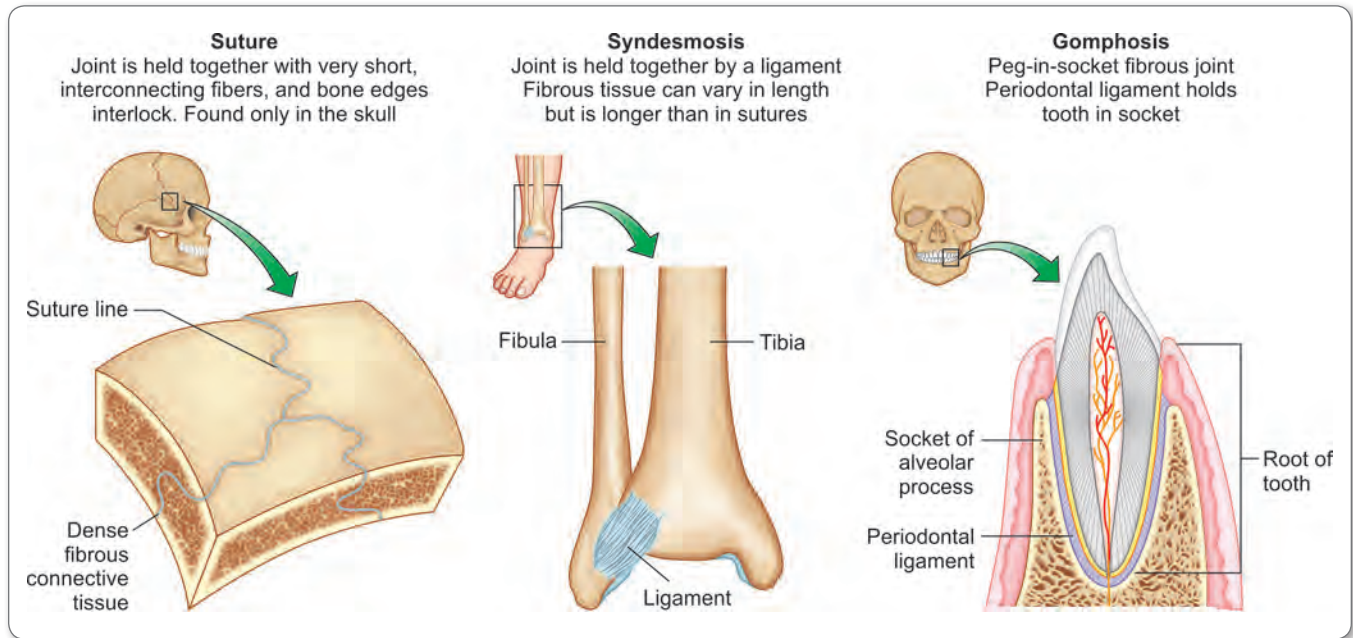


Fig. 5: Types of fibrous joints

Space between bones are joined together by fibrous tissue. Hence, these joints are immovable.

Fibrous joints are classified into:

- Sutures,
- Syndesmoses and
- Gomphosis

Suture

Found in skull. Immovable according to shape of margins of bones, sutures are named in various types

Note:

- Neonatal skull reveals fontanelles which are temporary in nature permit molding during normal childbirth
 - At six specific points on the sutures are membrane filled gaps called fontanelle
 - Anterior fontanelle is used to judge the hydration of infant
- All these fontanelle become bone by 18 months

Schindylesis

- Special kind of suture
- Between ala of vomer and rostrum of sphenoid

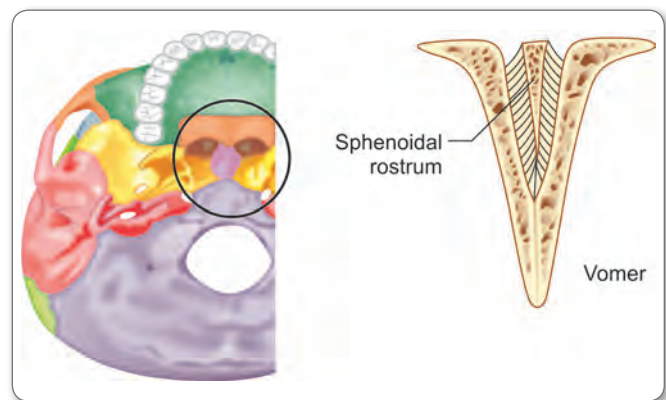


Fig. 6: Schindylesis (Ridge and groove)

Syndesmoses

Bones are connected by interosseous ligaments

Gomphosis

Otherwise known as peg and socket



Synovial Joint

- Articular surface covered by hyaline cartilage
- Synovial membrane lines entire joint except the articular surface
- Joint cavity is filled with synovial fluid
- Joint is covered by fibrous capsule.

6

Types

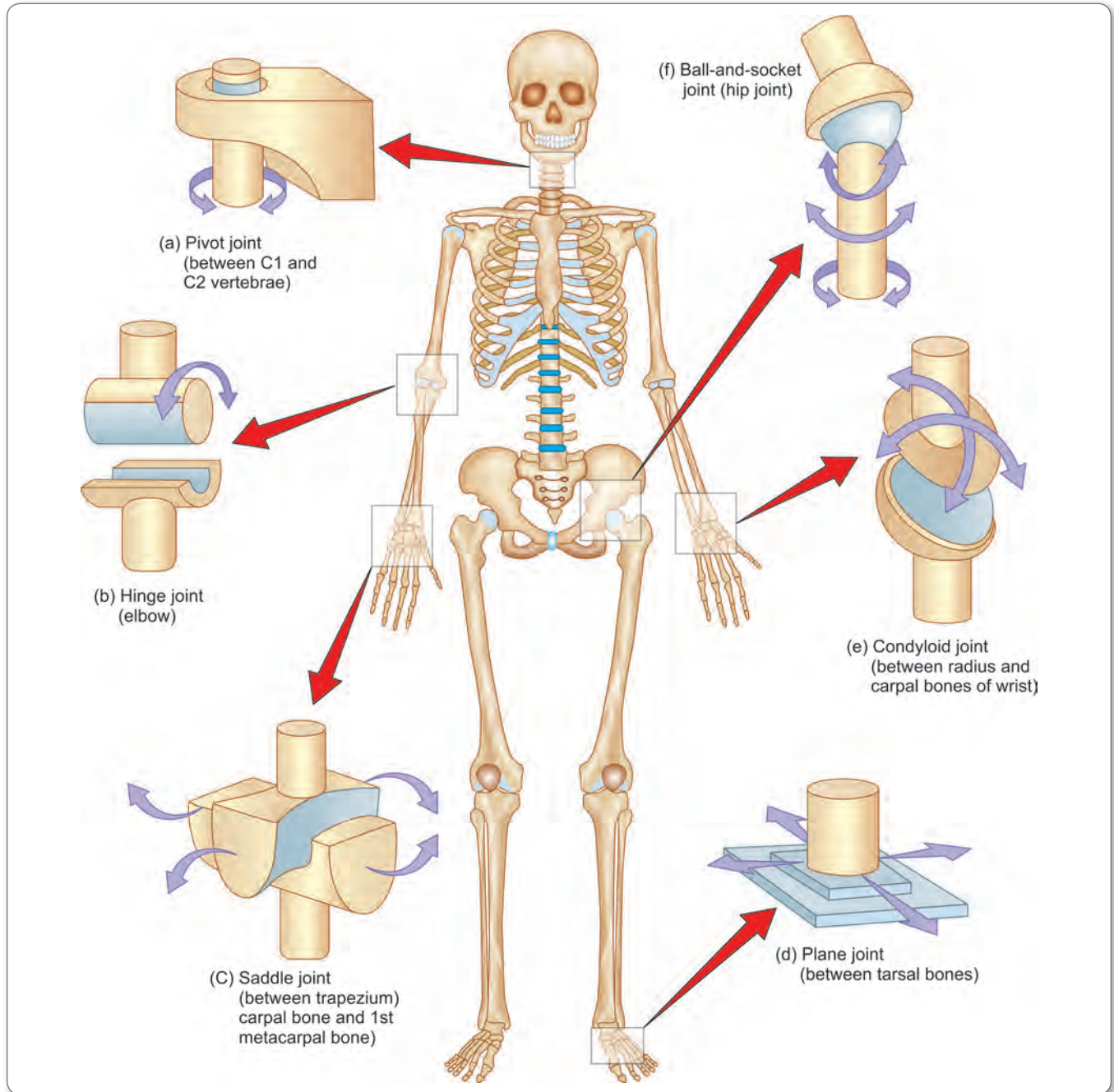


Fig. 7: Types of synovial joint

- **Plane:** Articular surface are more or less plane. Permit gliding movement
- **Uniaxial joints**
 - **Hinge:** Pulley shaped. Permit movement in one plane – transverse axis – permit flexion and extension
 - **Pivot:** Formed by bony pivot surrounded by an osteoligamentous ring. Permit movement in one plane–vertical axis–permit rotation only



- **Biaxial joints**
 - **Condylar:** Consists of two distinct condyles, in which one is reciprocally concave. Permit movement in transverse axis—flexion, extension and limited rotation takes place
 - **Ellipsoid:** Include convex male fitting into ellipsoid female. Permit movement in transverse axis, anteroposterior axis (not in vertical axis).
 - **Saddle:** Are reciprocally concavo convex
- **Multiaxial joint**
 - **Ball and Socket:** Consists of globular head fitting into cup-shaped socket – all movements takes place.

Classification Based on Function

- Immovable: No mobility
- Slightly movable
- Freely movable

Table 2: Various cartilaginous joints and sutures

Primary cartilaginous joint	Secondary cartilaginous joint	Sutures	Syndesmoses	Gomphosis
<ul style="list-style-type: none"> ● Joint between epiphysis and diaphysis ● Between basiocciput and basisphenoid 	<ul style="list-style-type: none"> ● Symphysis menti ● Symphysis pubis ● Manubrio sternal ● Joint between vertebral bodies, xiphisternal joint, midline intervertebral joint 	<ul style="list-style-type: none"> ● Serrate: Sagittal ● Denticulate: lambdoid ● Squamous: Temporoparietal ● Plane: Between palatine process of maxillae ● Schindylesis: Between rostrum of sphenoid and upper margin of vomer 	<ul style="list-style-type: none"> ● Inferior tibio-fibular joint 	<ul style="list-style-type: none"> ● Tooth fit in the socket

Table 3: Types of synovial joints

Hinge	Pivot	Condylar	Ellipsoid
<ul style="list-style-type: none"> ● Interphalangeal ● Joint of fingers and toes ● Elbow ● Ankle 	<ul style="list-style-type: none"> ● Atlanto-axial ● Superior and inferior radioulnar 	<ul style="list-style-type: none"> ● Knee ● Temporomandibular 	<ul style="list-style-type: none"> ● Wrist joint ● Knuckle joint ● Atlanto-occipital joint
Saddle	Plane	Ball and socket	
<ul style="list-style-type: none"> ● Carpometacarpal joint of thumb ● Sternoclavicular ● Calcaneocuboid ● Joint between malleus and incus 	<ul style="list-style-type: none"> ● Intercarpal joint ● Intertarsal joint ● Facet joint (between the articular facet of adjacent vertebra) 	<ul style="list-style-type: none"> ● Shoulder joint ● Hip joint ● Talocalcaneonavicular joint ● Articulation between incus and stapes 	

Note:

- **First chondrosternal joint – synarthrosis (fibrous joint) not Synchondrosis**

- **Parts of muscle**

- **Fleshy part:** Contractile part called belly
- **Fibrous part:** Noncontractile part and inelastic. When it is flattened it is called aponeurosis or cord like – tendon.

MUSCLES

CONTRACTILE TISSUE WHICH BRINGS ABOUT MOVEMENTS

- **Ends of muscle**
 - **Origin:** One end of muscle which mostly fixed during contraction
 - **Insertion:** Other end which mostly moves during its contraction

FASCICULAR ARCHITECTURE OF MUSCLES

Arrangement of muscle fibers varies according to the direction of force and range of habitual movement at particular joint. Muscles can be classified according to their arrangement of fasciculi into following groups.

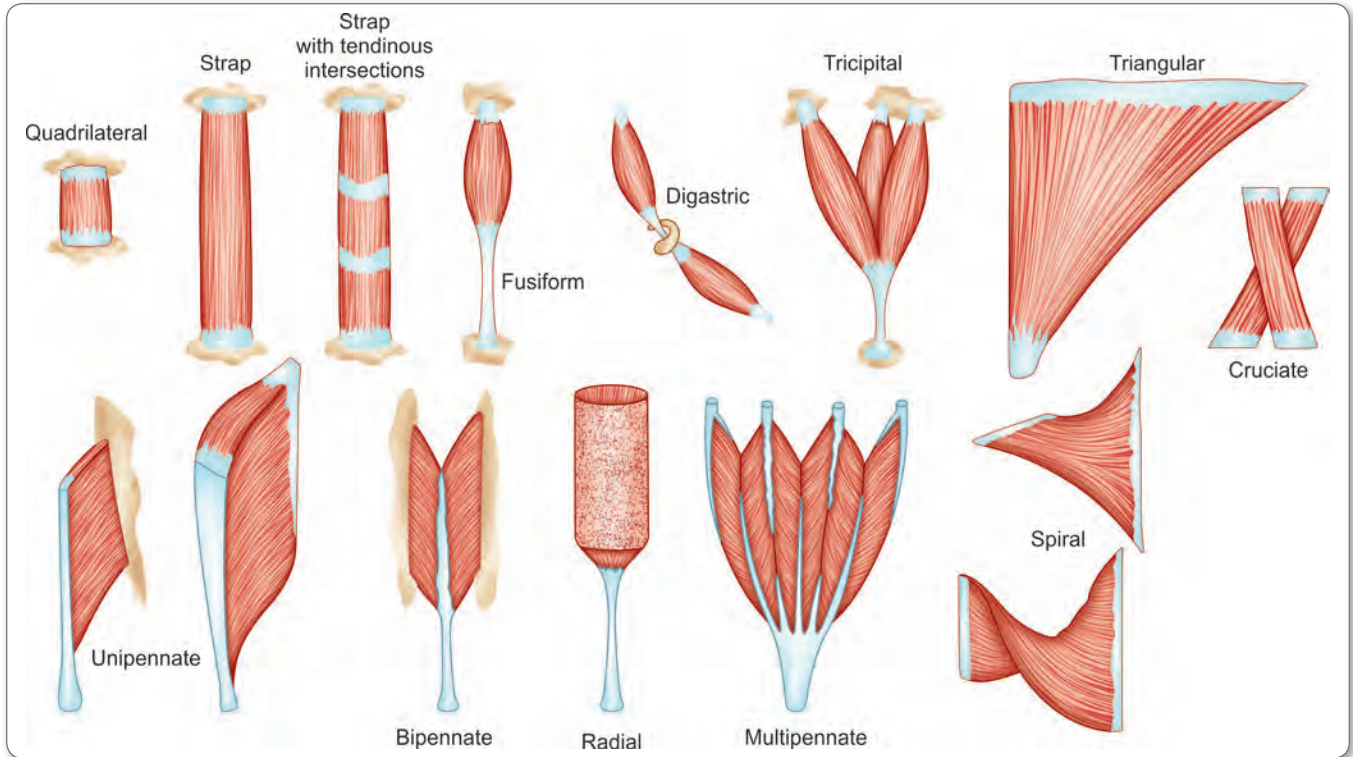


Fig. 8: Muscle shapes

- **Parallel fasciculi:** Fibers are parallel to each other
 - *Strap-like:* Infrahyoid muscles, Sartorius
 - *Strap like with digitations:* Rectus abdominis
 - *Fusiform:* Digastric and Biceps
 - *Quadrilateral:* Thyrohyoid and Pronator quadratus.
- **Convergent muscle:** Fibers converge at insertion point
 - *Fan shaped:* Temporalis.
- **Sphincter type:** Surrounding the orifice
 - Orbicularis oris
 - Orbicularis oculi
- **Spiral or twisted type:** Fibers are twisted
 - Pectoralis major, latissimus dorsi, trapezius.
- **Cruciate muscles:** In some muscles, fasciculi are crossed. Masseter, sternocleidomastoid, adductor magnus
- **Pennate muscle:** Feather-like
 - *Unipennate:* Extensor digitorum longus, flexor pollicis longus, peroneus tertius, palmar interossei
 - *Bipennate:* Rectus femoris, peroneus longus, dorsal interossei, flexor hallucis longus
 - *Multipennate:* Middle part of deltoid, Subscapularis, tibialis anterior (multipennate with oblique fibers)
 - Spiral or twisted fibers found in trapezius, pectoralis major, latissimus dorsi and supinator
 - *Cruciate* - In certain muscles fasciculi crossed – cruciate muscles – sternocleidomastoid, masseter, adductor magnus

Hybrid Muscles

- Muscles having more than one nerve supply
- Muscles in the body innervated by two or more nerves

Digastric

- Posterior belly-facial nerve
- Anterior belly-nerve to mylohyoid

Sternocleidomastoid

- Spinal root of accessory nerve
- Ventral rami of C2 & C3

Cricopharyngeal Part of Inferior Constrictor of the Pharynx

- External laryngeal nerve
- Recurrent laryngeal nerve

Trapezius

- Spinal root of accessory nerve
- Ventral rami of C2 & C3 – proprioceptive

Levator Scapulae

- Dorsal scapular nerve
- Ventral rami of C3 – C4

Subscapularis

- Upper subscapular nerve
- Lower subscapular nerve

Brachialis

- Musculocutaneous nerve
- Radial nerve



Flexor Digitorum Profundus

- Ulnar nerve supplying the medial half
- Median nerve supplying the lateral half

Opponens Pollicis

- Lateral terminal branch of median nerve
- Deep terminal branch of ulnar nerve

Flexor Pollicis Brevis

- Lateral terminal branch of median nerve supplying superficial head.
- Deep terminal branch of ulnar nerve supplying deep head

Pectoralis Major

- Lateral pectoral nerve
- Medial pectoral nerve

Adductor Magnus

- Obturator nerve supplying adductor part
- Tibial part of the sciatic nerve supplying hamstring part

Pectineus

- Femoral nerve
- Obturator nerve

Biceps Femoris

- **Long head:** Tibial component of sciatic nerve
- **Short head:** Common peroneal component of sciatic nerve

Table 4: According to nerve supply smooth muscle classification into

Single Unit	Multi Unit
<ul style="list-style-type: none"> • Seen in GIT, urinary tract • Nerve impulse reach one muscle cell and transmitted to other cell through fused cell membrane • Nerve supply – sparse. 	<ul style="list-style-type: none"> • Seen in muscles of ductus deferens, large elastic arteries, iris muscles, trachea & bronchi • Each muscle cell receives separate nerve fiber • Nerve supply – rich



Clinical Aspect

- Congenital absence of a muscle is known as **Amyoplasia** seen in **Poland syndrome** (undeveloped pectoralis muscle).
- Serratus anterior and external intercostal muscles are pierced while tapping of pleural fluid in mid-axillary line in 6th intercostal space.
- Ureter is single unit smooth muscle, either the whole muscle contracts or the whole muscle relaxes.
- Lockjaw is due to tonic spasm of **masseter** muscle.

LYMPHATIC SYSTEM

- Collection of vessels called lymphatic vessels that drain lymph from tissues and returns it to venous system
- Lymph – from most of the tissues is clear and colourless, but from small intestine is milky white due to absorption of fat
- Intestinal milky lymph called chyle and lymph vessels called lacteals
- Lymph consists of:
 - **Primary lymphoid organs:** Thymus and bone marrow involved in lymphoid production of lymphocytes.
 - **Secondary lymphoid organs:** Lymph nodes and spleen that maintain naive lymphocytes and initiate an adaptive immune responses.
 - **Lymphatic vessels**
 - **Lymph**

CISTERNA CHYLI

- Dilated lymphatic sac 5 cm to 7 cm situated in front of L1,2
- Receives lymph from most of the abdominopelvic organs, abdominal walls and from lower extremities
- Cisterna continues above as thoracic duct through aortic opening of diaphragm.

Tributaries

- Receives intestinal lymph trunks from preaortic lymph nodes
- Receives lumbar lymph nodes from each paraaortic lymph nodes.

THORACIC DUCT

- Elongated lymphatic trunk, which convey chyle and most of the lymph of the body into bloodstream
- Thoracic duct drains lymphatics from whole body except right side of head and neck, right upper limb, right lung and right thoracic wall, right half of the heart and convex surface of liver
- Begins from the upper end of cisterna chyli at lower border of T12
- Enters the thorax through aortic opening of diaphragm
- Pass upward in posterior mediastinum behind esophagus
- At T5, thoracic duct inclines to left and runs upwards in superior mediastinum
- At C7, thoracic duct terminates in the angle formed by junction of left internal jugular and left subclavian veins

Tributaries

- Left and right descending thoracic lymph trunks (convert lymph from 6 to 11 intercostal spaces)
- Left upper intercostal lymph trunks (convert lymph from left 1 to 5 intercostal spaces)
- Mediastinal lymph trunks
- Left subclavian lymph trunks
- Left jugular lymph trunk
- Left Broncho mediastinal lymph trunk.

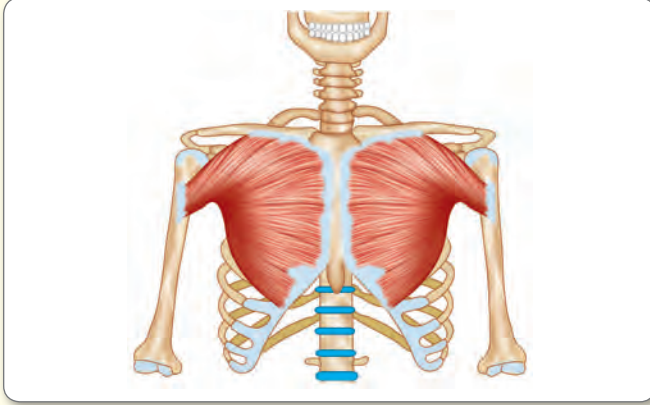


Multiple Choice Questions

10

1. Identify the type of muscle shown in figure:

(Recent Question 2018)



- a. Cruciate
- b. Spiral
- c. Multipennate
- d. Convergent

2. Which of the following is multipennate muscle:

(Recent Question Dec 2016)

- a. FPL
- b. EPL
- c. Deltoid
- d. FHL

3. In which of the following muscles, the muscle fibers are not parallel:

(AIIMS Nov 2016)

- a. Sartorius
- b. Sternohyoid
- c. Rectus abdominis
- d. Tibialis anterior

4. The Haversian system is found in:

(AI 2000)

- a. Diaphysis of long bones
- b. Cancellous bone
- c. Epiphysis
- d. Spongy bones of children

5. All of the following statements are true for metaphysis of bone, except:

(AI 2003)

- a. It is the strongest part of bone
- b. It is highly vascular
- c. Growth activity is maximized here
- d. region favoring hematogenous spread

6. Which of the following is aberrant epiphysis?

(Recent Question Dec. 2016)

- a. Coracoid process
- b. Greater tubercle of humerus
- c. Base of 1st metacarpal
- d. Base of 2nd metacarpal

7. Which of the following is an example of atavistic epiphysis?

(Recent Question Dec 2016)

- a. Greater trochanter
- b. Head of femur
- c. Upper end of radius
- d. Coracoid process of scapula

8. Bone which is pneumatic:

(PGI May 2015)

- a. Maxillary
- b. Parietal
- c. Temporal
- d. Frontal
- e. Ethmoidal

9. Enchondral ossification is/are seen in:

(PGI Nov 2015)

- a. Long bones
- b. Flat bones of skull
- c. Clavicle
- d. Mandible
- e. Nasal bones

10. Vomer-Sphenoidal rostrum junction is:

(Recent Question Dec 2013)

- a. Syndesmosis
- b. Synostosis
- c. Schindylesis
- d. Gomphosis

11. Joint between epiphysis and diaphysis of a long bone is a type of:

(AIIMS 2004)

- a. Plane Synovial joint
- b. Fibrous joint
- c. Symphysis
- d. Synchondrosis

12. The type of joint between the sacrum and the coccyx is a:

(AI 2005)

- a. Symphysis
- b. Synostosis
- c. Synchondrosis
- d. Syndesmosis

13. Median atlantoaxial joint is:

(Recent Question Dec 2016)

- a. Condylar
- b. Cartilaginous
- c. Fibrous
- d. Synovial Joint

14. Intracapsular articular disc is present in which joint:

(Recent Question Dec 2016)

- a. Sternoclavicular joint
- b. Elbow
- c. Hip joint
- d. Knee joint

15. Nutrient artery runs:

(Recent Question 2012)

- a. Towards metaphysis
- b. Away from metaphysis
- c. Away from epiphysis
- d. Away from metaphysis

16. Which of the following is a traction epiphysis?

(Recent Question 2012)

- a. Tibial condyles
- b. Trochanter of femur
- c. Coracoid process of scapula
- d. Head of femur

17. True statement is:

(AI 2000)

- a. Osteoblasts give rise to osteocytes
- b. Growth of bone occurs at diaphysis
- c. Epiphysis is present between metaphysis and diaphysis
- d. Interphalangeal joint is a saddle joint

18. Pisiform is which type of bone:

(Recent Question 2015)

- a. Pneumatic bone
- b. Sesamoid bone
- c. Accessory bone
- d. Long bone

19. All of the following are pneumatic bones, EXCEPT:

(AI 11)

- a. Frontal
- b. Ethmoid
- c. Mandible
- d. Maxilla

20. Ear ossicles articulate with each other through which type of joints?

(Recent Question 2012)

- a. Synostosis
- b. Synovial
- c. Synchondrosis
- d. Syndesmosis

21. What kind of a joint is syndesmosis? (Recent Question 2012)

- a. Fibrous
- b. Plain
- c. Pivot
- d. Cartilaginous

22. Which of the following is a not synovial joint of the ellipsoid variety?

(Recent Question 2014)

- a. First carpometacarpal joint
- b. Atlanto occipital joint
- c. Wrist joint
- d. Knuckle joint



Answers with Explanations

12

GENERAL ANATOMY

New SARP Series Anatomy

1. Ans. (b, d) Spiral > convergent

Spiral or twisted arrangements seen in Pectoralis major, latissimus dorsi, trapezius.

Some books saying spiral as convergent. Tendons converge at insertion.

But best answer is spiral > convergent

2. Ans. c. Deltoid

[Ref: Vishram singh general anatomy, 138]

Deltoid middle fibers – multipennate.

3. Ans. d. Tibialis anterior

The muscles with parallel fasciculi are sartorius, sternohyoid, rectus abdominis, digastric, thyrohyoid

4. Ans. a. Diaphysis of long bones

[Ref: Vishram singh general anatomy, 75]

Diaphysis of long bones contains compact bones, which contains osteon.

5. Ans. a It is the strong part of bone

[Ref: Vishram singh general anatomy 80]

Strong part of bone - diaphysis

6. Ans. d. Base of 2nd metacarpal

[Ref: BDC General anatomy 34]

Aberrant – head of 1st metacarpal and base of other metacarpal bones.

7. Ans. d. Coracoid process of scapula

Coracoid process – atavistic

8. Ans. a. Maxillary, d. Frontal, e. Ethmoidal

[Ref: Vishram singh general anatomy 74]

Pneumatic bones: Bones with air cavities. e.g. maxilla, frontal, sphenoid, ethmoid and mastoid.

9. Ans. a. Long bones

[Ref: Langmens embryology 127]

Long bones show enchondral ossification. Skull base, vertebra

10. Ans. c. Schindylesis

[Ref: Vishram singh general anatomy 95]

11. Ans. d. Synchondrosis

Joint between epiphysis and diaphysis: Primary cartilaginous.

12. Ans. a. symphysis

Sacrococcygeal joint: mid line joint – symphysis – secondary cartilaginous joint.

13. Ans. d. Synovial joint

[Ref: Vishram singh general anatomy 47]

Median atlantoaxial joint: Pivot type of synovial joint.

14. Ans. a. Sternoclavicular joint

[Ref: Vishram singh general anatomy]

Articular disc is seen in temporomandibular joint, sternoclavicular joint.

15. Ans. a. Towards metaphysis

[Ref: BDC General anatomy 30]

- Nutrient artery enters the shaft, divides into ascending and descending branches, which run towards and terminate in the metaphysis by anastomosing with the epiphyseal, metaphyseal and periosteal arteries

16. Ans. b. Trochanter of femur

[Ref: BDC General anatomy 34]

- Trochanter of femur is an example of traction epiphysis
- Tibial condyles and head of femur are under the pressure epiphysis
- Coracoid process of scapula is an example of atavistic epiphysis.

17. Ans. a. Osteoblasts give rise to osteocytes

[Ref: Vishram singh general anatomy 73]

- Osteoblasts that get trapped in Haversian lamellae become osteocyte and assume the function of bone maintenance.
- Growth activity is maximum at the growth plate metaphysis.
- Metaphysis is present between diaphysis and epiphysis.
- Interphalangeal joint is a hinge type

18. Ans. b. Sesamoid bone

[Ref: Vishram singh general anatomy 74]

- Sesamoid bones develop in certain tendons. Pisiform bone – sesamoid bone

19. Ans. c. Mandible

[Ref: Vishram singh general anatomy 74]

- Pneumatic bones have air spaces within them.
- Mandible – not pneumatic bone

20. Ans. b. Synovial

[Ref: Vishram singh general anatomy 46]

- Malleus-incus joint is a saddle synovial joint and incus-stapes is ball and socket synovial joint.

21. Ans. a. Fibrous

[Ref: Vishram singh general anatomy 46]

- Fibrous joints are three types: sutures, syndesmosis, and gomphoses

**22. Ans. a. First carpometacarpal joint**

[Ref: Vishram singh general anatomy 47]

Ellipsoid joint
Wrist joint
Knuckle joint
Atlanto occipital joint

23. Ans. b. Flexor Carpi ulnaris

[Ref: Vishram singh general anatomy, pg138]

- Flexor carpi ulnaris is supplied by a single nerve and is not a composite/hybrid muscle

24. Ans. a. Pectoralis major

[Ref: Vishram singh general anatomy, pg140]

- Pectoralis major and minor are the most common congenitally absent muscles - Poland syndrome

25. Ans. d. Popliteus

[Ref: bdc volume 2, 7th edition, pg 117]

- Popliteus has intracapsular origin from the lateral femoral epicondyle. It inserts on the posterior surface of the tibia, just proximal to the soleal line.

26. Ans. a. Right upper part of body

[Ref: bdc volume 1, 7th edition, pg 302]

- Right upper quadrant of the body drains the lymphatics into the right lymphatic duct and rest of the body drains into thoracic duct

27. Ans. d. Left brachiocephalic vein

[Ref: bdc volume 1, 7th edition, pg 302]

- Thoracic duct opens into the left venous (jugulo-subclavian) angle, at the beginning of left brachio-cephalic vein

28. Ans. c. Deltoid tuberosity

[Ref: BDC General anatomy 34]

Pressure: Take part in joint formation. They transmit weight
Head of humerus
Lower end of radius etc

Traction epiphysis: Non-articular and does not take part in weight transmission e.g.

Greater and lesser trochanter of femur
Greater and lesser tubercle of humerus and mastoid process

Atavastic: Phylogenetically independent but fused to nearest bone for nutrition e.g.

Coracoid process of scapula
Ostrigonum

Aberrant Epiphysis (Aberrant, Not usual): Not always present, e.g.

Head of 1st metacarpal bones

Base of other metacarpal bones

29. Ans. d. Symphysis

[Ref: Vishram singh general anatomy 47]

Fibrous Joint

Classified into: Sutures, syndesmoses and gomphoses

- **Suture:** Found in skull. Schindylesis – sphenovomerine joint
- **Syndesmoses:** Bones are connected by interosseous ligaments
- **Gomphoses:** Otherwise known as peg and socket

30. Ans. c. Adductor magnus – rider s bone

[Ref: BDC volume 2, 7th edition, pg 63]

- Rider s bone developed in adductor longus

31. Ans. d. Tibia and fibula – anterior tibial artery

[Ref: BDC volume 2, 7th edition, pg 119]

- Tibial – posterior tibial artery
- Fibula – peroneal artery

32. Ans. a. Hyoid

[Ref: BD chaurasia general anatomy 32]

Structures in adult size at birth

- Tympanic cavity
- Ear ossicles
- Mastoid antrum
- Internal ear

33. Ans. b. Adductor magnus – obturator nerve and femoral nerve

[Ref: BDC volume 2, 7th edition, pg 63]

- Adductor magnus supplied by obturator nerve and tibial component of sciatic nerve

34. Ans. c. Veins accompanying arteries

[Ref: BDC general anatomy 12]

Vena comitans are the Veins accompanying arteries

35. Ans. b. One diaphysis and two epiphysis

[Ref: BDC general anatomy 21]

Long bone has one diaphysis – shaft and two epiphyses growing ends

36. Ans. c. Ureter

GIT, urinary tract – single unit smooth muscle

[Ref: BDC general anatomy 148,149]

37. Ans. b. Compression

[Ref: Clinically Oriented Anatomy, Moore, Keith L, 5th edition, 2006 page 792-793]

- Communications between multiple branches if an artery provide numerous potential detours for blood flow in case



the usual pathway is obstructed by compression due to the position of a joint, pathology or surgical ligation

38. Ans. c. Ventral muscles are more precise and brisk

[Ref: *Essential of Neuroanatomy, A.K. Datta vol 4, 3rd edition 2007 page 269*]

- The ventral nerves are more in number because flexor muscles possess richer innervations than extensor muscles

- And the actions of flexor muscles are brisk and more precisely under voluntary control

39. Ans. a. Tendon

[Ref: *Text book of Anatomy, Inderbir Singh, vol.I. 5th edition, Page 6*]

- Structures connecting two bones: Ligaments
- Structures connecting muscle and bones: Tendon

2



GENERAL HISTOLOGY



EPITHELIUM

Rests on basement membrane and lines body surface, body cavities and interior of organs. Derived from all three germ layers.

CLASSIFICATION

It is classified into simple epithelium and compound epithelium.

Simple Epithelium

Simple epithelium (single layer of cells) is classified into:

- Squamous: Cells whose breadth is greater than length. Function – exchange. Nucleus – flat
- Cuboidal: Cells whose length is equal to breadth. Function – secretion. Nucleus – round

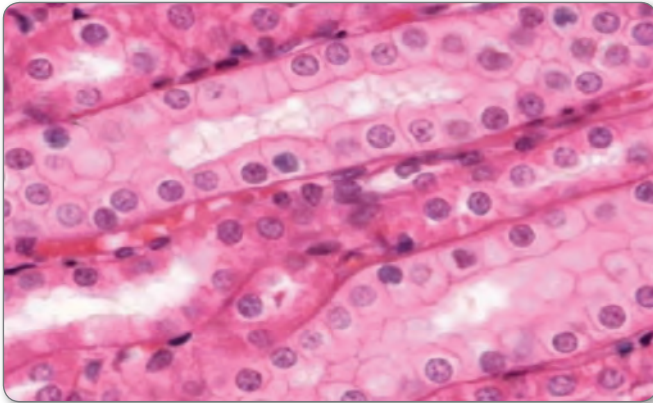


Fig. 1: Simple epithelium—Squamous, cuboidal cells

- Columnar: Cells whose length is greater than breadth. Function – secretion. Nucleus – elongated.

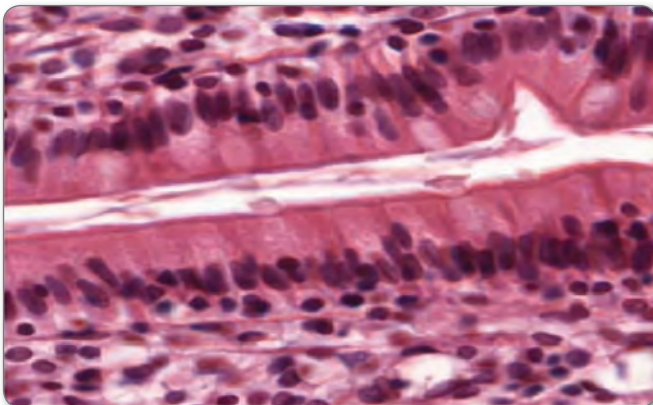


Fig. 2: Simple epithelium—Columnar cells

Table 1: Types of simple epithelium

Simple	Squamous	Lining of blood vessels (endothelium) Lining of body cavities pleura, pericardium and peritoneum Bowman’s capsule Alveoli
	Cuboidal	Germinal epithelium of ovary Thyroid follicles (inactive stages) Kidney tubules
	Columnar	Stomach and large intestine Small intestine and Gall bladder (with microvilli) Ciliated (auditory tube and middle ear, uterus and uterine tubes and ventricles of brain)

Compound Epithelium

Stratified Squamous

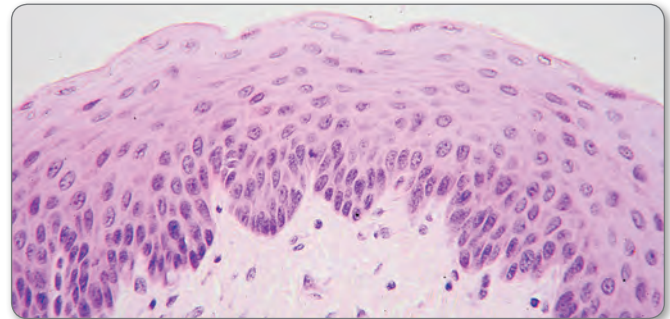


Fig. 3: Stratified squamous epithelium

- Surface layer is squamous but basal layer is either cuboidal or columnar. These basal cells are mitotic in nature
- Apical cells lost due to friction & replaced by cells from basal layer
- Barrier and protective function
- Can be keratinized or non-keratinized epithelium.

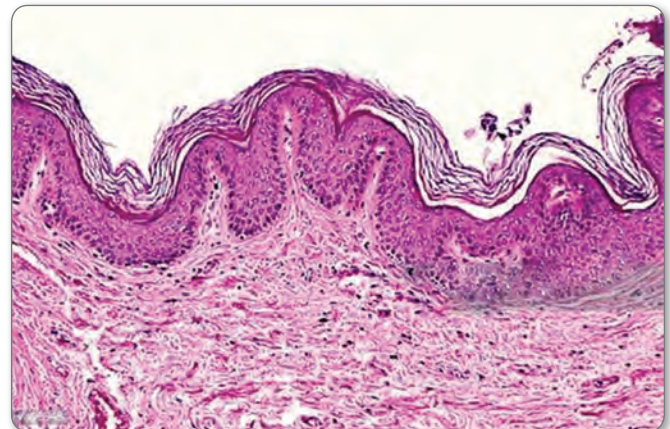


Fig. 4: Stratified squamous keratinized epithelium



Stratified Columnar

- Surface layer is columnar
- Acts as a barrier.

Stratified Cuboidal

- Surface layer is cuboidal
- Acts as a barrier.

Transitional Epithelium

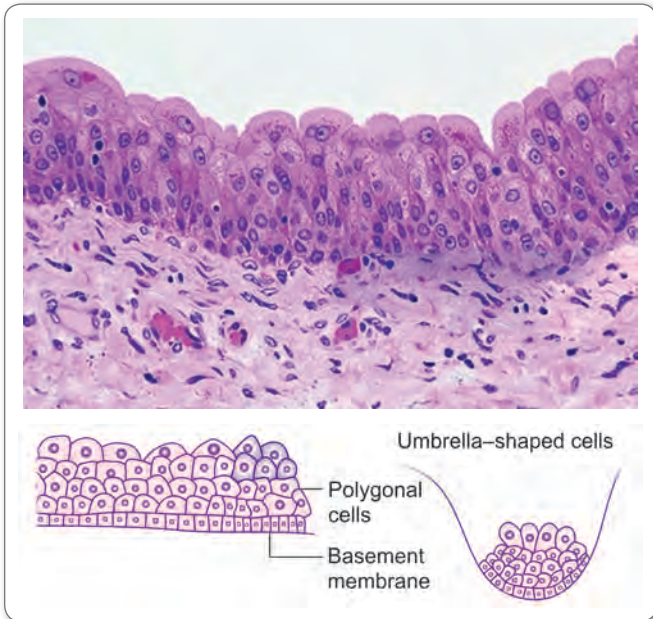


Fig. 5: Transitional epithelium

- It is composed of many layers:
 - Basal layer: Cuboidal or columnar
 - Intermediate layer: Polyhedral cells
 - Apical cell: Umbrella-shaped cell found in urinary system so called as urothelium.
- It can be relaxed & distended
- Impermeable and resist the transport of water across the membrane - Acts as a barrier.

Pseudostratified Ciliated Columnar

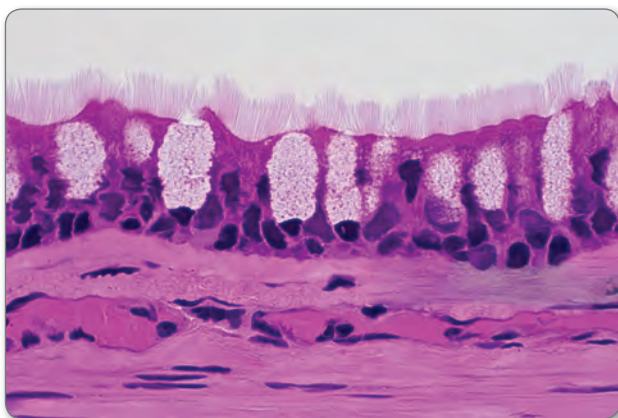


Fig. 6: Pseudostratified ciliated columnar epithelium

- It is found in trachea, bronchus and vas deferens.

REMEMBER

Stratified layer	Squamous without keratinization (moist)	Oral cavity, esophagus, tongue, tonsil, larynx, vagina and anal canal
	Squamous with keratin (dry)	Epidermis, filiform papillae in the tongue
	Cuboidal	Ducts of Sweat glands exocrine glands
	Columnar	Membranous urethra, penile urethra
Urothelium	Transitional epithelium	Renal calyces, ureter, urinary bladder and prostatic urethra

SURFACE PROJECTIONS

Apical epithelial surface possesses specialized structures such as microvilli, stereocilia, cilia.

Microvilli

- Finger like projections of epithelia approximately 1 micrometer long that extend into lumen and increase the cells surface area
- Microvilli constitute the brush border of kidney, proximal tubule cells, gall bladder and striated border of intestinal absorptive cells.

Stereocilia

- Long microvilli, 15–20 micrometer in length
- Situated in the hair cells of the inner ear and in epididymis of the male reproductive tract.

Cilia

It is of two types, motile and non-motile.

Motile Cilia

Processes of the cell that are 7–10 micron in length extending from certain epithelia that propel the substances along their surface.

Non-motile Cilia

- Present on nearly every human cell that is in G₀ stage of the cell cycle.
- These structures were believed to be nonfunctional evolutionary remnants but recently it has been demonstrated that they have essential functions in the organization of signalling pathway not only during embryonic development but also in the adult organism.



Clinical Aspect

Immotile Cilia Syndrome

- Results from genetic defect that causes an abnormal ciliary beat or absence of beat
- Syndrome is associated with recurrent lower respiratory tract infections, reduced fertility in women and sterility in men.



INTERCELLULAR ADHESIONS AND CELLULAR ADHESIONS

JUNCTIONAL COMPLEX

18

Connection between 2 neighboring cells and between cells and ecm

GENERAL HISTOLOGY

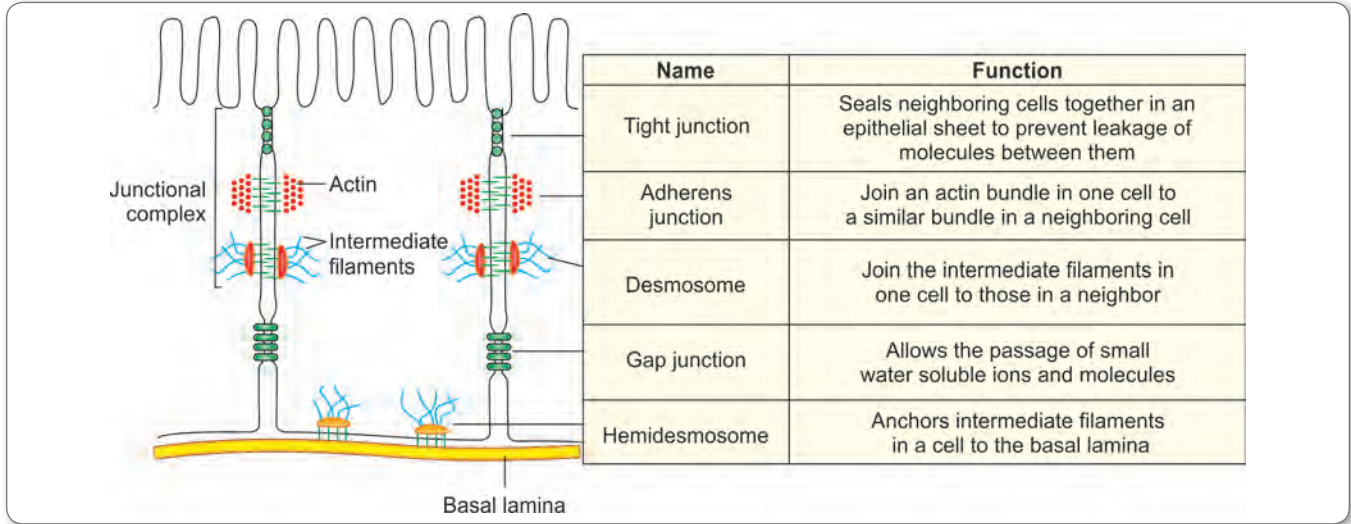
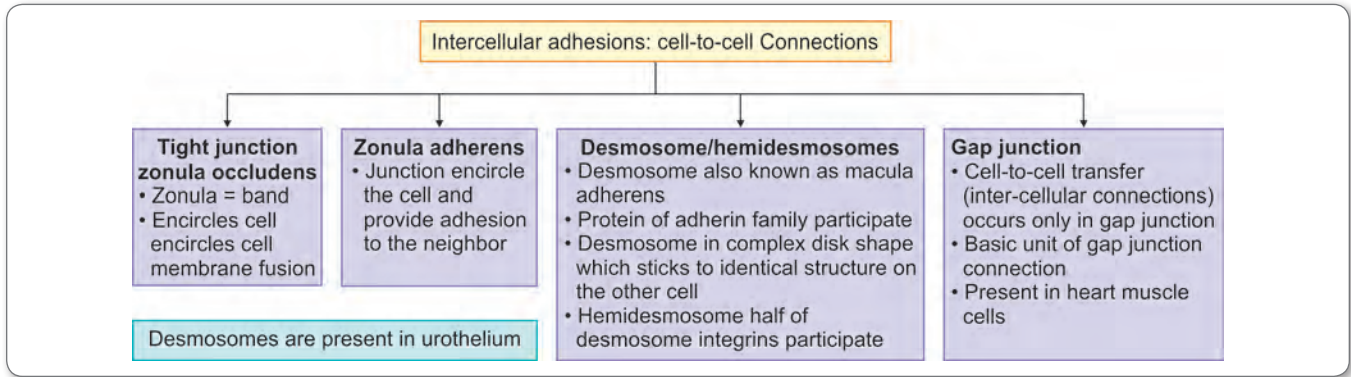


Fig. 7: Intercellular adhesions



Tight Junction – Occluding Junction

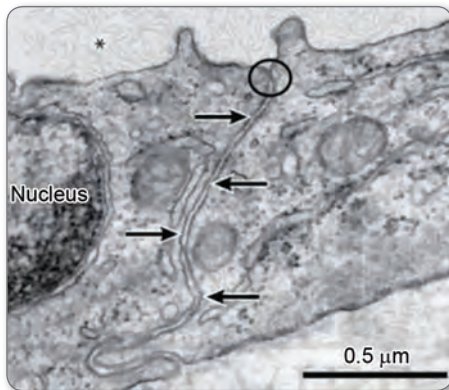


Fig. 8: Electron microscopic image of tight junction

- Checks the passage of substance across membrane
- Prevent the migration of cell membrane components
- Barrier in function. Provide the strength and stability
- E.g. – occludin, claudins, cingulin.

Anchoring Junction

- Link cell together so cells act as single unit – present in intercalated disc.
- Two types zonula adherens and desmosomes (macula adherens)

Zonula Adherens

- Attach actin filaments cytoskeleton of one cell to another
- Present in cardiac muscle – intercalated disc.

New SARP Series Anatomy

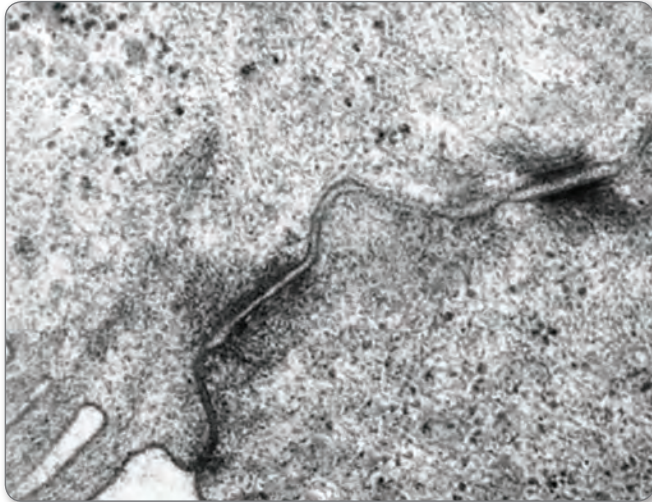


Fig. 9: Electron microscope image of anchoring junction

Macula Adherens – Desmosomes

- It attach the intermediate filaments cytoskeleton of one cell to another
- Use cadherins as cell adhesion molecule.

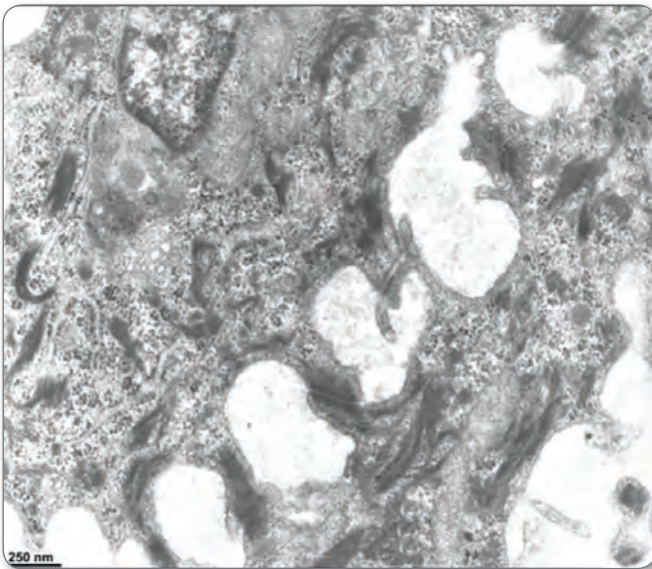


Fig. 10: Electron microscopic image of desmosomes

Communicating Junction – Gap Junction

- Helps the molecules to pass between cells
- Cytoplasm of 2 cells and chemical signals pass between cells without contact with extracellular fluid
- So action potential of one cell transmitted to another cell
- So muscles act as single unit
- Present in intercalated disc.

Clinical Aspect

Bullous Pemphigoid

- Auto antibodies directed against hemidesmosomes
- Acute or chronic autoimmune skin disease involves the formation of blisters (bullae) at the space between epidermis and dermis.

Pemphigus Vulgaris

- Auto antibodies detected against cadherins of desmosomes
- As desmosomes are attacked, layers of skin separate and clinical picture resembles blister
- Pemphigus vulgaris - Rare chronic blistering skin disease and most common form of pemphigus.

GLANDS

Glands are the epithelial cells with secretory function. These are classified as endocrine and exocrine glands.

- Endocrine glands discharge their secretion directly into blood—ductless glands for example, thyroid, suprarenal, pituitary, etc.
- Exocrine glands—discharge their secretions onto surface directly or by means of ducts and can be classified in five different ways as follows.

ACCORDING TO BRANCHING OF DUCTS

Simple and compound

- Simple: Secretions of these glands is conveyed to the surface by single unbranched duct – gastric glands, pyloric glands or sweat glands
- Compound: Ducts of these glands divide into so many branches – pancreas, parotid, Brunner's gland of duodenum.

ACCORDING TO SHAPE OF THE SECRETORY UNIT

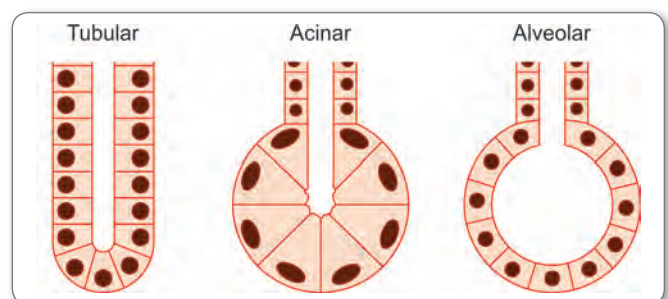


Fig. 11: Glands according to shape of the secretory unit

- Tubular: Secretory unit is tubular in shape – gastric glands, Brunner's glands of duodenum
- Acinar: Secretory unit is rounded or oval in shape – salivary glands.



ACCORDING TO MODE OF SECRETION

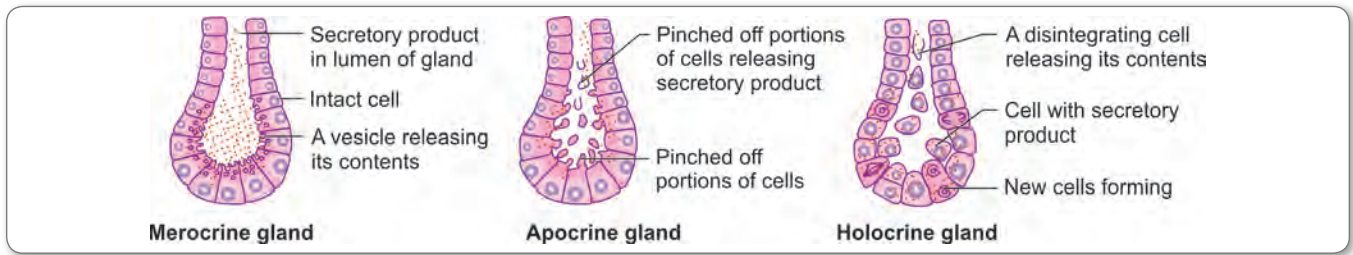


Fig. 12: Glands classified according to mode of secretion

- Merocrine: Secretions thrown out by exocytosis. e.g. **exocrine glands** (sweat glands)
- Apocrine: Apical part of gland disintegrates and pours the secretions. e.g. **atypical sweat glands and breast**
- Holocrine: Whole gland disintegrates and pours the secretions. e.g. **sebaceous glands**

ACCORDING TO TYPE OF SECRETION

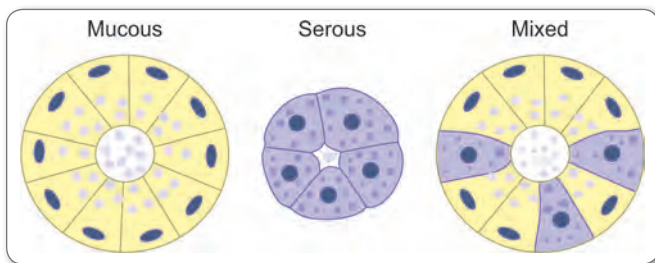


Fig. 13: Glands according to type of secretion

- Serous: Secretions of these glands is watery clear fluid – cells have rounded nuclei close to base of cell with basal basophilia – parotid, exocrine part of pancreas
- Mucous: Glands secrete mucin which then mixed with water and converted into mucous – cells flattened, peripheral nuclei lying against base of the skull-sublingual gland
- Mixed: They have both serous and mucous type of acini – submandibular glands, tracheal glands.

Table 2: Differences between serous and mucous acini

Serous acini	Mucous acini
• Smaller size – rounded in shape	• Larger in size, variable in shape
• Lumen hardly visible	• Lumen mostly visible
• Lining cells are pyramidal in shape and relatively more in number	• Lining cells truncated, columnar in shape and cells are fewer in number
• Nuclei – round and basal	• Nucleus – flattened and peripheral
• Cytoplasm – depicts basal basophilia and apical eosinophilia	• Cytoplasm is pale and vacuolated
• Serous acini may be present as demilunes on one aspect of some mucous acini	• Mucous acini only present

HIGH YIELD POINTS

Demilunes of Giannuzzi

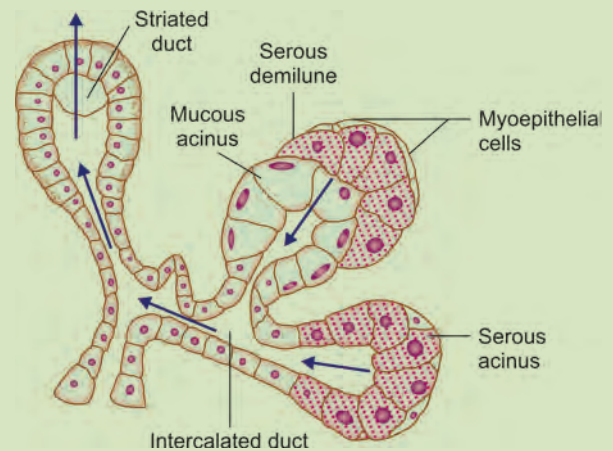
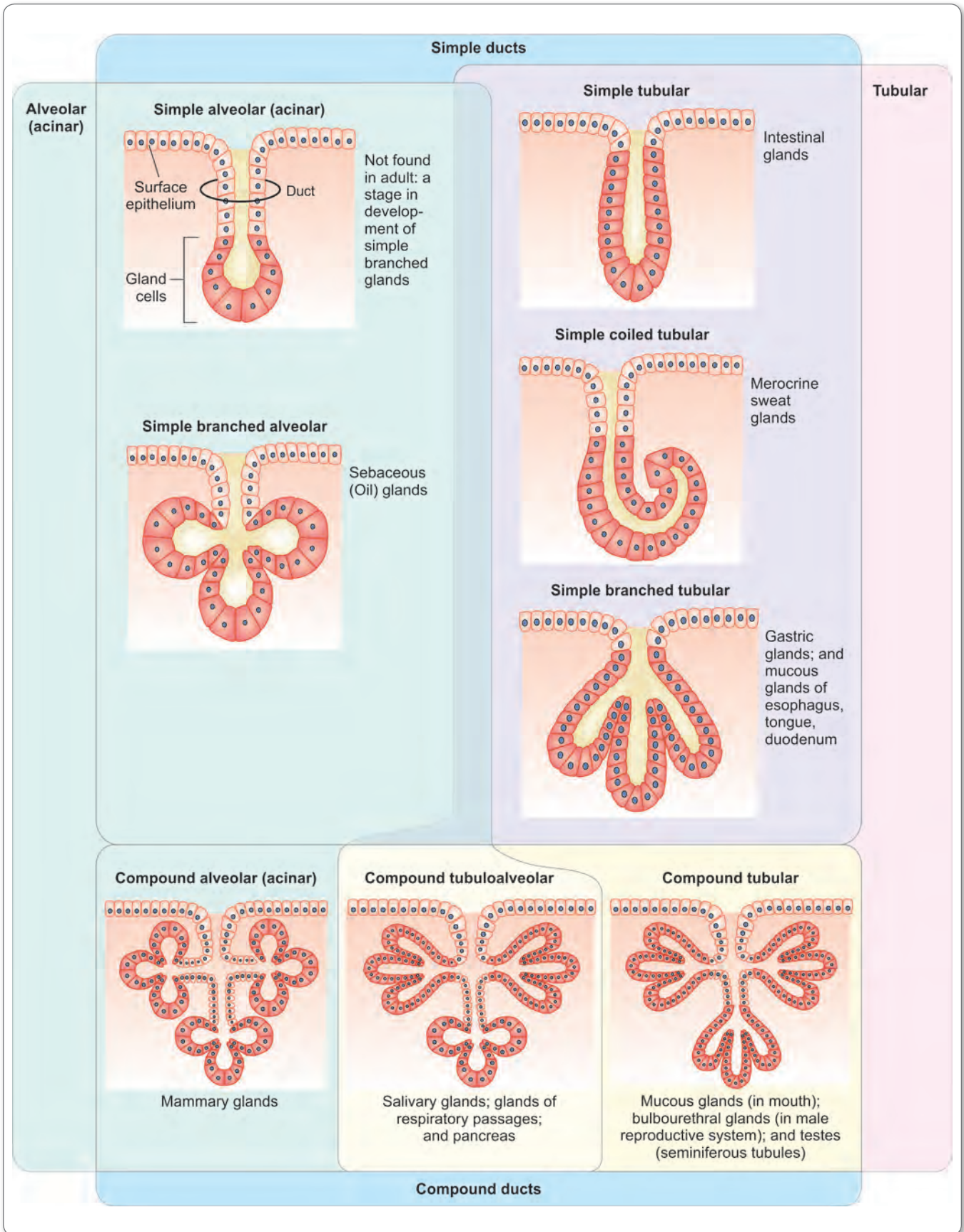


Fig. 14: Demilunes of Giannuzzi

- It is present in mixed salivary gland mostly and also in less number in mucous glands
- Between mucous cell and basement membrane are half moon shaped polyhedral granular serous cells
- Secretions of demilunes make mucous less viscous
- Myoepithelial cells – present between basement membrane and acinar cells which help to squeeze the secretion from acinus.

Gland	Example
Simple alveolar	Mucous gland in urethra
Branched alveolar	Cardiac glands, Meibomian glands, sebaceous gland
Simple tubular	Crypts of Lieberkuhn
Branched tubular	Fundic and pyloric glands
Simple coiled tubular	Sweat glands
Compound tubular	Brunner's gland, mucous gland in mouth, bulbourethral glands, seminiferous tubule
Compound alveolar	Mammary gland and pancreas
Compound tubuloacinar	Submandibular





ACCORDING TO NUMBER OF CELLS

- Unicellular: Unicellular glands-Goblet cells
- Multicellular: Most of the glands are multicellular in the body – lacrimal, parotid etc.

CONNECTIVE TISSUE

The connective tissue binds and weaves through diverse tissues of the body. It provides them mechanical support for withstanding stresses and strains to which the tissue are subject in life.

Composed of cells and extra cellular matrix (ground substance and fibers).

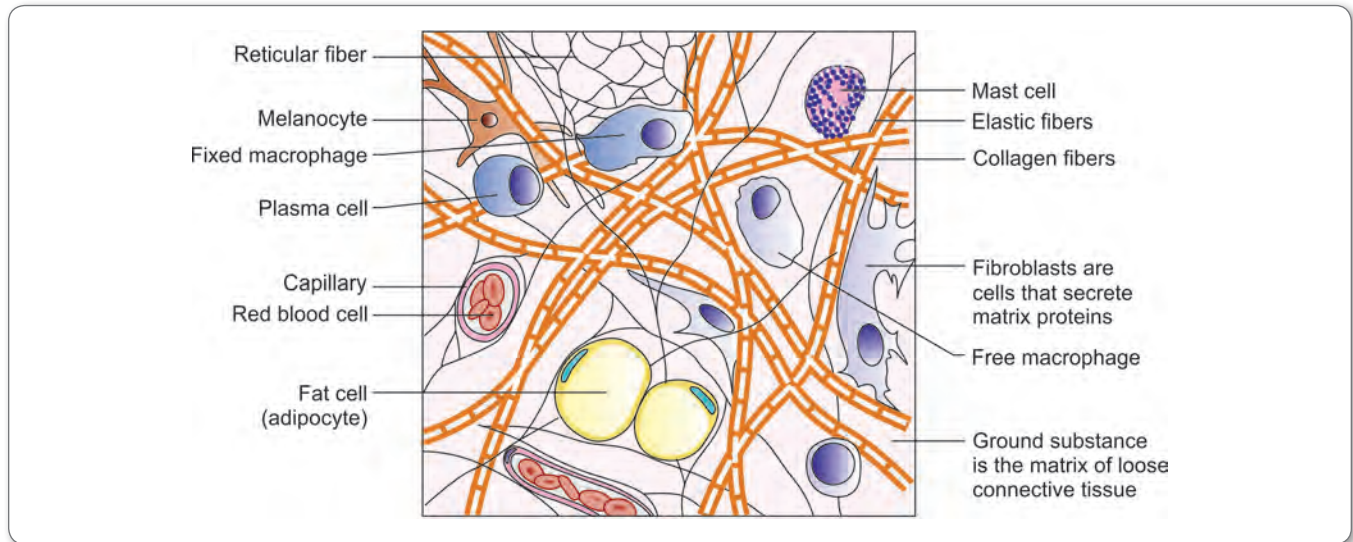


Fig. 15: Loose connective tissue

CELLS

Fibroblasts

- Responsible for the production and long-term maintenance of extracellular components, e.g. fibers and ground substance
- These are stem cells with multiple processes, basophilic cytoplasm, and large rounded vesicular nuclei
- In the resting phase, these cells appear spindle-shaped with long tapering ends and are called fibrocytes.

Adipose or Fat Cells

- Specialized cells for the synthesis and storage of fat
- These cells are spherical/oval in shape. Each of the cells accumulate lipid to such an extent that the nucleus gets flattened and displaced to 'one side' and cytoplasm becomes so thinned that it is resolved only as a thin line around the rim of the single large droplet
- It is present in the subcutaneous tissue, in the mesentery and posterior abdominal wall.

Mesenchymal Cells

- Mesenchymal cells are the precursors of all types of cells

- They are usually arranged along the blood vessels particularly along the capillaries.

Pigment Cells

- The pigment cells of skin and uveal tract protect the tissues against the harmful effects of ultraviolet light rays.
- These are stellate cells with branching processes. The cytoplasm contains dark brown/black pigment granules, which are usually of melanin.
- It is present in the epidermis of skin, including the hair follicles, a few areas of nervous tissue and the middle coat of the eyeball.

Wandering Cells

Macrophages/Histiocytes

- Phagocytic (phage—to eat) in nature, i.e. they phagocytose and digest bacteria and foreign bodies, damaged and dead tissues
- These cells may be fusiform, stellate or spheroidal in shape. The nucleus tends to be smaller, darkly stained, usually indented and lies at one end of the cell
- Most numerous in loose connective tissue, also in the connective tissue of various organs.

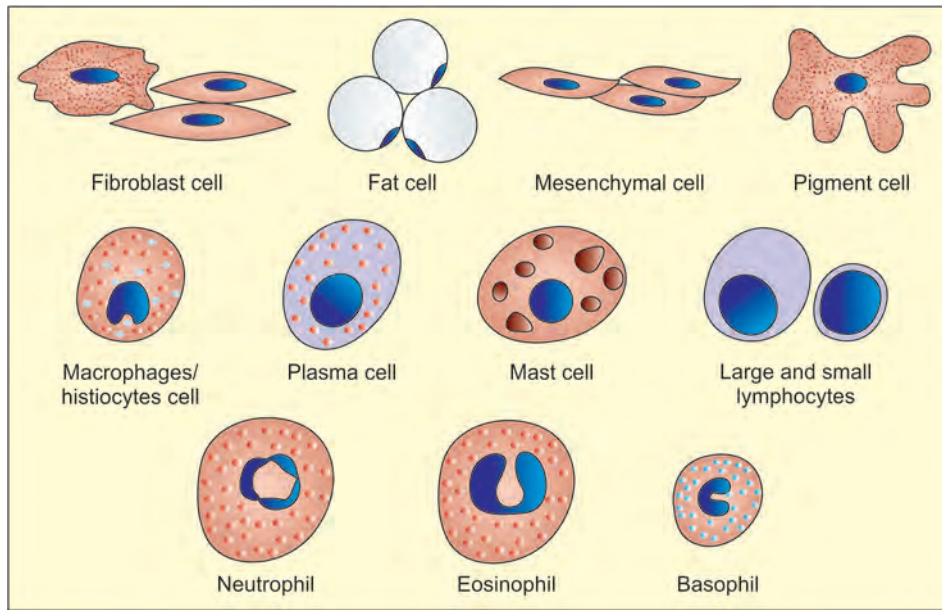


Fig. 16: Various cells of connective tissue (400X)

Plasma Cells

- Specialized for the manufacture of antibodies against antigens.
- Ovoid in shape, with a slightly eccentric, oval or round nucleus and intensely basophilic cytoplasm.

Mast Cells

- These cells secrete:
 - Histamine responsible for producing allergic symptoms
 - Heparin, the anticoagulant
 - 5-hydroxytryptamine or serotonin, which is a vasoconstrictor
- Large round or ovoid in shape. The nucleus is round and small, relative to the size of the cell. The cytoplasm is packed by intensely stained nad coarse granules.

White Blood Cells

- Carry the antibodies that phagocytose bacteria, etc.
- Lymphocytes are large or small according to the amount of contained cytoplasm. Neutrophils have usually 3 to 5 lobes of nuclei with small or fine eosinophilic granules. Eosinophils are associated with allergic reactions while small basophils are responsible for anaphylaxis
- Present in loose connective tissue. White blood cells wander to reach the site of infection. The lymphocytes are preponderant in chronic infection, while neutrophils are active in acute infections.

FIBERS

Fibers are of three types:

- Collagen fibers
- Elastic fibers
- Reticular fibers

Collagen Fibers

These are seen in all types of connective tissue (aponeurosis and superficial fascia).

According to the chemical composition, collagen fibers are classified into four grades:

- Grade I are the thickest fibers seen in bone and connective tissue
- Grade II are visible in the hyaline cartilage
- Grade III are in the walls of arteries
- Grade IV are the thinnest fibers present in the basement membranes. Grade IV fibers are also termed as the reticular fibers.

Table 3: Types of collagen

Type of collagen	Found in
Type I	Bones, fibrocartilage, tendons, ligaments, fascia, connective tissue, thymus, skin and capsule
Type II	Hyaline and elastic
Type III	Spleen, lymph node, bone marrow. Found in relation to smooth muscles and nerve fibres
Type IV	Basement membrane and lens capsule

Elastic Fibers

These are found in the **ligamentum nuchae**, **ligamentum flavum** and in the walls of the large arteries. The fibers appear yellow in color. These are made up of a protein called **elastin**, which is highly resistant to boiling as well as dilute acids and alkalies.



Reticular Fibers

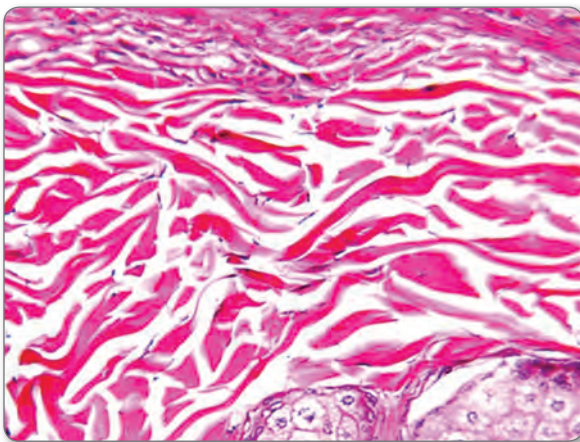
These are seen in lymph nodes, liver, and spleen. Reticular fibers are fine branching fibers, which form a supporting framework for the rich cellular lymphoreticular system and hepatocytes. Reticular fibers absent in thymus

CLASSIFICATION OF CONNECTIVE TISSUE

Loose Areolar Connective Tissue

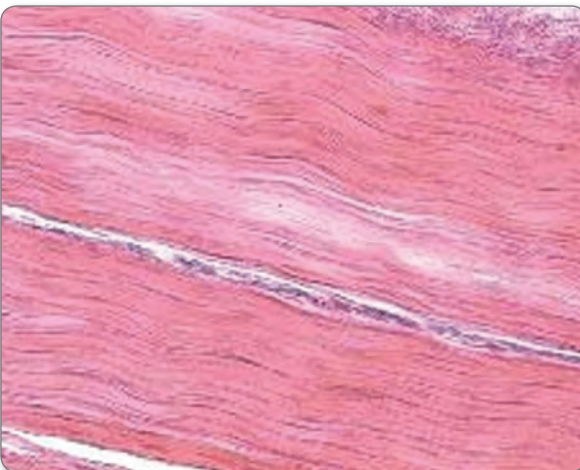
- Loosely arranged cells and fibers in semi fluid substance
- More cells and more ground substances with little collagen
- E.g. – areolar tissue (contain fibroblast, macrophage, mast cells – support frame work) and adipose tissue (store fat).

Dense Irregular Connective Tissue



- Few cells and few ground substances with more collagen (randomly arranged)
- Dermis of skin**, organ capsules, submucosal layer of digestive tract.

Dense Regular Connective Tissue



- Filled completely with parallel bundles of collagen
- Ligaments, tendons, aponeurosis.

Reticular Connective Tissue

- Delicate network of reticular cells with attached fibroblasts
- Bone marrow, liver, pancreas, adrenal glands, all lymphoid organs except thymus.

Adipose Tissue

The differences between white and brown adipose tissue have been discussed below.

Table 4: Main differences between white adipose tissue and brown adipose tissue

Features	White adipose tissue	Brown adipose tissue
Main localization	Subcutaneous, abdominal, inguinal, perirenal, retrosplenic, gonadal, around organs, more dispersed in other places	Interscapular (babies), axillar, perineal, paravertebral, cervical, dispersed in arteries and around organs.
Color	White, yellowish ivory	Brown, reddish to pinkish
Blood vessels	Vascularized	Highly vascularized
Innervation	Sympathetic and parasympathetic nervous systems (normal innervation)	Sympathetic nervous system (highly innervated)
Tissue organization	Highly packaged in small lobules	Organized in lobules
Adipocyte	Rounded, ovoid, 25–200 μm, unilocular: one lipid drop, flattened nucleus: Semilunar and eccentric, very thin cytoplasm, few mitochondria, average amount of endoplasmic reticulum	Polygonal, 15 μm, multilocular: many lipid drops, round to ovoid nucleus, abundant cytoplasm, many mitochondria, scarce endoplasmic reticulum
Immune cells	Abundant	Scarce



Clinical Aspect

- Scleroderma** is a slowly progressive rheumatic disease accompanied by vascular lesions, especially in the skin, lungs and kidneys. It is characterized by deposition of fibrous tissue in the skin. This leads to thickness and firmness of the affected areas. It is an autoimmune disease of connective tissue.
- Dupuytren's contracture:** Occurs due to contraction of fibrous tissue of palmar aponeurosis. The disease results in flexion deformities of fingers especially ring finger and little finger.

CARTILAGE

Specialized dense connective tissue



Composition

- Composed of cells, ground substances and fibers
- Cartilage is usually covered by fibrovascular membrane called perichondrium (composed of outer dense vascular connective tissue with type 1 collagen and inner circular chondrogenic layer which gives chondroblast that secrete cartilaginous matrix)
- Articular cartilage and fibrocartilage are not covered by perichondrium
- Growth in cartilage occurs by:
 - Appositional growth: By surface deposition from cells of inner perichondrial layer
 - Interstitial layer: By multiplication of cells situated within the matrix of the cartilage.

Cells

- Chondrocytes are situated in spaces of matrix known as lacunae
- Single cells are spherical in shape but small groups of 2-4 cells are rounded with flat opposing surfaces – D shaped. These group of cells are termed as cell nests
- The nuclei of the cartilage cells are large and round with 1-2 nucleoli and cytoplasm is basophilic.

Ground Substances

- Amorphous gel-like substance which are produced and maintained by chondrocytes
- Stained by basic dyes due to presence of glycoprotein, the chondro mucoprotein which on hydrolysis yields chondroitin sulphate and keratosulphate
- Ground substances which surround the chondrocytes usually stains more deeply than else where.

Classification

Based on visibility and nature of fibers in the ground substance.

- Hyaline: Contains thin invisible bundles of collagen fibers
 - Chondrocytes in islands or groups
 - Collagen fibers not seen, matrix and collagen fibers refractive index are same.

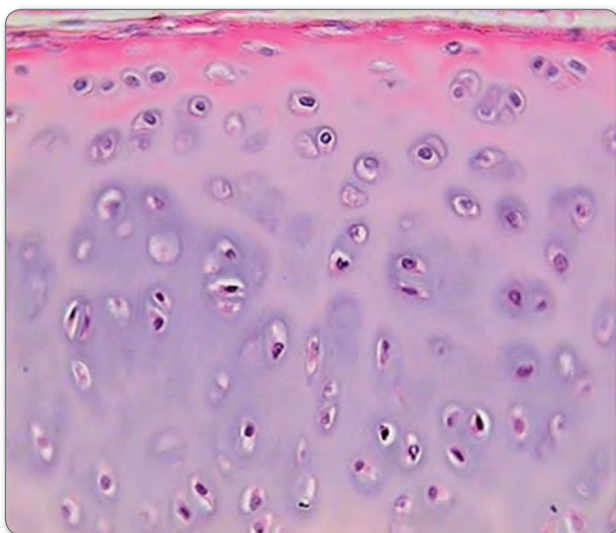


Fig. 17: Hyaline cartilage

- Elastic: With branching elastic fibers
 - Same as that of hyaline
 - But elastic fibers seen using some special stains.

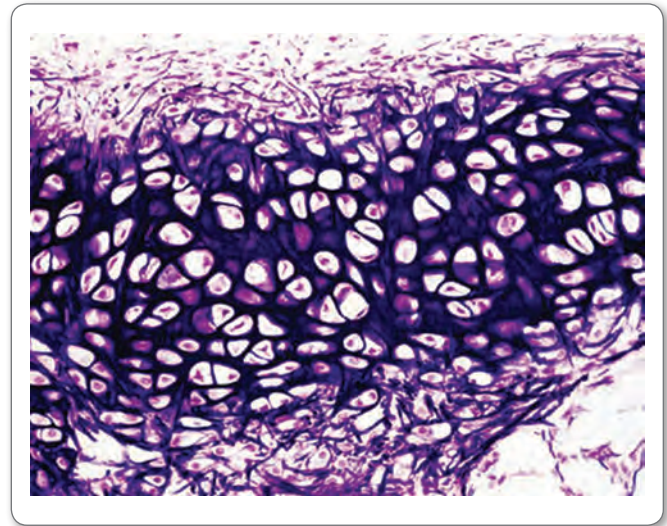


Fig. 18: Elastic cartilage

- Fibrocartilage: Contains thick bundles of collagen fibers
 - Cartilages arranged in rows
 - Bundles of collagen fibers seen.

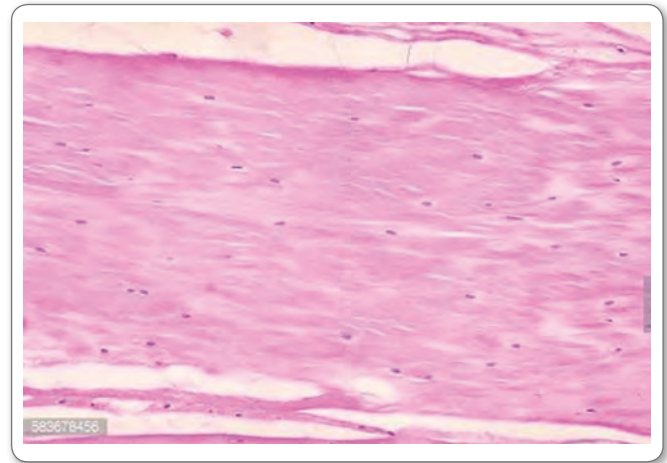


Fig. 19: Fibrocartilage



Table 5: Comparison of types of cartilages

	Hyaline cartilage	Elastic cartilage	Fibrocartilage
Perichondrium	Present, comprising of an outer fibrous layer and inner chondrogenic vascular layer	Present, comprising of an outer fibrous layer and inner chondrogenic vascular layer	Absent
Fibers	Thin collagen fibers	Elastic fibers branching and anastomosing	Thick bundles of collagen fibers
Cells	Chondroblasts and chondrocytes	Chondroblasts and chondrocytes	Fibroblasts and chondrocytes
Ground substance	Glycoprotein—the chondromucoprotein	Glycoprotein—the chondromucoprotein	Minimal ground substance
Calcification	Occurs in old age	Does not occur	Occurs only during bone repair
Collagen type	Type II	Type II	Type I
Examples	<ul style="list-style-type: none"> • Articular cartilage • Costal cartilage • Embryonic cartilage • Trachea and bronchi • Thyroid cartilage • Cricoid cartilage • Arytenoid except apex • Epiphyseal plate 	<ul style="list-style-type: none"> • Eustachian tube • External ear • Epiglottis • Corniculate • Cuneiform • Apex of arytenoid 	<ul style="list-style-type: none"> • Menisci of knee joint • Intervertebral discs • Articular disc of temporomandibular joint and sternoclavicular joint • Labrum of shoulder joint and hip joint • Found in secondary cartilaginous joint

BONES

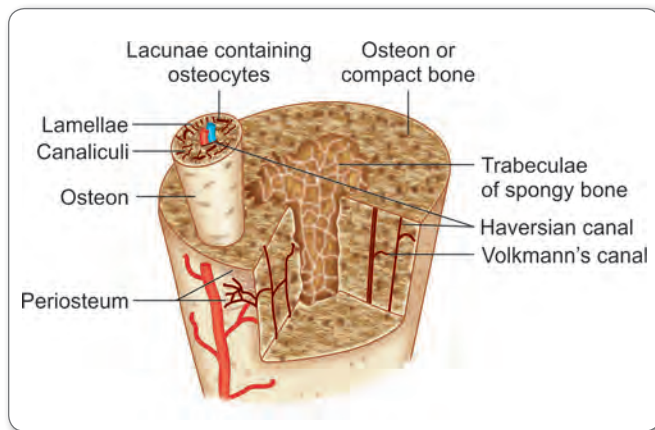


Fig. 20: Histology of bone

- Bone is another specialized dense connective tissue where the matrix is impregnated with calcium salts making it hard and rigid
- Bone has an organized canalicular mechanism and is highly vascular
- Bone is composed of cells and intercellular substances
- Covered by fibrovascular osteogenic membrane called periosteum.

Cells of Bone

- Osteogenic cells: Precursors of other cell types and are found in the inner layer of periosteum
- Osteoblasts: Found where active bone is formed. Large basophilic cells with large rounded eccentric nuclei. These cells lay down fibers and matrix in the areas of bone formation
- Osteocytes: Resting cells enclosed in the bony matrix. Osteocytes lie in spaces/lacunae in the matrix. Radiating in all directions from the lacunae are exceedingly slender branching tubular passages called canaliculi. Canaliculi anastomose with similar canaliculi of the neighboring lacunae
- Osteoclasts: Large/giant cells present where bony resorption is required.

Classification of Bones

- Compact or dense: Bone is harder and denser, e.g. shaft of long bones
- Cancellous or spongy: Bone has bigger marrow spaces and is relatively less hard, e.g. end of long bones.

Microstructure of Compact Bone

- Bone is covered by periosteum consisting of outer fibrous layer and inner osteogenic and vascular layers
- Collagen fibers from this layer penetrate into outermost lamellae of bones nailing the two together termed sharpey's fibers
- Characteristic feature of compact bone is Haversian system or osteon

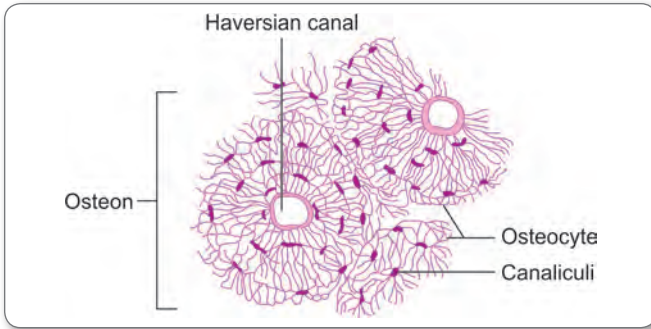


Fig. 21: Microstructure of compact bone

- Each Haversian system comprises:
 - Centrally situated Haversian canal containing fine vessels, nerves and lymphatics. The Haversian canal is surrounded by 6–12 concentric lamellae
 - Haversian lamella or matrix is composed of collagen fibers and deposited calcium salts.

- Between lamellae or on the lamellae are spaces/lacunae imprisoning the osteocytes.
- Canaliculi from adjacent lacunae communicate with each other
- Haversian canals are connected with one another and communicate with marrow cavity via Volkmann’s canal
- Interstitial lamellae lie in the angles between adjoining Haversian lamellae
- Bone marrow absent.

Microscopic Structure of Cancellous/Spongy Bone

- Haversian systems are absent in spongy bone
- Bone tissue is arranged as thin plates or trabeculae
- Between the adjoining trabeculae are large irregular spaces containing bone marrow
- At the margin of trabeculum are osteoblasts and osteoclasts and in the lacunae of trabeculum are present in the osteocytes
- Cancellous bone is covered with periosteum.

MUSCLE

Table 6: Types of muscles and their features

Features	Skeletal muscle	Smooth muscle	Cardiac muscle
Location	Mostly in limbs, trunks	In the wall of viscera and blood vessels	Heart
Connective tissue	Encloses the muscle as epimysium, perimysium and endomysium	Organized as only endomysium	Organized as only endomysium
Fiber length	Very long	Up to 15–200 nm	50–100 nm
Width	Wide fiber	Small	Small
Striations	Transverse striations prominent	Not seen	Faint transverse striations
Nucleus	Peripheral and multinucleated	Central and single	Central and single
Shape	Cylindrical	Spindle shaped	Short cylinders with branches
Junctional complexes	Nil	Gap junctions	Intercalated disc with desmosome
Nerve supply	Cranial and spinal nerves	Autonomic system	Autonomic system
Activity	Voluntary contraction strong, discontinuous Quick voluntary contractions	Slow weak involuntary contractions	Quick, strong continuous involuntary contractions

Structure of Skeletal Muscle

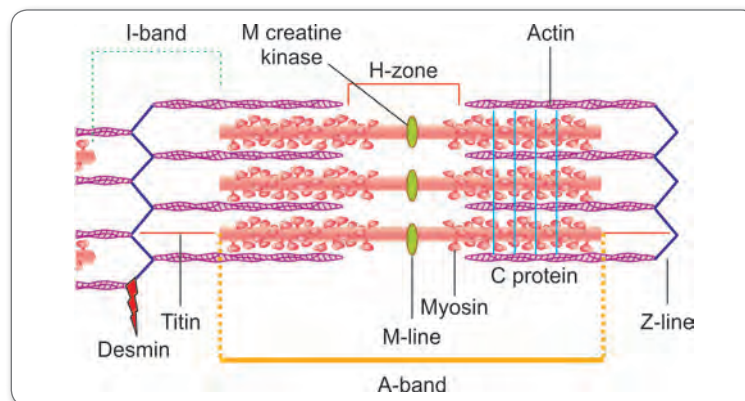


Fig. 22: Structure of skeletal muscle

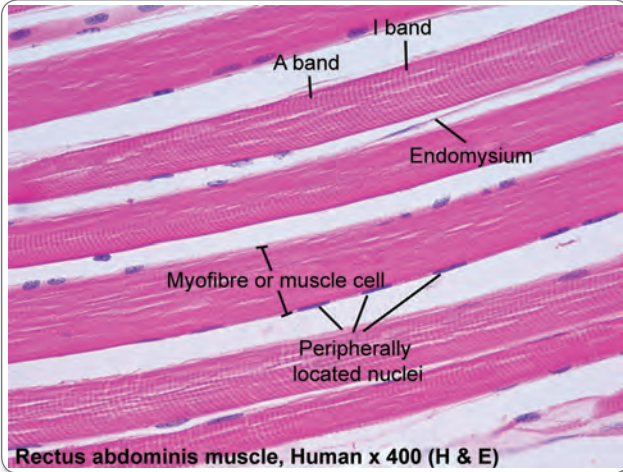


Fig. 23: Histology of skeletal muscle

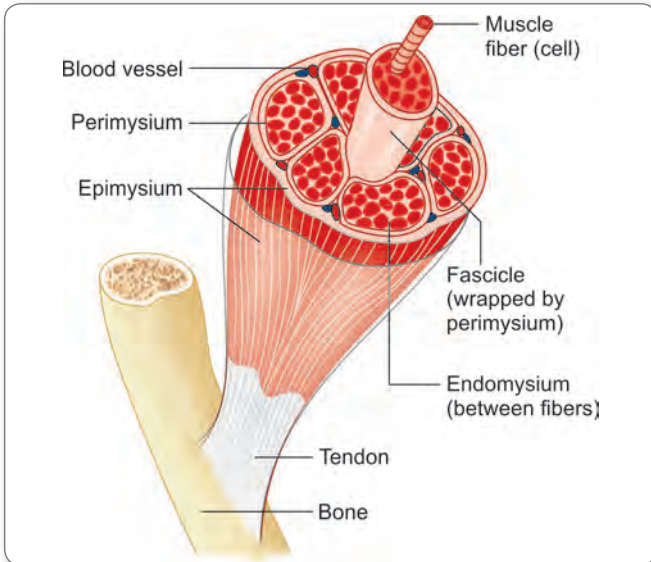


Fig. 24: Single multinucleated skeletal muscle cell

- Each fiber is surrounded by outer limiting membrane called sarcolemma
- Under high power, myofibrils depict alternate dark and light bands
- These dark and light bands produce cross striations in muscle
- Each of dark and light bands are intersected by lines
- Dark band or A band contains a light zone called H zone
- Light band I band is similarly bisected by a dark transverse line Z line
- Functional unit of muscle fiber is known as sarcomere which is segment between two successive Z lines and therefore includes one A and half of two contiguous I band
- During phases of contraction, length of A band remains constant while length of H and I band is shortened.

Cardiac Muscle

- Muscle fibers are joined together by surface specialisations known as intercalated discs

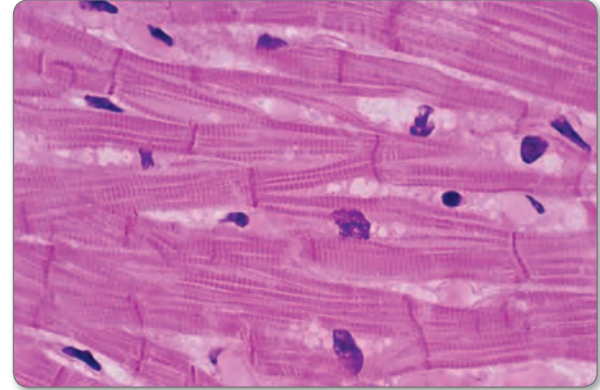


Fig. 25: Histology of cardiac muscle

- Three types of cell junctions make up an intercalated disc— fascia adherens, desmosomes and gap junctions
- Fascia adherens: Are anchoring sites for actin and connect to the closest sarcomere
- Desmosomes (macula adherens): Stop separation during contraction by binding intermediate filaments, joining the cells together
- Gap junctions: Allow action potentials to spread between cardiac cells by permitting the passage of ions between cells producing depolarization of heart muscle.

BLOOD VESSELS

Blood vessels consists of arteries, capillaries and veins
Consists of three layers from within outward.

- Tunica intima
- Tunica media
- Tunica adventitia.

LARGE SIZE ARTERY—ELASTIC ARTERY

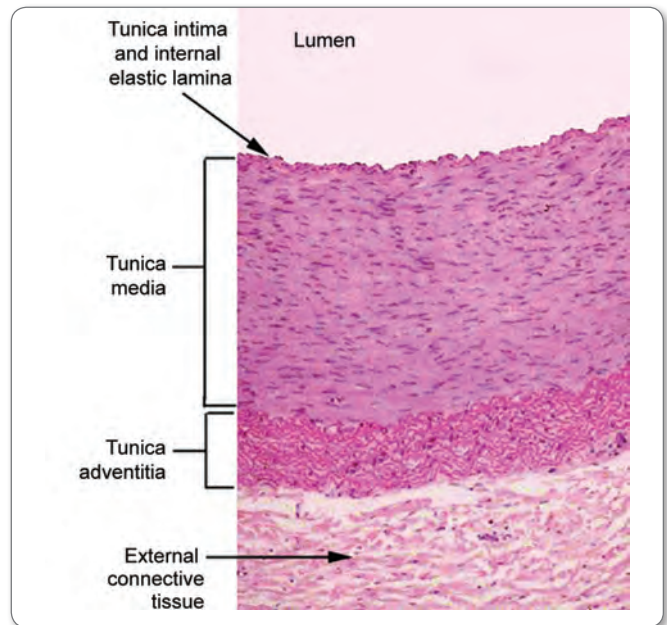


Fig. 26: Elastic artery



Tunica Intima

- Consists of single layer of endothelial cells directed towards the lumen
- Endothelium is supported by thin layer of subendothelial connective tissue consisting of both collagen and elastic fibers
- Fenestrated elastic membrane known as internal elastic lamina made up of elastic fibers that separates tunica intima from tunica media.

Tunica Media

- Thickest layer consisting of predominantly elastic fibers
- These fibers are arranged circularly in the form of fenestrated elastic lamellae
- In between elastic lamellae circularly arranged smooth muscle fibers are present
- The last layer of elastic lamellae is named as external elastic membrane.

Tunica Adventitia

- Thin connective tissue made up of fibrous tissue with loose network of elastic fibers

Note: In internal and external elastic lamina are present but cannot be differentiated from surrounding elastic fibers present in tunica media.

MUSCULAR ARTERY—MEDIUM SIZED ARTERY

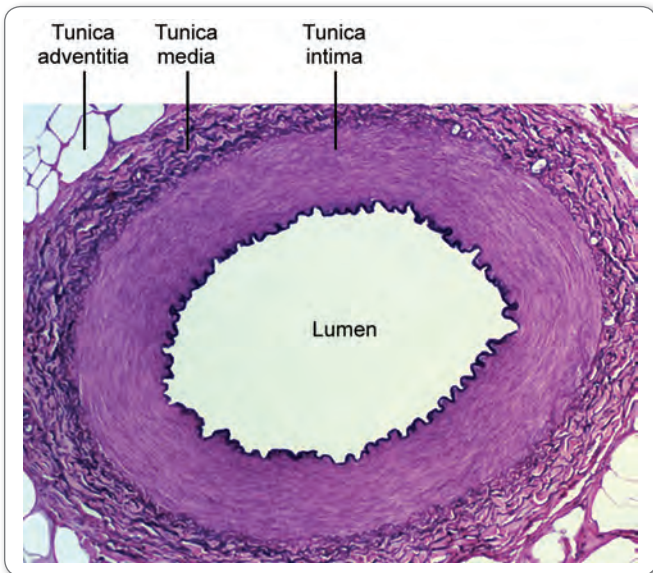


Fig. 27: Muscular artery

Tunica Intima

- Single layer of endothelium resting on basement membrane
- **Internal elastic membrane is more clearly seen.** Appears as wavy fold because of contraction of muscular media.

Tunica Media

- Composed predominantly of circular and spirally arranged smooth muscle with few elastic and collagen fibers
- It is separated from tunica adventitia by well defined external elastic membrane.

Tunica Adventitia

- Composed of loose connective tissue with collagen and elastic fibers
- Thickness of tunica adventitia of muscular artery is almost equal to that of media.

Table 7: Features of large and medium sized artery

Features	Large artery	Medium sized artery
Tunica intima	Internal elastic lamina not clearly demarcated	Internal elastic lamina clearly seen
Tunica media	Thickest layer, consists of elastic fibers arranged in the form of fenestrated elastic lamellae with smooth muscle fiber present in between lamellae	Consists predominantly of circularly arranged smooth muscle fiber with few elastic fiber
Tunica adventitia	Thin layer separated from media by external elastic lamina which is not clearly seen	Thickness of tunica adventitia is equal to thickness of tunica media with well-defined external elastic lamina

LARGE VEIN

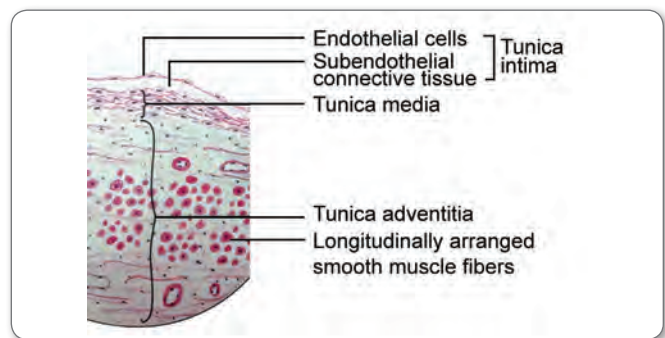


Fig. 28: Large vein

Tunica Intima

- Consists of flattened endothelial cells supported by minimal amount of subendothelial connective tissue
- Internal elastic lamina absent in large veins (wall of the vein collapsed).

Tunica Media

Made up of few layers of circularly arranged smooth muscle.



Tunica Adventitia

- Thickest layer of large vein
- Also contains longitudinally oriented smooth muscle fibers (this is absent in medium sized veins).

MEDIUM SIZED VEIN

Tunica Intima

Consists of endothelial cells, thin layer of subendothelial connective tissue and thin internal elastic membrane.

Tunica Media

Thinner and made up of several layers of circularly arranged smooth fibers with few collagen and elastic fibers.

Tunica Adventitia

Thicker and made up of collagen and elastic fibers.

HISTOLOGY OF LYMPHATIC SYSTEM

PRIMARY AND SECONDARY LYMPHOID ORGAN

- Primary lymphoid organ: Bone marrow, thymus
- Secondary lymphoid organ: Lymph node, tonsil, spleen and mucosa-associated lymphoid tissue (MALT)

HISTOLOGY OF SPLEEN

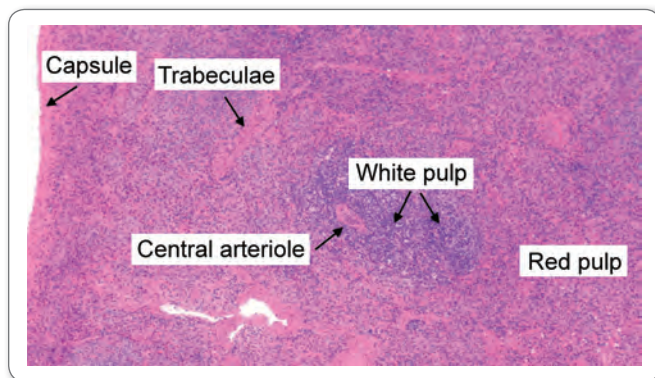


Fig. 29: Structure of spleen

- Covered by capsule and trabeculae arising from the capsule
- Trabeculae extend into the substance of the spleen
- Parenchyma of spleen consists of red pulp and white pulp
- Red pulp: Consists of splenic cords of Billroth's and sponge like sinusoidal space, through which red cells are passed. These phagocytic cells lining the sinusoid engulf the broken red cells and other debris
- Splenic cords of Billroth: Consists of anastomosing bundles of collagen, elastic fibers and reticular fibers with lymphocytes, fibroblast, reticular cells and macrophages

- Splenic sinusoids are surrounded by flattened, elongated modified endothelial cells called as stave cells—banana shaped cell
- White pulp: Aggregations of T and B lymphocytes that surround the arteries (periarteriolar lymphocytic sheath). White pulp also contain some antigen presenting cells.

Open and Closed Circulation

- Splenic branch of splenic artery—end artery
- Enters the spleen through hilum
- Divides into trabecular artery which runs in connective tissue trabeculae
- Leaves the trabeculae and it is surrounded by lymphatic tissue then it is called as central arteriole
- Central arterioles opens into splenic cords of red pulp as penicillar artery
- Here blood is exposed to macrophages and enter the splenic sinuses—open circulation
- Penicillar artery opens directly into splenic sinuses—closed circulation.

HISTOLOGY OF THYMUS

Lymphoid organ consists of right and left lobes covered on the outer aspect by fibrous capsule

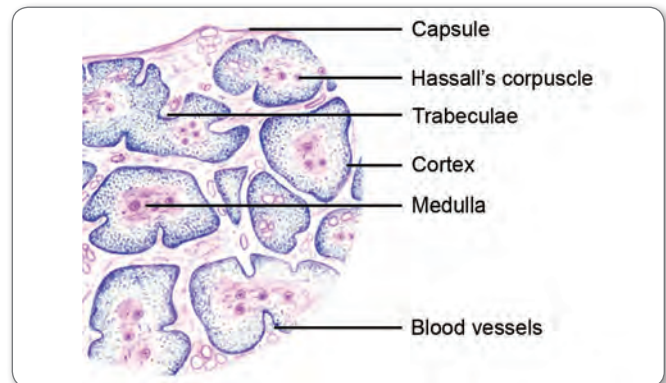


Fig. 30: Histology of thymus

- Septum arising from capsule incompletely divides the parenchyma into lobules
- Connective tissue septum separate the lobules
- Each lobule contains outer darkly stained cortex, in which densely packed lymphocytes and inner lightly stained medulla, in which the cells are diffuse
- Medulla consists of lymphocyte, more reticular cells and also Hassall's corpuscles
- Hassall's corpuscles consists of central pink hyaline mass formed by degenerated epithelial cells. Around this mass, concentrically arranged epithelial cells. The functional significance of this cell is not known
- Blood thymic barrier: Protects the newly generating lymphocytes from antigen present.



Six types of epithelioreticular cells present in thymus named from I to VI

- Hassall’s corpuscles contain type VI epithelioreticular cells
- Blood thymic barrier contains type I epithelioreticular cells.

Structures Forming Blood Thymic Barrier

- Endothelial lining of capillaries and its basal lamina
- Perivascular lining of capillaries and its basal lamina
- Type 1 epithelioreticular cells.

HISTOLOGY OF LYMPH NODES

- Covered by fibrous capsule from which trabeculae extend into cortex
- Subcapsular sinus present below the capsule separates the cortex from the capsule
- Parenchyma of the lymph node is then divided into outer cortex and inner medulla.

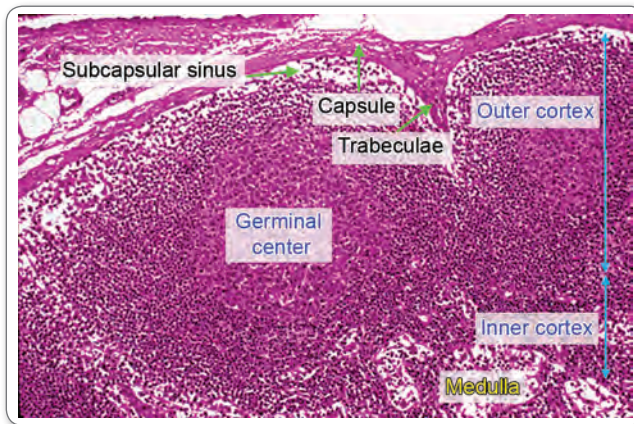


Fig. 31: Histology of lymph nodes

Cortex

- Lymphocytes are arranged in the form of lymphatic follicles.
- Lymphatic follicle consists of pale germinal center contains large immature cells called lymphoblast and surrounded by thick peripheral cells contain mature lymphocytes. Deep part of cortex contains diffuse lymphatic tissue not arranged as nodules. This portion of cortex is known as Para cortex.

Medulla

Medulla contains lymphocytes arranged in the form of anastomosing cords called medullary cords. Medullary sinuses occupy the spaces present in between the medullary cords. Each medullary cord contains lymphocytes, macrophages, dendritic and plasma cells.

Features of Lymph Node

- Just below capsule a space is present, hence, it called as sub capsular sinus

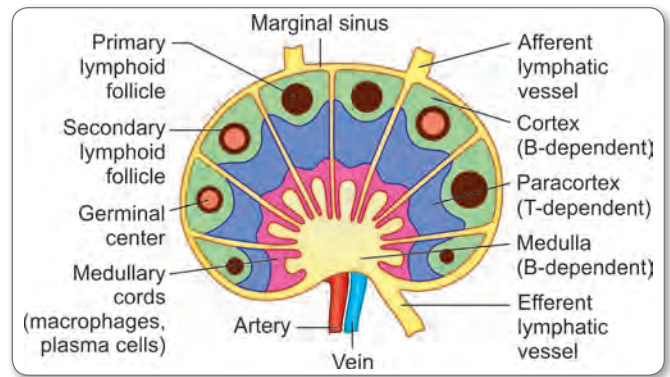


Fig. 32: Flow of lymph through lymph node

- Lymph enters into lymph node through afferent lymphatics
- Afferent lymphatics penetrates the capsule to enter into the lymph node
- Then it passes through sinuses present in the lymph node
- Passes through lymphatic tissue
- Finally lymph exits the lymph node through efferent lymphatic vessel at the hilum of lymph node.

HISTOLOGY OF TONSIL

- Mucous membrane covered by non-keratinized stratified squamous epithelium
- Epithelial lining invaginates into underlying connective tissue forming numerous grooves called tonsillar crypts
- Underlying lamina propria contains numerous lymphatic nodules

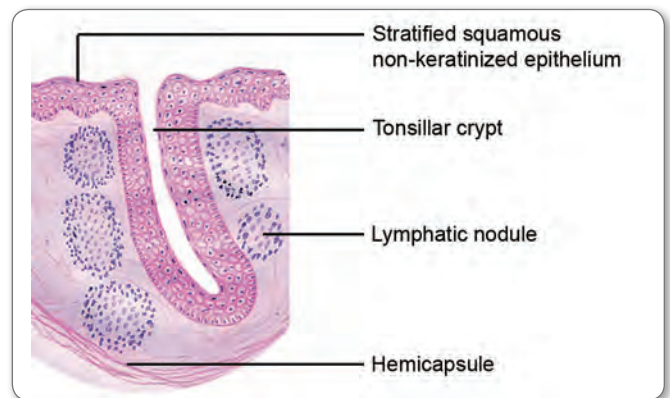


Fig. 33: Histology of tonsil

- These lymphatic nodules contains pale germinal center surrounded by peripheral dark staining lymphoid aggregates
- Beneath the capsule few skeletal muscle fibers seen (belongs to superior constrictor)
- Tonsil have no afferent lymphatic vessel, only efferent vessel drain into deep cervical nodes.

Note: Tonsil is the only lymphoid organ covered by epithelium. Thymus, spleen and lymph node have capsules.



HISTOLOGY OF NERVOUS SYSTEM

- Nervous tissue is a specialized tissue responsible for excitation and conduction of impulse
- Nervous tissue consists of neuron and neuroglia – connective tissue

NEURON

- Neurons are structural and functional unit of nervous system
- Each neuron is consisting of cell body (perikaryon) and its process
- Process include axons and dendrites
- Each neuron has only one axon and one or more dendrites
- Depending upon cell processes, neurons are classified into:
 - Unipolar: Neurons with one cell process which divide close to cell body into two branches, e.g. neurons of dorsal root ganglia
 - Bipolar: Have one axon and one dendrite. These associated with receptors for special senses, e.g. bipolar cells in the olfactory mucosa, neurons associated with ganglion of vestibulocochlear nerve
 - Multipolar: Neurons with single axon and more than one dendrite, e.g. motor neurons and inter neurons.

SUPPORTING CELLS

Table 8: Types of supporting cells and their functions

Astrocyte	Takes part in formation of blood brain barrier
Oligodendrocyte	Responsible for myelination of nerve fibers in the central nervous system
Schwann cells	Surrounds the axons of the neurons. Responsible for myelination of nerve fibers in the peripheral nervous system
Microglial cells	It performs phagocytic function in central nervous system
Ependymal cells	Lines the ventricles
Satellite cells	Surrounds the cell bodies of neurons and it provides electrical insulation to neurons and it act as pathway for metabolic exchange

PERIPHERAL NERVE

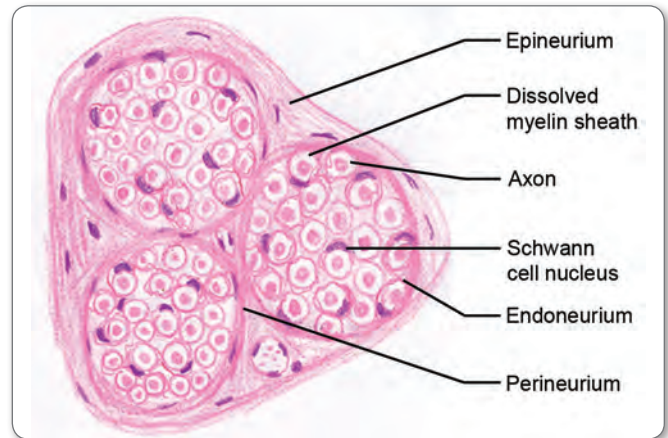


Fig. 34: Peripheral nerve (TS)

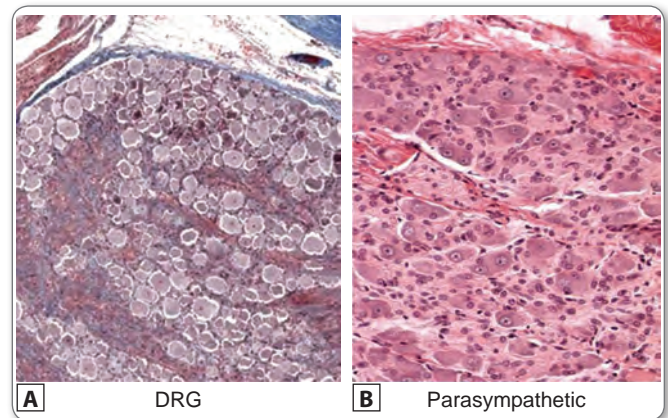
- Transverse section of peripheral nerve shows nerve fibers
- Each nerve fiber consists of axon and its surrounding myelin sheath
- Each individual nerve fibers are surrounded by thin layer of loose connective tissue called endoneurium
- Space present between endoneurium and axons is occupied by myelin sheath and nucleus of schwann cells
- Nerve fibers are arranged in bundles called nerve fascicles. Fascicles are surrounded by connective tissue called perineurium
- Bundles of these nerve fibers together form the peripheral nerve. The entire peripheral nerve is surrounded by epineurium.

GANGLIONS

Collection of nerve cell bodies of neuron outside the central nervous system.

Types

- Sensory ganglion: Dorsal root ganglion (spinal ganglion)
- Motor ganglion: Autonomic ganglion includes both sympathetic and parasympathetic ganglion.



Figs 35A and B: Sensory and autonomic ganglia (cells)



Table 9: Differentiating features of sensory and autonomic ganglia

Features	Sensory ganglia	Autonomic ganglia
Capsule	Covered by thick capsule	Covered by thin capsule
Type of neuron	Unipolar neurons consists of round cell bodies with centrally placed nucleus	Multipolar neurons consists of polygonal shaped cells bodies with eccentrically placed nucleus
Arrangement of cell bodies	Arranged as groups towards the peripheral portions of ganglion	Cell bodies are scattered uniformly throughout the ganglion
Nerve fibers	Consists of predominantly myelinated and few unmyelinated nerve fibers	Consists of predominantly unmyelinated and few myelinated nerve fibers
Supporting cells	Satellite cells are prominent and more in number	Satellite cells are few in number and merged with surrounding connective tissue

SPINAL CORD

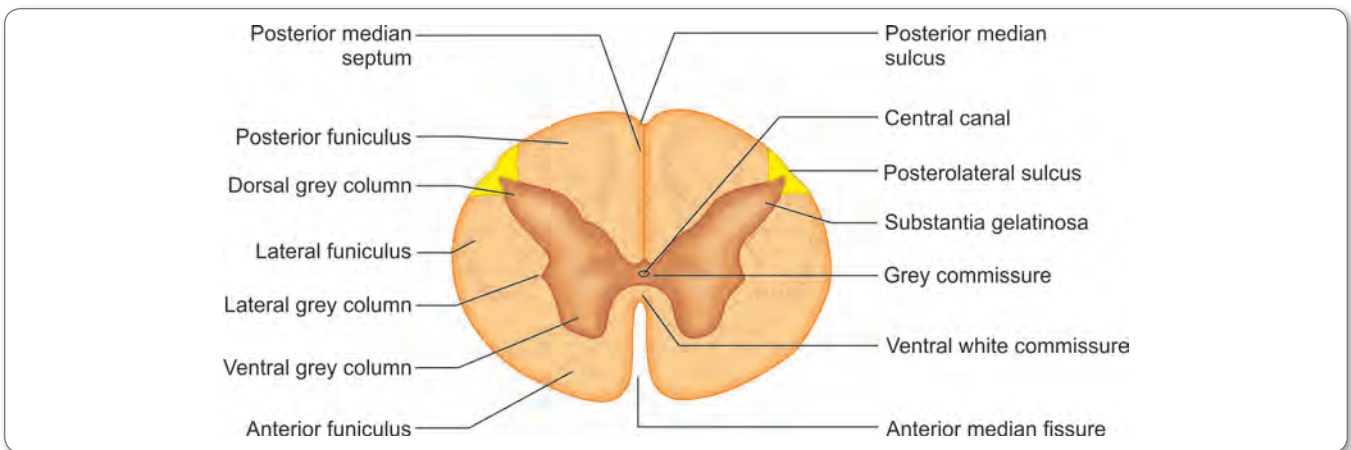


Fig. 36: Transverse section of spinal cord

- Cut section of spinal cord shows inner grey and outer white matter
- Inner grey matter presents pair of broad and short ventral horn and narrow and long posterior horn
- Neurons in anterior horn are motor in function so consist of large multipolar neuron
- Neurons in posterior horn are sensory in function and so consists of small and medium sized neurons
- Both these horn connected by gray commissure
- Lateral horns are present in thoracic and upper lumbar segments which are sympathetic in function
- Grey commissure is traversed by central canal. CSF is the content of central canal. Columnar cells lines the central canal.

Table 10: Features of cut sections of different segments of spinal cord

<p>Cervical segment</p> <ul style="list-style-type: none"> • Transverse diameter is more than anteroposterior diameter • Grey matter contains slender posterior horn and anterior broad horn • Central canal is located anterior to midline • White matter is more than grey matter 	<p>Thoracic segment</p> <ul style="list-style-type: none"> • Anterior posterior diameter is equal to transverse diameter • All horns are slender, resemble shape of letter H • Consists of lateral horn • Central canal anterior to midline
<p>Lumbar segment</p> <ul style="list-style-type: none"> • Anteroposterior diameter is equal to or slightly more than transverse diameter • Amount of grey matter is more • Central canal is in midline • Upper lumbar segments only contains lateral horns 	<p>Sacral segment</p> <ul style="list-style-type: none"> • Anterior posterior diameter is equal to transverse diameter • Grey matter is more expanded • Central canal posterior to midline

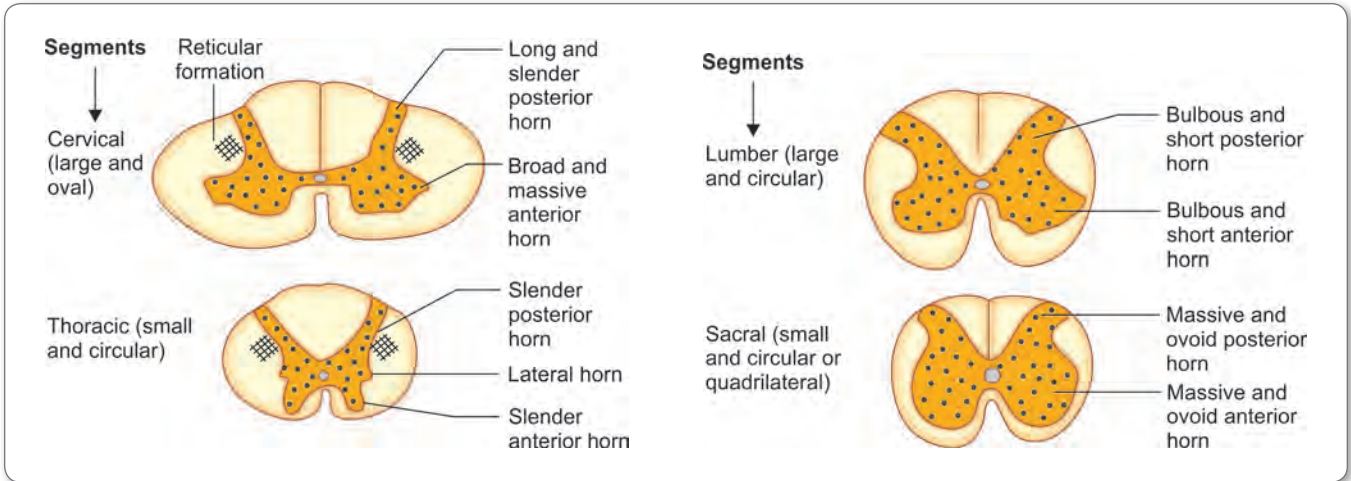


Fig. 37: Features of cut sections of different segments of spinal cord

CEREBRUM

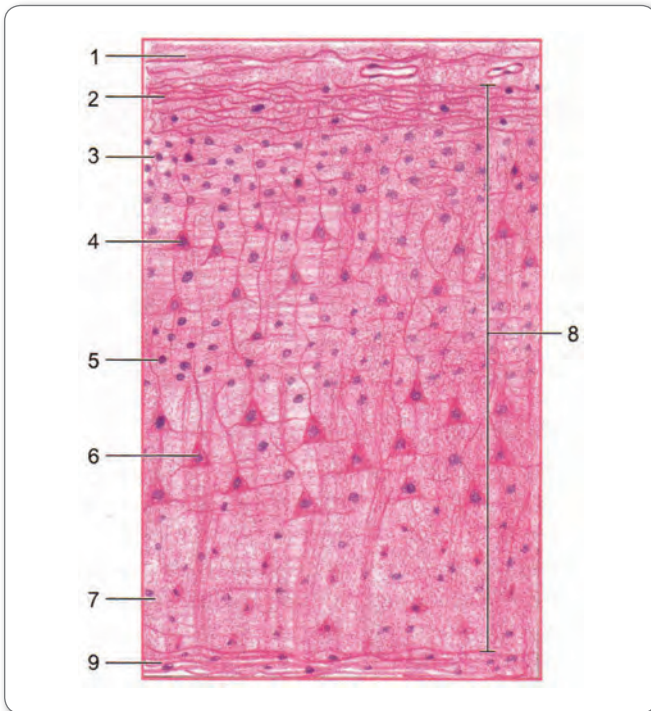


Fig. 38: Histology of cerebrum. Piamater with blood vessels (1) and the layers of cerebral cortex (8) are—molecular layer (2), outer granular layer (3), outer pyramidal layer (4), inner granular layer (5), inner pyramidal layer (6), polymorphic layer (7) White matter (9) can be seen in the lower part of the figure

- Cerebrum consists of outer grey matter and inner white matter
- There are several types of cell present in gray matter are arranged in six layers, from superficial to deep
 - Molecular layer: Consists of cell bodies and processes of horizontal cells of cajal, neuroglial cells and few blood vessel
 - Outer granular layer: Consists of granule cells with its cell processes, dendrites and cell bodies of small pyramidal cells
 - Outer pyramidal cells: Consists of cell bodies and presence of medium sized pyramidal neurons with few granule cells
 - Inner granular layer: Consists of cell bodies and process of granule cells with few small pyramidal cells and neuroglial cells
 - Inner pyramidal layer: Made up of large pyramidal cells with few granular cells and numerous neuroglial cells
 - Multiform layer: Contains cells of varying size and shapes includes fusiform cells and granules and cells of martinotti
 - Deep to gray matter, white matter contains cell processes of neurons entering into or leaving from cortex.

CEREBELLUM

- Cerebellum consists of outer gray matter and inner white matter
- Cortex is arranged in the form of numerous folds known as folium
- Each folium consists of three distinct layers. They are:
 - **Outer molecular layer:**
 - Contains stellate cells and basket cells, dendrites of purkinje cells and axons of granule cells
 - **Inner purkinje layer**
 - Consists of flask-shaped purkinje cells

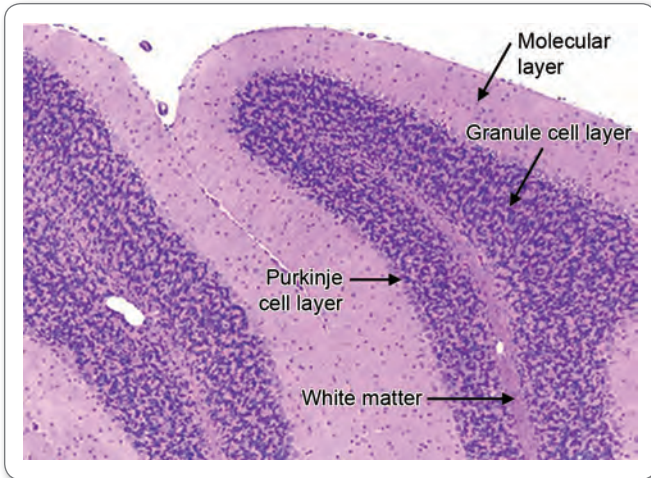


Fig. 39: Histology of cerebellum

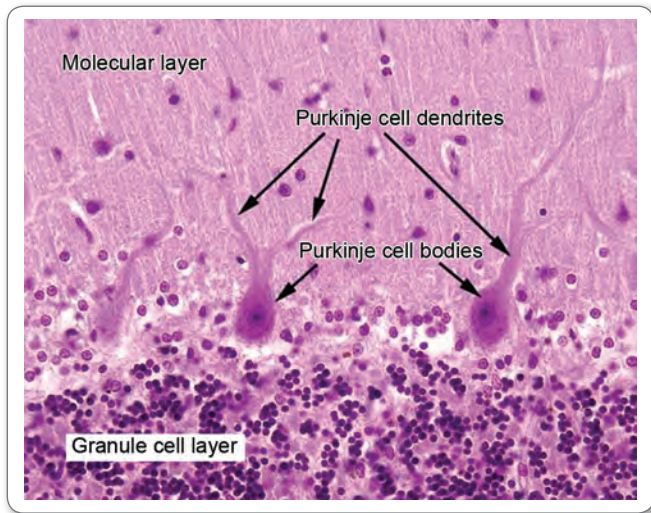


Fig. 40: Histology of cerebellum (High power)

- **Inner granular layer**
 - Contains granular cells, Golgi cells and axons of purkinje cells
- Central core of each folium is invested by white matter
- Granule cells are only excitatory cells whereas all other cells are inhibitory
- Climbing and mossy fibers are afferents reaching cerebellum
- Most of the afferent of cerebellum are reached through mossy fibers
- Purkinje cells is the sole output of cerebellum
- Axons from purkinje cells reach the intracerebellar nuclei. They are—dentate, emboliforms, globose and fastigial nucleus.

SKIN

- Consists of epidermis and dermis
- Depending upon the thickness of epidermis the skin is divided into thin skin and thick skin

THICK SKIN

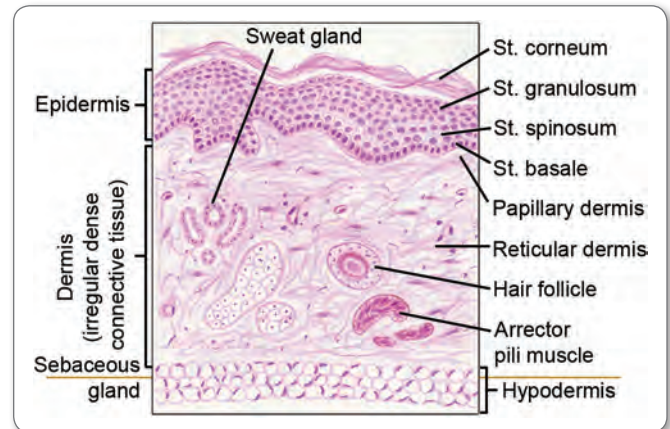


Fig. 41: Histology of thick skin

Epidermis—Consists of 5 Layers

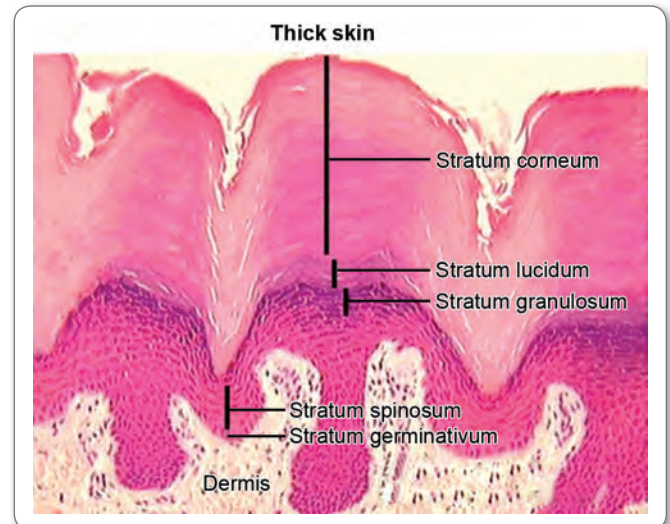


Fig. 42: Histology of epidermis

- Stratum basale: Made up of single layer of columnar cells located on the basement membrane
- Stratum spinosum: Polygonal cells arranged in several layers.
- Stratum granulosum: Consists of 2–3 layers of cells filled with basophilic keratohyaline granules
- Stratum lucidum: Consist of flattened cells that loses their nuclei and organelles and become dead cells
- Stratum corneum: Consists of thick keratin filaments along with ruptured plasma membrane.

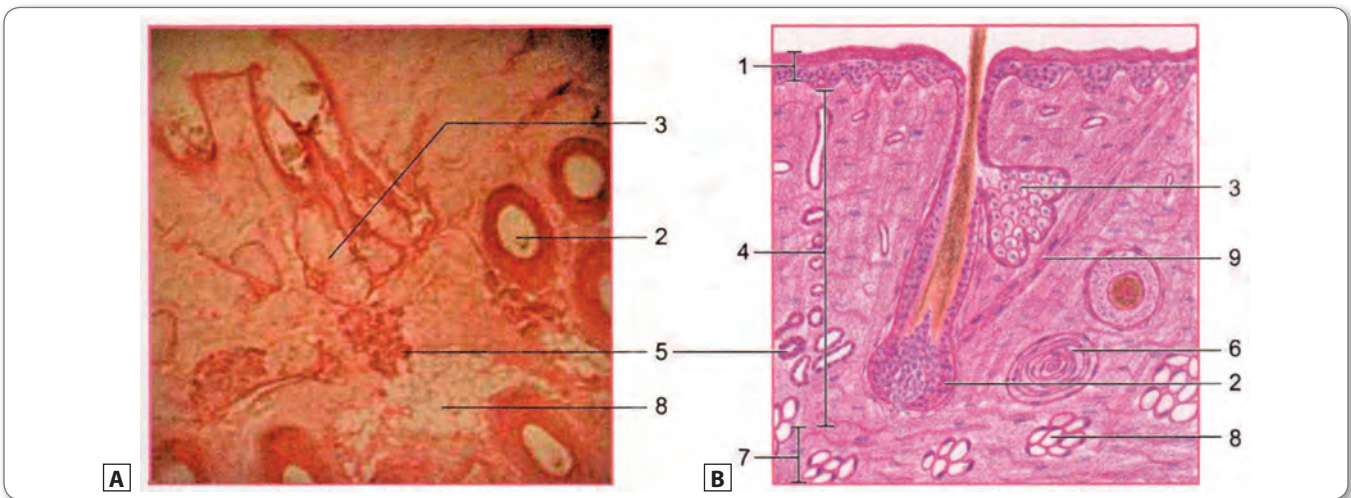
Dermis—2 Layers

- Papillary layer: Present immediately beneath epidermis consisting of numerous cells with loosely arranged connective tissue fibers
- Reticular layer: Present deep to dermis. Secretory part of sweat glands located in dermis.



THIN SKIN

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Figs 43A and B: Histology of thin skin. **(A)** Micrograph; **(B)** Sketch showing thin epidermis (1), hair follicle (2), sebaceous gland (3), sweat gland (5), lamellar corpuscle (6), dermis (4), hypodermis (7), adipose tissue (8) and arrector pili muscle (9)

Epidermis

Avascular structure derive the nutrition from blood vessels in underlying dermis by diffusion

Consists of Four Layers

- Stratum basale: Consists of single layer of basal columnar cells—stem cells
- Stratum spinosum: Consists of few layers of polygonal cells which are larger than cells present in basal layer
- Stratum granulosum: 2–3 layers of gradually flattened cells filled with keratohyaline granules. Stratum lucidum absent in thin skin
- Stratum corneum: Consists of ruptured plasma membrane of cells and its keratin filaments. It is thinner than the corresponding layer in thick skin.

Dermis

- Papillary layer: Thin and more cellular
- Reticular layer: Thick and less cellular

Dermis of thin skin contains root of hair follicle, sebaceous gland, arrector pili muscles (smooth muscle), sweat glands and its ducts.

CELLS PRESENT IN EPIDERMIS

Keratinocytes

Epithelial cells which secrete keratin. Most abundant cell in epidermis.

Melanocytes

Produce melanin pigment. Derived from neural crest cells

- Langerhans cell: Antigen presenting cells
- Merkel cell: Sensory cells.

SENSORY RECEPTORS

- Exteroceptors: Receive information from outside
- Proprioceptors: Receive information from muscles, tendons and joints
- Interoceptors: Receive information from within internal environment.

Types of Sensory Receptors

Free Nerve Endings

- Not covered by connective tissue capsule
- Involved in sensations like temperature, fine touch, etc.

Encapsulated Nerve Ending

- Pacinian corpuscles – receptor for pressure and vibration. Located deep in the dermis & connective tissue of mesenteries and joints.
- Meissner's corpuscles – receptor for fine touch – reading braille. Located superficially within the **dermal papillae**. Dermoepidermo junction. Seen in finger tips, lips, nipple, eyelids.
- Ruffini corpuscles – respond to skin stretch. Seen in dermis and joints
- Muscle spindle – carry proprioceptive impulse
- Golgi tendon organs – mechanoreceptor sensitive to stretch and tension in tendons.

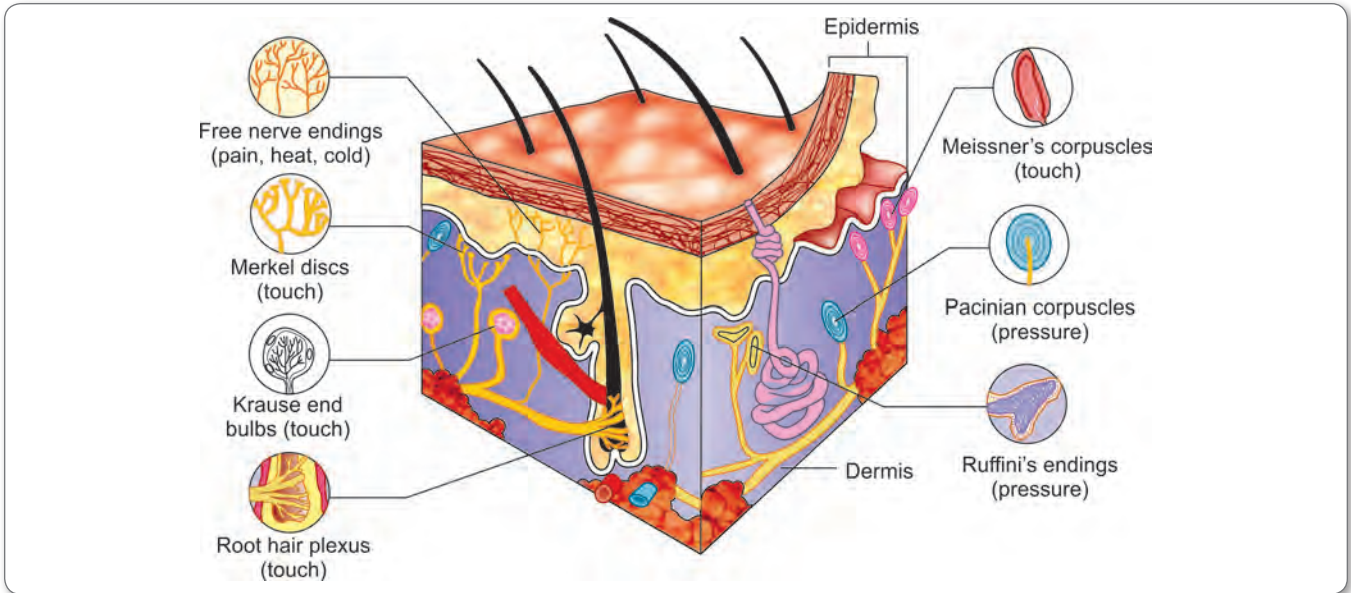


Fig. 44: Sensory receptors

HISTOLOGY OF GASTROINTESTINAL TRACT

Gastrointestinal tract (GIT) consists of four layers:

- Mucosa
- Submucosa
- Muscularis externa
- Serosa (or) Adventitia.

MUCOSA—3 LAYERED

- Lining epithelium
- Lamina propria: Subepithelial layer, which connects lining epithelium to muscularis interna
- Muscularis interna (or) muscularis mucosa is divided into inner circular and outer longitudinal fibers.

SUBMUCOSA

- **Strongest layer of gut wall** connects mucosal layer to muscularis externa.
- It contains blood vessels, glands, nerve plexus and lymphatics.

MUSCULARIS EXTERNA

- Inner circular and outer longitudinal layer (this arrangement is reversed in urinary system—inner longitudinal and outer circular)
- In between circular and longitudinal muscles, myenteric plexuses are present.

SEROSA/ADVENTITIAL LAYER

Organs covered with peritoneum, then it is serosal layer, not covered with peritoneum and then it is adventitial layer.

HISTOLOGICAL FEATURES OF ESOPHAGUS

- Epithelium: Lined by stratified nonkeratinized squamous epithelium
- Submucosa contain esophageal glands
- Muscularis externa-
 - Upper 1/3: Skeletal muscles
 - Middle 1/3: Skeletal and smooth muscles
 - Lower 1/3: Smooth muscles
- Not covered with peritoneum, so it is adventitial layer.

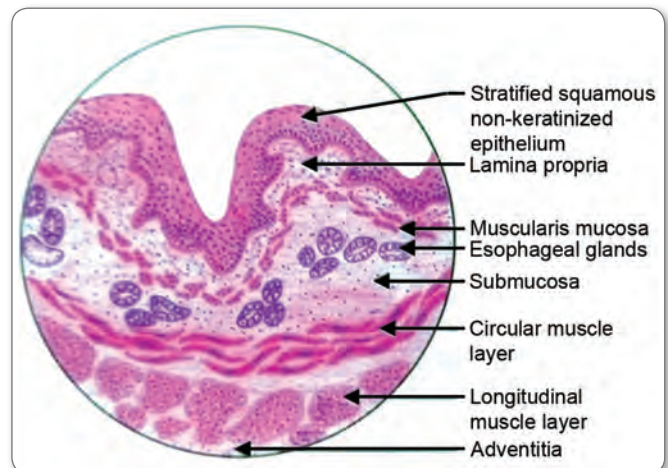


Fig. 45: Histology of esophagus



HISTOLOGY OF STOMACH

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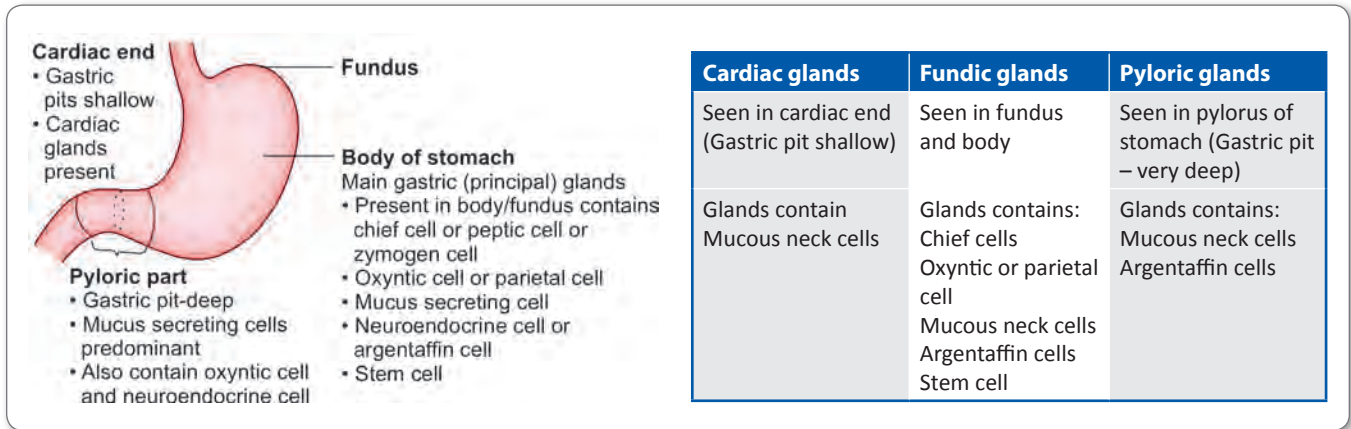


Fig. 46: Structure of stomach

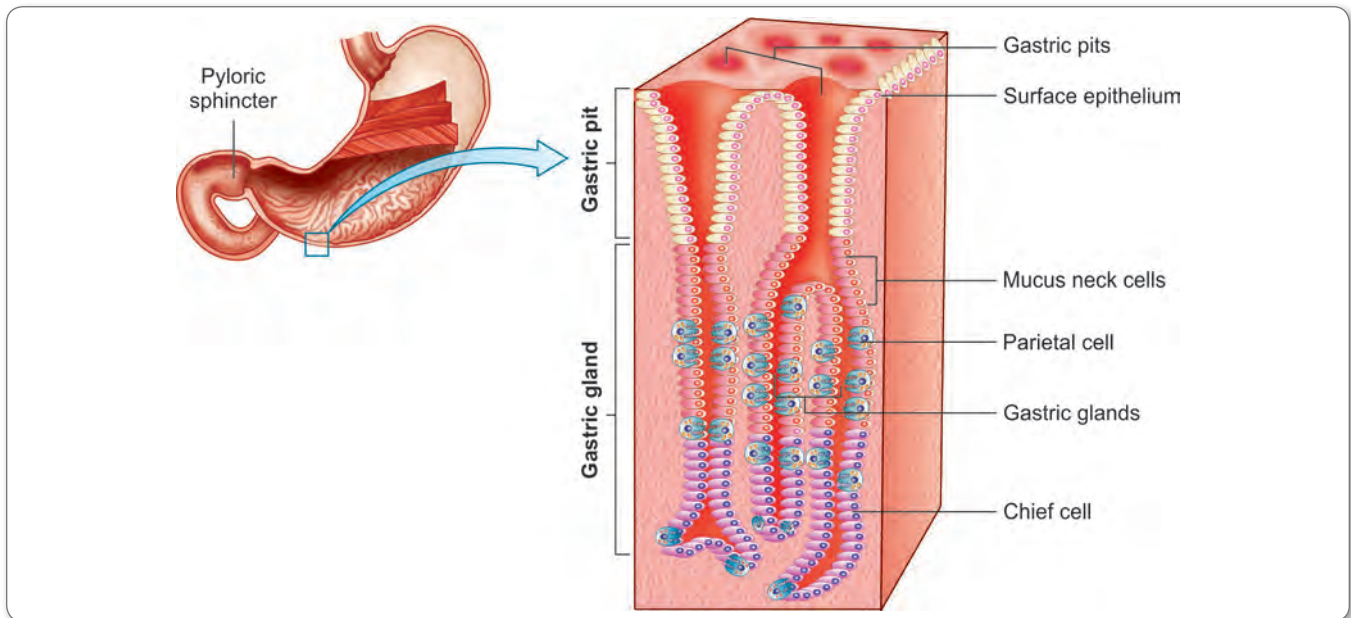


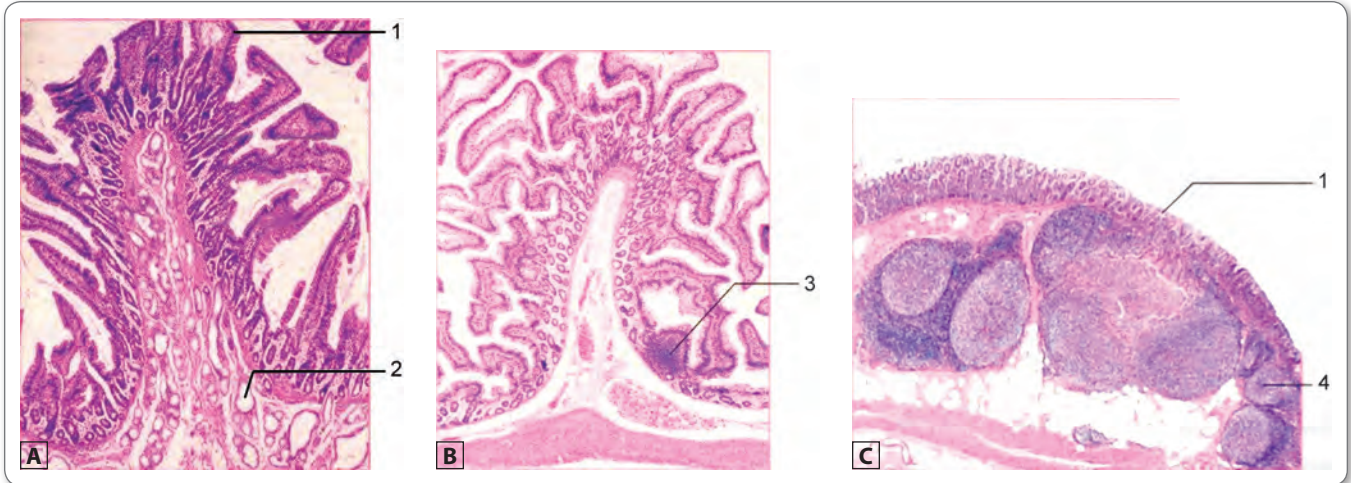
Fig. 47: Histology of stomach

- **Stem cell** present in **neck** of gland/isthmus
- Mucous neck cells present in neck
- Parietal cells/oxyntic cell: Large, round cell, highly eosinophilic cytoplasm. Present in **upper part of gland**
- Chief cell/peptic cell/zymogen cell: Present in **base** of gland. Basophilic cytoplasm. Secrete **pepsin**
- Endocrine cells (Argentaffin cells): Scattered among exocrine cells (Argentaffin cell) **secrete gastrin**
- They reduce silver salts (hence called argentaffin cell).

HISTOLOGY OF SMALL INTESTINE

Luminal surface of small intestine possesses plicae circulares, intestinal villi and microvilli which collectively increase the surface area by factor 400–600.

- Small intestine slides are identified by their villi



Figs 48A to C: Histology of: (A) Duodenum; (B) Jejunum and (C) Ileum. All 3 are lined by simple columnar epithelium (1). Villi of duodenum are tall, broad and leaf-shaped, while in jejunum and ileum, they have clubbed end and are finger-shaped, respectively. Mucus secreting Brunner's gland (2) in submucosa are a typical feature of duodenum. Jejunum contains large number of lymphatic follicles (3) in lamina propria. Peyer's patches (4) mark the distinction while identifying ileum.

Table 11: Basic difference between duodenum, jejunum and ileum

	Duodenum	Jejunum	Ileum
Villi	✓	✓	✓
Brunner glands	✓	×	×
Peyer's patches	×	×	✓

- Lined by simple columnar cells
- **Mucosa also contains:** Goblet cells: Secrete mucus. Increase in number from duodenum to ileum.

Lamina Propria

Occupies core of the villi and interstices between the numerous glands or crypts of Lieberkuhn.

Contains loose connective tissue with lymphoid cells, fibroblasts, mast cells, smooth cells, nerve endings and lymphoid nodules

Also contain lacteals blind ended lymphatic vessels. Composed of following cells:

- M cells-Antigen presenting cells
- Paneth cells-These cells migrate to base of crypt of Lieberkuhn [Note: All other cell migrate to tip]. These Paneth cells contain secretory granules containing lysozyme. These cells are also rich in Zn
- Stem cells- mitotic in function
- Neuroendocrine cells-hormone secreting cells.

Submucosa of Small Intestine

- Consists of fibroelastic connective tissue containing blood and lymphatic vessels, nerves and Meissner's plexus

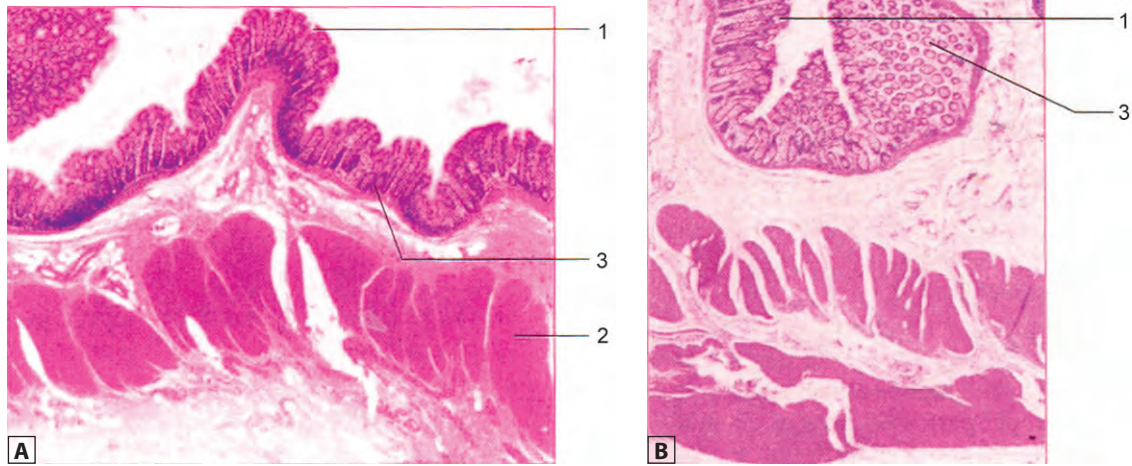
- Also houses brunner's gland only in duodenum
- These glands produce alkaline fluid and urogastrone (enhances epithelial cell division and inhibits gastric HCl production)
- Muscularis externa: Inner circular and outer longitudinal
- External layer of small intestine
- Serosa covers jejunum and ileum and part of duodenum
- Adventia: Covers remainder of duodenum.

HISTOLOGICAL FEATURES OF LARGE INTESTINE

- Lined by **simple columnar** epithelium up to dentate line
- Anal verge is lined by stratified **keratinized squamous epithelium**
- In between, pecten area is lined by stratified squamous non-keratinizing epithelium without sweat and sebaceous glands.
- Goblet cells progressively increase in number as we proceed from appendix to anal canal.

Cecum and Colon

- Mucosa lacks villi and possesses no specialized folds
- Epithelium: Simple columnar with numerous goblet cells
- Lamina propria: Similar to large intestine possessing gut associated lymph tissues in large number, blood and lymph vessels and closely packed crypts of lieberkuhn which lacks Paneth cells
- Submucosa: Consists of fibroelastic connective tissue containing blood and lymphatic vessels, nerves and Meissner's plexus
- Muscularis externa: Inner circular and outer longitudinal
- Outer longitudinal muscles gather and form tenia coli. Auerbach plexus present between two layers of smooth muscles.



Figs 49A and B: Histology of: **(A)** Colon and **(B)** Rectum. They are lined by simple columnar epithelium with plenty of goblet cells (1) and intestinal glands (3) are seen. The Taenia coli (2) can be seen in muscularis externa layer in colon, which are absent in rectum lymphatic nodule (4) can be seen in rectum.

BASIC STRUCTURE OF LIVER

- Parenchyma of liver consists of hepatic lobule which is hexagon in shape
- Each hepatic lobule contains centrally located central vein and anastomosing plates of hepatocytes
- Each plate of hepatocytes consists of one cell thick, radiating from central vein towards periphery of hepatic lobules. Hepatocytes are separated by hepatic sinusoids which flow towards central vein
- At angular interval contains, portal canal, containing:
 - Branch from portal veins
 - Branch from hepatic artery and intralobular bile duct

Sinusoid is the space between the hepatocyte and are lined by endothelium

- **Kupffer cells** are hepatic macrophages found along the endothelial cells of sinusoids
- **Central veins – terminal hepatic venules which join to form hepatic veins which drain into inferior vena cava**

Portal Lobule

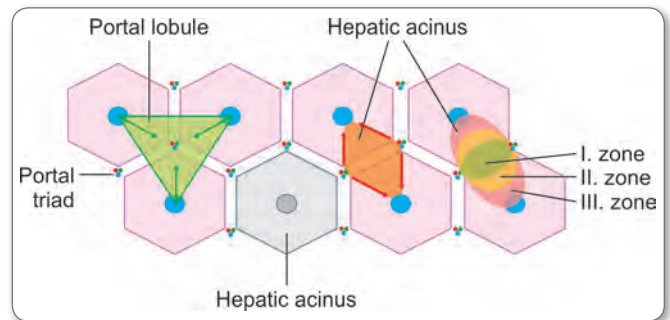


Fig. 51: Portal lobule

- **Portion of adjacent three classic lobules that signifies the direction of bile flow**
- Portal lobule, consists of lobule which is supplied by one branch of portal vein; portal vein in center and central vein in periphery
- Larger than liver acinus.

Portal Acinus

- Diamond shaped
- Portion of two adjacent classic lobules supplied by distributing branches of hepatic artery and portal vein that runs along the interlobular septum

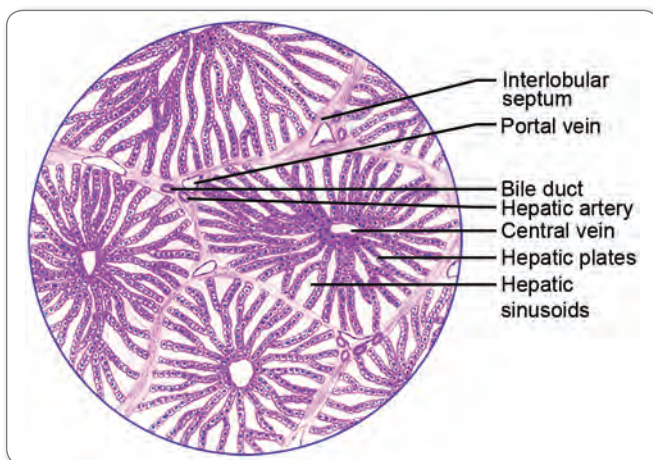


Fig. 50: Histology of liver



- Functional unit of liver and smaller than portal lobule**
 Zone 1: Highly vascular; rich in O₂ and nutrient
 Zone 2: Less vascular than zone 1
 Zone 3: Prone to hypoxic injury
- Space of Disse: Perisinusoidal space**—Surface of liver cell separated from endothelial cell by space of Disse. **Ito cell present in space of Disse.** Store vitamin A in liver.

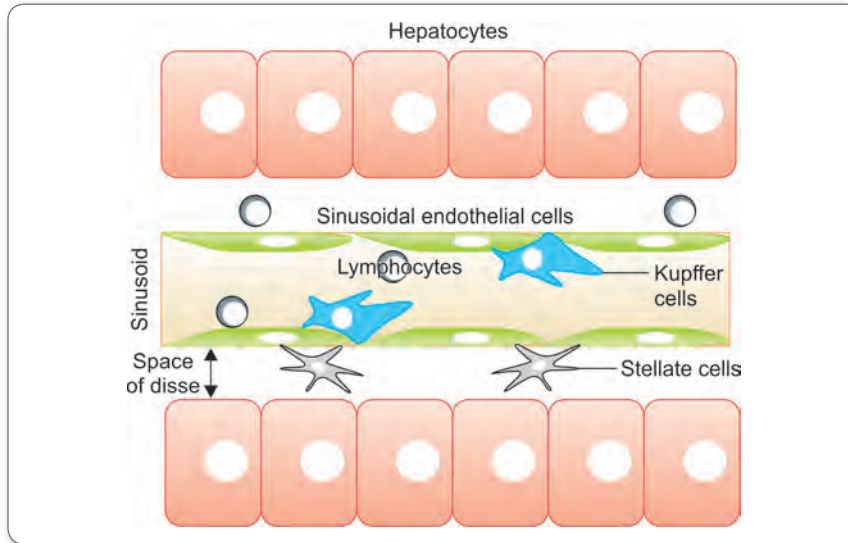


Fig. 52: Space of Disse and portal acinus

- Exchange of metabolic products and nutritive products between liver and blood takes place in this space
- Periportal space: **Space of Mall** - Space around the portal canal.

HISTOLOGY OF RESPIRATORY SYSTEM

Respiratory system functionally classified into

- Conducting part – consists of airways that deliver air to the lungs
- Respiratory portions – consists of structures in which oxygen in the inspired air is exchanged for carbon dioxide in the blood.

OLFACTORY EPITHELIUM

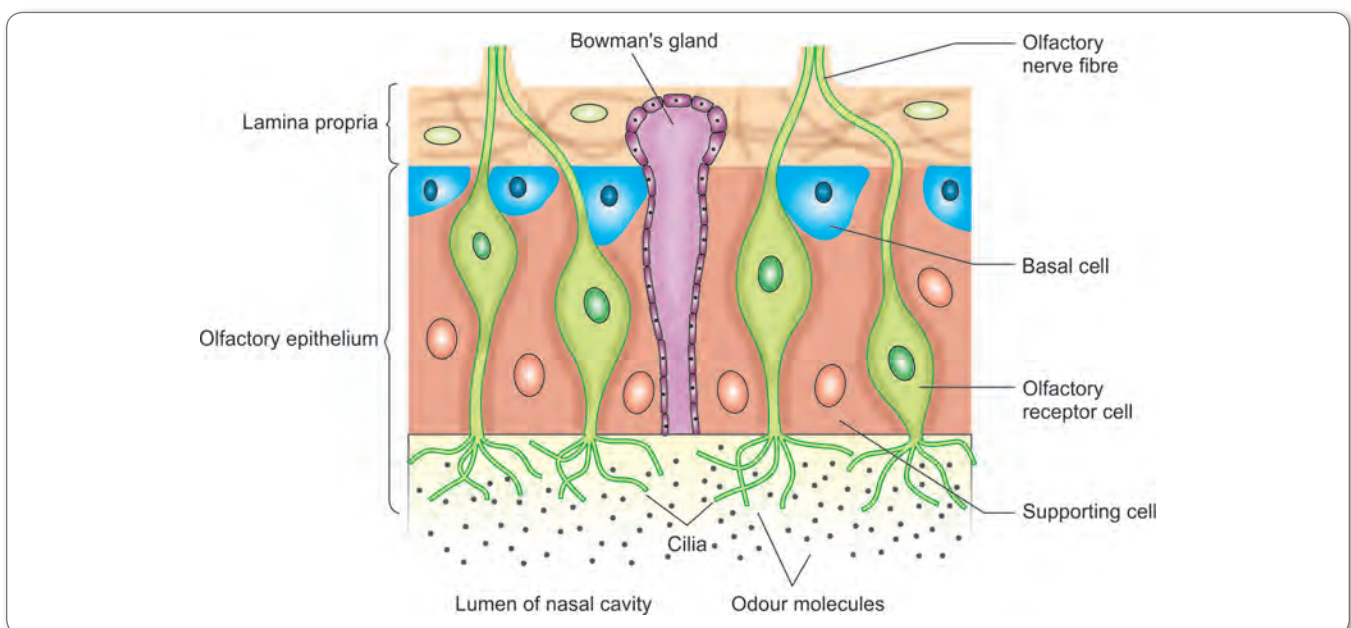


Fig. 53: Olfactory epithelium



- Located in the roof of nasal cavity, on the either side of nasal septum and on superior nasal conchae.
- It is pseudostratified columnar epithelium consisting of olfactory cells, supporting cells and basal stem cells
- It has lamina propria that contains many veins, unmyelinated nerves and bowman glands.

RESPIRATORY EPITHELIUM

Pseudostratified ciliated columnar epithelium with goblet cells

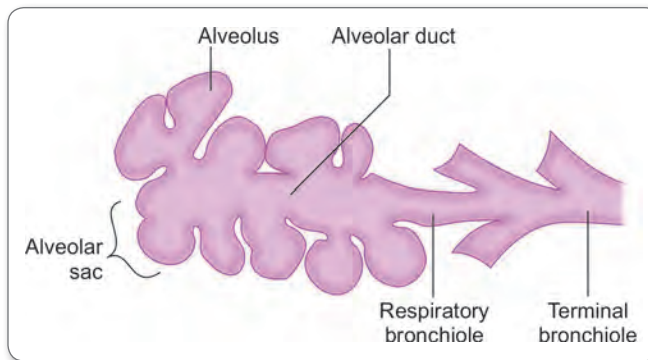
Table 12: Features of the various parts of the respiratory passages

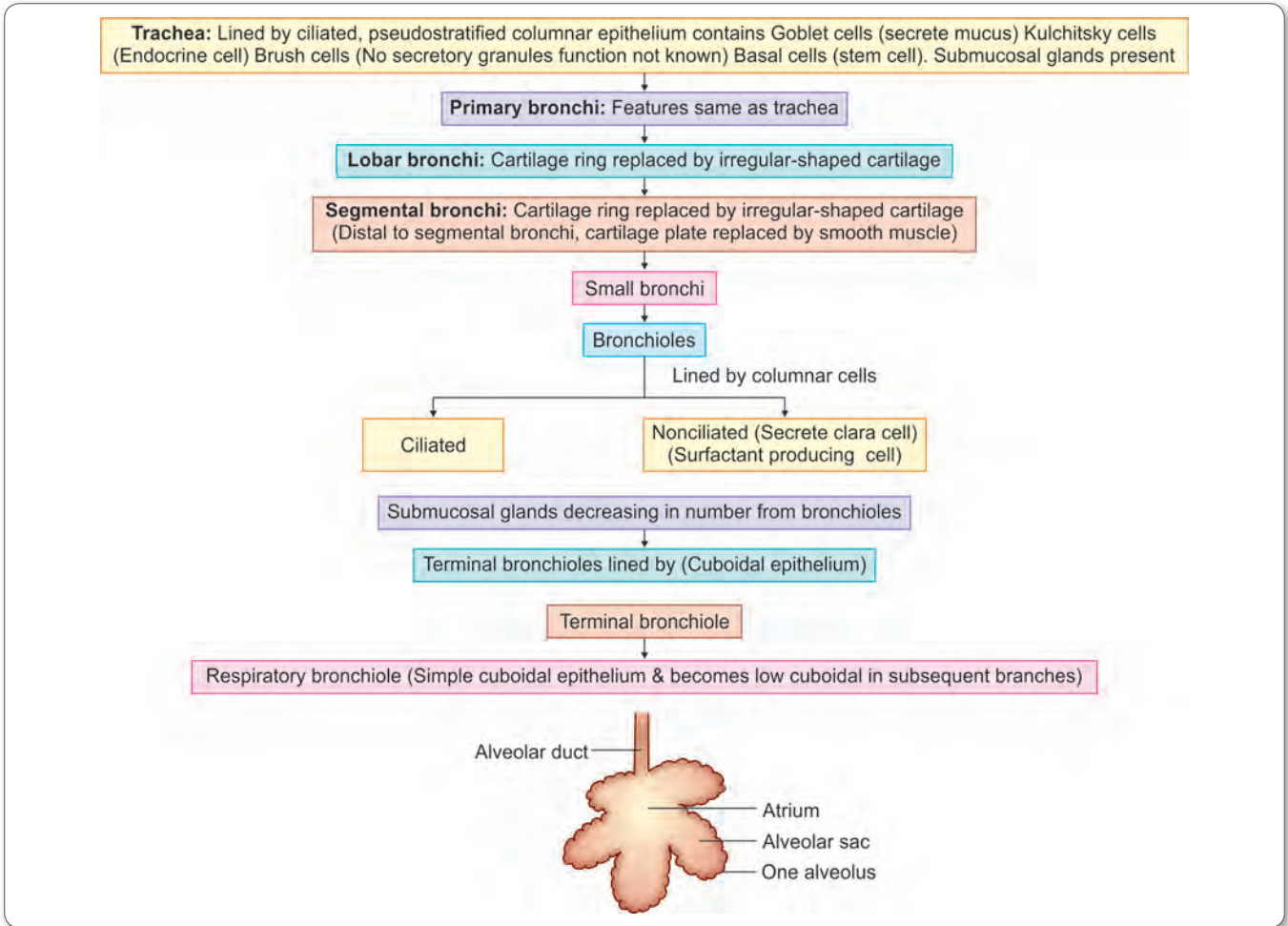
Division	Support	Glands	Epithelium	Ciliated cells	Goblet cells	Special features
Trachea, Primary bronchi	C shaped hyaline cartilage rings	Mucous and seromucous gland	Pseudostratified ciliated columnar	Yes	Yes	Trachealis muscle, elastic lamina, two mucous cell types, short cells, diffuse endocrine cells
Intra-pulmonary bronchi	Plates of hyaline cartilage	Seromucous	Pseudostratified ciliated columnar	yes	Yes	Two helically oriented ribbons of smooth muscle
Primary bronchioles	Smooth muscle	None	Simple ciliated columnar to simple cuboidal	Yes	Only in large ones	Clara cells
Terminal bronchioles	Smooth muscle	None	Simple cuboidal	Some	None	Clara cells
Respiratory bronchioles	Some smooth muscle	None	Simple cuboidal	Some	None	Occasional alveoli and clara cells
Alveolar ducts	Smooth muscle at alveolar openings, Some reticular fibers	None	Simple squamous	None	None	Linear structure formed by adjacent alveoli type 1 and type 2 pneumocytes, alveolar macrophages
Alveoli	Reticular fibers, elastic fibers at alveolar openings	None	Simple squamous	None	None	Type 1 and type 2 pneumocytes, alveolar macrophages

HIGH YIELD POINTS

Epithelium is pseudostratified columnar in large bronchi. Reduced to simple columnar in bronchioles and further reduced to simple cuboidal epithelium in terminal bronchioles.

UP TO TERMINAL BRONCHIOLES: CONDUCTING PART





Alveoli

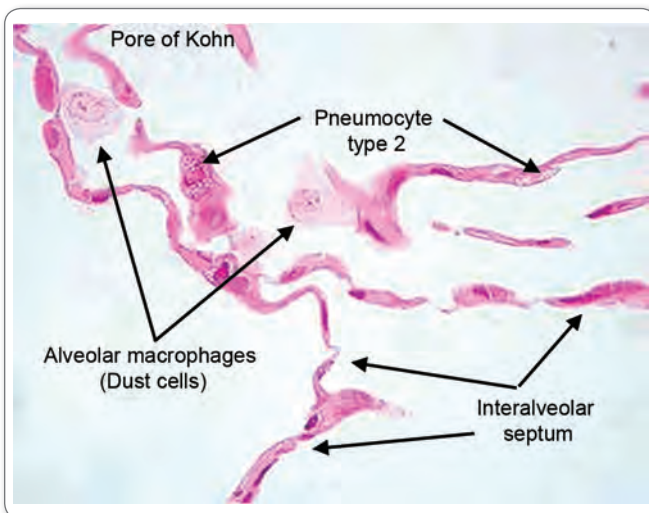


Fig. 54: Histology of Alveoli

- Thin walled cell across which oxygen and carbon dioxide diffuse between air and blood

- They are separated from each other by interalveolar septa that may contain one or more alveolar pores (pores of kohn)
- They are rimmed by elastic fibers and supported by reticular fibers
- Lined by simple squamous epithelium composed of type I and type II pneumocytes.

Type I Pneumocytes

- Cover about 95% of the alveolar surface and form part of blood gas barrier
- Form tight junction with adjacent cells
- Not able to divide

Type II Pneumocytes

- Secrete surfactant
- Free surface contain microvilli
- Able to divide and regenerate both alveolar pneumocytes.

Alveolar Macrophage

- Phagocytose the erythrocytes, so called as **heart failure cells** (brick red color)
- Also called as **dust cells** (accumulation of phagocytosed particles from inspired air).

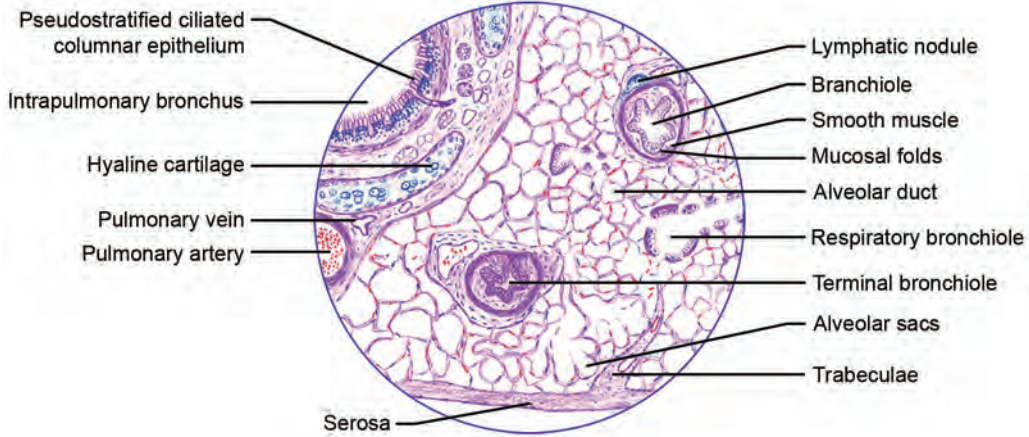


Fig. 55: Histology of lung

URINARY SYSTEM

Nephron is the structural and functional unit of kidney

PARTS OF NEPHRON

A renal corpuscle consists of the glomerulus and Bowman capsule and it is the structure in which the filtration of blood occurs

- **Bowman capsule**
 - The parietal layer is the simple squamous epithelium that lines the outer wall of the Bowman capsule

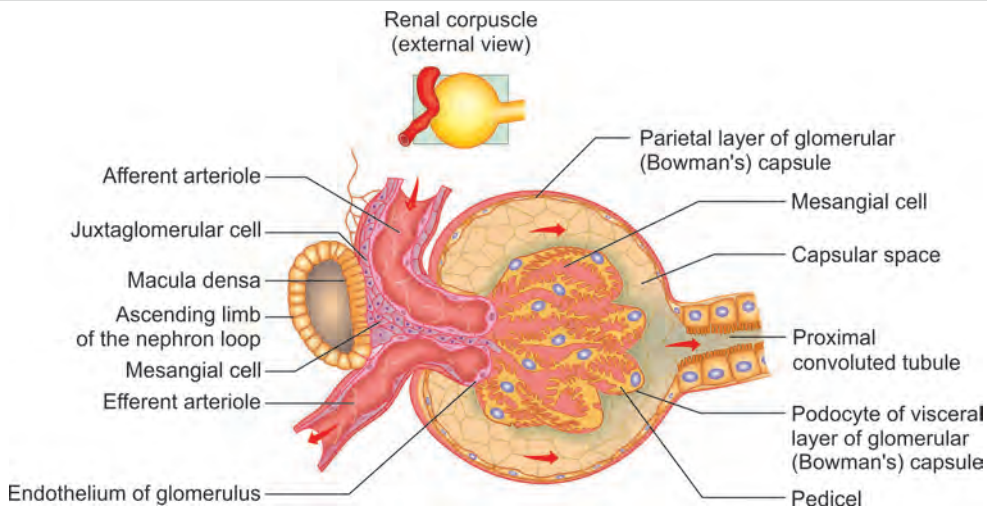


Fig. 56: Renal corpuscle (internal view)

- The visceral layer (glomerular epithelium) is the modified simple squamous epithelium composed of podocytes that lines the inner wall of the Bowman capsule and envelops the glomerular capillaries
- **Bowman space** (also known as capsular space or urinary space) is the narrow chalice-shaped cavity between the visceral and parietal layers into which the ultrafiltrate passes
- **The vascular pole** is the site on Bowman capsule where the afferent glomerular arteriole enters and the efferent glomerular arteriole leaves the glomerulus
- **The urinary pole** is the site on Bowman capsule where the capsular space becomes continuous with the lumen of the proximal convoluted tubule
- **Podocytes:** Podocytes are highly modified epithelial cells that form the visceral layer of Bowman capsule and synthesize glomerular endothelial growth factor a signaling molecule that facilitates the formation and maintenance of the glomerular endothelial cells.
 - Podocytes have complex shapes and possess several primary processes that give rise to many secondary processes called pedicels.

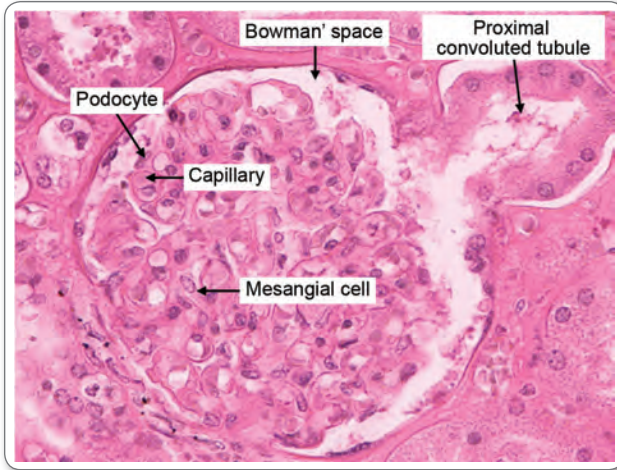


Fig. 57: Histology of renal corpuscle

- **The renal glomerulus:** The renal glomerulus is the tuft of capillaries that extends into the Bowman capsule
 - **Glomerular endothelial cells**
 - Form the inner layer of the capillary walls
 - Possess large fenestrae (60-90 nm in diameter) but lack the thin diaphragm that typically span the openings in other fenestrated capillaries
 - The **basal lamina** is between the podocytes and the glomerular endothelial cells and is manufactured by both cell populations
 - The **mesangium** is the interstitial tissue between glomerular capillaries. It is composed of mesangial cells and amorphous extracellular matrix elaborated by these cells.

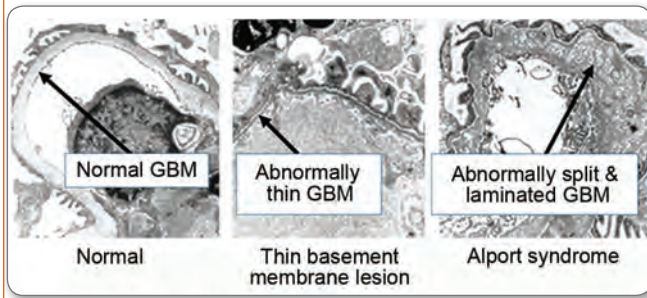


Clinical Aspect

Glomerulonephritis

- Glomerulonephritis is a type of nephritis characterized by inflammation of the glomeruli
- It is sometimes marked by proliferation of podocytes, endothelial cells, and mesangial cells in the glomerular tuft
- This disease often occurs secondary to a streptococcal infection
- Result from immune or autoimmune disorders
- It is associated with production of urine-containing blood (hematuria), protein (proteinuria) or both; in severe cases, decreased urine output (oliguria) is common.

Alport Syndrome



Contd...

Mutation in the $\alpha 5$ of the IV collagen causes defective basal lamina formation in the kidney glomerulus. Since the mutation is X-linked, men are more seriously affected than women whose second X chromosome may not bear the same mutation. The effects on the kidney result in thickening of the basal lamina and the inability of the glomerular filtration to occur normally and protein and blood begin to be present in the urine.

Proximal Convoluted Tubule

- The proximal convoluted tubule is lined by a single layer of irregularly shaped (**cuboidal to columnar**) epithelial cells that have **microvilli** forming a prominent **brush border**.
- Function
 - It reabsorbs from the glomerular filtrate all of the glucose, amino acids, and small proteins and 60% to 80% of the sodium chloride and water and returns into the peritubular capillary system to be distributed from there into the remainder of the body
 - It exchanges H^+ in the interstitium for HCO_3^-
 - It secretes organic acids (e.g. Creatinine) and bases and certain foreign substances into the filtrate.

Loop of Henle

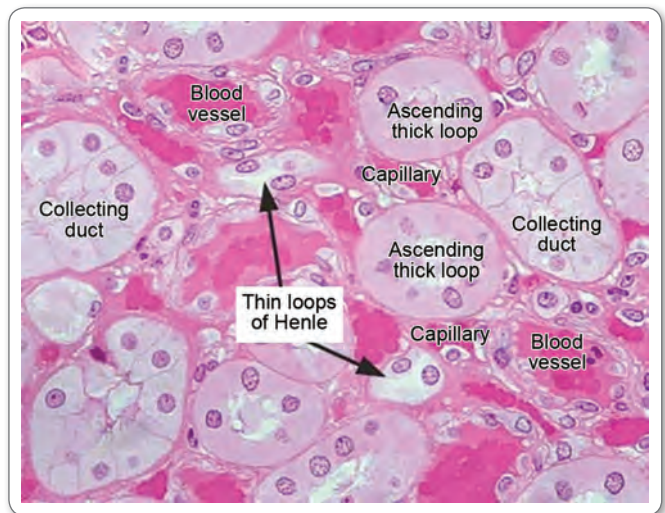


Fig. 58: Histology of renal medulla

- **Descending thick limb of the Henle loop**
 - **The descending limb** of the Henle loop is also known as the straight portion (pars recta) of the proximal tubule
 - It is lined by a **simple cuboidal epithelium** that has a prominent brush border and is similar to that lining the proximal convoluted tubule
 - Its function is to resorb, exchange, and secrete in a manner similar to that of the proximal convoluted tubule.
- **Thin limb of the Henle loop**
 - The thin limb of Henle loop is composed of a descending segment, a loop, and an ascending segment, all of which are lined by **simple squamous epithelial** cells possessing a few short microvilli



- **Ascending thick limb of the Henle loop**
 - The ascending thick limb of the Henle loop is known as the straight portion (pars recta) of the distal tubule.
 - It is lined by **cuboidal epithelial** cells that possess only a few microvilli, an apical nucleus, and mitochondria compartmentalized within basal plasma membrane infoldings. These cells manufacture and release a glycoprotein that reduces the ability of the kidney to form kidney stones.

Distal Convoluted Tubule

- The distal convoluted tubule is continuous with the macula densa and is similar histologically to the ascending thick limb of the Henle loop
- It is much shorter and has a wider lumen than the proximal convoluted tubule and **lack brush border**
- Function the distal convoluted tubule reabsorbs Na^+ from the filtrate and actively transports it into the renal interstitium; this process is stimulated by aldosterone. It also transfers K^+ , NH_4^+ , and H^+ into the filtrate from the interstitium.

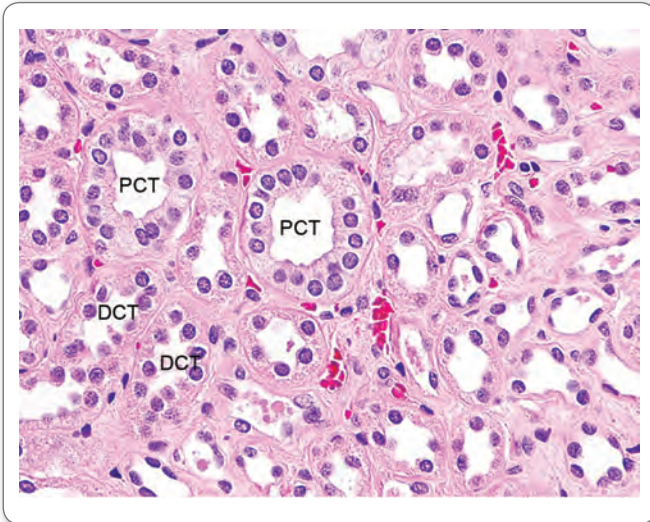


Fig. 59: Histology of Distal convoluted tubule

The connecting tubule

Connecting tubules is a short segment between the distal convoluted tubule and the collecting tubule into which it drains.

Collecting tubules

Collecting tubules have an embryological origin different from that of nephrons.

Cortical collecting tubules

Cortical collecting tubules are located primarily within medullary rays, although few are by a simple epithelium containing two types of cuboidal cells

- Principal (light) cells possess a round central nucleus and a single primary cilium.

Medullary collecting tubules

In the outer medulla, medullary collecting tubules are similar in structure to cortical collecting tubules and contain both principal and intercalated cells in their lining epithelium.

Ureter

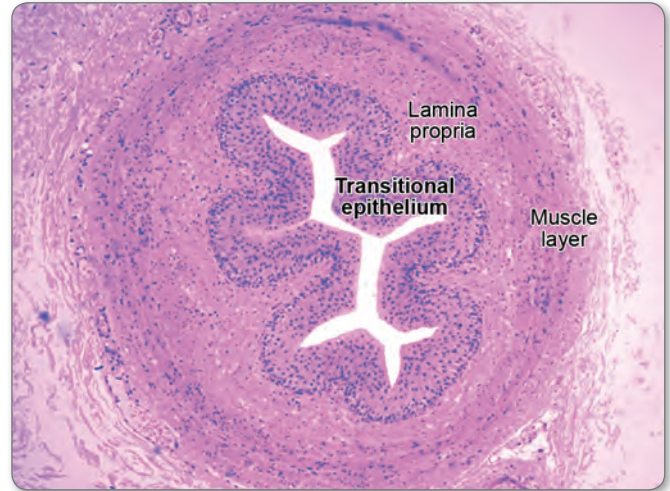


Fig. 60: Histology of ureter

- The ureter conveys urine from the renal pelvis of each kidney to the urinary bladder
- It has a **transitional epithelium** that is thicker and contains more cell layers than that of the renal calyces
- It possesses a two-layer muscularis (**an inner longitudinal and outer circular layer of smooth muscle**) in its upper two-third. In the lowest third possesses an additional outer longitudinal layer of smooth muscle
- It contracts its muscle layers, producing peristaltic waves that propel the urine, so that it enters the bladder in spurts.

Urinary Bladder

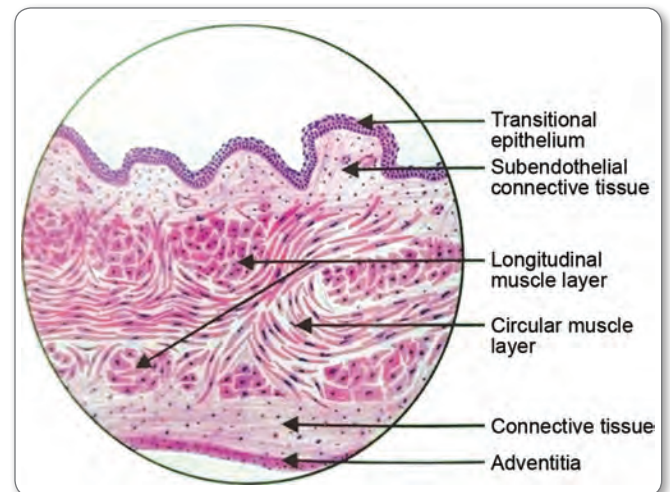


Fig. 61: Histology of urinary bladder



- The urinary bladder possesses a **transitional epithelium** with a morphology that differs in the relaxed (empty) and distended states, a thin lamina propria of fibroelastic connective tissue, and a three-layer muscularis
- Epithelium of the relaxed bladder is five to six cell layers thick and has rounded superficial dome-shaped cells that bulge into the lumen. These cells contain unique plaques (having a highly ordered substructure) in their thick luminal plasma membrane and flattened elliptical vesicles in their cytoplasm
- Epithelium of the distended bladder
 - The epithelium of the distended bladder is only three to four cell layers thick
 - It has squamous superficial cells
 - It is much thinner and has a larger luminal surface than the relaxed bladder. This results from insertion of the elliptical vesicles into plasma membrane of the surface cells.

Urethra

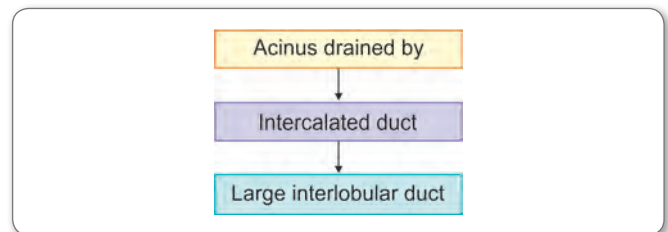
- **Overview**
 - The urethra conveys urine from the bladder to outside the body. In men, urethra also carries semen during ejaculation
 - It has a two-layer muscularis consisting of an **inner longitudinal and an outer circular layer** of smooth muscle
 - It is surrounded at some point by an external sphincter of skeletal muscle, which permits its voluntary closure.
- **Male urethra**
 - The male urethra is about **20 cm long** and is divided into prostatic, membranous, and cavernous portions
 - It is lined by **transitional epithelium in the prostatic** portion and by **pseudostratified or stratified columnar epithelium** in the other two portions. The fossa navicularis,

located at the distal end of the cavernous urethra is lined by **stratified squamous epithelium**

- It contains mucus-secreting glands of Littre in the lamina propria.
- **Female urethra**
 - The female urethra is much shorter than the male urethra
 - It is lined primarily by **stratified squamous epithelium**, although patches of **pseudostratified columnar epithelium** are present
 - It may contain **glands of Littre** in the lamina propria.

HISTOLOGY OF PANCREAS

- Consists of exocrine gland and endocrine gland
- It looks like serous salivary gland and differentiated from the latter by presence of islets of Langerhans. (Secreting unit is called Acini)



CENTROACINAR CELLS

- Present at the junction of acini and intercalated duct
- Function: They add bicarbonate ion to pancreatic juice.

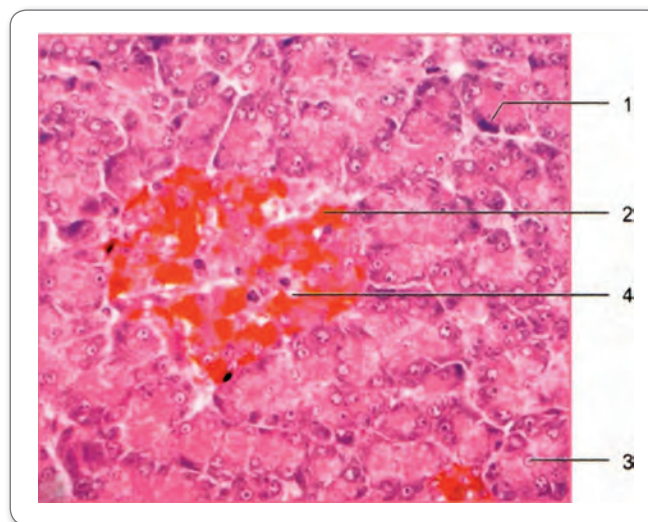


Fig. 62: Histology of Pancreas. Beta cells (2) of pancreatic islet (4) look brown due to the DAB reaction, when insulin antibody is used. Serous acini (1) of the pancreas are stained with H and E. Centroacinar cells (3) can be seen in the serous acini



FEMALE REPRODUCTIVE SYSTEM

OVARY

48

GENERAL HISTOLOGY

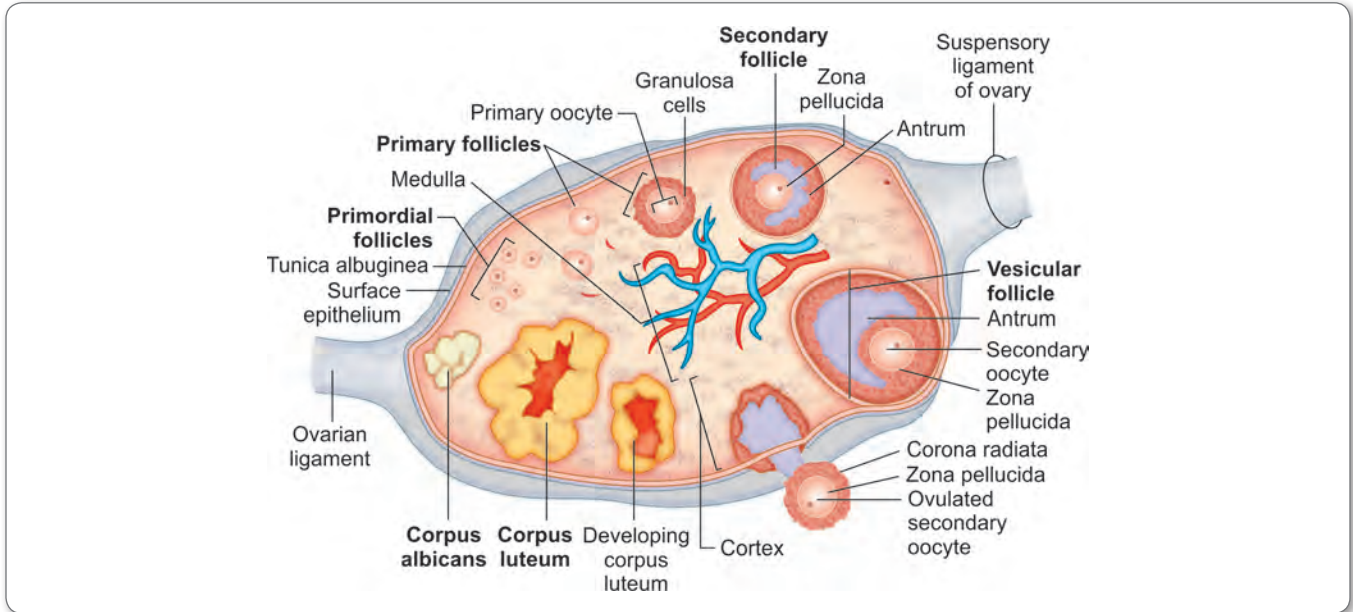


Fig. 63: Histology of ovary

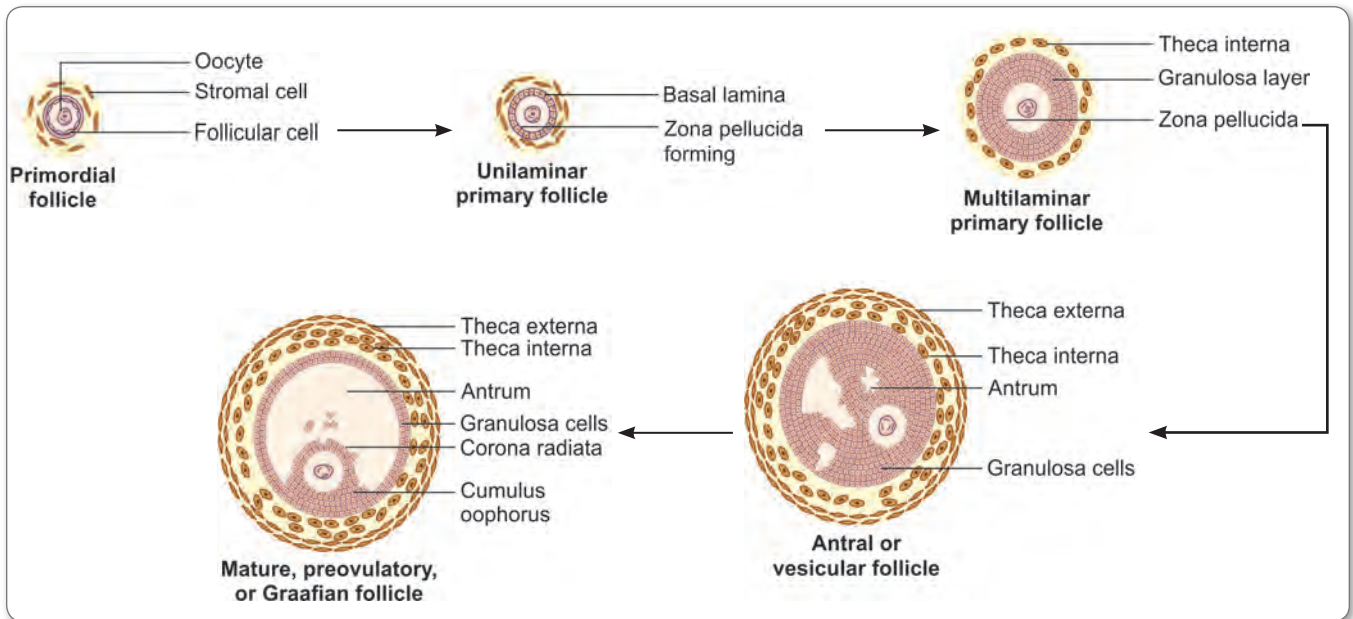


Fig. 64: Development of Graafian follicle

- Outer surface of ovary lined by single layer of cuboidal epithelial cells
- Beneath epithelium densely arranged connective tissue layer called tunica albugenia
- Deep to albugenia, ovary consists of outer cortex and inner medulla
- Stroma of cortex consists of various stages of ovarian follicle
- Medulla: Connective tissue with blood vessels.

Primary Follicle

- Primary oocyte enlarged in size and surrounding follicular cells become cuboidal in shape

New SARP Series Anatomy



- Primary oocyte and follicular cells secrete zona pellucida layer
- Zona pellucida is located between primary oocyte and follicular cells
- Follicular cells proliferate to form multiple layers around the primary oocyte. So follicular cells are called as granulosa cells
- Stromal cells surrounding oocyte forms theca layer. Theca layer consists of theca externa and theca interna.

Secondary Follicle

- Multiple small fluid cavities appear between granulosa cells that coalesce to form cavity called antrum folliculi
- Antrum folliculi pushes oocyte, zona pellucida and its surrounding follicular cells towards periphery of follicle
- Discus proligerus: Follicular cells which connect the oocyte to wall of follicle
- Cumulus oophorus: Follicular cells surrounding oocyte.

Graafian Follicle

Diameter more than 10 mm and occupies entire thickness of cortex with bulging on the surface of ovary

- Antrum increases in size
- Oocyte and cumulus oophorus gradually loosened from rest of cells
- Follicular cells which are immediately surrounding oocyte are called as corona radiata.

FALLOPIAN TUBE

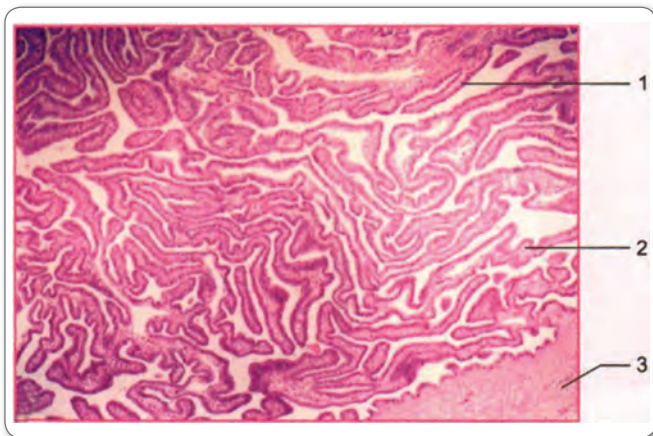


Fig. 65: Histology of Fallopian tube. Highly branched and folded mucosa (1), Lamina propria (2), Inner circular layer (3), and outer longitudinal layer (4)

Wall of fallopian tube consists of following layers:

Mucosa

- Thrown into numerous irregular folds which branch and almost completely fill the lumen of tube
- Lined by ciliated columnar epithelium with underlying lamina propria
- Peg cells: Non ciliated columnar cells perform secretory function.

Muscular Layer

Consists of inner circular and outer longitudinal layer of smooth muscle fibers.

Serosa

Consists of single layer of flattened mesothelial cells with few connective tissue fibers.

UTERUS

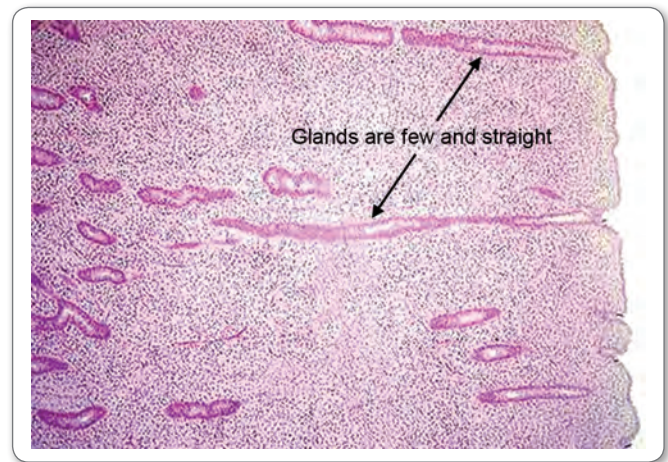


Fig. 66: Uterus proliferative (follicular) phase

Wall of uterus consists of three layers. From inward to outward

Endometrium

- Simple columnar epithelium with underlying lamina propria
- In proliferative phase, the lamina propria contains straight tubular glands

Endometrium consists of:

- Stratum basal: Located adjacent to myometrium. Supplied by basal artery
- Stratum functionale: Gradually increases in thickness during proliferative phase. Supplied by spiral arteries.

Myometrium

- Consists of smooth muscle fibers oriented in various directions
- External layer: Consists of predominantly longitudinal fibers
- Intermediate: Oriented longitudinally, obliquely and transversely
- Internal layer: Fibers arranged as longitudinal and circular layer.

Perimetrium

Consists of serosa

- Uterus: Secretory phase
- Endometrium: Simple columnar with underlying lamina propria.



Uterine glands become dilated and tortuous and have cork screw appearance

- Stromal cells also proliferate
- Endometrial thickness also increases three times more than proliferative phase
- Myometrium and perimetrium same as proliferative phase.

MALE REPRODUCTIVE SYSTEM

TESTIS

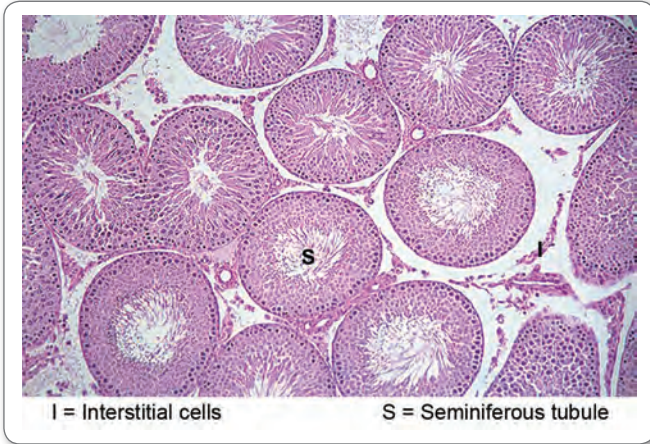


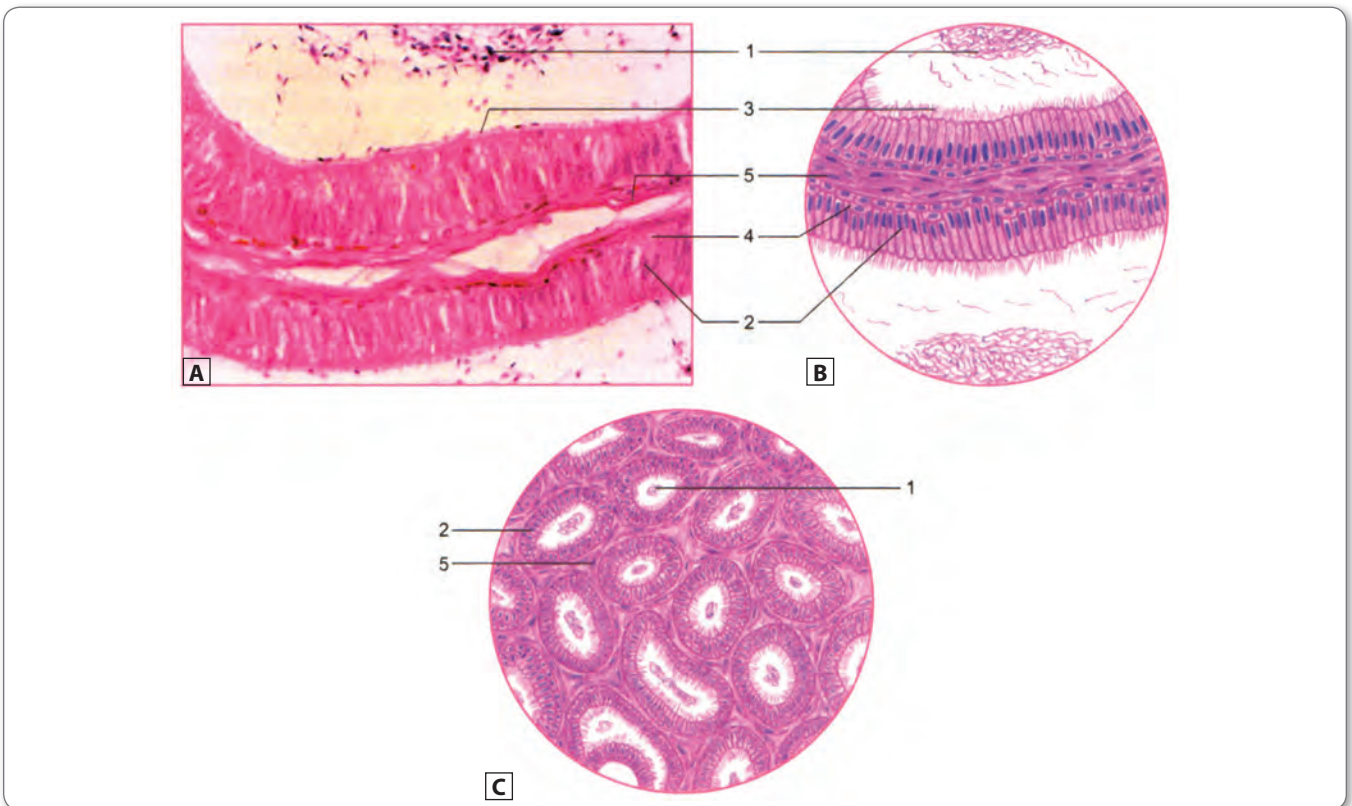
Fig. 67: Histology of testis

- Covered from outside inwards by tunica vaginalis, tunica albugenia and tunica vasculosa
- At the posterior border, tunica albugenia forms partition called mediastinum testis
- Connective tissue arising from mediastinum forms lobules
- Each lobule consists of 2-3 seminiferous tubules
- In cut sections, each lobule shows seminiferous tubules cut in various planes
- Interstitial cells of Leydig (secrete testosterone) present in the stroma around seminiferous tubules.

Sertoli Cells

- Tall columnar cells with ovoid cells
- They provide nourishment for developing sperms called supporting cells or sustentacular cells.

EPIDIDYMIS



Figs 68A to C: Histology of epididymis. (A) Micrograph-LS, (B) Sketch-LS; (C) Sketch-TS. Pseudostratified epithelial (2) lining consists of columnar principal cells with stereocilia (3) and basal cells (4) sperms (1) and smooth muscle fibres (5)



- Consists of numerous highly coiled efferent tubules
- Each efferent tubule lined by pseudostratified columnar epithelium with stereocilia
- Lumen of efferent tubule contains mature sperms
- Circularly arranged smooth muscle surrounding efferent tubule.

VAS DEFERENS

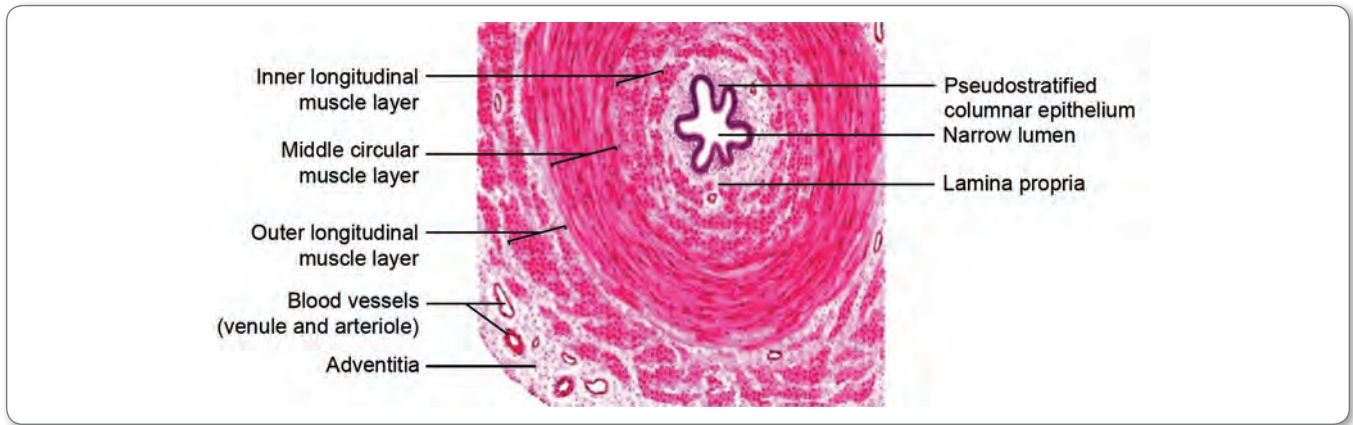


Fig. 69: Histology of vas deferens

- Consists of three layers from inside outward.

- Adventitia: Consists of irregular connective tissue with blood vessels and nerves.

Mucosa

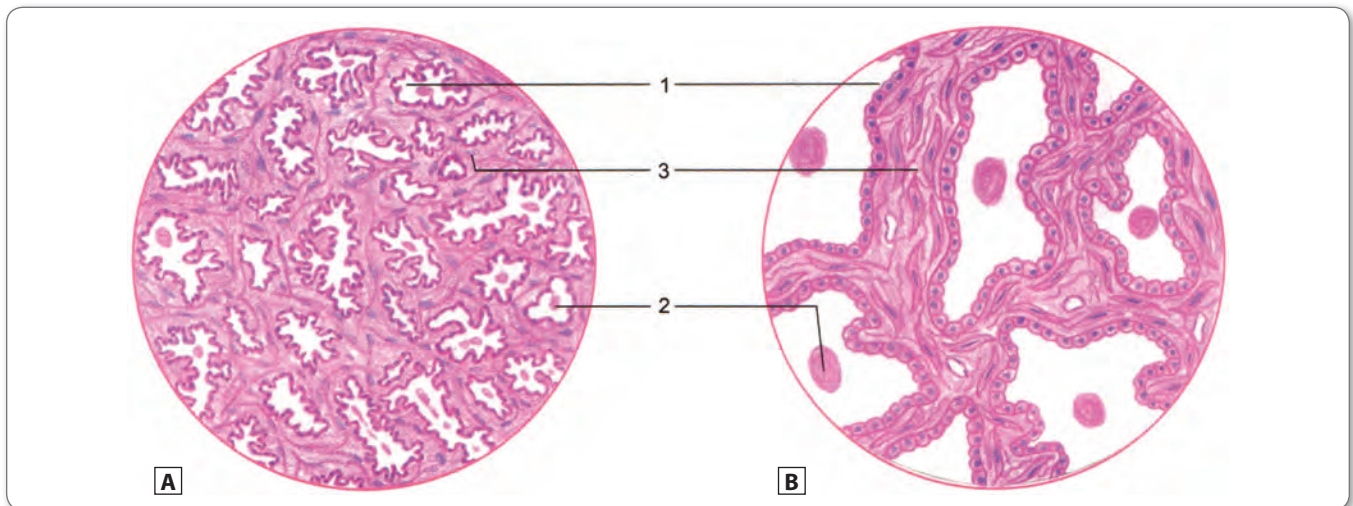
- Lined by pseudostratified columnar epithelium with stereocilia
- Epithelium supported by underlying lamina propria
- Mucosa shows numerous longitudinal folds which project into lumen.

Muscular Layer

- Thick layer and consists of inner and outer longitudinal layers with intermediate circularly arranged smooth muscle fibers

PROSTATE

- Prostate is fibromuscular glandular structure
- Glandular part consists of 30–50 tubuloalveolar glands.
- Alveoli of the gland shows large, irregular lumen with simple columnar epithelium
- Lumen of the alveoli contains secretion of prostate which becomes calcified known as corpora amyacea
- Stroma consists of fibromuscular component
- Fibrous part made up of collagen fibers and muscular part consists of smooth muscle fibers.



Figs 70A and B: Prostate: (A) Low magnification; (B) High magnification showing prostatic acini (1) with prostatic concretions (2) Fibromuscular stroma (3) lies in between the prostatic acini



Clinical Aspect

52

GENERAL HISTOLOGY

- **Myoepithelial cells** contain actin and myosin filament. They are found in mammary gland, lacrimal gland, salivary and sweat glands.
- Periosteum is attached to the bone by **Sharpey's fibers**, a strong layer of collagen fibers. It also provides attachment between muscle and tendon.
- **Panniculus carnosus** is a thin layer of skeletal muscle within superficial fascia lying beneath panniculus adiposus.
- **Panniculus adiposus** is subcutaneous fatty layer beneath dermis. It is found in orbit.
- **Merkel cells** neural crest derived cells which form basal layer of epidermis. Play important role in reading Braille characters.
- **Type 1 pneumocytes** are involved in formation of blood air barrier.

EYE

CORNEA - 5 LAYERS

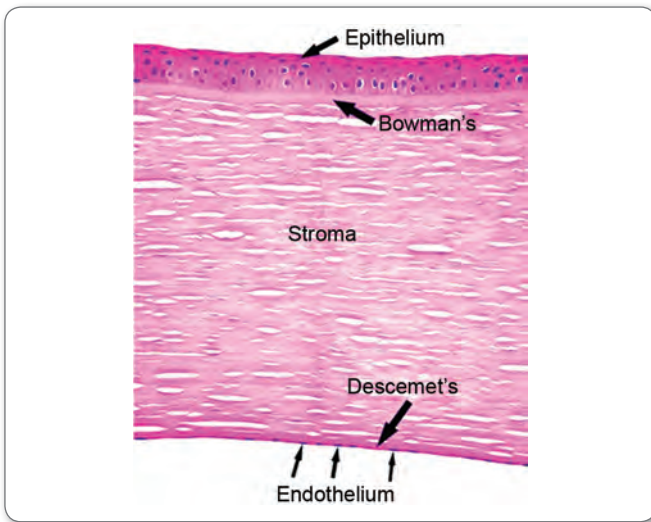


Fig. 71: Histology cornea

- Corneal epithelium – non keratinized stratified squamous epithelium
- Bowman's layer – anterior limiting layer – acellular consists of type I collagen

- Corneal stroma – 90% corneal thickness is made by these layer. Consists of type 1 collagen distributed over the keratocytes
- Descemet's membrane – acellular – consists of type IV collagen
- Corneal endothelium – lined by simple squamous or low cuboidal – regulate the transport of fluid from corneal stroma and aqueous humor.

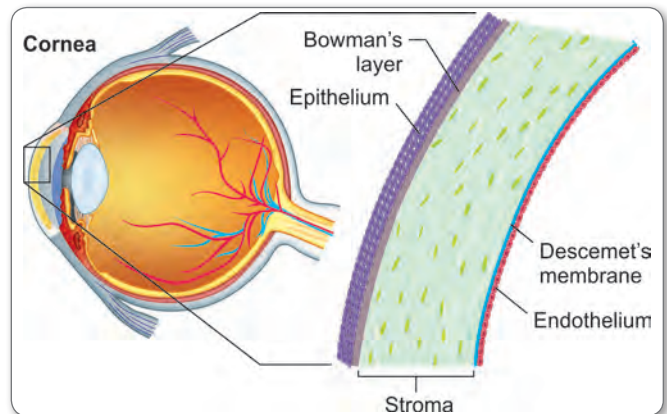


Fig. 72: Cornea (Cross-section)

Retina

- Innermost layer – responsible for photoreception
- Present between choroid and vitreous humor
- Consists of ten layers, discussed in order from outermost to inner most

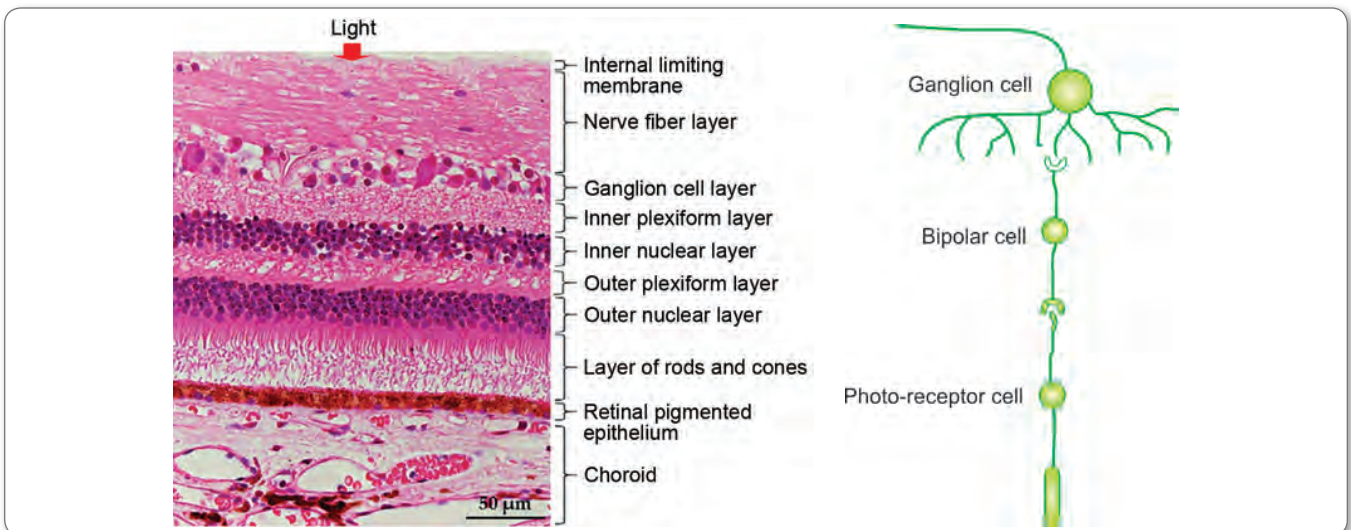


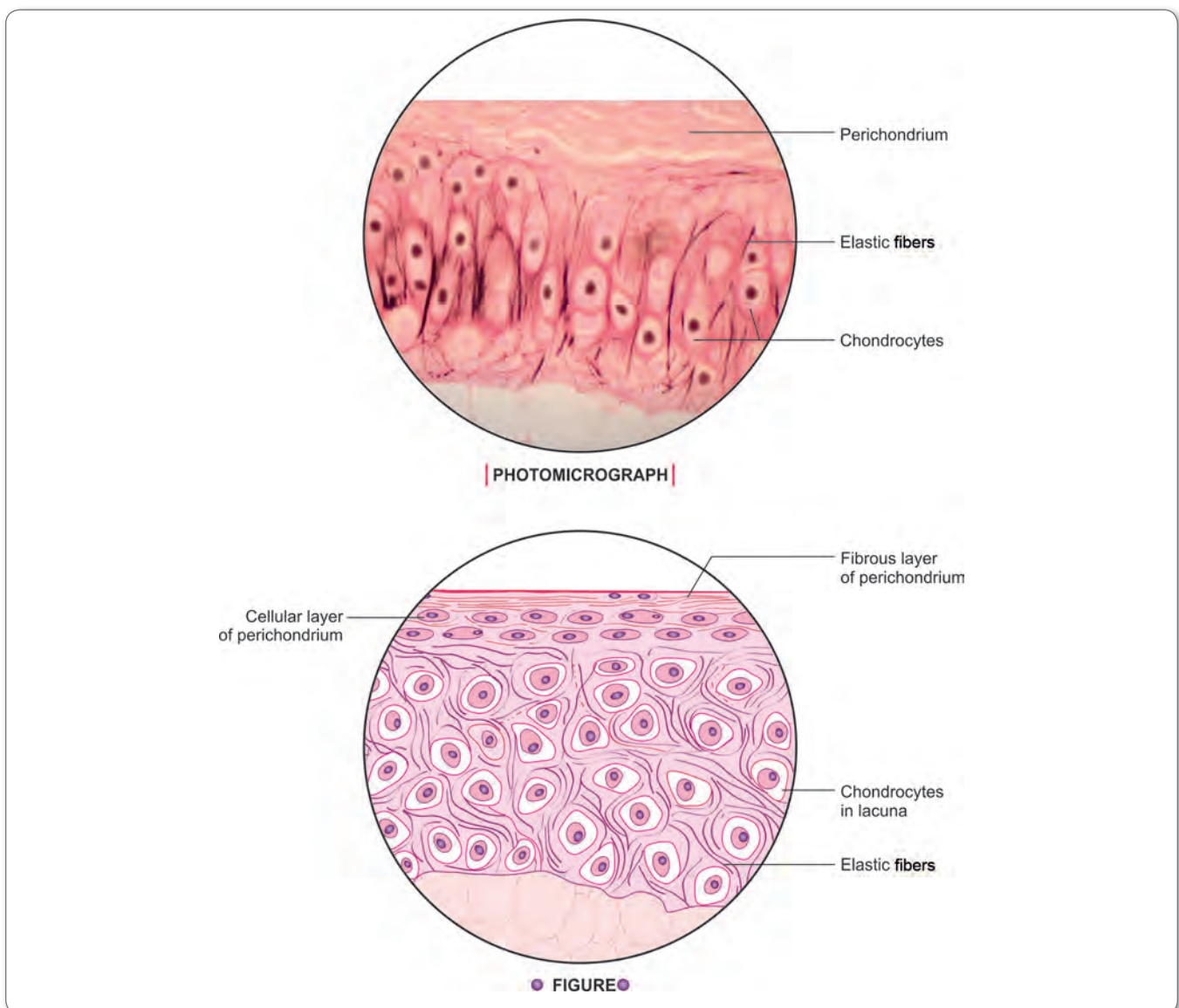
Fig. 73: Layers of retina

New SARP Series Anatomy



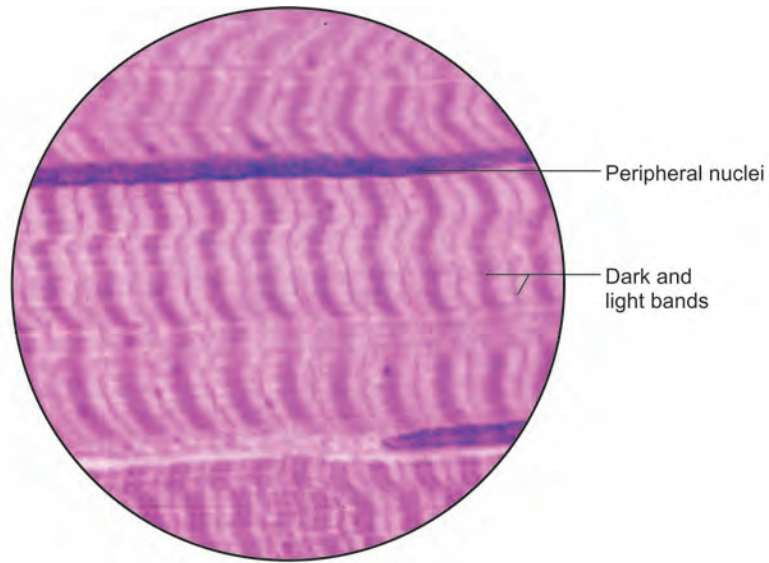
- Retinal pigment epithelium – layer of columnar cells firmly attach to bruch membrane. Act as blood retinal barrier. Synthesize melanin, esterify vitamin A
- Photo receptor cells - Layer of rods and cones – rods (sensitive to light of low intensity) & cones (sensitive to light of high intensity). Cones are much less numerous than rods but produce greater visual acuity than rods. Macula contains only cones
- External limiting membrane – it is not true membrane. It is the area present between photo receptor cells and retinal glial cells (Muller's cell)
- Outer nuclear layer – consists of nuclei of rods and cones
- Outer plexiform – contains synapse between axons of photoreceptor cells and dendrites of bipolar cells and horizontal cells
- Inner nuclear layer – contains cell bodies of bipolar cells, horizontal cells, amacrine cells and nuclei of muller's cells
- Inner plexiform layer – contains synapse between axons of bipolar cells and dendrites of ganglion cells
- Ganglion cell layer – contains body of ganglion cells. Ganglion cells are typical neurons that project their axons to specific region of retina called optic disc
- Optic nerve fiber layer – unmyelinated axons of ganglion cells which form the fibers of the optic nerve
- Inner limiting membrane – consists of terminations of muller's cell process and their basement membrane.

SOME IMPORTANT HISTOLOGICAL SLIDES

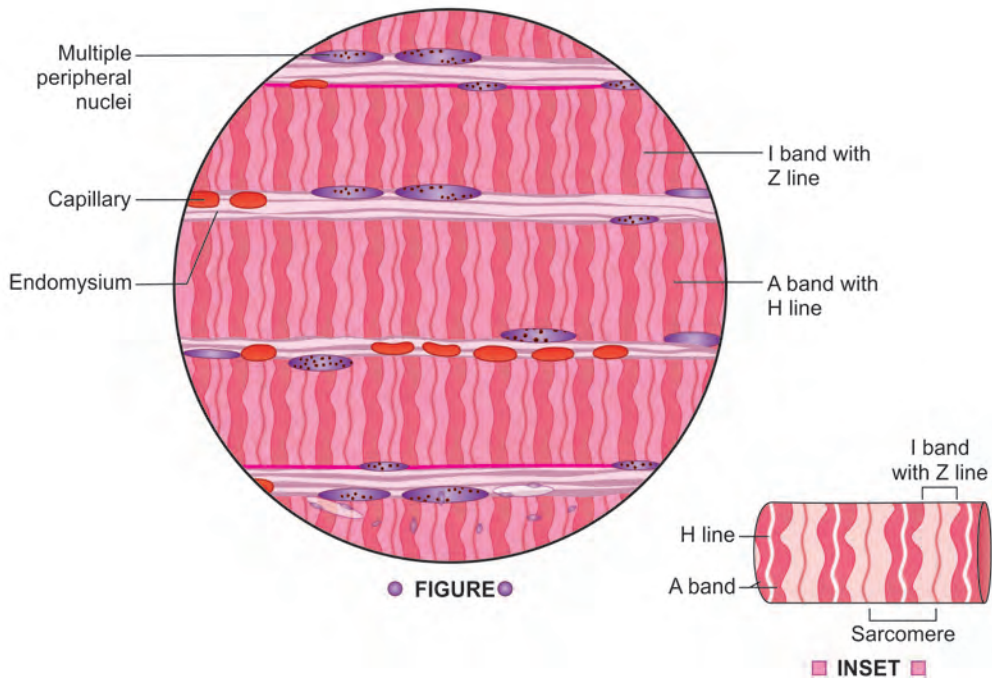


Elastic cartilage: Epiglottis. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.

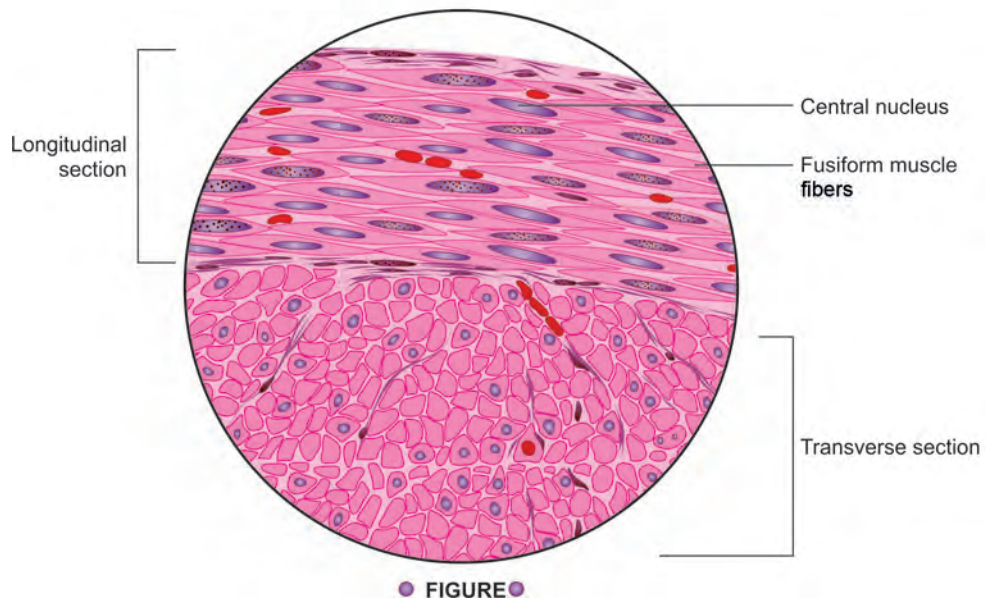
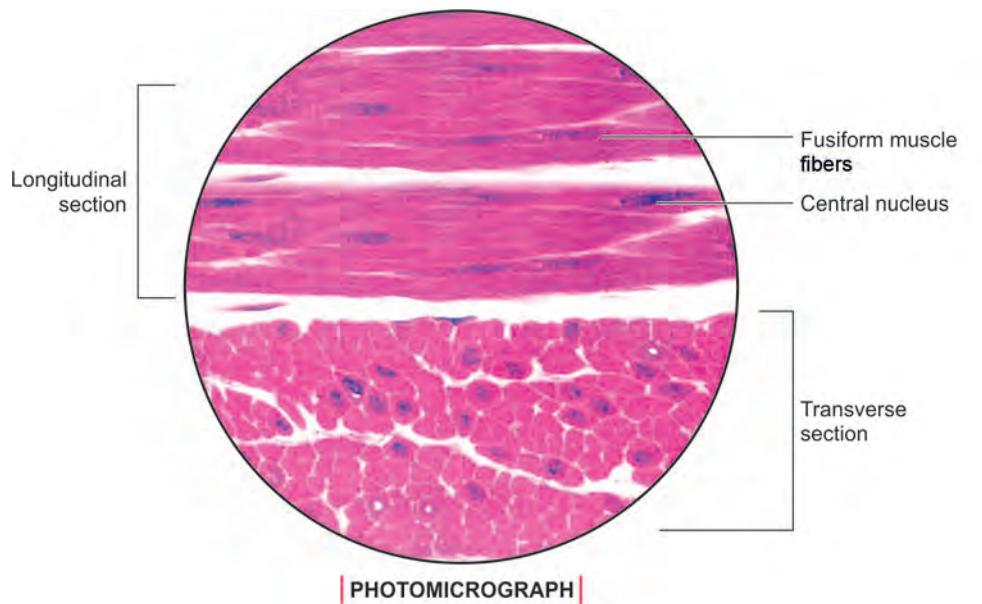


PHOTOMICROGRAPH



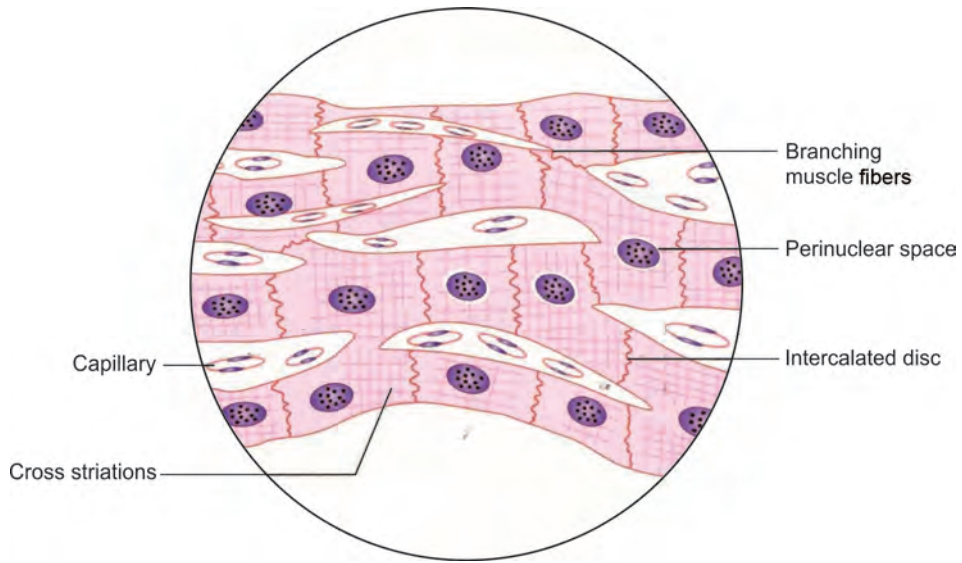
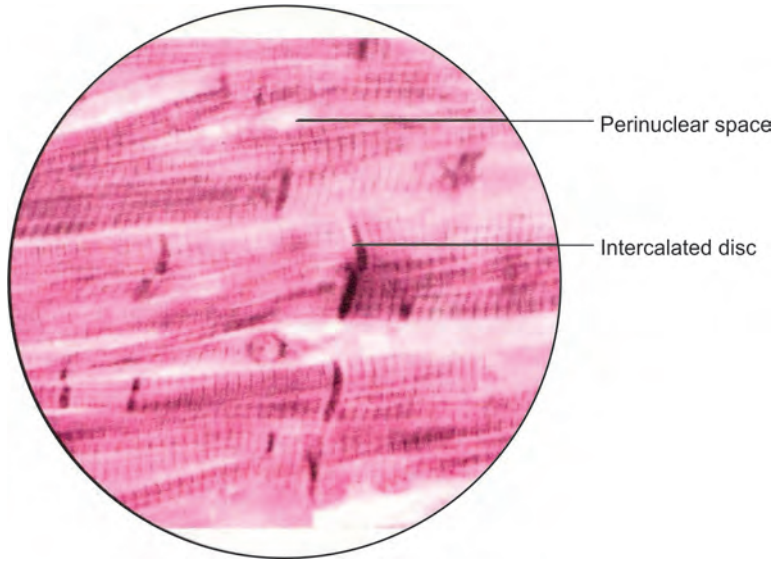
Striated muscle: (longitudinal section) : Tongue. Stain: Haematoxylin-eosin, 400X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



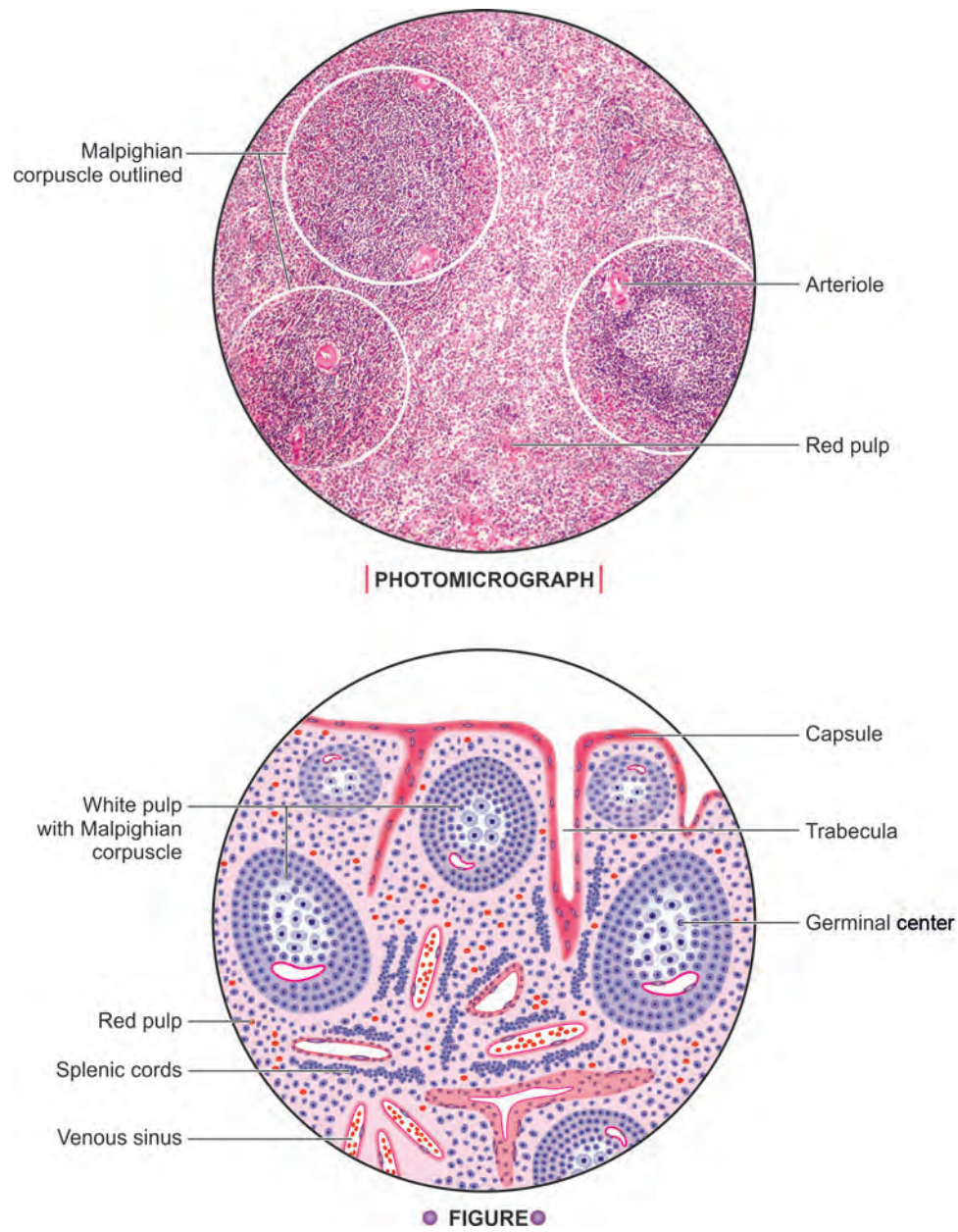
Striated muscle: Stomach. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



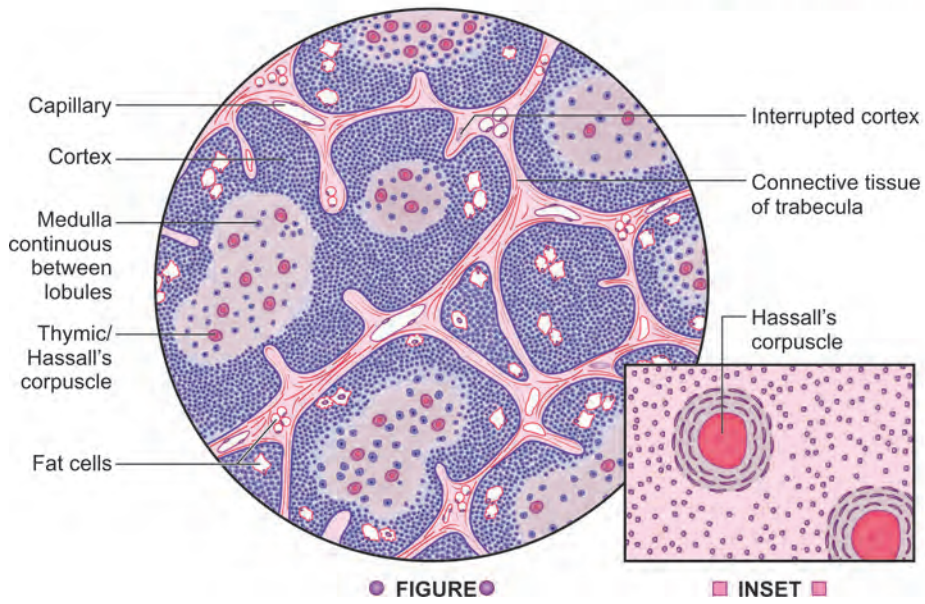
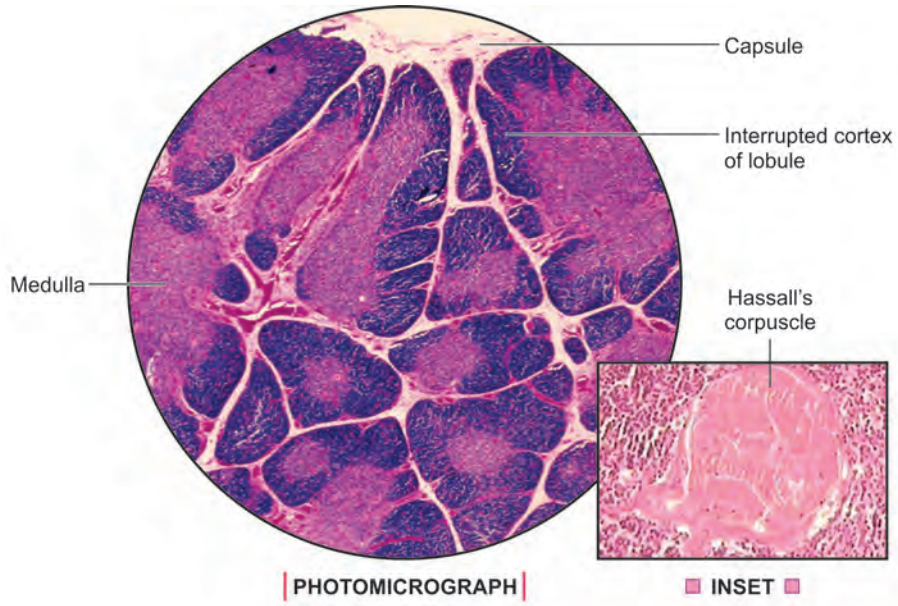
Cardiac muscle: Stain: Haematoxylin-eosin, 400X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



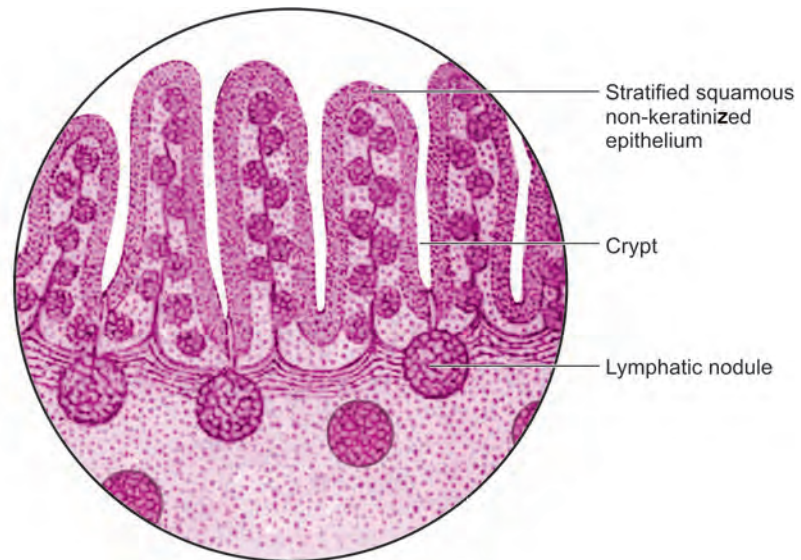
Structure of spleen. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.

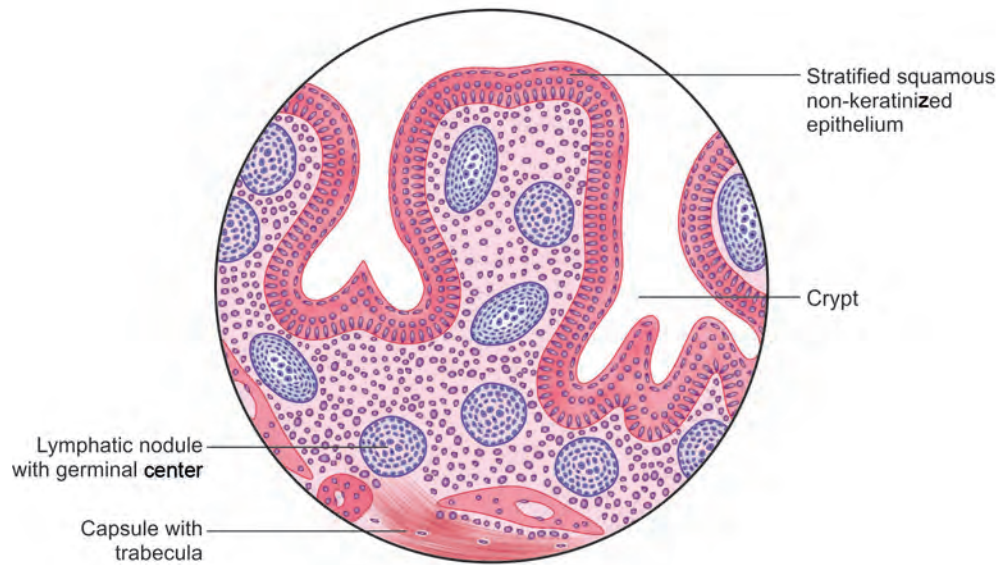


Structure of thymus of a child. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



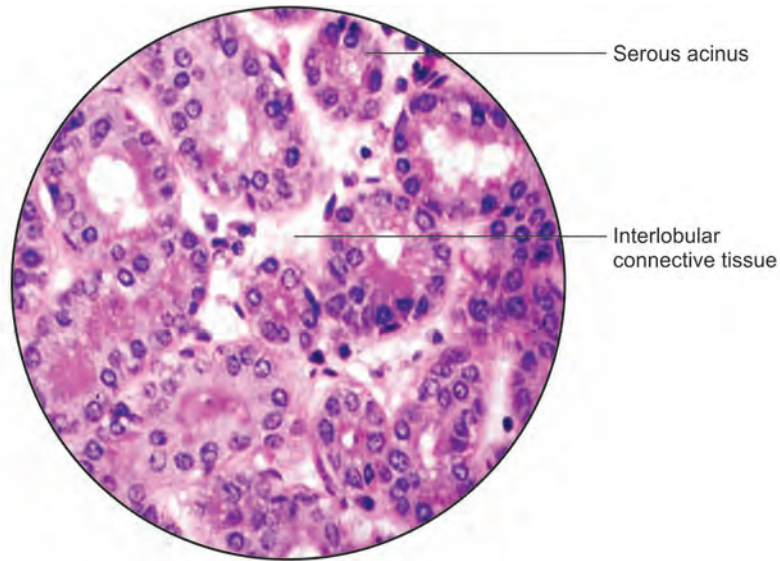
PHOTOMICROGRAPH



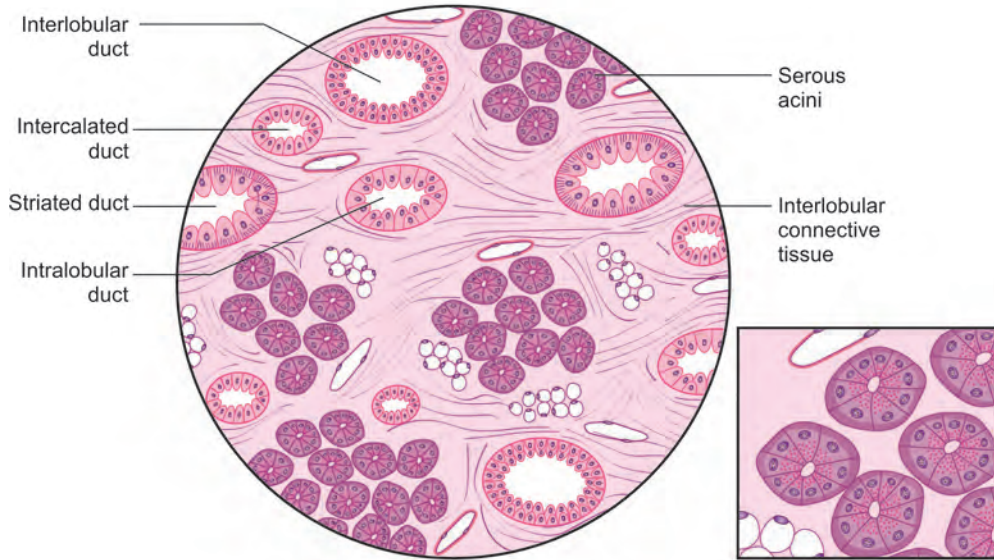
FIGURE

Structure of palatine tonsil. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



PHOTOMICROGRAPH

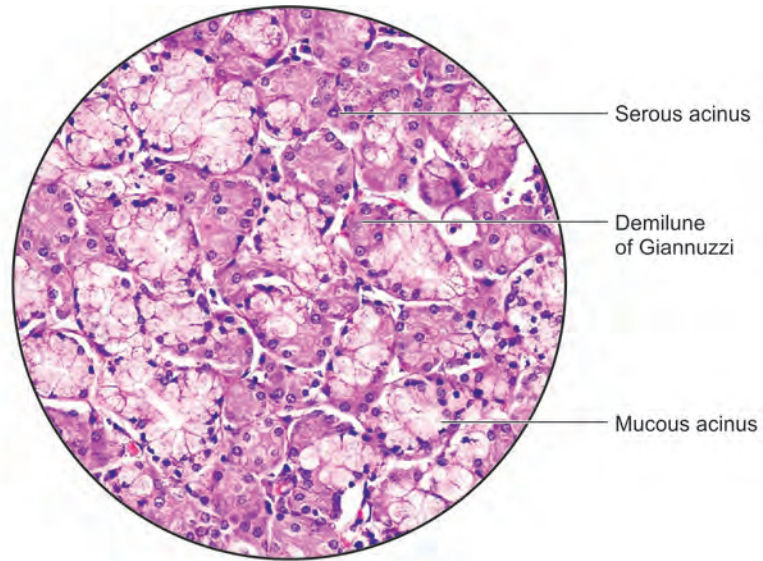


FIGURE

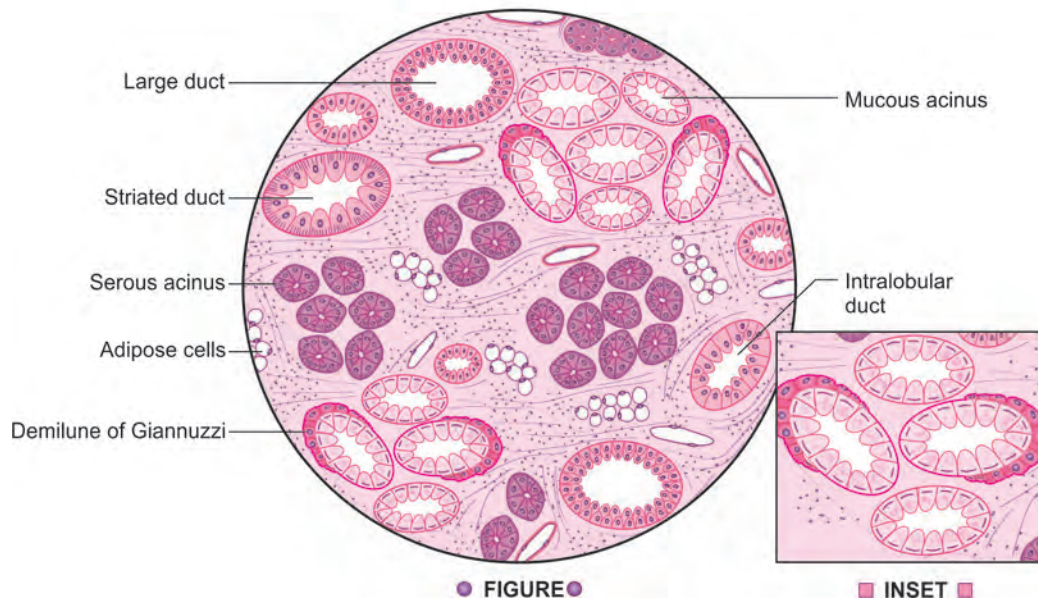
INSET

Structure of serous gland: parotid gland. Stain: Haematoxylin-eosin, 100X

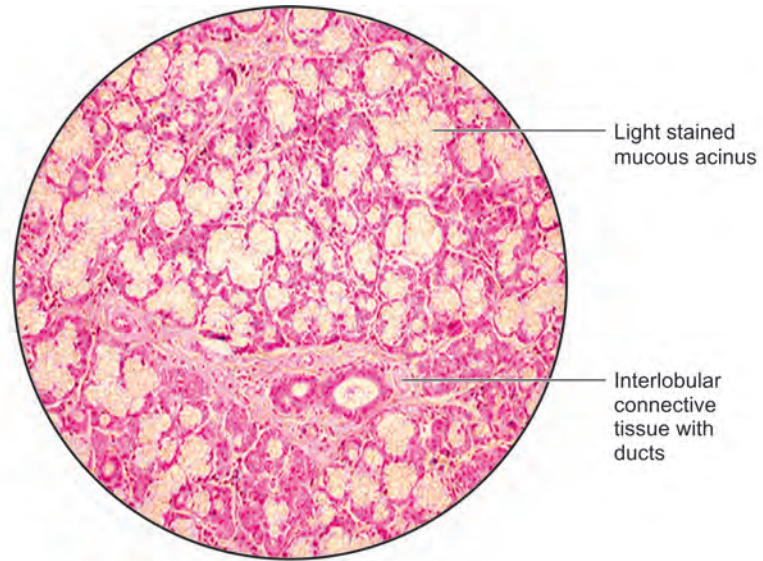
Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



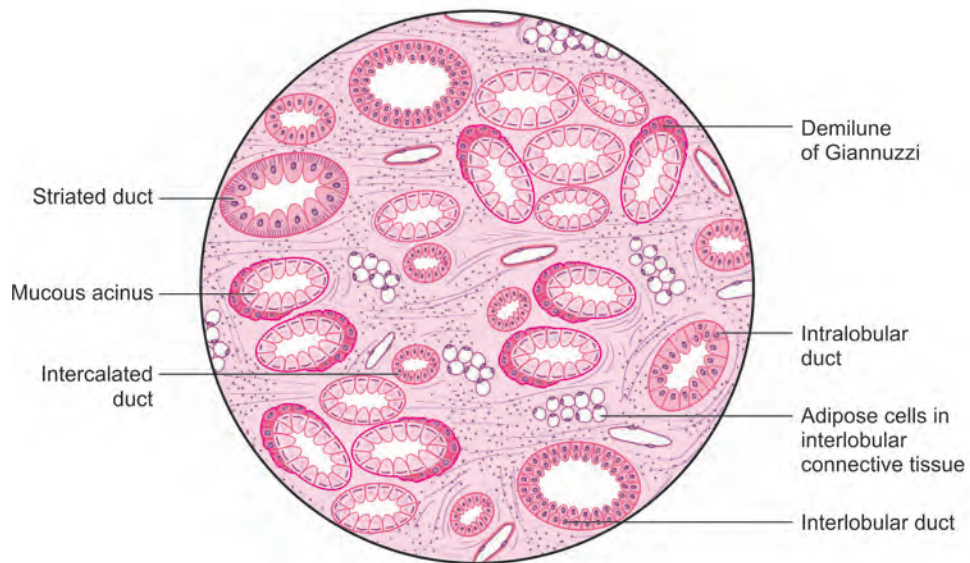
PHOTOMICROGRAPH



Structure of submandibular salivary gland. Stain: Haematoxylin-eosin, 100X
Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



| PHOTOMICROGRAPH |



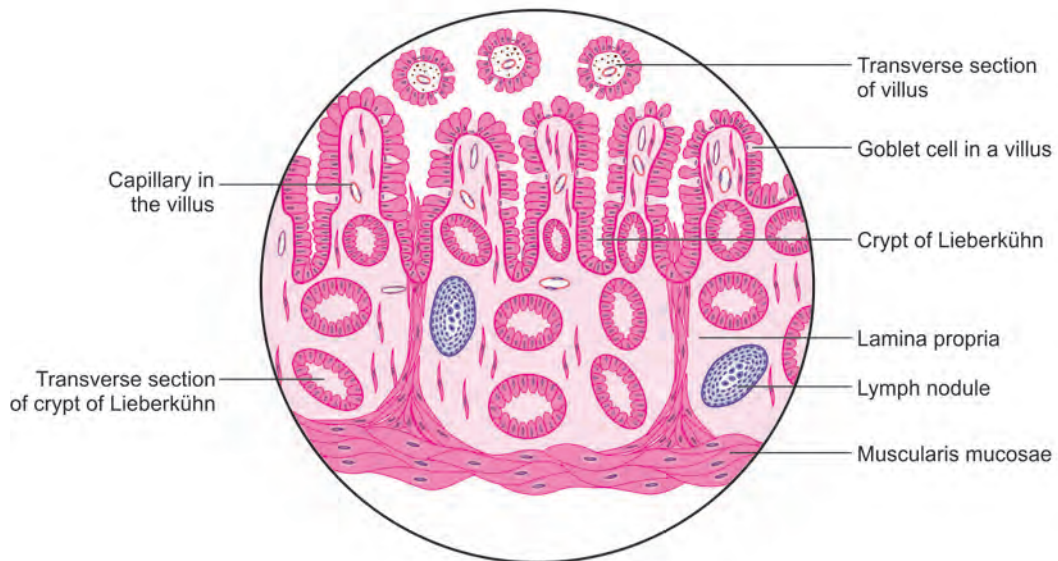
● FIGURE ●

Structure of sublingual gland. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



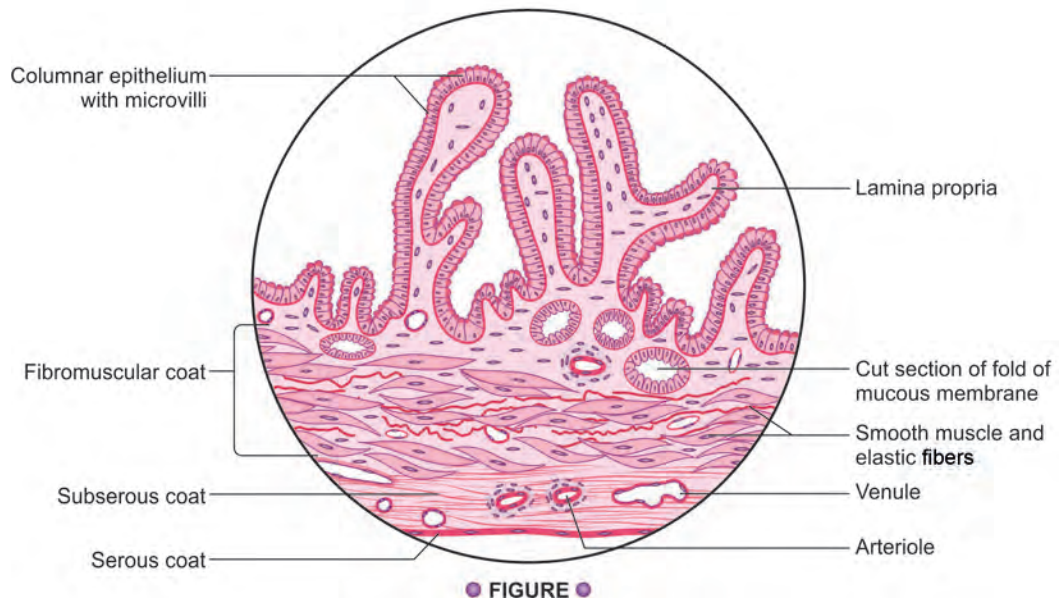
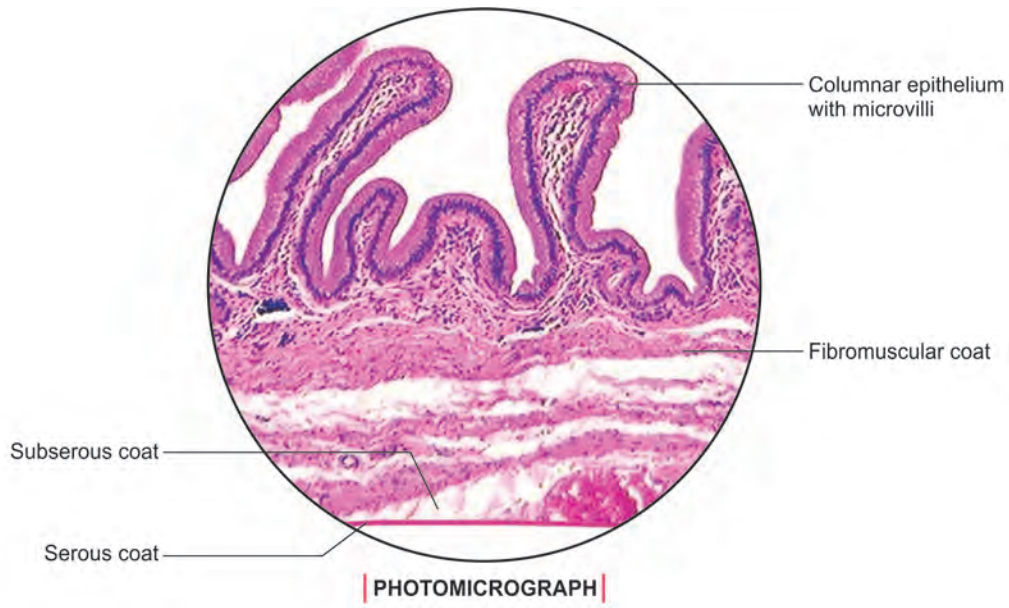
| PHOTOMICROGRAPH |



● FIGURE ●

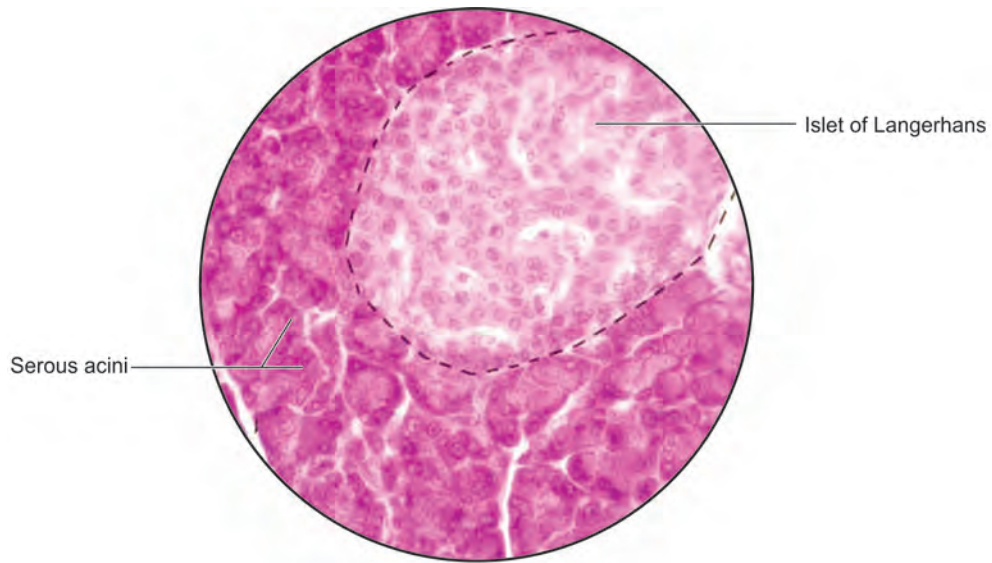
Villi of small intestine. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.

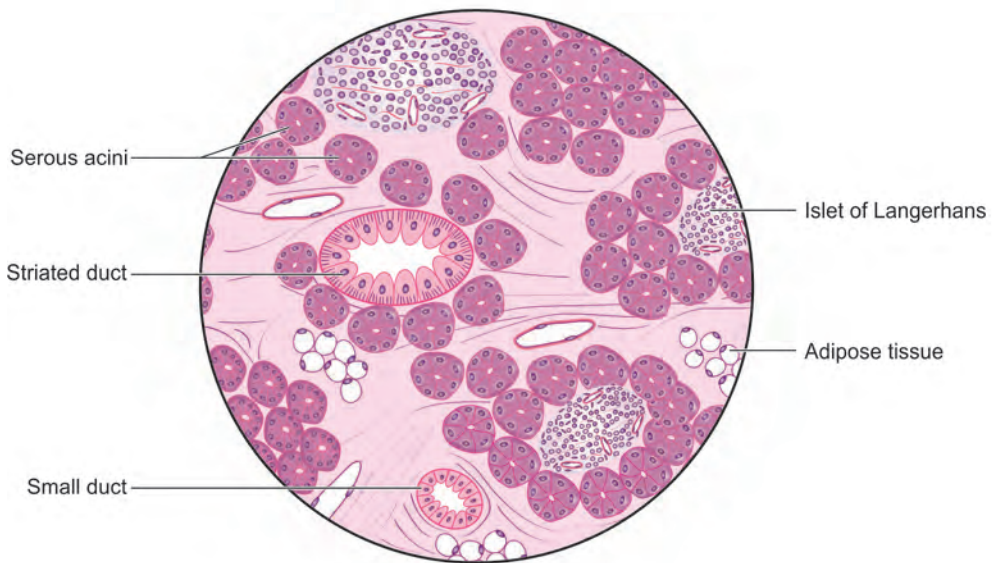


Gallbladder. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



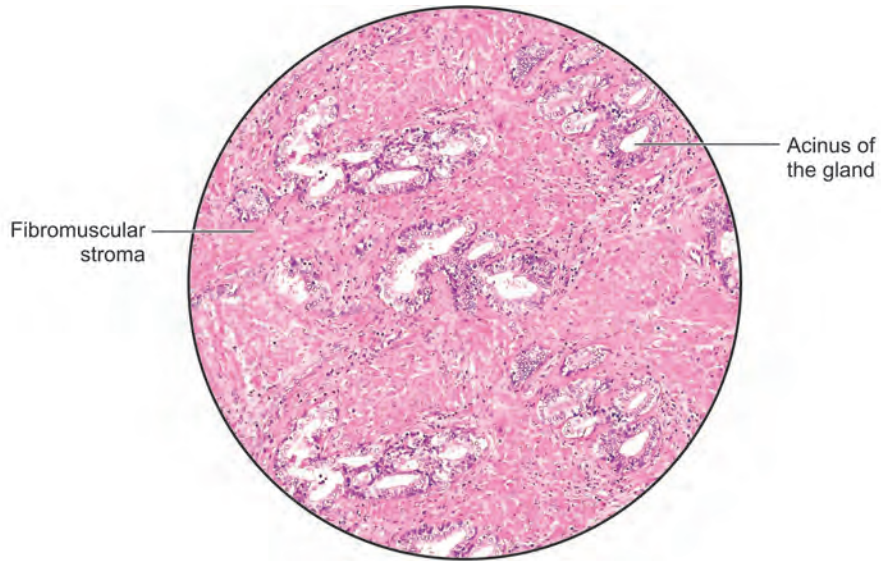
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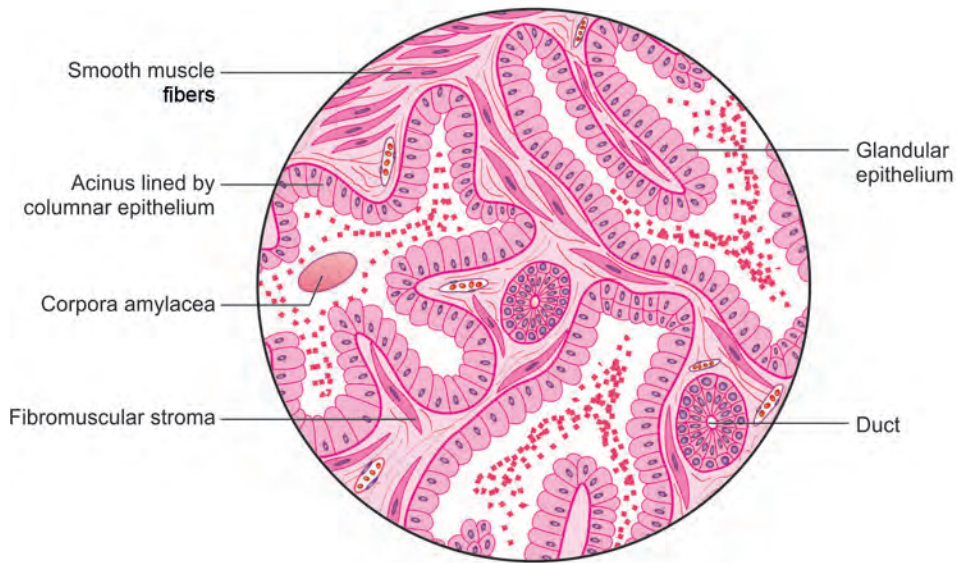
● FIGURE ●

Pancreas. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



PHOTOMICROGRAPH



FIGURE

Prostate gland. Stain: Haematoxylin-eosin, 100X

Courtesy: Krishna Garg et al. Textbook of Histology Color Atlas, 5th ed. CBS Publishers and Distributors Pvt. Ltd., 2014.



Chapter at a Glance

- Blood-Brain Barrier (BBB): Astrocyte
- Blood-Testis Barrier (BTB): Sertoli cells
- Placental barrier: syncytiotrophoblast
- **Stave cells** are found in spleen
- Hassall's corpuscles are found in **thymus**
- Tonsil: Lined by stratified squamous epithelium and tonsillar crypts are present
- **Lymphatic nodule is absent in thymus and present in lymph node, spleen and tonsil**
- Barret's esophagus: Metaplasia – stratified squamous epithelium converted to simple columnar and caused by reflex of gastric contents
- Parietal cell: Main source of intrinsic factor – help in absorption of vitamin B12
- In cirrhosis of liver: Progressive and irreversible proliferation of hepatocytes with increased amount of connective tissue
- Surfactant mainly produced by type 2 alveolar cells
- Alveolar macrophages: Dust cells – heart failure cell
- Space of Disse: Peri-sinusoidal space
- Space of Mall: Peri-portal space.



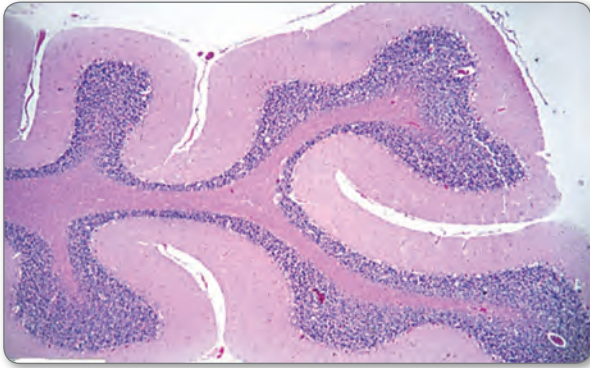
Multiple Choice Questions

68

- The cell junction allowing exchange of cytoplasmic molecules between two cells are called:** (AI 2003, DNB 2004)
 - Gap junctions
 - Tight junctions
 - Anchoring junctions
 - Focal junctions
- The ducts of all the following consists of stratified cuboidal epithelium except:** (AIIMS May 2005)
 - Sweat glands
 - Sebaceous gland
 - Salivary glands
 - Pancreas
- The cells belonging to the following type epithelium are provided with extra reserve of cell membrane** (AI 2003)
 - Transitional
 - Stratified squamous
 - Stratified cuboidal
 - Stratified columnar
- The ureter is lined by -----epithelium** (DNB 2001)
 - Stratified squamous
 - Cuboidal
 - Ciliated columnar
 - Transitional
- Which group has similar kind of epithelium** (PGI 1995)
 - Alveoli – olfactory epithelium
 - Olfactory epithelium – skin
 - Esophagus – urinary bladder
 - Lung alveoli – bowmans capsule
- A patient with acute abdominal pain on clinical suspicion patient underwent cholecystectomy. On histopathological examination the finding is normal. The gall bladder epithelium will be?** (AIIMS Nov. 2007)
 - Squamous
 - Simple Columnar
 - Simple Columnar with brush border
 - Cuboidal with stereocilia
- Cell lining of common bile duct is-** (Recent Question July 2015)
 - Stratified Columnar
 - Stratified Squamous
 - Simple Cuboidal
 - Simple Columnar
- Ansa nephroni is lined by** (DNB 2002)
 - Columnar
 - Squamous epithelium
 - Cuboidal and columnar
 - Stratified squamous
- Which vitamin deficiency may lead to keratinization?** (DNB 2003)
 - A
 - B
 - C
 - D
- Myelin sheath in CNS synthesized by** (DNB 2004)
 - Microglia
 - Schwann cells
 - Oligodendrocytes
 - All
- Oligodendrocytes are important in** (DNB 2009)
 - Blood-brain barrier
 - Myelin formation
 - Phagocytosis
 - Chemotaxis
- Glitter cells are** (DNB 2008)
 - Microglia
 - Modified macrophages
 - Astrocytes
 - Neutrophils
- Pseudounipolar neurons seen in** (DNB 2006)
 - Olfactory
 - Celiac ganglion
 - Spinal dorsal root ganglion
 - Cochlea
- Neuro – epithelial type of sensory receptors are found in following system except:** (AIIMS May 2005)
 - Visual
 - Olfactory
 - Gustatory
 - Auditory
- Secreting active thyroid follicles are lined by which type of epithelium** (Recent Question 2014)
 - Simple Squamous
 - Simple Cuboidal
 - Simple Columnar
 - Stratified Cuboidal
- Thyroid follicles are lined by** (PGIC)
 - Simple Squamous
 - Simple Cuboidal
 - Stratified Cuboidal
 - Simple Columnar
 - Stratified Columnar
- Which of the following is a holocrine gland** (Recent Question 2013)
 - Sweat Gland
 - Breast
 - Pancreas
 - Sebaceous Gland
- Lining epithelium of vagina is** (Recent Question 2013)
 - Pseudostratified Columnar Epithelium
 - Keratinized Stratified Squamous Epithelium
 - Non-Keratinized Stratified Squamous Epithelium
 - Ciliated Columnar Epithelium
- Reticular fibers of collagen tissues are present in all except:** (AIIMS 2015)
 - Thymus
 - Bone Marrow
 - Spleen
 - Lymph Node
- Dense and regular arrangement of collagen fibers is seen in all except:**
 - Tendon
 - Ligament
 - Aponeurosis
 - Periosteum
- Ear lobule made up of** (DNB 2003)
 - Elastic cartilage
 - Hyaline cartilage
 - Fibrocartilage
 - All
- Heart muscle true are all except** (AI 2007)
 - Acts as syncytium
 - Has multiple nuclei
 - Has gap junctions
 - Has branching
- Cardiac muscle is able to function as syncytium because of the structural presence of** (AI 1998, DNB 2000)
 - Branching fibers
 - Intercalated disc
 - Protoplasmic bridges between the cells
 - Gap junction
- The toughest layer of the esophagus is the-** (AI 1995)
 - Mucosa
 - Submucosa
 - Muscularis
 - Adventitia
- All are true about esophagus except-** (Recent Question Dec. 2013)
 - Lined by stratified squamous epithelium
 - Mucosa is thick
 - Middle third contains both skeletal and smooth muscles
 - Lower third contains only skeletal muscle
- Centroacinar cells are present in-** (Recent Question Dec. 2013)
 - Pancreas
 - Parotid gland
 - Prostate
 - None
- Within which part of the gastric gland are chief cells are located** (AI 2009, DNB 2005)
 - Gastric pit
 - Neck
 - Isthmus
 - Fundus

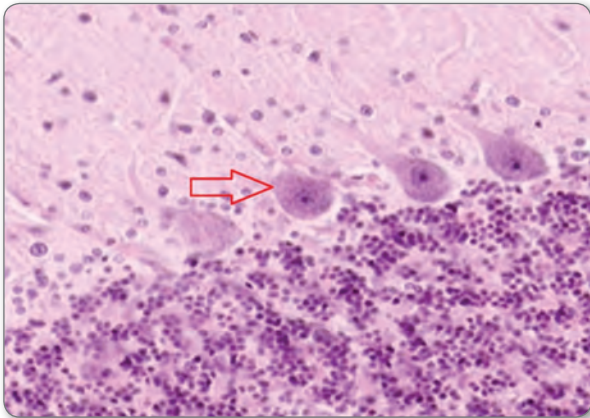


57. Histology of given picture leads to which of the following speech disorder (AIIMS Nov 2016)



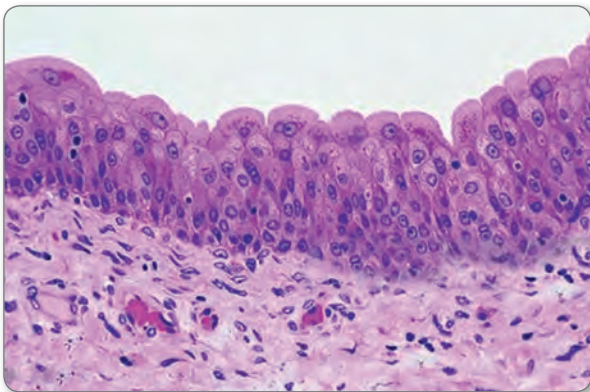
- a. Apraxia
- b. Aphasia
- c. Dysarthria
- d. Verbal dyspraxia

58. The marked cell inhibits which of the following (AIIMS May 2017)



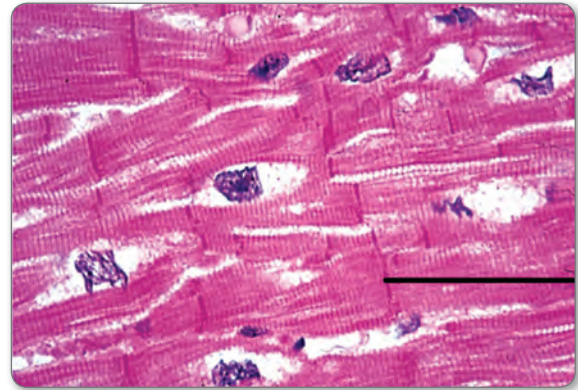
- a. Golgi cell
- b. Basket cell
- c. Vestibular cell
- d. Deep cerebellar nuclei

59. Identify the organ given in this slide (AIIMS May 2017)



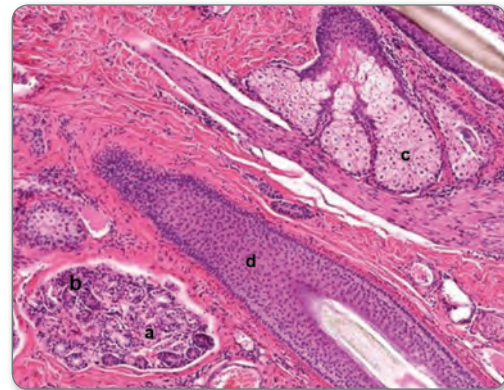
- a. Gallbladder
- b. Urinary bladder
- c. Skin
- d. Trachea

60. The marked structure in the given picture contains all of the following except (AIIMS Nov 2016-2017)



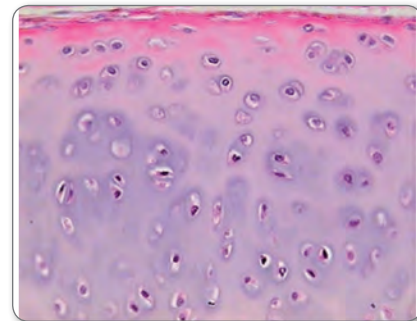
- a. Gap junctions
- b. Zona occludens
- c. Macula adherens
- d. Desmosomes

61. Identify the Holocrine cells in the given diagram (AIIMS Nov 2017)



- a. A
- b. B
- c. C
- d. D

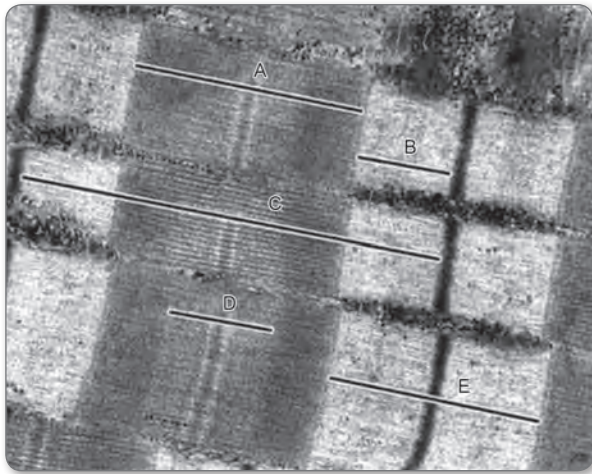
62. An image of haematoxylin and Eosin (H&E) stained section of a tissue is shown below. The tissue shown in lower two thirds of this picture is found in (AIIMS May 16)



- a. Articular disc
- b. Intervertebral discs
- c. Epiphyseal plates
- d. Pinna of ear



63. The below is the electron microscopic image of functional unit of a muscle. Identify the structure marked as E

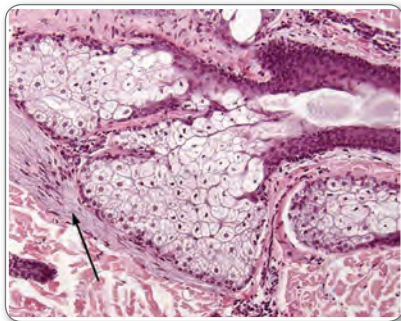


- a. A band
- b. H band
- c. M band
- d. I band

64. Dense irregular collagen fibers is seen in which of the following (AIIMS Nov 2017)

- a. Tendon
- b. Ligament
- c. Dermis
- d. Lamina propria

65. Histology slide of gland is given in figure, identify the type of gland (AIIMS May 2016)



- a. Apocrine
- b. Merocrine
- c. Holocrine
- d. Endocrine

66. Which of the following faithfully represents the braille characters (Recent Question 2015)

- a. Meissner's corpuscle
- b. Merkel cell
- c. Pacinian corpuscle
- d. Ruffini receptor

67. What constitutes Malpighian layer (Recent Question 2018)

- a. Stratum lucidum
- b. Stratum spinosum
- c. Stratum granulosum
- d. Stratum spinosum and Basale

68. All the following are true statement about terminal bronchiole except (Recent Question)

- a. Supplied by bronchial artery
- b. Hyaline cartilage and glands are absent
- c. Goblet cells more in number
- d. Lining epithelium simple columnar

69. Hyaline cartilage of respiratory tube extends till

(Recent Question)

- a. Bronchus
- b. Terminal bronchiole
- c. Respiratory bronchiole
- d. Alveolar duct

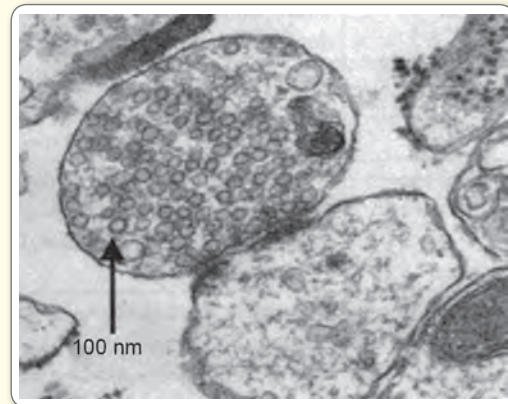
70. Oxyntic cells present in (Recent Question 2016)

- a. Pylorus
- b. Cardiac notch
- c. Body
- d. Fundus

71. Type I collagen is present in all except: (AIIMS May 2018)

- a. Bone
- b. Cartilage
- c. Ligament
- d. Aponeurosis

72. Which of the following is the marked structure in the below picture? (AIIMS May 2018)



- a. Neurotransmitter
- b. Microtubule
- c. Synaptic vesicles
- d. Collagen fibril

73. Ligamentum flavum consists of: (AIIMS Nov 2018)

- a. Type-II collagen
- b. Type-I collagen
- c. Reticulin
- d. Elastin

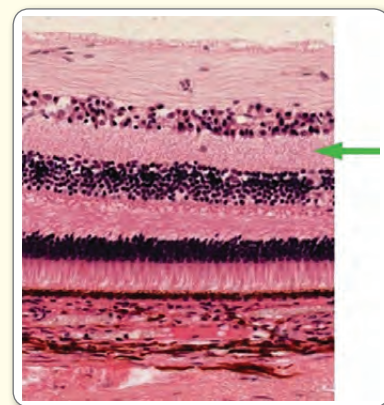
74. Golgi apparatus in serous acinar cells is at:

- a. Supranuclear
- b. Apical (AIIMS Nov 2018)
- c. Adjacent to nucleus
- d. Basal

75. What is the location of Meissner's corpuscles?

- a. Lucidum
- b. Basale (AIIMS Nov 2018)
- c. Reticular dermis
- d. Papillary dermis

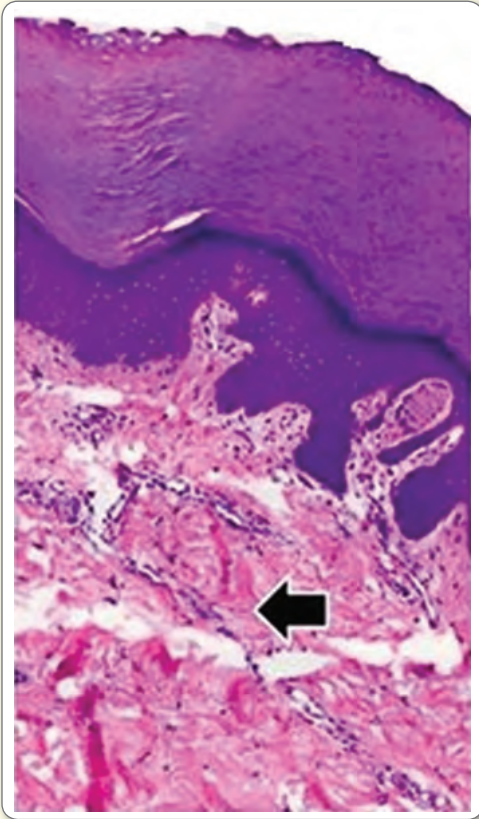
76. Identify the marked layer in the given histological section: (AIIMS Nov 2018)



- a. Inner plexiform layer
- b. Outer plexiform layer
- c. Inner limiting layers
- d. Outer limiting layer

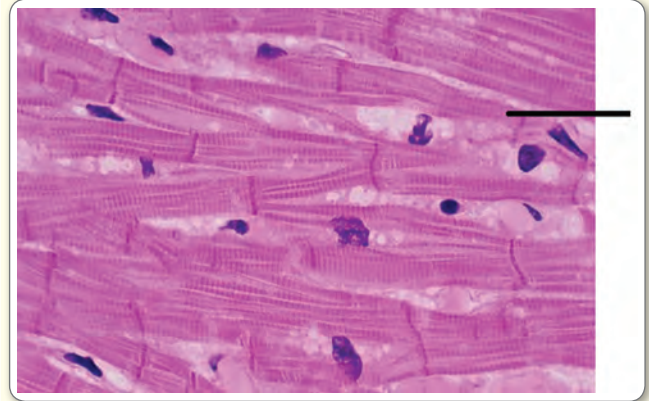


77. Type of connective tissue present in the arrow marked area is: (AIIMS Nov 2018)



- a. Loose and irregular
- b. Specialized
- c. Dense irregular
- d. Dense regular

78. Organelles not present in the marked cell: (AIIMS Nov 2018)



- a. Mitochondria
- b. Lysozymes
- c. Smooth endoplasmic reticulum
- d. Golgi apparatus

79. Testosterone is secreted by: (Recent Question 2019)

- a. Leydig cell
- b. Sertoli cells
- c. Vas
- d. Epididymis

80. True statement about terminal bronchiole: (Recent Question 2019)

- a. Most distal portion of the conducting zone
- b. Lined by columnar epithelium
- c. Composed of C-shaped hyaline cartilage rings
- d. Wall is composed of smooth muscle and glands
- e. Gaseous exchange takes places



Answers with Explanations

1. Ans. a. Gap junctions

[Ref: Textbook of Histology, I.B.Singh 6th ed]

Gap junctions – cell to cell transfer occurs
 Intercalated disc – consists of three major junctional complexes
 zonula adherens, desmosomes and gap junctions.

2. Ans. b. Sebaceous gland

[Ref: Difiore's Atlas of Histology 11th Edition Pg29-41]

Ducts of sebaceous glands lined by stratified squamous epithelium
 Remaining glands lined by stratified cuboidal epithelium

3. Ans. a. Transitional

[Ref: I.B.Singh Human Histology 6th ed PG 45-52]

Transitional epithelium	Stratified squamous non keratinization epithelium
Multilayered 4-6 layers Basal cell – cuboidal or columnar Intermediate cell – polyhedral Apical cell – umbrella shaped cell Extra reserve of cell membrane They have desmosomes Found in urinary system	Multilayered 4–6 layers Basal cell – cuboidal or columnar Intermediate cell – polyhedral Apical cell – squamous shaped cell No extra reserve of cell membrane They don't have desmosomes Found in oral cavity, esophagus, vagina, larynx

4. Ans. d. Transitional

[Ref: I.B.Singh Human Histology 6th ed 45-52]

5. Ans. d. Lung alveoli – Bowmans capsule

[Ref: Difiore's Atlas of Histology 11th Edition Pg 29-41]

Alveoli, bowmans capsule – simple squamous
 Olfactory epithelium – pseudostratified ciliated columnar
 Thick skin – keratinized stratified squamous epithelium
 Thin skin, esophagus – stratified squamous epithelium
 Urinary bladder – urothelium

6. Ans. c. Simple columnar with brush border

[Ref: Gray's Anatomy 39th Edition Pg 622]

Gall bladder lined by tall columnar cell with brush border.

7. Ans. d. Simple columnar

[Ref: Basic Histology by V Subhadra Devi first edition pg 201]

Common bile duct lined by simple columnar

8. Ans. b. Squamous epithelium

[Ref: I.B.Singh Human Histology 6th ed; Difiore's Atlas of Histology 11th Edition pg 29-41; I.B.Singh Human Histology 6th ed pg 45-52]

Kidney

Parts	Lining epithelium
Bowman's capsule	Simple squamous
PCT	Cuboidal cell or low columnar with brush border with highly eosinophilic cytoplasm
Thick descending loop of Henle	Cuboidal cells
Thin Descending loop of Henle (Ansa nephroni)	Low cuboidal or Squamous
Thin ascending loop of Henle (Ansa nephroni)	Low Cuboidal or squamous
Thick ascending loop of Henle	Cuboidal cells
DCT	Cuboidal cell without brush border
Small collecting tubules	Simple cuboidal
Large collecting tubules	Simple columnar

9. Ans. a. A

[Ref: Gray's Anatomy 39th Edition pg 29-33,622]

10. Ans. c. Oligodendrocytes

[Ref: Bloom and Fawcett Concise Histology pg 114]

11. Ans. b. Myelin formation

[Ref: Bloom and Fawcett Concise Histology pg 120]

Neuroglial Cell	Function
Astrocytes	Blood brain barrier
Oligodendrocytes	Myelin sheath formation in CNS
Schwann cells	Myelin sheath formation in CNS
Microglia	Phagocytic formation
Ependymal	Lining the ventricular system of brain.

12. Ans. a. Microglia

[Ref: I.B.Singh Human Histology 6th ed pg 45-52, 202-206,278]

Glitter cells – these cells are eventual result of microglial cell's phagocytosis of infectious material or debris



13. Ans. c. Spinal dorsal root of ganglion

[Ref: Bloom and Fawcett Concise Histology pg 110]

Pseudounipolar neurons	Bipolar neurons
Spinal (Dorsal root) ganglion, Sensory ganglia of cranial nerve, V, VII, IX, X cranial nerves	Found in olfactory nerve, in retina, cranial nerve VIII

14. Ans. a. Visual

[Ref: Gray's Anatomy 40th ed pg 57]

Neuroepithelium seen in taste buds (gustatory), hair cell (auditory) and also in olfactory system.

Visual system is the answer for this question because it is not given in Gray's anatomy. (According to some workers, visual system contains rods and cones neuroepithelium)

15. Ans. c. Simple columnar

[Ref: Bloom and Fawcett Concise Histology pg 156-157]

16. Ans. a. Simple Squamous; b. Simple Cuboidal; d. Simple Columnar

[Ref: Bloom and Fawcett Concise Histology Pg 156-157]

Thyroid follicles normally lined by simple cuboidal epithelium. Hyper secretion (Active state) – lined by columnar epithelium. Inactive stage (hyposecretion) – lined by squamous epithelium

17. Ans. d. Sebaceous gland

[Ref: Bloom and Fawcett Concise Histology pg 27-29]

Holocrine – whole of gland disintegrate and pour the secretions. e.g. sebaceous glands

18. Ans. c. Non-Keratinized Stratified Squamous Epithelium

[Ref: Bloom And Fawcett Concise Histology pg 20]

19. Ans. a. Thymus

[Ref: Bloom And Fawcett Concise Histology]

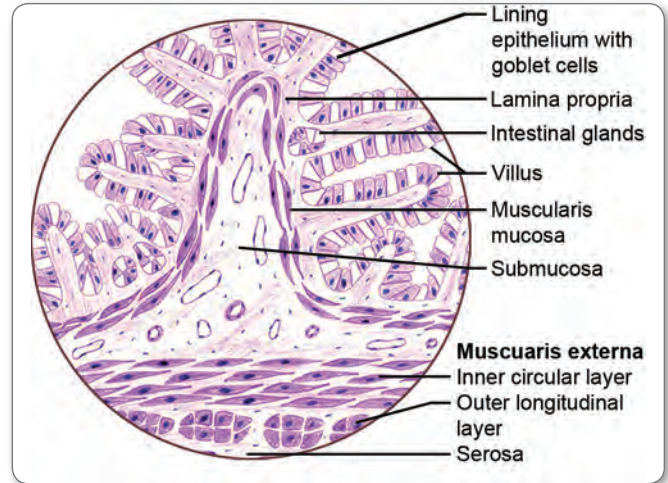
Reticular fibers absent in thymus

20. Ans. d. Periosteum

[Ref: Bloom and Fawcett Concise Histology pg 46-47]

Dense irregular connective tissue – randomly arranged fibers – dermis of skin, capsules around liver, spleen and other organs and fibrous sheath around bones.

Dense regular connective tissue – parallel arranged fibers – tendons, ligaments and aponeurosis.



21. Ans. a. Elastic cartilage

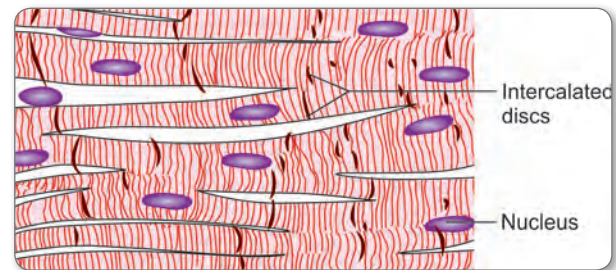
[Ref: Bloom and Fawcett Concise Histology pg 63-67]

22. Ans. b. Has multiple nuclei

[Ref: Bloom and Fawcett Concise Histology pg 103-105]

23. Ans. d. Gap junction

[Ref: Bloom and Fawcett Concise Histology pg 103-105]



Intercalated disc – consists of three major junctional complexes zonula adherens, desmosomes and gap junctions.

Desmosomes connect the Intermediate filaments of adjacent cells

Gap junction conduct the electrical impulse between adjacent myocytes and convert the whole cardiac muscle into single physiological syncytium.

24. Ans. b. Submucosa

Submucosa consists of dense connective tissue - rich in blood vessels and nerves. It is the strongest layer.



25. Ans. **d. Lower third contains only skeletal muscle**

[Ref: Basic Histology by V Subhadra Devi 1st ed pg 176]
Lower third contains smooth muscle

26. Ans. **a. Pancreas**

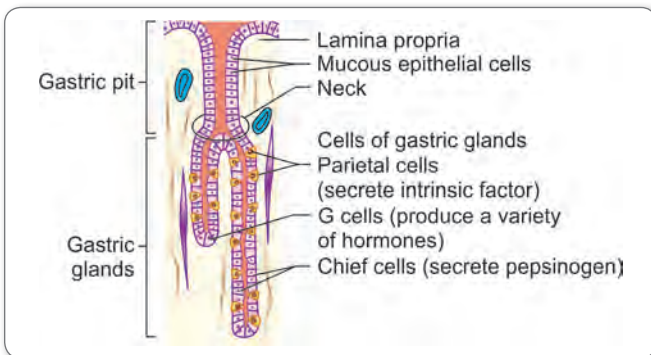
[Ref: Basic Histology by V Subhadra Devi 1st ed pg 202 to 204]
Centroacinar cells found in pancreas

27. Ans. **d. Fundus**

[Ref: Bloom and Fawcett Concise Histology pg 195-198]

28. Ans. **d. Goblet cells**

[Ref: Bloom and Fawcett Concise Histology Pg 195-198]

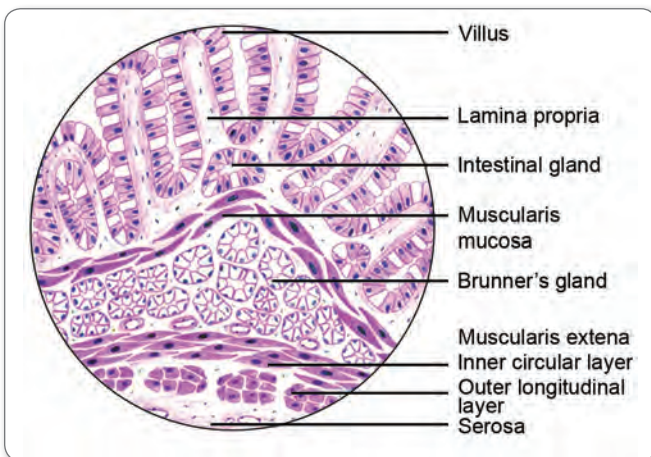


Goblet cells found in small intestine and large intestine. Goblet cells increase as we go from small intestine and large intestine.

29. Ans. **a. Duodenum**

[Ref: Bloom and Fawcett Concise Histology pg 202-205]

Duodenal or Brunner's Glands



Brunner's gland-Compound tubo-alveolar glands - present in duodenum
Mucous secreting gland and also activates enzyme trypsinogen produced by pancreas.

30. Ans. **c. GALT is absent in lamina propria; e. Close cell secrete digestive enzymes**

[Ref: Bloom and Fawcett Concise Histology pg 202-205]

31. Ans. **c. Neck cell**

[Ref: Bloom and Fawcett Concise Histology Pg 202-205]
Mucous neck cells present in stomach

Cells Present in Small Intestine

Paneth cells maintains normal flora
Micro fold cells - antigen presenting cell
Enterocytes - most numerous cells - function absorption
Goblet cells - for mucus secretion
Stem cell - located at the base of the gland and so the zone of replication is restricted to lower half of the gland.
Enteroendocrine cell - neuroendocrine cell (APUD cell)

- Closed cell do not secrete anything
- Open cell secrete cholecystokinin, gastrin, GIP, motilin

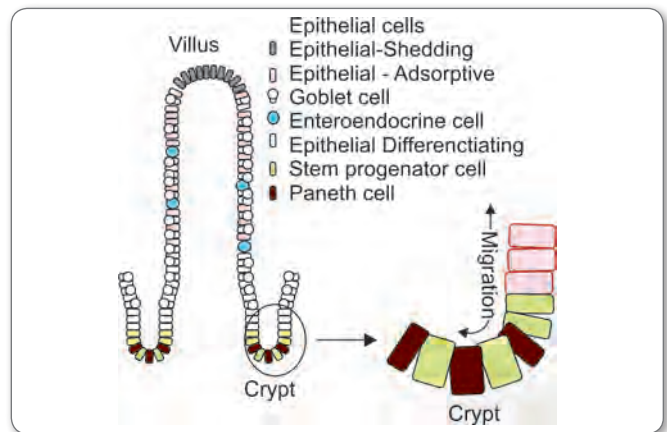
Gut-associated lymphoid tissue is predominant in lamina propria of small intestine and secretory Ig A provides mucosal immunity.

32. Ans. **d. Numerous lysozyme granules.**

33. Ans. **c. Paneth cell**

[Ref: Bloom and Fawcett Concise Histology pg 204]

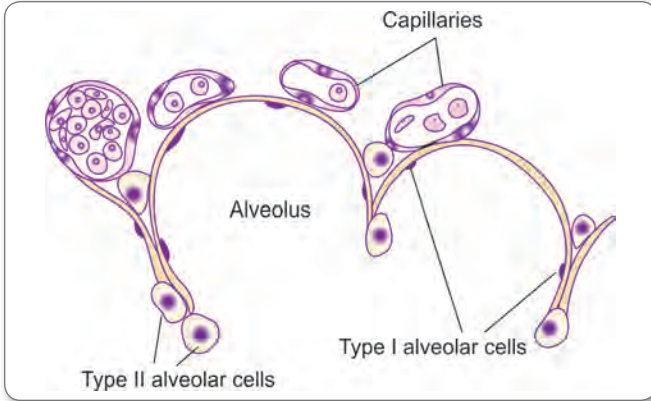
Paneth Cells Otherwise known as Zymogen cells



Found in deeper part of the intestinal crypts. Paneth cells are highly eosinophilic (dark pink) in the apical region. This is due to presence of large number of lysozyme. They do rich in zinc and contain rough endoplasmic reticulum, but these are not answer of first preference
Foamy cytoplasm is feature of goblet cell (they rich in mucus and give the foamy appearance)
This is the only cell migrate towards base of the villi, whereas other cells migrate towards the top of the villi

34. Ans. **d. Langerhan's cells**

[Ref: Bloom and Fawcett Concise Histology pg 234-237]



Langerhans cell found in epidermis of skin.

- Stellate shaped cell contain birback granules.
- These are antigen presenting cell.

Merkel cell – found in basal layer of epidermis. Important role in sensory reception.

Clara cell like type II pneumocyte release surfactant.

Brush cells found throughout the respiratory epithelium.

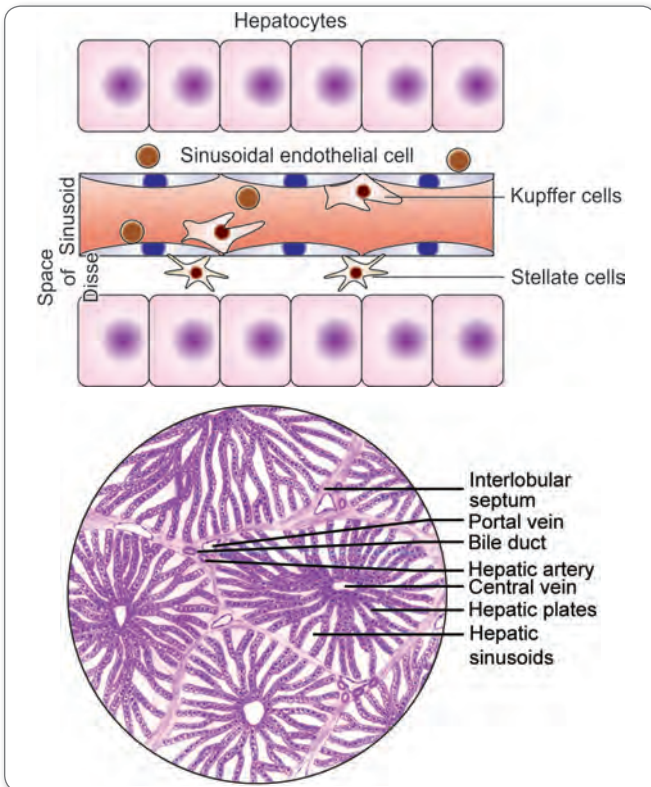
35. Ans. a. Vagina

[Ref: Bloom and Fawcett Concise Histology pg 281]

- Vagina does not contain mucous secreting glands
- Vagina contains Doderlein bacilli
- Secretion found is vagina derived from transudate from vaginal epithelium and secretions from cervix.

36. Ans. c. Liver

[Ref: I.B.Singh Text book of histology 6th ed pg 266]



37. Ans. b. Hepatic vein

[Ref: Basic histology by v subhadra devi first edition pg 198-200]

Portal triad contains branch from portal vein, hepatic artery and bile duct.

38. Ans. c. Kupffer cell

[Ref: Basic histology by v subhadra devi first edition pg 198-200]

Space of Disse – perisinusoidal space
Main constituent – plasma
Microvilli of hepatocyte project into this space
Kupffer cell – macrophage found among the endothelium in space of Disse.

Primary and Secondary Lymphoid Organ

Primary lymphoid organ – bone marrow, thymus
Secondary lymphoid organ – Lymph node, tonsil, spleen and MALT

- MALT – Mucosa Associated Lymphoid Tissue include Gut Associated lymphocyte Tissue (GALT), Respiratory associated lymphocyte and in urogenital system.

39. Ans. d. Vascular sinus

[Ref: I. B. Singh Textbook of histology 6th ed pg 195 and 196]

Histology of Spleen

Covered by capsule and trabeculae arising from the capsule. Trabeculae extend in to the substance of the spleen.
Red pulp – consists of sponge-like sinusoidal space, through which red cells are passed. These phagocytic cells lining the sinusoid engulf the broken red cells and other debris.
White pulp – Aggregations of T and B lymphocytes that surrounding the arteries (Periarteriolar lymphocytic sheath).
White pulp also contain some antigen presenting cells

40. Ans. c. Cortex

[Ref: basic histology by v subhadra devi 1st ed. pg 136]

Lymphocytes are arranged in the form of follicles in cortex

41. Ans. d. Lymphnode

[Ref: Basic histology by v subhadra devi 1st ed. pg 136]

Subcapsular sinus – the feature of lymphnode

42. Ans. b. Kidney

[Ref: Di Fiore histology 7th ed. pg 112-115, 121-122]

Sinusoids are present in liver, lymph node, spleen, adrenal medulla, parathyroid.

43. Ans. a. Thymus

[Ref: I. B. Singh Text book of histology 6th ed. pg 197]

Histology of thymus – Made up of lymphoid tissue not arranged in the form of follicles
Medulla consists of lymphocyte and more reticular cells and also Hassall corpuscles.
Hassall corpuscles consists of central pink hyaline mass formed by degenerated epithelial cells. Around this mass, thus are concentrically arranged epithelial cells. The functional significance of this cell is not known.

**44. Ans. a. Betz cells**

[Ref: I.B.Singh Textbook of Histology 6th ed]

Cells of cerebral cortex are
Pyramidal cells (Giant pyramidal cells of Betz)
Stellate or granular cells

45. Ans. b. Bipolar

[Ref: I.B.Singh Textbook of Histology 6th ed]

Cells in the Cerebellar cortex are:

Outer molecular layer consists of two cells – Stellate and Basket cells
Middle layer consists of – Purkinje cell which is flask-shaped cell
Deep granular layer consists of – Golgi cell and granule cell.

46. Ans. a. Type 1

[Ref: BDC Handbook of General Anatomy 4th/e pg. 50]

Hyaline and elastic cartilage contain type 2 collagen but fibrocartilage contains type 1.

47. Ans. b. Hyaline cartilage

[Ref: BDC Handbook of General Anatomy 4th/e pg. 50]

Hyaline cartilage found in thyroid cartilage, cricoids cartilage, arytenoids except tip, articular cartilage, costal cartilage, trachea, bronchi, growth plate cartilage.

48. Ans. a. Hyaline

[Ref: BDC Handbook of General Anatomy 4th/e pg. 50]

In Hyaline cartilage, chondrocyte converted to osteocyte.

49. Ans. a. Stratified columnar epithelium

Lacrimal sac lined by stratified columnar epithelium.

50. Ans. c. Muscularis

[Ref: BDC vol 1, 6th/e pg. 110]

Auerbach plexus (myenteric)—located between circular and longitudinal muscle.
Meissners plexus (submucosal plexus)—in submucosa

51. Ans. b. Serosa

Esophagus not lined by peritoneum so serosa absent.

52. Ans. d. Columnar epithelium with brush border

Gall bladder lined by columnar epithelium with brush border.

53. Ans. a. Stratified columnar

[Ref: BDC vol 1, 6th/e pg.110]

Only prostatic urethra lined by transitional epithelium, rest of male urethra and female urethrae lined by stratified columnar.

54. Ans. b. Transitional epithelium

[Ref: BDC vol 1, 6th/e pg.110]

Urinary bladder – lined by transitional epithelium.

55. Ans. d. Non keratinized stratified squamous

[Ref: Textbook on Anatomy 'Abdomen and Lower Limb' By Vishram Singh pg 286]

Upper area (above the pectinate line) – lined by columnar epithelium
Pecten area – lined by stratified squamous without keratin
Anal verge or lower area – lined by keratinized stratified squamous epithelium

56. Ans. b. Monocytes

Osteoclast derived from monocytes.

57. Ans. c. Dysarthria

Key given slide is cerebellum
Cerebellum lesion cause – dysarthria

58. Ans. d. Deep cerebellar nuclei

Marked cell – purkinje cell
Axons from purkinje cell inhibit the cerebellar nuclei

59. Ans. b. Urinary bladder

Given epithelium – transitional epithelium – seen in urinary bladder

60. Ans. b. Zona occludens

Key-the given slide is cardiac muscle and marked structure is intercalated disc.

Explanation

Intercalated disc is made up of three types of cell junctions

1. Fascia adherens (macula adherens)
2. Gap junctions
3. Desmosomes

61. Ans. c. C

C – sebaceous gland
D – hair follicle
A and B – sweat gland and ducts

62. Ans. c. Epiphyseal plates

Given image – hyaline cartilage
Seen in epiphyseal cartilage

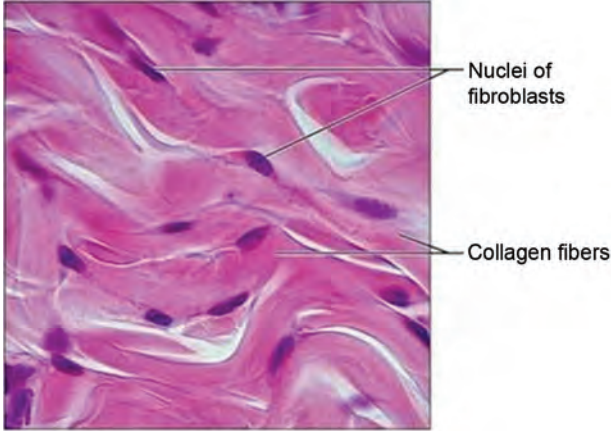
63. Ans. d. I band

Key
A-A Band (dark band)
C-Sarcomere
D-H band (middle of a bdn is traversed by light band H)
E-I band (light band)



64. Ans. c. Dermis

- Loose connective tissue – loose arrangement of fibres
- Dense irregular connective tissue – dense woven network of collagenous fibres in a viscous matrix. Found in joint capsules, muscle fascia and dermis of skin



Photomicrograph: Dense irregular connective tissue from the dermis of the skin (400x)

- Dense regular connective tissue – densely packed and arranged in parallel. Found in tendon, ligaments.

65. Ans. c. Holocrine

Given gland – sebaceous gland - holocrine

66. Ans. b. Merkel cell

Merkel cell faithfully represents the braille dots

67. Ans. d. Stratum spinosum and Basale

Malpighian layer is stratum spinosum and Basale

68. Ans. c. Goblet cells more in number

Goblet cells absent in bronchiole

69. Ans. a. Bronchus

Hyaline cartilage absent in bronchiole, present up to bronchus

70. Ans. c. Body

Oxyntic cells in body of gland

71. Ans. b. Cartilage

[Ref: Ross and Pawlina, 7th ed., Histology A Text and Atlas, pg.160-167 and Janqueira's Basic Histology, 13th ed., pg.106-108]

Type II – seen in cartilage

72. Ans. c. Synaptic vesicles

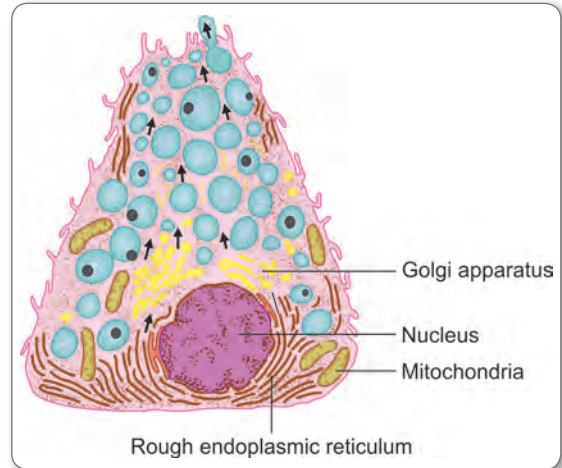
[Ref: Z. Taoufiq, OIST 2013]

Marked structure is synaptic vesicles

73. Ans. d. Elastin

Though ligaments contain type I collagen, majority of fibers in ligamentum flavum is elastin. The ligamentum flavum has such a high content of elastin that it is always under tension, and can be stretched by 80% without damage

74. Ans. a. Supra nuclear

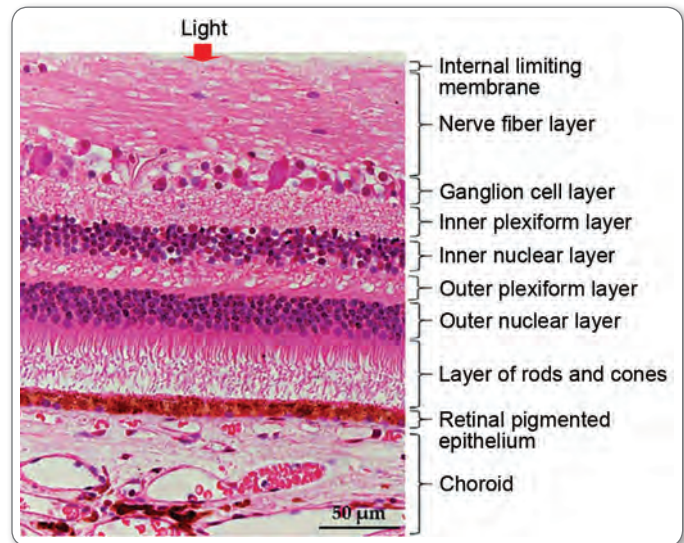


75. Ans. d. Papillary dermis

Meissner's corpuscles – receptor for fine touch – reading braille.

Located superficially within the papillary dermis

76. Ans. a. Inner plexiform layer



77. Ans. c. Dense irregular

Marked structure – dermis of skin



Dense Irregular Connective Tissue

Few cells and few ground substances with more collagen (randomly arranged)

Dermis of skin, organ capsules, submucosal layer of digestive tract

78. Ans. b. **Lysozymes**

Cardiac muscle given.

Cardiac myocytes marked

Cardiac myocytes contain mitochondria, sarcoplasmic reticulum, golgi, lipid droplets and glycogen

79. Ans. a. **Leydig cells**

Leydig cells secrete testosterone

Sertoli cells secrete Mullerian inhibiting factor

80. Ans. a. **Most distal portion of the conducting zone; b. Lined by columnar epithelium**

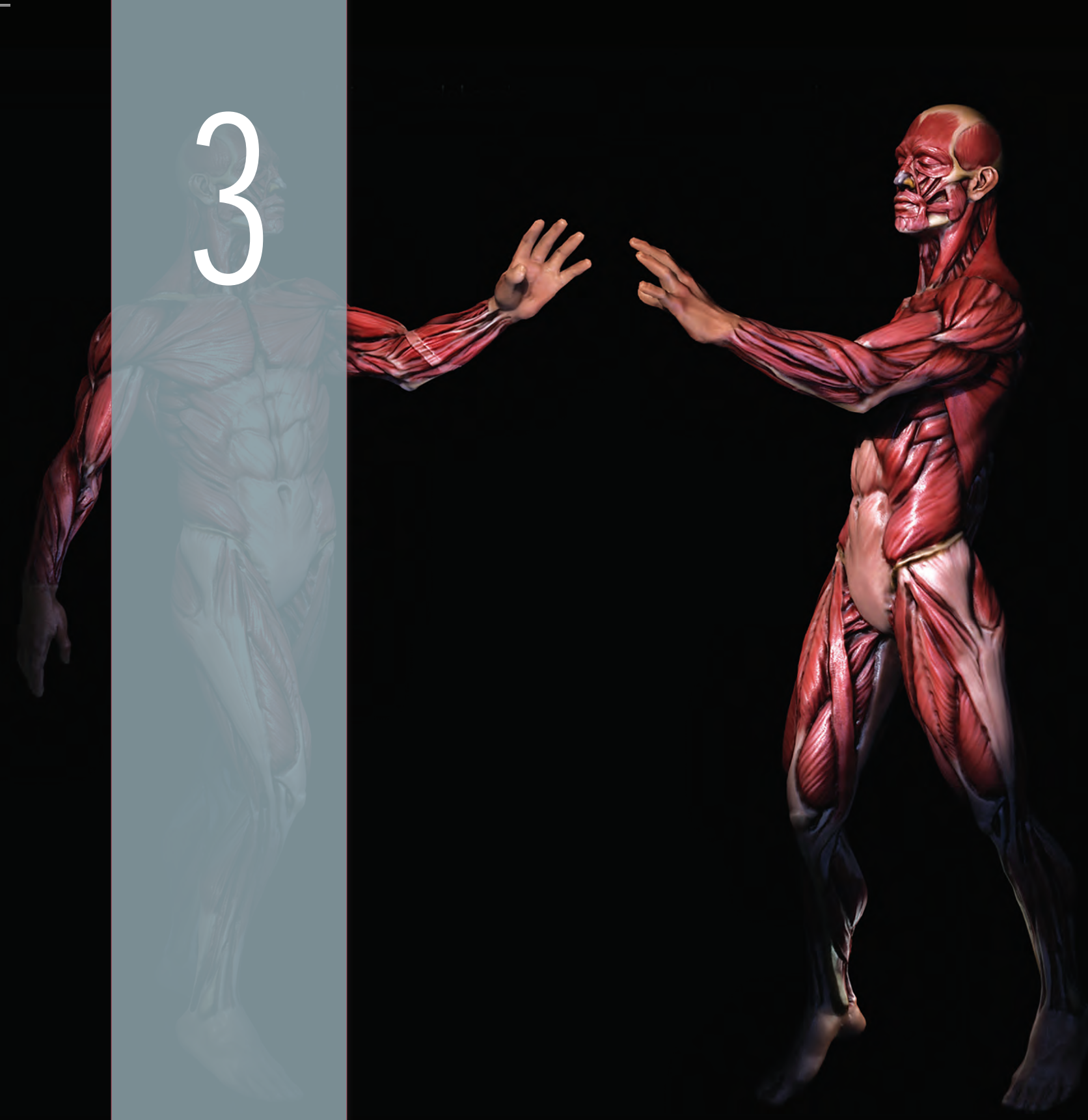
Terminal bronchiole—no cartilage, no smooth muscle.

In respiratory bronchiole—gaseous exchange takes place

NOTES

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3



GENERAL EMBRYOLOGY



GENERAL EMBRYOLOGY

SEXUAL REPRODUCTION

82

GENERAL EMBRYOLOGY

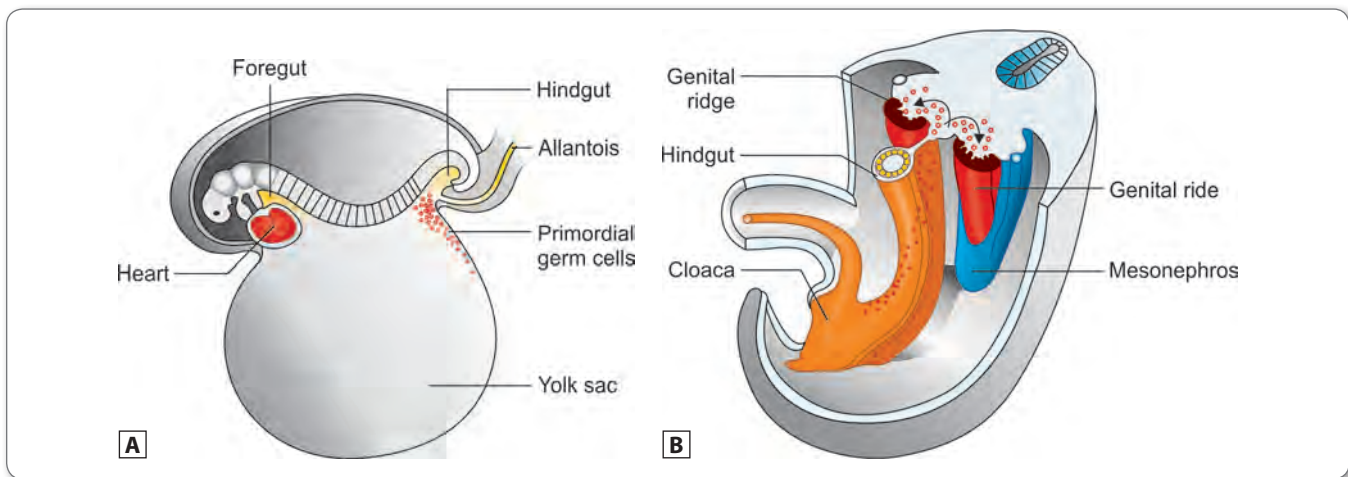
- Sexual reproduction occurs when male and female gametes unite at fertilization
- Gametes are direct descendants of primordial germ cells (produced by **epiblast** cells) and subsequently migrate to future gonad region
- Gametes are produced by gametogenesis
- Gametogenesis employs a specialized process of cell division meiosis and mitosis

Mitosis	Meiosis
Daughter cell chromosomal number is same as that of parent cell (equational division)	Daughter cells have half the number of chromosomes as parent cell (reduction division)
Takes place in somatic cells	Takes place in germ cells
Completes in one sequence	Completes in two sequences
No crossing over – so daughter cells identical to parent cell	Meiosis I, Meiosis II.
	(but meiosis II is not true reduction division)
	Crossing over takes place. Daughter cells are not identical to parent cell

Meiosis

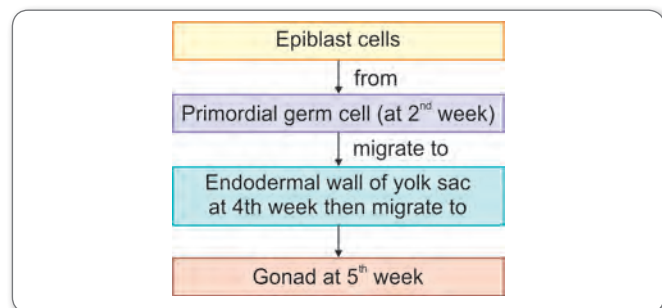
- Specialized process of cell division occurs in female ovary and male testes
- It occurs in two steps—Meiosis 1 and Meiosis 2
- In meiosis, chromosomal number is reduced to half number in daughter cells.
- But Meiosis 2 is not true reduction division.

Primordial Germ Cell (PGC)



Figs 1A and B: (A) A 3-week-old embryo showing the primordial germ cells in the wall of the yolk sac close to the attachment of the allantois; (B) Migrational path of the primordial germ cells along the wall of the hindgut and the dorsal mesentery into the genital ridge

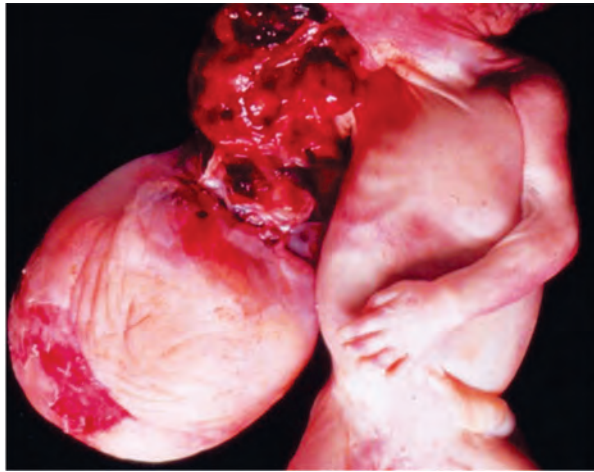
- PGC produced by epiblast during 2nd week
- PGC then migrate to endodermal wall of the yolk sac by 4th week
- Then reach the gonad by 5th week.



New SARP Series Anatomy



Clinical Aspect



Craniopharyngeal teratoma



Sacrococcygeal teratoma

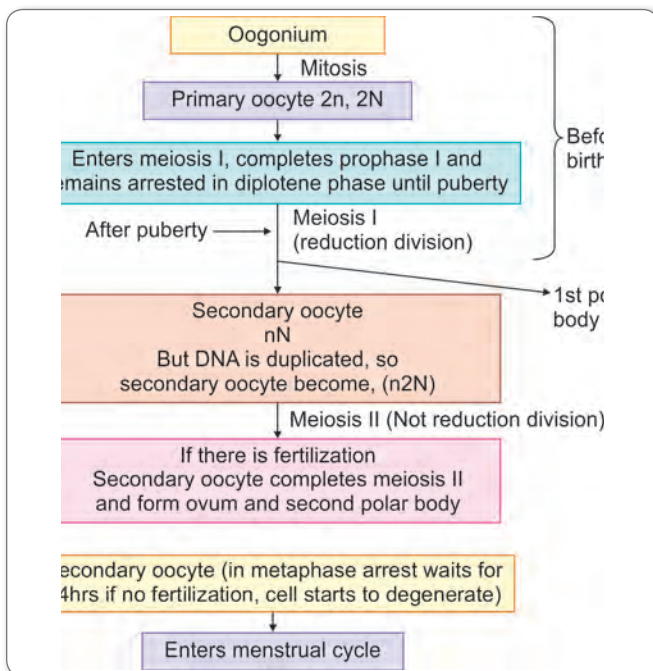
- Abnormal migration of PGC to head and neck instead of gonad cause Craniopharyngeal teratoma
- Abnormal migration of PGC to sacrum and coccyx cause sacrococcygeal teratoma

Gametogenesis

Formation of gametes is called gametogenesis. There are two types of gametogenesis:

- Oogenesis:** Formation of female gametes, i.e. oogonium
- Spermatogenesis:** Formation of male gametes, i.e. spermatogonium

Oogenesis



- PGC differentiates into Oogonium (46, 2N)
- Oogonium then forms primary oocyte (46, 2N)

- All oogonium converted to primary oocytes (46, 2N) by 7th month
- Primary oocyte enters meiosis 1 and completes prophase phase and remains arrested in diplotene phase
- Primary oocyte remains dormant in diplotene phase till puberty
- After puberty primary oocyte completes meiosis 1 and forms secondary oocyte (23, N) and polar body I
- Polar body is formed due to unequal division of cytoplasm. All the cytoplasm goes to secondary oocyte and polar body is the one with no cytoplasm
- DNA content of secondary oocyte duplicates. So the chromosomal number for secondary oocyte (23, 2N – n, 2N)
- Secondary oocyte enters meiosis II and completes metaphase and remains arrested after that.
- If the fertilization occurs, secondary oocyte in metaphase arrest completes Meiosis II and forms ova and polar body II
- No fertilization – secondary oocyte disintegrates in the menstrual cycle.

Note: Secondary oocyte gets arrested in metaphase stage and waits only for 24 hours.

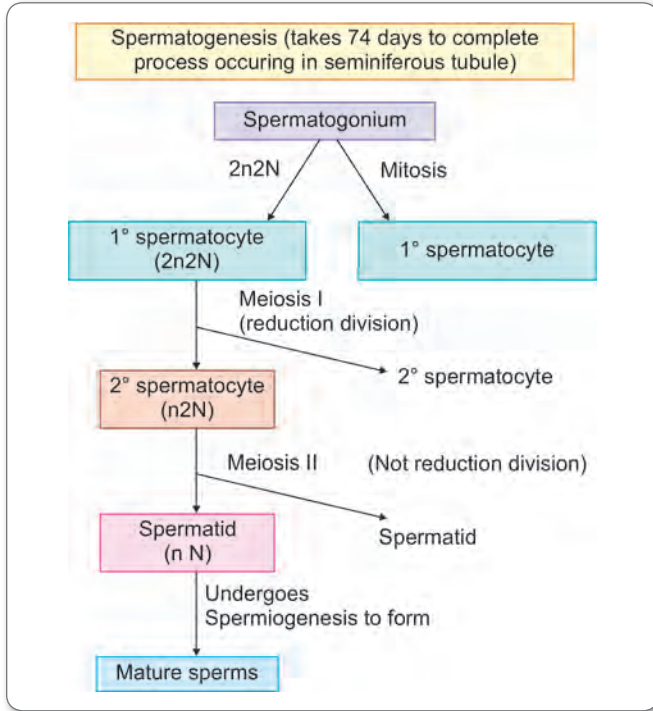
HIGH YIELD POINTS

- Meiosis II is not reduction division, because only DNA number is reduced from 2N to N.
- Polar body II (rarely formed) formed only if fertilization occurs.
- LH surge occur usually 36 hours before ovulation
- LH peak is associated with release of 1st polar body and occurs 12 hours before ovulation
- Sperms viable for 48 hours inside the female genital tract and secondary oocyte in metaphase arrest waits for 24 hours. So viable period for fertilization is 2 days before ovulation + one day after ovulation



Spermatogenesis

- Spermatogenesis begins only after puberty
- So until that, primordial germ cell remains in the dormant phase
- No polar bodies are formed in spermatogenesis, so each primary spermatocyte forms 4 spermatids



Spermatozoon

- **Length:** 55–65 microns
- **Parts**—Head, neck, body or middle piece and tail or principal piece.

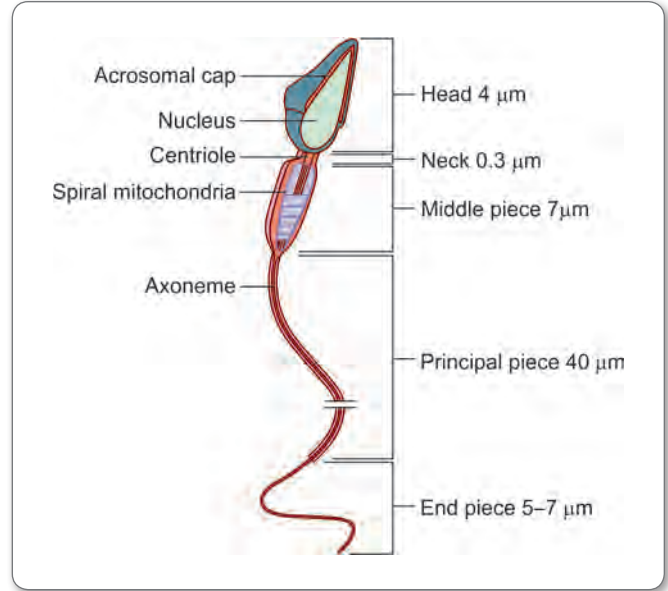


Fig. 2: Spermatozoon

Structure of Spermatozoa

- **Head:** Contains nucleus – Anterior two-thirds of the nucleus is overlapped by the bilaminar acrosomal or head cap derived from the Golgi apparatus
- **Neck:** Contains one centriole with two cylinders
- **Body (Middle piece)** (from within outwards) Consists of axial filaments (Axoneme), mitochondrial sheath (small amount of cytoplasm) and cell membrane.
- **Tail** – consists of from within outwards axial filaments, fibrous sheath, thin film of cytoplasm and cell membrane.

Table 1: Features of spermatogenesis and oogenesis

Spermatogenesis	Oogenesis
Process starts only after puberty	Process starts before birth
One primary spermatocyte forms 4 spermatid	One primary oocyte forms only one ovum + 3 polar body

Table 2: Parts of spermatozoa and their significance

Parts	Size	Content	Formed by	Role
Head	4 μm	Acrosomal cap, Nucleus	Golgi Apparatus	Contains lysosomal enzymes hyaluronidase, acrosin (dissolve ZP)
Neck	0.3 μm	One centriole with two cylinders	Centriole	
Principal/Middle piece	7 μm	Axoneme, mitochondrial sheath (small amount of cytoplasm) and Cell membrane	Mitochondria	Power house of sperm
End piece/Tail	5–7 μm	Axial filaments, fibrous sheath, thin film of cytoplasm and cell membrane	Tubules: 9 + 2 and Cen Trioles	Provides motility

Note:

- Spermatogenesis occurs in seminiferous tubules and maturation of sperms in epididymis
- Capacitation in female genital tract – last for 7 hours.
 - Involves removal of glycoprotein coat and seminal plasma protein from acrosomal region of spermatozoa
 - Only capacitated sperms can pass through the corona cells and undergo acrosome reaction



Clinical Aspect

MALE INFERTILITY

Sperm motility and number: Infertile males produce less than 10 million sperms/mL. Fertile males produce 20- more than 100 million sperms/mL.

Kallmann syndrome: Due to decreased production of GnRH by hypothalamus. This genetic disorder is characterized by hypogonadotropic hypogonadism and anosmia

Drugs: Cancer chemotherapy, anabolic steroids, cimetidine, spironolactone, sulfasalazine, nitrofurantoin, phenytoin cause male infertility

Other Factors: Klinefelter syndrome, seminoma, cryptorchidism, varicocele, hydrocele, mumps, prostatitis, vas deferens obstruction

Female Infertility: Anovulation - absence of ovulation in some women due to inadequate FSH, LH is often treated with clomiphene citrate

Pelvic Inflammatory Disease: Poly cystic ovarian disease – infrequent, irregular ovulations

Endometriosis – ectopic endometrial tissues in ovary, uterine ligaments, pelvic peritoneum.

PHASES OF DEVELOPMENT

There are three phase of development

- Germinal phase or pre-embryo phase up to 2nd week
- Embryo phase from 3rd to 8 week
- Fetal phase 9th week to 38 week

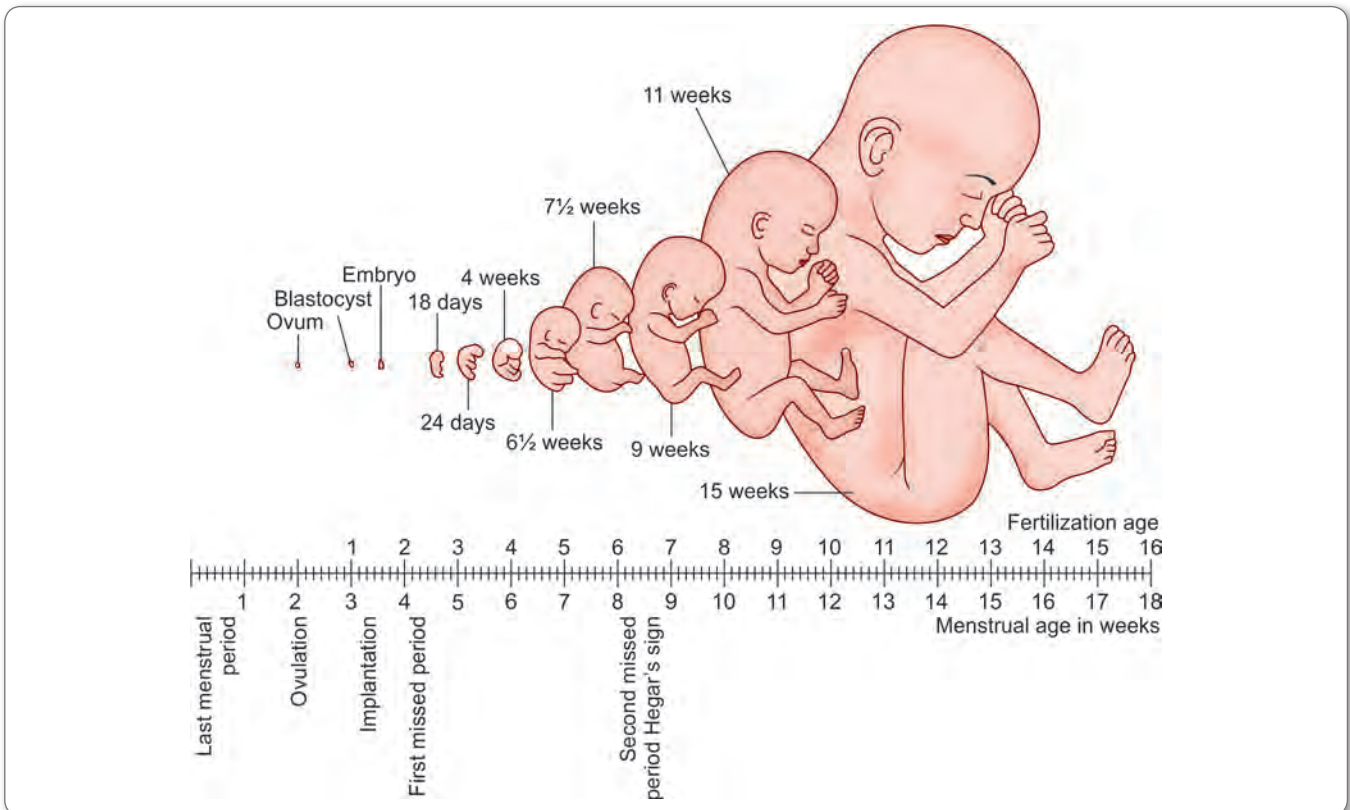


Fig. 3: Phases of development



Germinal Phase or Pre-embryonic Phase (Up to 3 Weeks)

First Week of Development – Fertilization

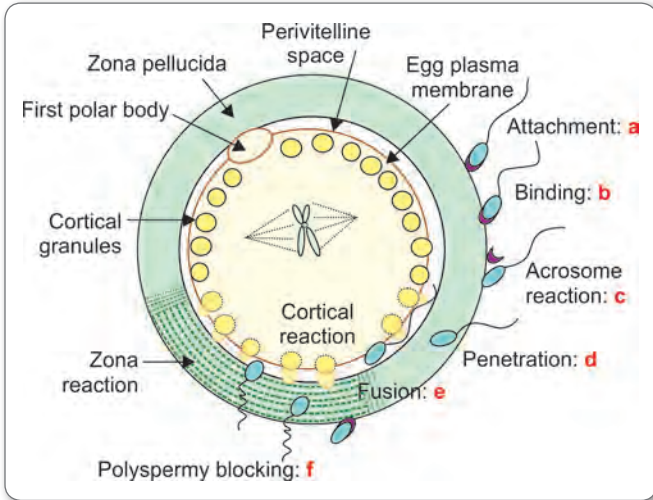
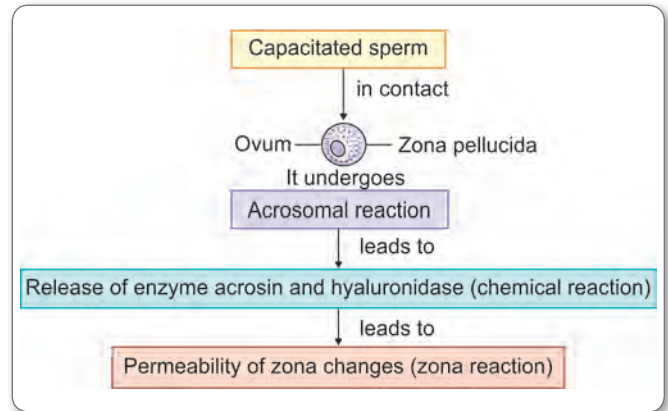


Fig. 4: Fertilization

- Fertilization occurs in ampulla of the fallopian tube and includes three phases
 - **Phase 1:** Sperm penetration of corona radiata
 - **Phase 2:** Penetration of zona pellucida
 - Sperm bind to zona pellucida - binding occurs through interaction of sperm glycosyltransferases and ZP3 receptor

- Sperm binding triggers the **acrosome reaction** (fusion of outer acrosomal membrane and sperm cell membrane resulting in the release of acrosomal enzymes)
- Penetration of zona pellucida – requires acrosomal reaction. Sperm contact with cell membrane of the secondary oocyte triggers **cortical reaction** (cortical granules released from oocyte cytoplasm). Cortical enzymes reach the zona. This change the permeability of zona (**zona reaction**). Zona reaction is necessary to prevent poly spermy.
- **Phase 3:**
 - Fusion of sperm and oocyte cell membrane
 - Male and female pronuclei fuse to form zygote



Cleavage and Blastocyst Formation

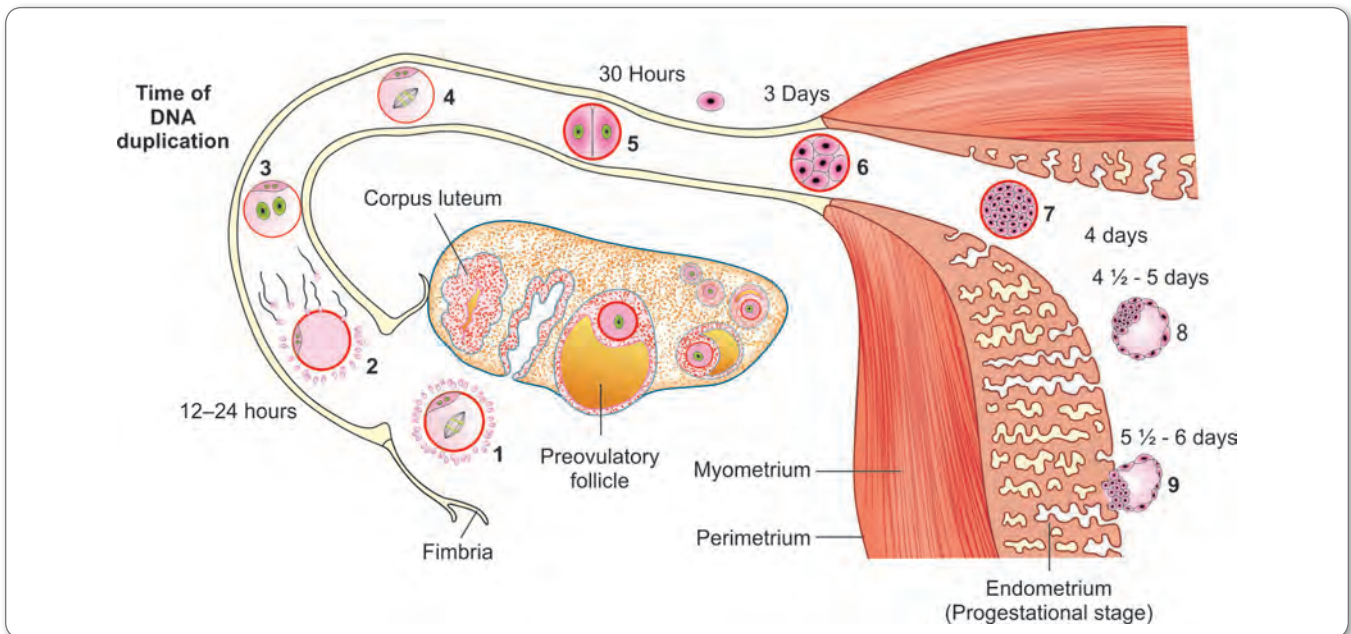


Fig. 5: Cleavage and formation of blastocyst



- Zygote formed 12–24 hours after ovulation
- Two-cell stage formed 24 hours after fertilization
- 8–16 (morula) formed 3 days after fertilization
- Advanced morula: 32 cell stage formed 4 days after fertilization enters uterine cavity.

Development of the Embryo

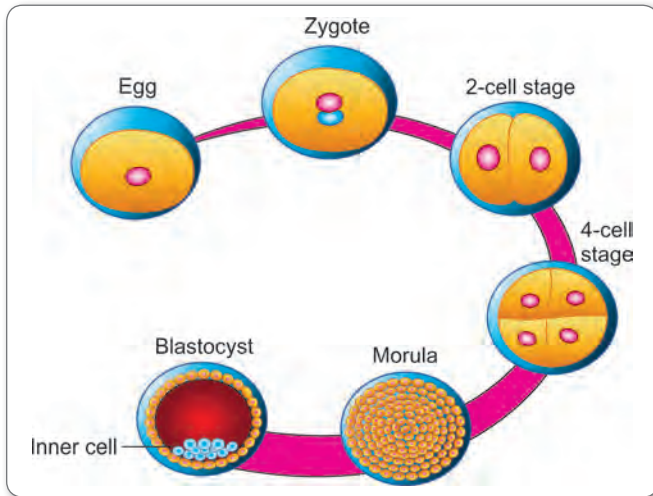


Fig. 6: Development of the embryo

- Blastocyst is formed by 4 1/2 days after fertilization
- Blastocyst formation involves fluid secreted within the morula that forms blastocyst cavity. The conceptus is called blastocyst.

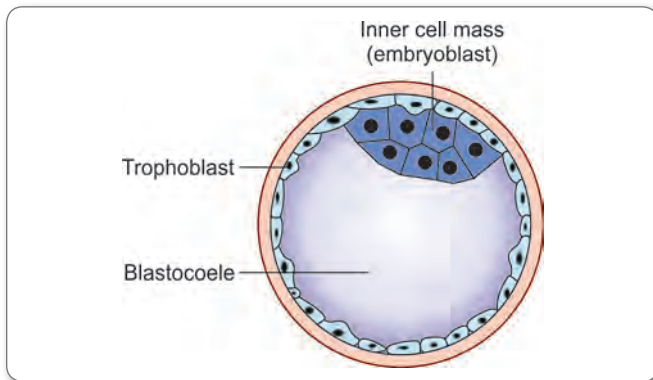


Fig. 7: Blastocyst

- Blastocyst consists of inner cell mass which forms embryo proper called embryoblast, outer cell mass forms trophoblast which forms placenta.
- Zona pellucida disappear by 5th–6th day after fertilization
- Implantation occurs by 6–7th day after fertilization

Note:

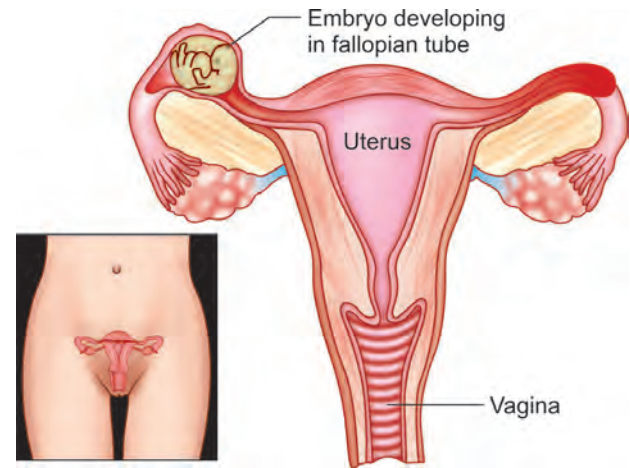
- Up to 8 cell stage: Cells are totipotent – each blastomere can form complete embryo
- After that cells became pluripotent



Clinical Aspect

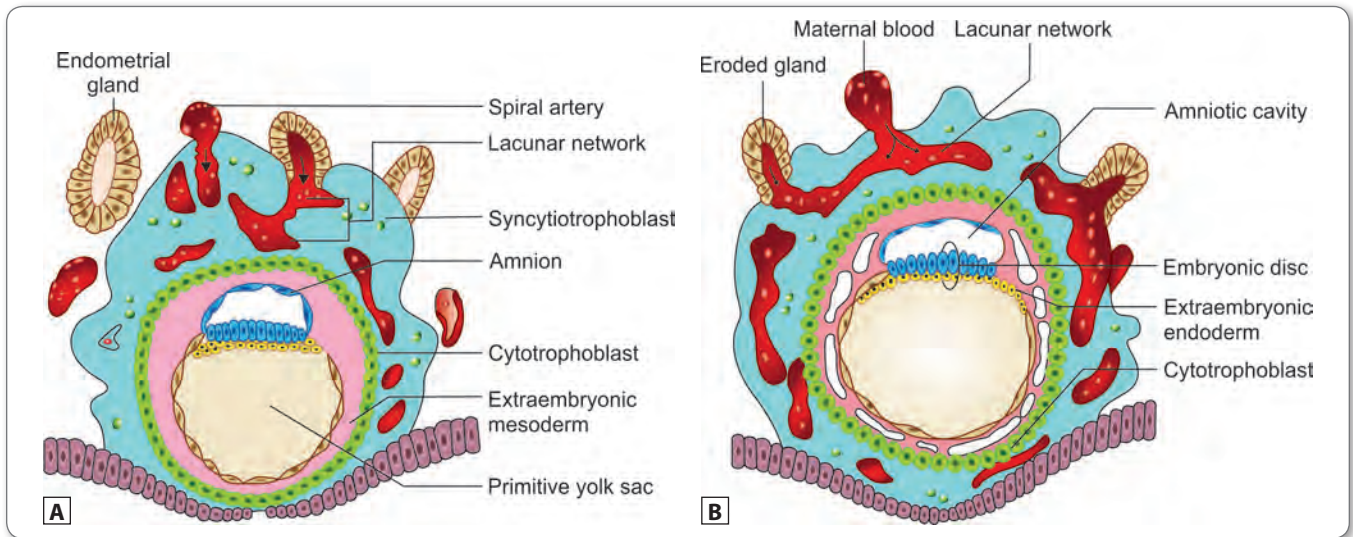
Ectopic Tubal Pregnancy

- Occurs when the blastocyst implants within the uterine tube due to delayed transport
- **Ampulla** of the uterine tube is the common site for ectopic pregnancy
- Most commonly seen in endometriosis and pelvic inflammatory disease
- Usually patients present with abnormal uterine bleeding, unilateral pelvic pain, increased level of hCG, but lower than originally expected with uterine implantation pregnancy
- **Differential diagnosis:** Appendicitis and aborting intrauterine pregnancy





2nd week—"Full of 2"



Figs 8A and B: Implantation continues

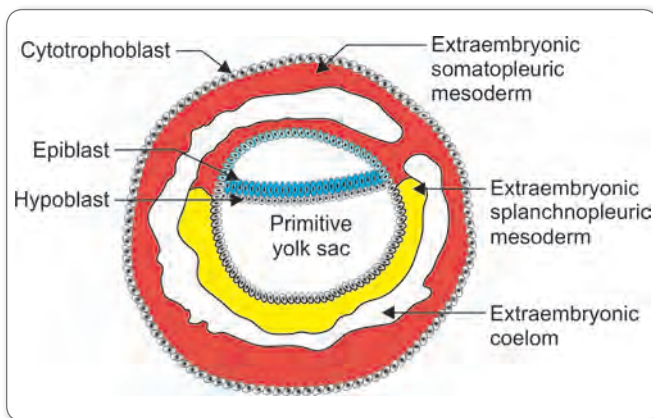


Fig. 9: 2nd week development of embryoblast

Further Development of Embryoblast

- Embryoblast differentiates into two layers—dorsal epiblast columnar cells and ventral hypoblast cuboidal cells
- So in the 2nd week, bilaminar embryonic disc is formed
- Within the epiblast, cleft develop and coalesce to form amniotic cavity
- Hypoblast cells migrate and line the inner surface of cytotrophoblast to form exocoelomic membrane, which enclose cavity called primary yolk sac
- Later some hypoblast cells become columnar and form pro-chordal plate.

Further Development of Trophoblast

Trophoblast differentiate into cyto (inner) and syncytio- (outer) trophoblast on day 8

Syncytiotrophoblast

- Syncytiotrophoblast erodes endometrial glands and blood vessels. Lacuna formed within the syncytiotrophoblast and filled with maternal blood.
- These lacunae fuse together and form lacunae network through which maternal blood flows and thereby establishing uteroplacental circulation
- It is the primitive circulation established and the embryoblast receive nutrition by diffusion this time

Note:

- Uteroplacental circulation established at day 12
- Feto placental circulation established at day 22

Cytotrophoblast

- Cytotrophoblast produce primary chorionic villi and that bulge into surrounding syncytiotrophoblast

Development of Extra Embryonic Mesoderm

Extra embryonic mesoderm (EEM) consists of loosely arranged cells that fill the space between exocoelomic membrane and cytotrophoblast

- Source of EEM is not clear. It may derive from yolk sac or hypoblast or epiblast

YOLK SAC > HYPOBLAST, EPIBLAST

- Spaces develop in the EEM and they join to form extra embryonic celom
- This extra embryonic celom divides EEM into visceral extra embryonic mesoderm and somatic extra embryonic mesoderm
- Extra embryonic mesoderm cranial to amnion is undivided and this undivided part forms connecting stalk



- Chorion is also formed in the second week, which is made up of somatic extra embryonic mesoderm + cytotrophoblast + Syncytiotrophoblast
 - Amnion covered by inner layer – amniogenic layer and outer somatic layer of EEM
- After formation of EEM, primary yolk sac decreases in size and became smaller and form secondary yolk sac
- At the end of 2nd week – 2nd week full of two
 - Two layers of cells—epiblast and hypoblast
 - Two membranes—amnion and chorion
 - Two cavities formed—primary and secondary yolk sac
 - Two extraembryonic mesoderm—somatopleuric and splanchnopleuric EEM



Clinical Aspect

Human chorionic gonadotropin (hCG)

- Glycoprotein produced by syncytiotrophoblast which stimulates production of progesterone by corpus luteum until 8th week
- Later placenta takes over the production of progesterone
- hCG – assayed in maternal blood at day 8 or maternal urine by day 10 and this is basis for pregnancy testing
- Low values of hCG: Spontaneous abortion, ectopic pregnancy
- Elevated values: Multiform pregnancy, hydatidiform mole, gestational trophoblastic neoplasia

Hydatidiform Mole

- Abnormal placenta characterized by enlargement of chorionic villi
- Gross edema of chorionic villi forming grape-like vesicles
- Complete mole is distinguished from partial by amount of villi
- **Clinical signs:** Pre-eclampsia during first trimester, elevated hCG and enlarged uterus with bleeding

Gestational Trophoblastic Neoplasia

- Malignant tumor of the trophoblast that may occur following normal pregnancy, ectopic pregnancy, abortion or hydatidiform mole
- hCG: High degree of elevation are diagnostic
- Nonmetastatic GTN: Treatment is successful
- Metastatic GTN: Prognosis is poor, commonly metastasis to liver and brain

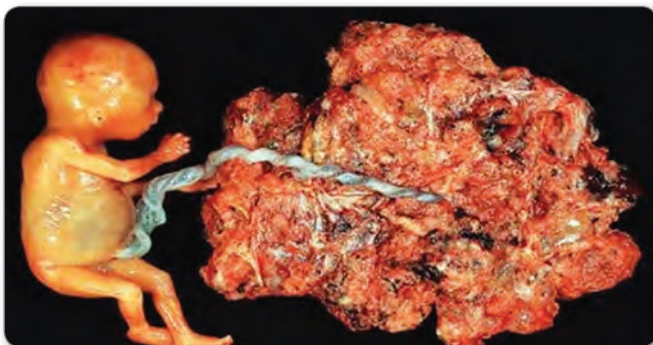


Fig. 10: Partial mole



Fig. 11: Complete molar pregnancy

Double Bleb Sign

USG of second week shows 2 bubbles – one for amnion and other yolk SAC



Fig. 12: UsG of second week

Embryonic Period 3rd–8th Weeks

Gastrulation

- Formation of all three germ layers
- Occurs at 3rd week
- Appearance of primitive streak is the first sign of gastrulation. Gastrulation occurs in craniocaudal sequence.
- Prechordal plate—flattened cells become columnar at cranial end of embryonic disc
 - Prochordal plate forms oro(buuco)pharyngeal membrane which contains endoderm and ectoderm only. No mesoderm
- Primitive streak—epiblast cells proliferate at caudal end and form primitive streak, which appears at the end of 2nd week or beginning of 3rd week.
- Cloacal membrane is the future site of the anus where epiblast and hypoblast cells fuse. Cloacal membrane is located caudal to primitive streak
- Endodermal cells are first germ layer derived from epiblast
- Mesoderm—primitive streak cells move inward and form intraembryonic mesoderm
- Intraembryonic mesoderm is derived from primitive streak which is derived from epiblast



- Remains of epiblast cells form ectoderm
- Ectoderm is the last germ layer to develop.
- At the end of 3rd week – 3rd week full of three

- Three germ layers established—ectoderm, mesoderm and endoderm
- Trilaminar disc
- Tertiary stem villi are formed.

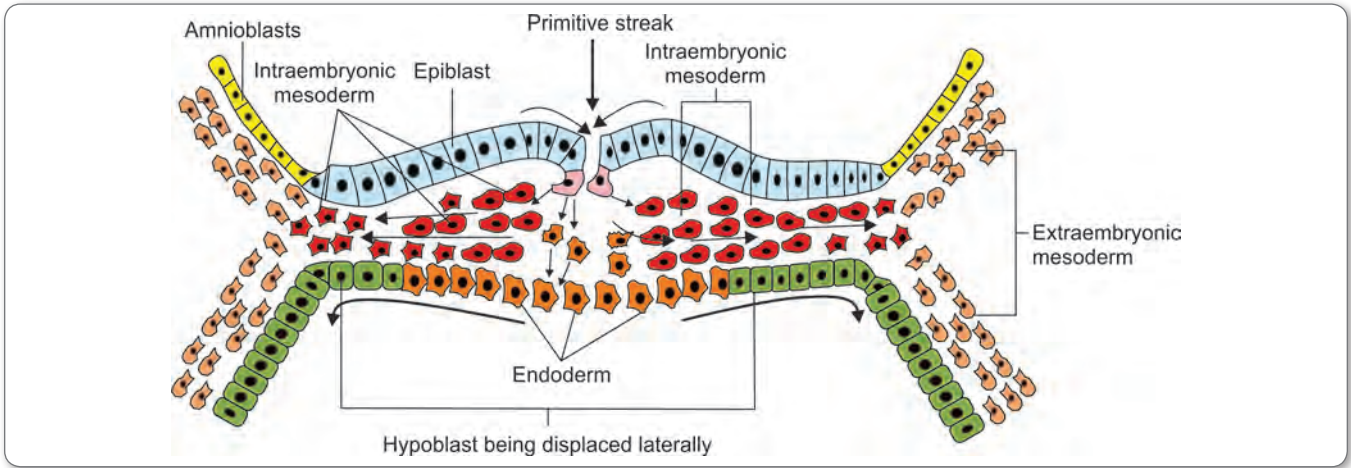
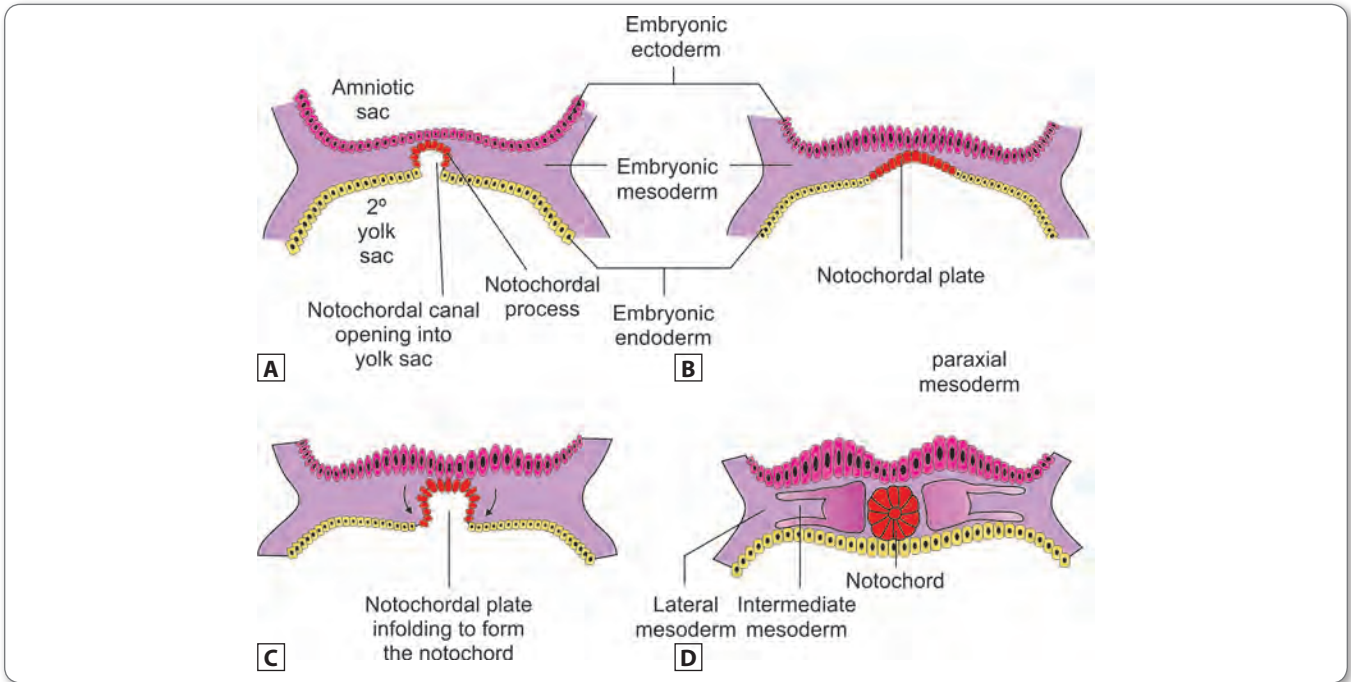


Fig. 13: Gastrulation

Notochord



Figs 14A and D: Notochord formation

- Solid cylinder of mesoderm extending in the midline of the trilaminar embryonic disc from primitive node to prochordal plate.
- Functions
 - Induces the overlying ectoderm to differentiate into neuroectoderm to form neural plate
 - Cranial end of notochordal cells are formed first, cells are added to the caudal end

- Notochord central in position (but does not form vertebral canal) and degenerate to forms nucleus pulposus of intervertebral disc
- Sometimes notochord persists and form congenital benign tumor, chordoma

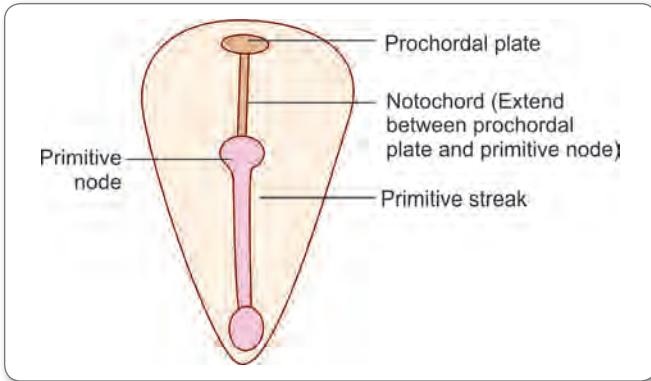
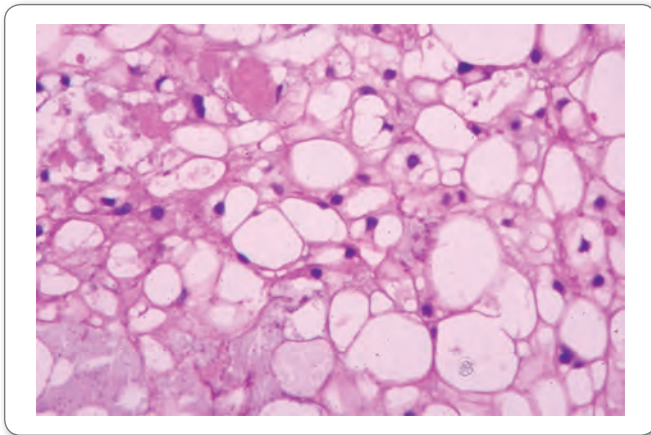
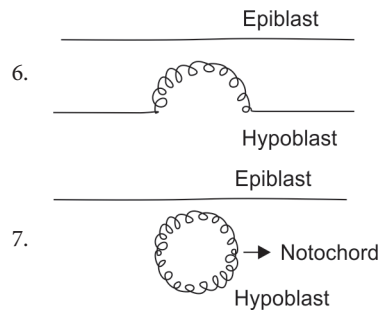
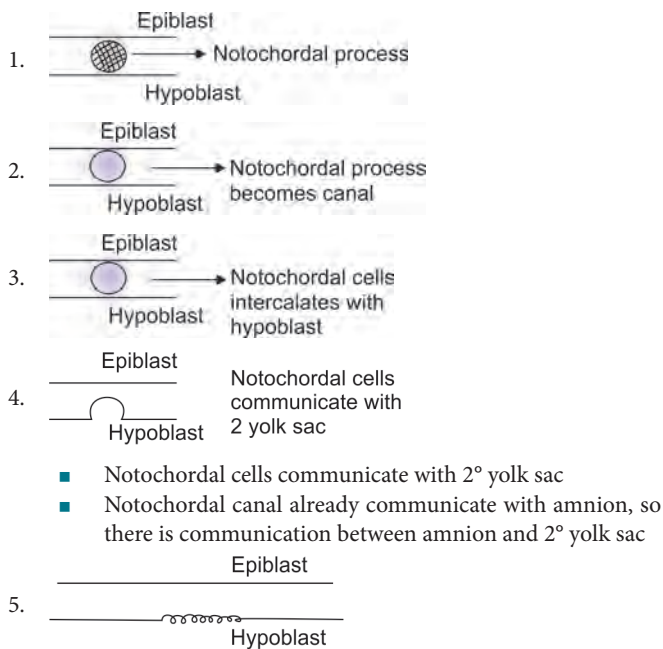


Fig. 15: Primitive streak

In chordoma – physaliferous cells seen (small round nuclei with abundant vacuolated cytoplasm)



Steps Involved in Notochord Formation from Notochordal Process



Neural tube formation starts at the 3rd week. Neuralation process explained in neuroanatomy.

REMEMBER

Cells Derived from Epiblast

- Endoderm
- Mesoderm
- Ectoderm
- Primordial germ cells
- Neural crest cells (4th germ layer)
- Notochord

Primitive Streak

- Derived from epiblast at the caudal end through which epiblast cells migrate to form endoderm and mesoderm layers during gastrulation.
- Formed at end of second week or beginning of third week
- Determines craniocaudal and medial lateral axis of embryo
- It initiates germ layer formation and determines site of gastrulation
- Primitive node – hensen's node – at the cranial end of primitive streak. Plays important role in the formation of notochord
- Primitive pit – depression in the primitive node.

Clinical Aspect



Contd...



- Tumors arising from remnants of primitive streak which normally degenerates and disappears
- Sacrococcygeal teratoma also due to primordial germ cell abnormal migration to sacrum and coccyx instead of gonads
- Sacrococcygeal teratoma is the most common germ cell tumor of the childhood

Septum Transversum

- Derived from visceral (splanchnic) mesoderm surrounding heart and assumes the position between primitive thoracic and abdominal cavity

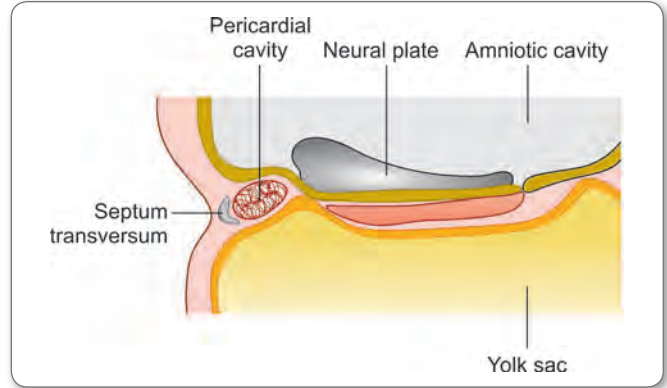
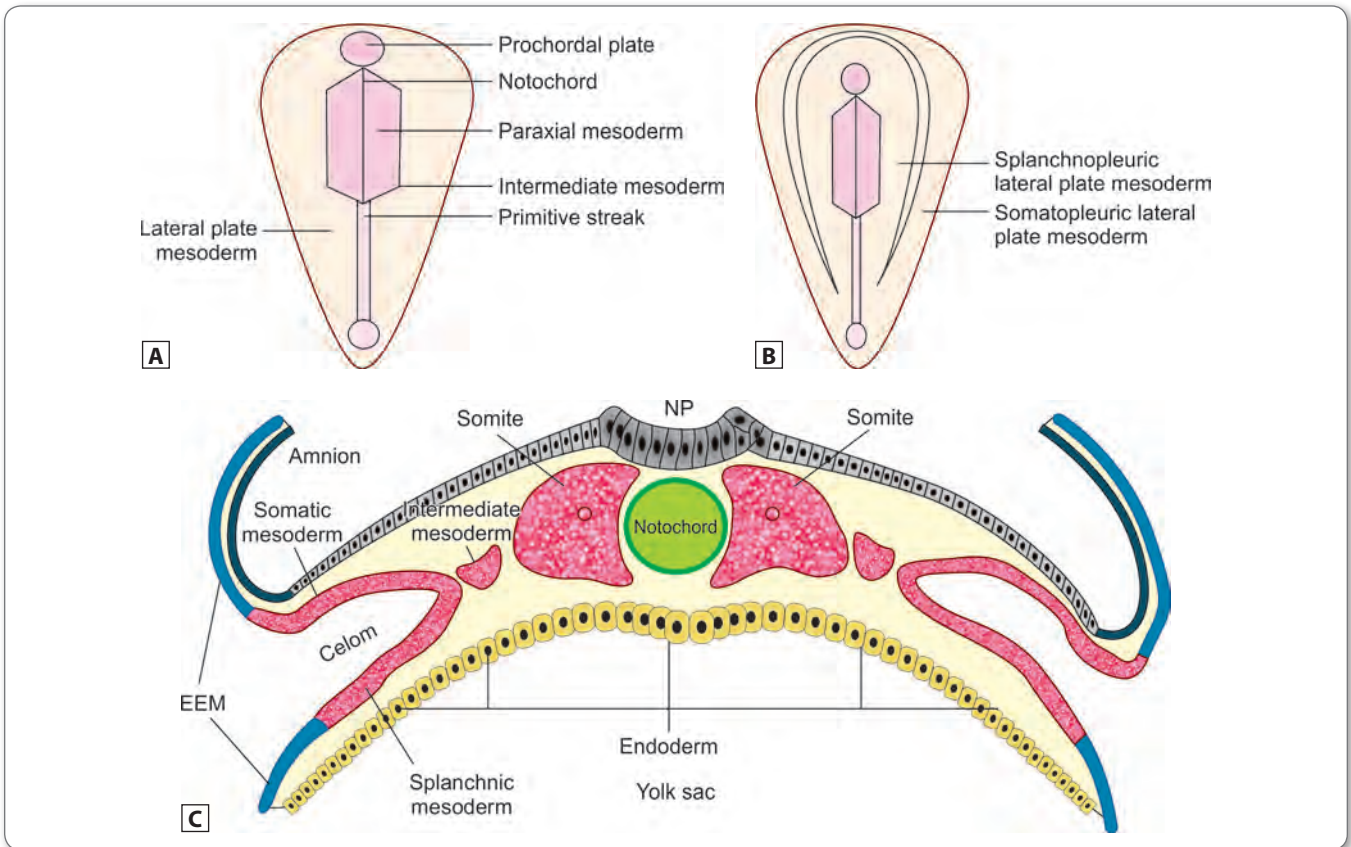


Fig. 16: Sagittal section showing the position of the septum transversum rostral to the pericardial cavity – 3 week embryo

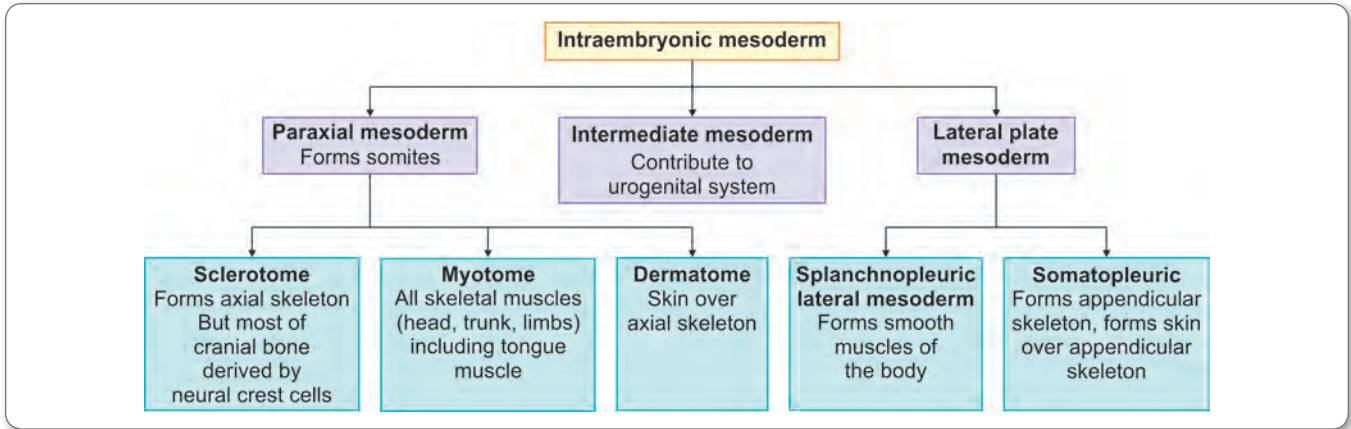
Derivatives

- Central tendon of diaphragm
- Connective tissue of liver capsules, sinusoids, kupffer cells, etc.
- Ventral mesogastrium
- Fibrous pericardium

Subdivision of Intraembryonic Mesoderm



Figs 17A to C: Subdivisions of intraembryonic mesoderm



Somites

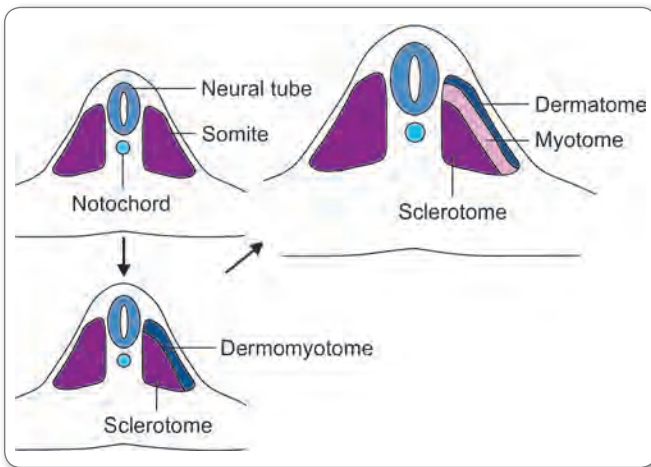


Fig. 18: Development of somites

- Derived from paraxial mesoderm
- Located on each side of midline
- Paraxial mesoderm become segmented and form somites
- First pair of somites appear at 20th day in the occipital region
- Somites appear at the rate of 3 per day in craniocaudal sequence up to 5th week. By the end of 5th week, 42/44 pairs present.
- Caudal somites and some cranial somites disappear and give final count of approximately 35 pair of somites
- Somites then differentiate into sclerotome, myotome and dermatome
- Sclerotome forms axial skeleton but most of the cranial bones developed from neural crest cells
- Myotome forms skeletal muscles (epiaxial & hypoaxial)
- Epiaxial muscles – erector spinae group– extensors of back
- Hypoaxial – remaining skeletal muscles (limb muscles, abdominal muscles and intercostal muscles)
- Dermatome forms skin over axial skeleton

Note:

- Tongue muscles are derived from occipital myotome, except Palatoglossus which is derived from NCC.
- Diaphragm muscles derived from cervical myotome – Diaphragm supplied by phrenic nerve – root value – C3,4,5

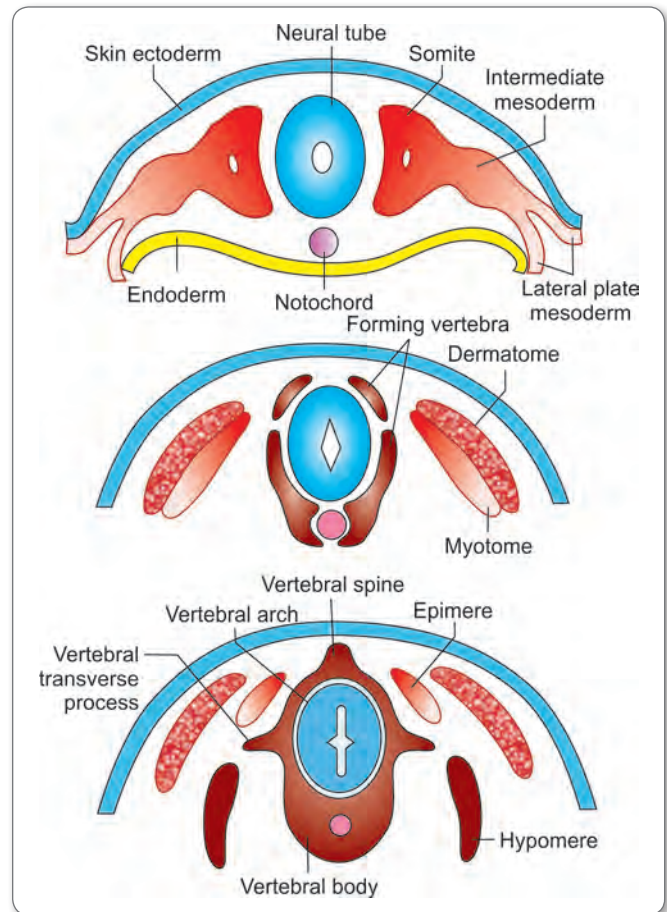


Fig. 19: Subdivisions of somites

Derivatives of Lateral Plate Mesoderm

Somatopleuric lateral mesoderm	Splanchnopleuric lateral mesoderm
All parietal layers Appendicular skeleton and skin over appendicular skeleton	All visceral layers Smooth muscles and cardiac muscle



HIGH YIELD POINTS

- Smooth muscle for dorsal aorta derived from lateral plate mesoderm (LANGMAN'S EMBRYOLOGY 13TH EDITION)
- Smooth muscle for coronary artery from proepicardial cells and proximal part from neural crest cells
- Smooth muscle over pharyngeal arch arteries derived from NCC
- Smooth muscle over gut tube from splanchnic layer of lateral mesoderm
- Iris muscles and muscles in mammary gland and sweat glands from ectoderm

Derivatives of Germ Layers

Table 3: Structures developing from ectoderm and mesoderm

Surface ectoderm	Neuroectoderm	Mesoderm
<ul style="list-style-type: none"> • Anything that opens to exterior is developed from surface ectoderm • Skin and its appendages (hair, nail, sweat and sebaceous gland) • Eye lens and epithelium of cornea • Epithelial lining of external auditory canal, male urethra tip, anal canal below the pectinate line • Adenohypophysis 	<ul style="list-style-type: none"> • Optic nerve • Retina • Epithelium over iris and ciliary body • Iris muscles (sphincter and dilator pupillae) • Neurohypophysis • Entire CNS cells and associated cells like astrocyte, oligodendrocyte, ependymal cells 	<ul style="list-style-type: none"> • All muscles (including skeletal and smooth), connective tissue, bones, cartilage, body cavities, genitourinary system, cardiovascular system (heart, blood vessels, lymphatic system. so microglia develop from mesoderm) • Adrenal cortex duramater

Table 4: Structures developing from endoderm and neural crest cells

<p>Neural crest cells (secondary mesenchyme)</p> <ul style="list-style-type: none"> • Arise from embryonic ectoderm • Considered as 4th germ layer • Formed in 3rd week along with neural tube • Migrate to various parts and has capacity to generate cells of different types • Derivatives 	
Endoderm	Neural crest cells
<ul style="list-style-type: none"> • GIT • Respiratory system • Urinary bladder • Urethra • Lower part of vagina • Pharyngeal pouch derivatives • Tonsillar fossa • Middle ear cavity • Eustachian tube • Thymus • Superior parathyroid • Inferior parathyroid • Thyroid 	<ul style="list-style-type: none"> • Cranial nerve ganglia • Dorsal root ganglia • Sympathetic ganglia • Parasympathetic ganglia • Schwann cells • Adrenal medulla • Melanoblast • Pia and arachnoid • Pharyngeal arch derivatives • Most of skull bones • Most of eyeball derivatives • Parafollicular cells of thyroid • Ultimobranchial body • Conotruncal septum

Glands

Table 5: Glands developed from ectodermal and endodermal

Ectodermal glands	Endodermal glands
<ul style="list-style-type: none"> Sweat gland Sebaceous gland Mammary gland Lacrimal gland Parotid gland 	<ul style="list-style-type: none"> Submandibular gland Sublingual gland

Vasculogenesis

Occur in two general locations mesoderm extraembryonic and intra-embryonic mesoderm

Extraembryonic mesoderm

- Angiogenesis occurs first within extraembryonic visceral mesoderm around the yolk sac on day 17
- On day 21, angiogenesis extends into somatic extraembryonic mesoderm and also around the connecting stalk to form umbilical vessels and in secondary villi to form tertiary villi

Note:

- Angiogenesis: Process by which extraembryonic mesoderm differentiate into angioblasts, which form the angiogenic cell clusters which give rise to endothelial cells

Intraembryonic mesoderm

- Blood vessels are formed in the intraembryonic mesoderm in the same way as extraembryonic mesoderm
- Blood vessels in intraembryonic mesoderm and extraembryonic mesoderm become continuous and thereby establishing blood system between embryo and placenta.

Hematopoiesis

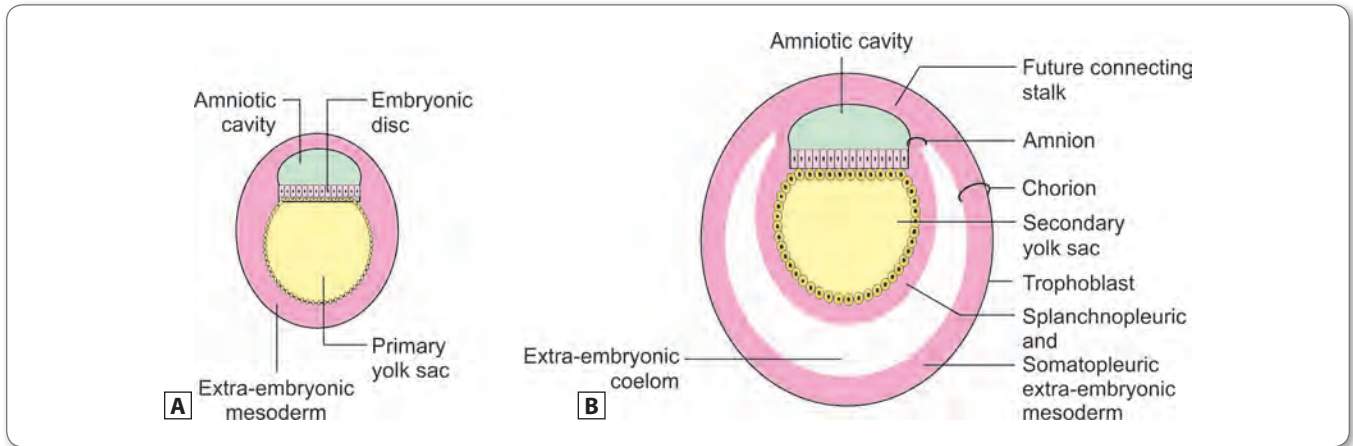
- Hematopoiesis first occurs in the extraembryonic visceral mesoderm around yolk sac during week 3
- During this, angioblasts give rise to primitive blood cells.
- By week 5, hematopoiesis is taken over by sequence of liver, thymus, spleen and bone marrow

Clinical Aspect

First missed period is usually the first indication of pregnancy. Week 3 of development coincides with first missed menstrual period. Note that at this time embryo has already undergone 2 weeks of development



YOLK SAC



Figs 20A and B: Development of yolk sac

- Develops from cavity of the blastocyst
- Passes through three stages in the development
- Primary yolk sac – formed in second week
 - Hypoblast forms exocoelomic membrane (flattened cell) and blastocyst cavity is converted into primary yolk sac
 - Along with amnion, in USG during the second week it shows two bubbles – double bleb sign
- Secondary yolk sac – formed in second week
 - Extra-embryonic coelom is developed in extra-embryonic mesoderm so primary yolk sac becomes smaller in size.
 - Lining epithelium becomes cuboidal from flat cells
- Definitive yolk sac – formed in fourth week
 - Part of the yolk sac surrounded by endoderm and converted into gut tube and remaining part of the yolk sac becomes – definitive yolk sac
 - Yolk sac communicates with mid gut through vitello-intestinal duct
 - Vitello-intestinal duct disappears by 7th week but in 2% of population the proximal part persists and forms Meckel's diverticulum

Table 6: Critical periods in prenatal development

Body System	Especially sensitive development
Central nervous system/brain	4th–8th weeks
Heart	5th–9th weeks
Upper limbs	6th–10th weeks
Eyes	6th–10th weeks
Lower limbs	6th–10th weeks
External genitalia	9th–11th weeks

HIGH YIELD POINTS

Molecular Control

Nodal gene transforming growth factor beta (TGFβ)—initiates and maintains the formation of **primitive streak**

Primary organizer: Fibroblast growth factor (FGF), homeobox transcription growth factor

Signaling molecule: Bone morphogenic protein (BMP), fibroblast growth factor, transcription factor

PLACENTA

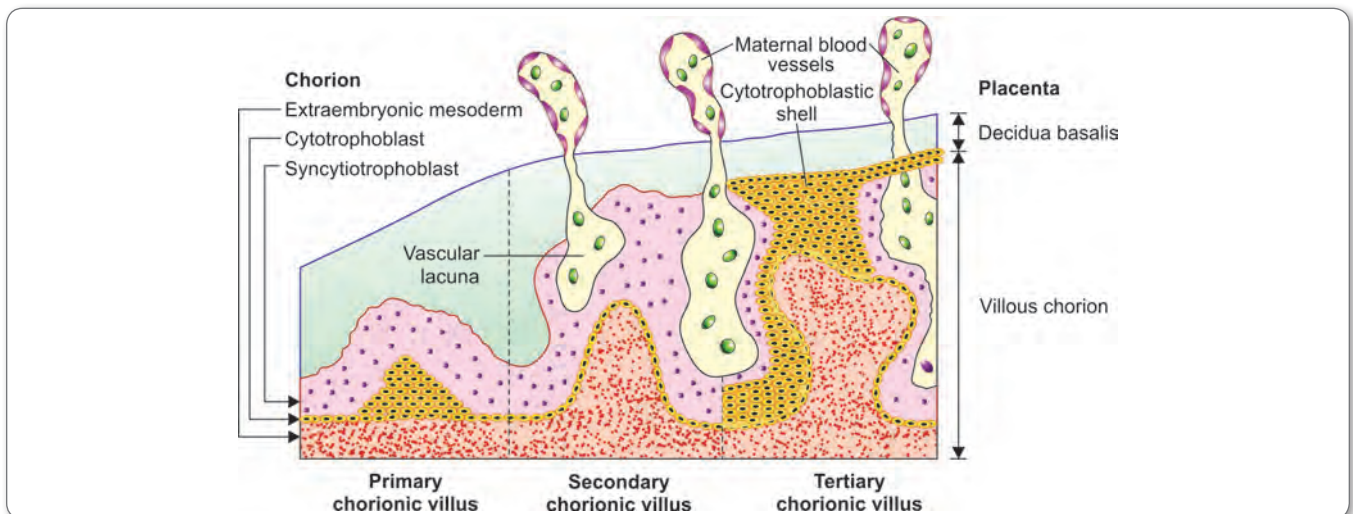


Fig. 21: Placenta and extraembryonic membranes

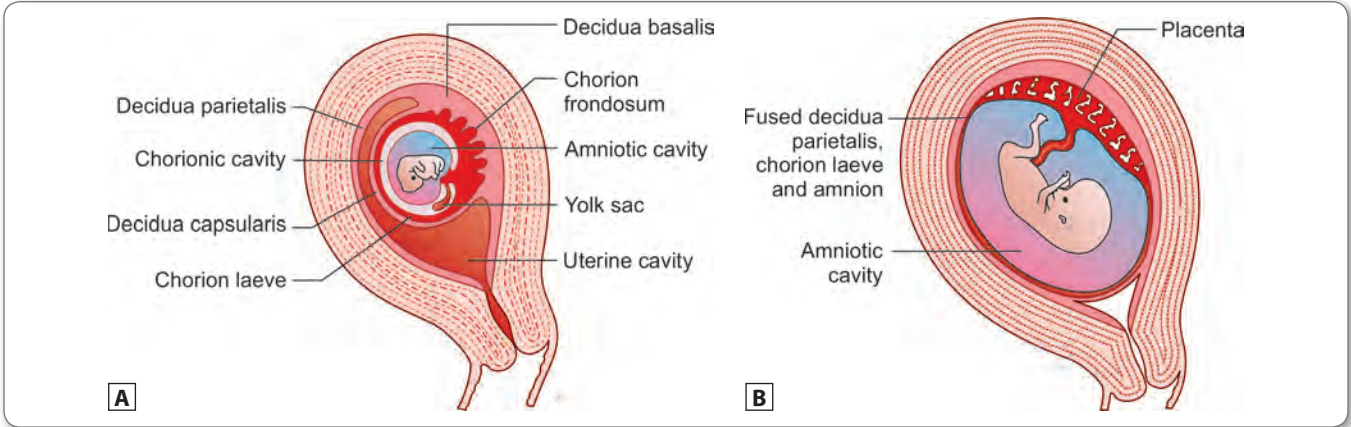


Link between mother and fetus, therefore consists of maternal part (derived from deciduas) and fetal part (derived from chorion)

Maternal Component

Maternal component of placenta consists of decidua basalis.

Types of Decidua

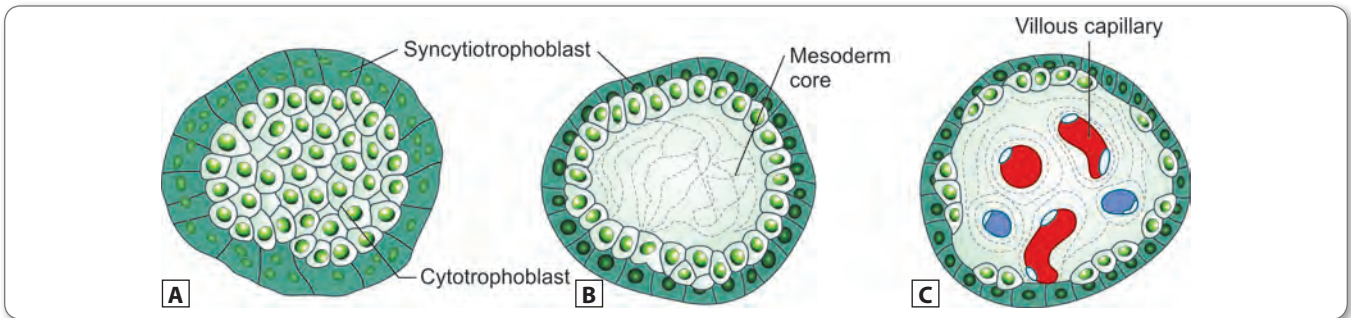


Figs 22A and B: Decidua and placenta

- Decidua basalis: Portion of endometrium located between blastocyst and myometrium
- Decidua capsularis: Portion of endometrium separating blastocyst from uterine cavity
- Decidua parietalis: Rest of the endometrium other than the site of implantation

Fetal Component

Fetal component is formed by tertiary chorionic villi



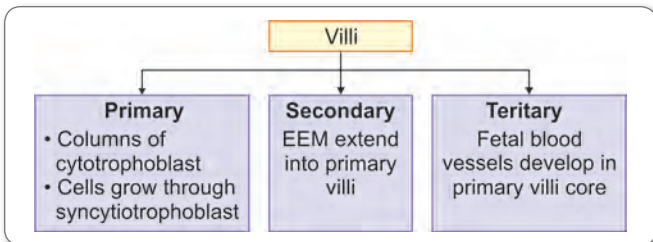
Figs 23A and to C: Tertiary chorionic villi. (A) Primary villus; (B) Secondary villus and (C) Tertiary villus

- **Primary villi:** Consist of column of cytotrophoblast and cells grow through syncytiotrophoblast during week 2
- **Secondary villi:** Extraembryonic mesoderm extends into primary villi—formed at the start of week 3
- **Tertiary villi:** Fetal blood vessels develop in secondary villi - Tertiary villi develop by the end of 3rd week

Placental Membrane

Membrane separates fetal from maternal blood in placenta. Consists from maternal to fetal side:

- In the early pregnancy
 - Syncytiotrophoblast
 - Cytotrophoblast
 - Basement of cytotrophoblast
 - Connective tissue
 - Endothelium and basement membrane of fetal blood vessels.
- In late pregnancy-placental membrane is formed by
- Syncytiotrophoblast and endothelium of fetal capillaries.





UMBILICAL CORD

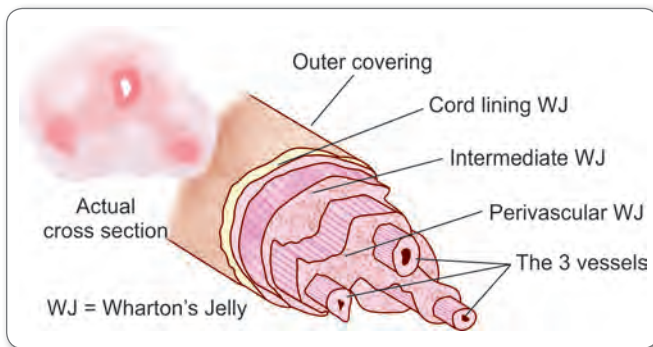


Fig. 24: Umbilical cord

- Length—50 cm
- Patent opening called primitive umbilical ring exists on the ventral surface of the embryo through which three structures pass—yolk sac, connecting stalk and allantois
- Nonfunctional allantois degenerates to form median umbilical ligament
- As amnion expands, amnion squeezes the vitelline duct, connecting stalk and allantois together to form primitive umbilical cord
- At week 6, gut tube connected to yolk sac herniates into extraembryonic celom—physiological hernia
- Reduction of physiological hernia occurs by 10th week
- Attachment—One end attached to the center of the anterior abdominal wall of the fetus and other end to the center of the fetal surface of the placenta.
- Contents—2 umbilical arteries derived from the ventral division of the internal iliac artery and 1 umbilical vein (Early part of the pregnancy, 2 umbilical veins are present and later right umbilical vein disappears and left umbilical vein alone persists) and mucous connective tissue (Wharton's jelly).

FETAL MEMBRANES

Amnion

- Appears as small space between ectoderm and trophoblast
- It is formed in 2nd week
- After folding of embryo, amniotic cavity completely surrounds the embryo
- Around the amniotic cavity is the extraembryonic celom. Outside the celom is the chorion
- Later, extraembryonic celom disappears, amnion comes in direct contact with chorion to form chorioamniotic membrane.

Amniotic Fluid

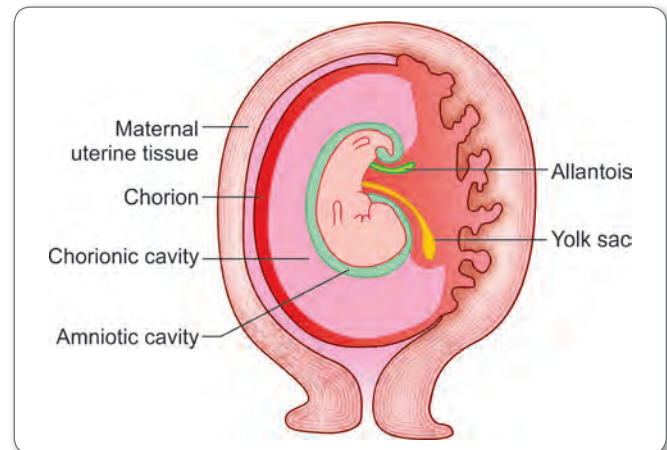


Fig. 25: Fetal membranes

Production

- Direct transfer from maternal circulation in response to osmotic and hydrostatic forces and also by excretion of fetal urine by the kidneys into amniotic sac
- **Note:** Kidney defects (bilateral renal agenesis and Potter syndrome) result in oligohydramnios
- Reabsorption
- Amniotic fluid is swallowed by fetus
- So esophageal atresia and duodenal atresia produce polyhydramnios.

Note:

- Amniotic fluid index – less than 5 in oligohydramnios
- Amniotic fluid index – greater than 25 in polyhydramnios

Chorion

- Layer found between cytotrophoblast and somatopleuric extraembryonic mesoderm
- Formed in second week
- Fetal surface of placenta formed by chorion

Allantois

- Formed at 16th day
- It is diverticulum from posterior wall of yolk extending into connecting stalk
- Allantois forms urachus and then median umbilical ligament after birth

HIGH YIELD POINTS

Allantois is associated with early blood formation.



TWINNING

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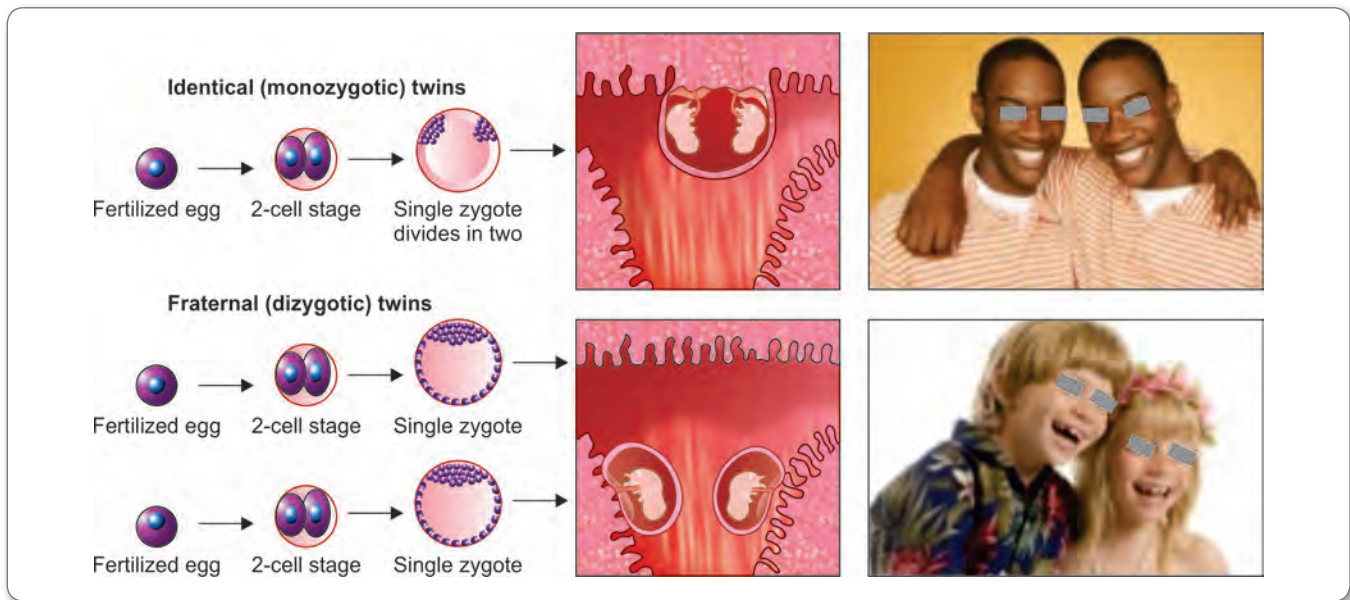


Fig. 26: Twins: Monozygotic and dizygotic

Steps Seen in Monozygotic Twins

- Secondary oocyte arrested in metaphase of meiosis II is fertilized by one sperm
- Then male and female pronuclei fuse to form zygote
- Cleavage division produces cluster of blastomeres called morula
- The molecular mechanisms that establish twin embryogenesis are active in morula and responsible for later splitting of inner cell mass
- If the splitting occurs before the differentiation of trophoblast, monozygotic and dichorionic twin
- If the splitting occurs after the differentiation of trophoblast, monozygotic and monochorionic twin

Steps Seen in Dizygotic Twinning

- Secondary oocyte arrested in metaphase of meiosis II is fertilized by two sperms
- Secondary oocyte completes meiosis 2 and it does not form polar body II. Instead DNA present in polar body forms another female pronucleus
- Then 2 male and 2 female pronuclei fuse to form 2 zygotes with different genotypes
- If the splitting occurs before the differentiation of trophoblast, dizygotic and dichorionic twin
- If the splitting occurs after the differentiation of trophoblast, dizygotic and monochorionic twin.

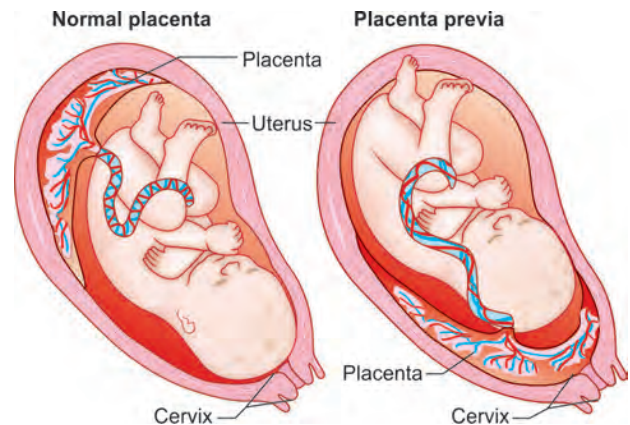


Clinical Aspect

Velamentous Placenta

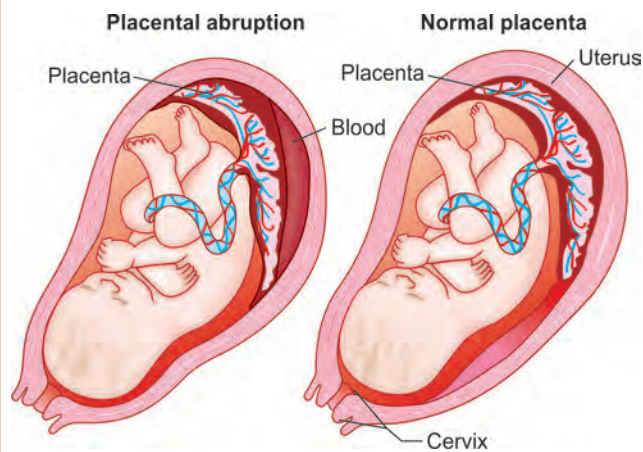
- Umbilical vessels abnormally pass through amniochorionic membrane before reaching placenta proper
- If the umbilical vessels pass through internal os called vasa previa
- In vasa previa umbilical vessel ruptures results in the death of the fetus

Placenta Previa



- Placenta attaches to lower part of uterus covering internal os
- Uterine blood vessels ruptures as they begin to dilate
- So in placenta previa maternal vessels rupture and result in the death of the mother

Contd...

**Abruptio Placenta**

- Normally implanted placenta prematurely separates from uterus before delivery.

Alpha Fetoprotein

- Fetal albumin produced by fetal hepatocytes and yolk sac
- Frequently assayed in maternal serum and amniotic fluid between 14-18 weeks
- Elevated AFP levels: Neural tube defects (allow the fetal serum to leak into amniotic fluid) and in esophageal and duodenal atresia
- Reduced AFP levels: In down syndrome (yolk sac small in size – so less AFP)

DEVELOPMENT OF VARIOUS ORGAN SYSTEMS**GESTATION PERIOD**

- Fertilization to birth (38 weeks)
- Prenatal period (before birth)
- Embryological development
 - First 2 months after fertilization (embryo)
 - All principal adult organs are present
- Fetal development
 - From 9 weeks until birth (fetus)
 - Placenta is functioning by end of 3rd month

NEONATAL PERIOD

- First 42 days after birth
 - Within 1 month, gross characteristics of all the organs have begun to develop
 - During the next 2–3 months, details of the organs are established
 - Beyond 4 months, organs of the fetus are grossly the same as those of the neonate.
 - However, cellular development in each organ is far from complete

CIRCULATORY SYSTEM

- Beating of the heart begins (4th week)
- Contraction of the heart—65 beats/min
- Increases to 140 beats/min before birth

FORMATION OF BLOOD CELLS

- 3rd week—nucleated RBCs
In yolk sac and mesothelial layers of the placenta
- 4th to 5th weeks—nucleated RBCs

FETAL MESENCHYMAL AND ENDOTHELIUM OF FETAL BLOOD VESSELS

- 6th weeks: RBCs liver
- 3rd months: Spleen and other lymphoid tissue
- 3rd months onwards
Principles source RBCs and most of WBC—bone marrow
Lymphocytes and plasma cells—lymphoid tissue

RESPIRATORY SYSTEM

- No respiratory activity during fetal life
- No air to breath in amniotic fluid
- Lungs are completely deflated
- Inhibition: Prevents filling of the lungs with fluids and debris from meconium excreted by fetus' get into the amniotic fluid

NERVOUS SYSTEM

- 3rd to 4th months
- Spinal cord and brain stem reflexes are present
- Cerebral cortex is immature
- Myelination of major tracts is completed 1 year of postnatal life

GASTROINTESTINAL SYSTEM

- By midpregnancy
- Fetus ingests and absorbs large quantities of amniotic fluid
- Last 2–3 months: Function approaches that of normal neonate
- Formation of meconium during the last 2–3 months

KIDNEYS

- 2nd trimester: Urine excretion. Accounts 70–80% of amniotic fluid
- Oligohydramnios: Reduced formation of amniotic fluid
 - Abnormal kidney development
 - Severe impairment of kidney function
- Renal control systems: Regulation of fetal ECF volume and electrolyte balances, especially acid base balance are almost nonexistent until late fetal file
- Do not reach full development unit a few months after birth



FETAL CIRCULATION

Clinical Aspect

Primitive streak is initiated and maintained by expression of **nodal** genes, a member of TGF β family.

Vitellointestinal duct (VID) is normally obliterated during 7th week. If it persists it gives rise to anomalies. Persistence of:

- Proximal part → MD (Meckel's diverticulum)
- Intermediate part → Enterocystoma
- Distal part → Raspberry tumor

Hyrtil's anastomosis is a transverse anastomosis between two umbilical arteries.

Chances of pregnancy are maximum if fertilization occurs on the day of ovulation.

Ca⁺⁺ ions are responsible for cortical reaction and they prevent penetration by another sperm (polyspermy).

Sirenomelia is due to insufficient production of mesoderm by primitive streak (Also known as Caudal dysgenesis/**Mermaid syndrome**).

Phacomelia is absence or severe hypoplasia of the long tubular bones usually reported by use of thalidomide in pregnancy.

Rhizomelia is shortening of the bones in the upper arms and thighs. Rhizomelic chondrodysplasia punctata is associated with significantly delayed development and severe intellectual disability.

Heuser's membrane is the primary yolk sac formed from migration of endodermal cells containing squamous epithelium to inner layer of cytotrophoblast.

DEVELOPMENT OF SKELETAL SYSTEM

Vertebra

- Derived from sclerotome of somites (paraxial mesoderm)
- Sclerotomes surround the notochord and neural tube and divided into three parts
 - Ventral sclerotome – forms body of the vertebra and annulus fibrosus
 - Lateral sclerotome – forms vertebral arch which forms pedicle and lamina
 - Dorsal sclerotome – forms spinous process

Clinical Aspect

- Hemi vertebra – due to defective development of ventral sclerotome
- Spina bifida occulta – due to defective development of dorsal sclerotome
- Meningocele – spina bifida cystica – neural tube fails to close and vertebral arches also fails to close – meninges protrude over the defect
- Myelomeningocele – meninges and spinal cord extend out of the spinal canal

Ribs derived from – costal process of thoracic vertebra

- They became cartilaginous in embryonic period and ossify during fetal period
- Original site of fusion of costal process with vertebra is replaced by Costovertebral synovial joints

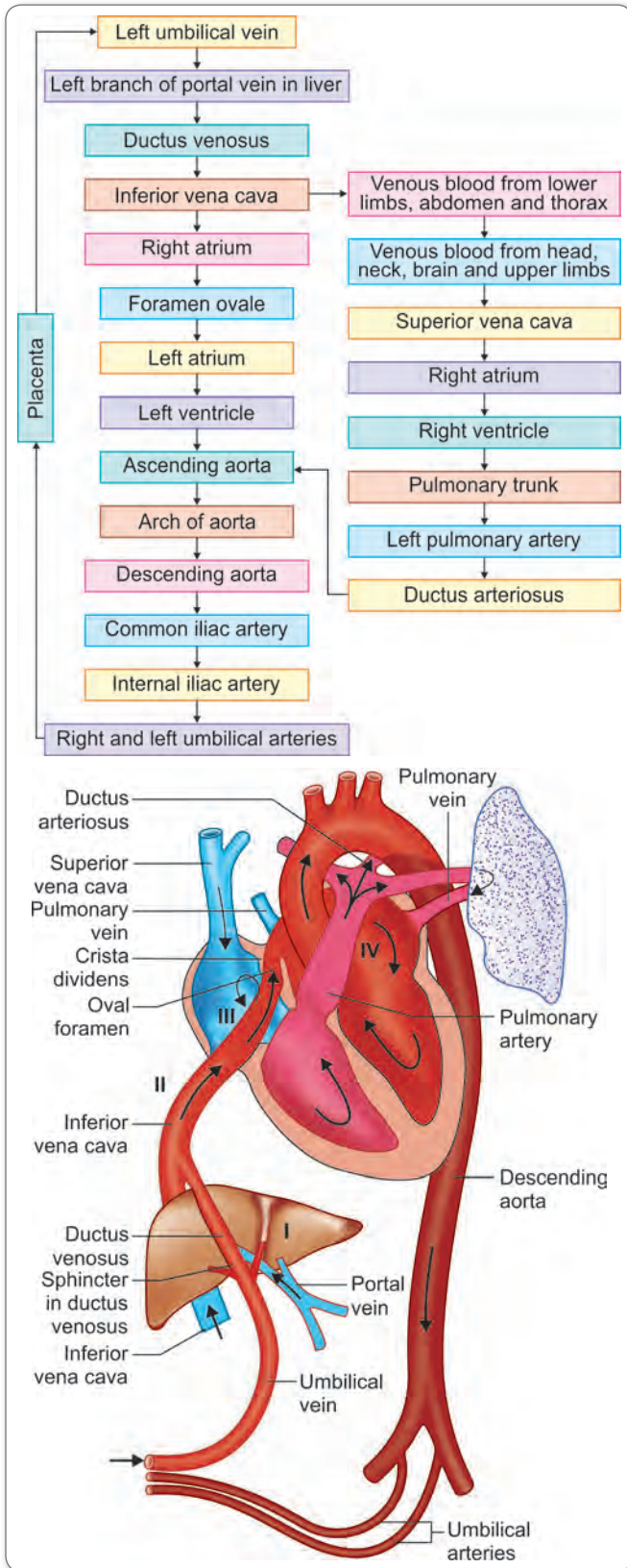


Fig. 27: Fetal circulation



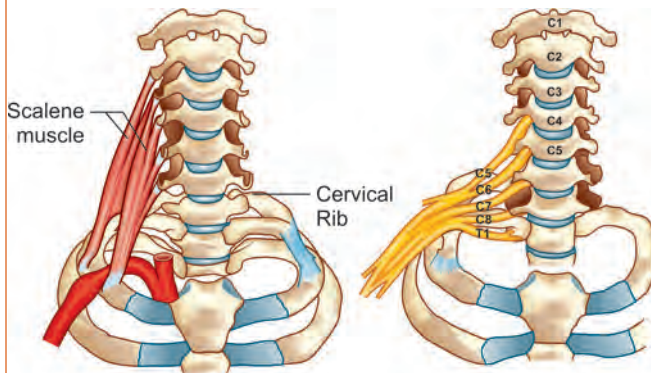
Sternum

- Develops independently in the parietal layer of lateral plate mesoderm in the ventral body wall
- Two sternal bands formed in either side of midline fuse to form cartilaginous model of manubrium, sternbrae and xiphoid process



Clinical Aspect

Cervical rib



Thoracic outlet syndrome



- Occurs in 1% of cases
- Develops from costal elements of seventh cervical vertebra
- These cervical rib put pressure on the lower trunk of brachial plexus, subclavian artery leading to superior thoracic outlet syndrome.

Contd...

Funnel Shaped Chest – Pectus Excavatum



Pectus excavatum causes a caved-in chest. Sometimes the ribs can flare out.

- Most common congenital anomaly of the chest
- Occurs because lower half of the sternum and attached costal cartilage are pulled inwards due to abnormally short tendon of diaphragm
- Chest is compressed anteroposteriorly and sternum is pushed backwards compressing the heart
- Clinically present as anterior median ridge of the chest wall

Pigeon Chest – Pectus Carinatum



- Upper part of sternum and costal cartilages project forward in the midline as in birds (pigeon). Hence the name.



Chapter at a Glance

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GENERAL EMBRYOLOGY

- Structures derived from the surface ectoderm: First layer of cornea and lens
- Primordial germ cells are derived from epiblast
- All the germ layers are derived from epiblast
- Polar body II is formed only after fertilization
- Meiosis II is not true reduction division
- Oogenesis forms only one ovum from single primary oocyte
- Spermatogenesis forms 4 spermatids from single primary spermatocyte
- Oogenesis starts before birth
- Primary oocyte remains arrested in diplotene stage after completing prophase I of meiosis
- Secondary oocyte in metaphase arrest undergoes fertilization
- Two days before ovulation and one day after ovulation is viable for fertilization
- First pair of somites appear at 20th day in the occipital region
- Somites appear at the rate of 3rd day in craniocaudal sequence up to 5th week
- Notochord forms nucleus pulposus of intervertebral disc
- Glycoprotein layer Zona Pellucida on the outer surface of ovum secreted by granulosa cells
- Zygote: Union of male and female gamete—day 1
- Diploid (two-cell stage): 24 hours after ovulation—day 2
- Morula: 12–16 cells stage—day 3
- 8 to 32 cells is called as blastula
- Blastocyst: 4th or 5th day
- Zona pellucida disappear at 5th–6th day after fertilization
- Implantation occurs on 6th–7th day
- LH surge occurs about 36 hours before ovulation and peaks 12 hour before ovulation and coincides with release of first polar body
- Primitive streak is formed at the end of 2nd week and beginning of 3rd week.



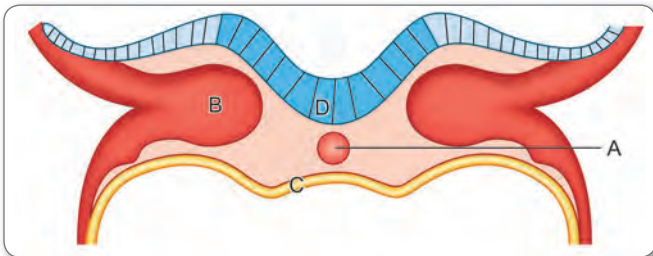
Multiple Choice Questions

1. **Trophoblast gives rise to all of the following except** (JIPMER Nov 2017)
- Cytotrophoblast
 - Syncytiotrophoblast
 - Intra embryonic mesoderm
 - Extra embryonic mesoderm

2. **Extra embryonic mesoderm derived from** (Nov 2016 AIIMS)
- Primary yolk sac
 - Secondary yolk sac
 - Epiblast
 - Hypoblast

3. **Sacrococcygeal teratoma is due to** (Recent Question 2018)
- Primitive streak
 - Cloacal membrane
 - Notochord
 - Closure of caudal neuropore

4. **From which of the following does NUCLEUS PULPOSUS is formed** (AIIMS May 2017)



- A
- B
- C
- D

5. **Primitive streak develops from** (Nov 2017)
- Mesoderm
 - Epiblast
 - Neural plate
 - Hypoblast

6. **Which of the following is not mesoderm derivative** (Nov 2017)
- Supra renal medulla
 - Renal cortex
 - Cardiac muscle
 - Skeletal muscle

7. **Correct statement(s) about meiosis** (PGI Nov 2016)
- Somatic cells not divide by meiosis because number of chromosome reduces to half
 - Occur in germ cell which result in haploid cells
 - One spermatocyte produce one sperm and one oocyte produces one ovum
 - Germ cell undergoes division to form diploid cell and increase their number
 - Meiosis is needed to produce large number of eggs and sperms

8. **The given clinical picture is due to aberrant migration of cells from**



- Amnion
- Epiblast
- Chorion
- Hypoblast

9. **Process of maturation of male gamete starts at**

- 5th month
- At birth
- At puberty
- 7th month

10. **Which cell undergoes fertilization**

- Primary oocyte in prophase arrest
- Primary oocyte in metaphase arrest
- Secondary oocyte in prophase arrest
- Secondary oocyte in metaphase arrest

11. **A 20 years old woman presents at the emergency department with severe abdominal pain on the right side with signs of internal bleeding. She indicated that she has been sexually active without contraception and missed her last menstrual period. Based on this information, which of the following disorders must be included as an option in the diagnosis?**

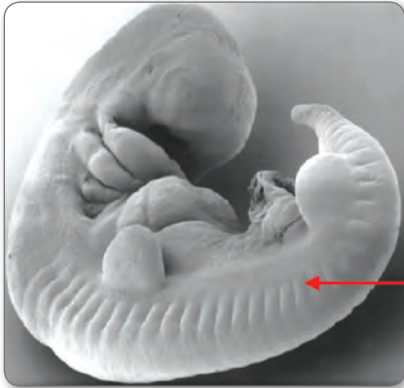
- Ovarian cancer
- Appendicitis
- Normal pregnancy
- Ectopic tubal pregnancy

12. **A 42 year old women presents with complaints of severe headaches, blurred vision, slurred speech, and loss of muscle coordination. Her last pregnancy 5 years ago resulted in a hydatidiform mole. Laboratory results shows a high hCG level. Which of the following conditions is a probable diagnosis?**

- Vasa Previa
- Placenta previa
- Succenturiate placenta
- Choriocarcinoma



13. Image of fetus is given in the diagram. There are 42 pair of marked structure. Identify the age of the fetus



- a. 3rd week
- b. 4th week
- c. 5th week
- d. 6th week

14. All the following muscles from PARA AXIAL MESO DERM except

- a. Genioglossus
- b. Diaphragm
- c. Biceps
- d. Detrusor

15. Femur developed from

- a. Splanchno plueric mesoderm
- b. Somato pleuric mesoderm
- c. Intermediate mesoderm
- d. Paraxial mesoderm

16. A male new-born has a haemangioma on the left temporal region of his face and scalp. The cells forming the haemangioma are derived from which of the following cell layers?

- a. Ectoderm only
- b. Mesoderm only
- c. Endoderm only
- d. Ectoderm and mesoderm

17. True about placental development

- a. Trophoblast differentiates into cytotrophoblast and Syncytiotrophoblast at the end of 2nd week
- b. Amnion develop from hypoblast
- c. Secondary villi consists Syncytiotrophoblast invaded by cytotrophoblast
- d. Tertiary villi develop by the end of third week

18. A 26 years old pregnant woman experiences repeated episodes of bright red vaginal bleeding at week 28, week 34 of pregnancy. The bleeding spontaneously subsided each time. Use of ultrasound shows that the placenta is located in the lower right portion of the uterus over the internal os. What is the diagnosis?

- a. Hydatid form mole
- b. Vasa previa
- c. Placenta previa
- d. Placental abruption

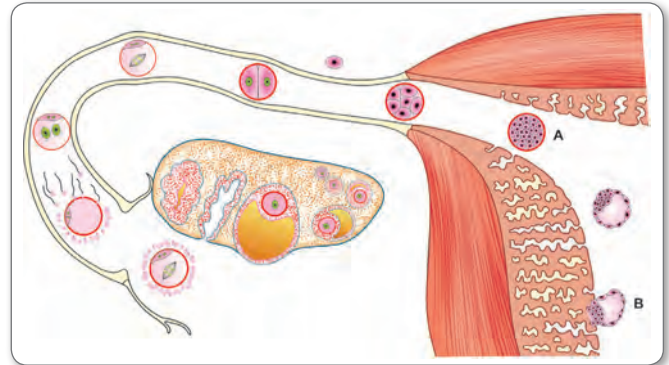
19. A 32 year old pregnant woman at 30 weeks of gestation comes to her physician because of excess weight gain in a 2 week period. Ultrasonography reveals polyhydramnios. which fetal abnormality is most likely responsible for the polyhydramnios?

- a. Bilateral kidney agenesis
- b. Umbilical cord knots
- c. Velamentous placenta
- d. Oesophageal atresia

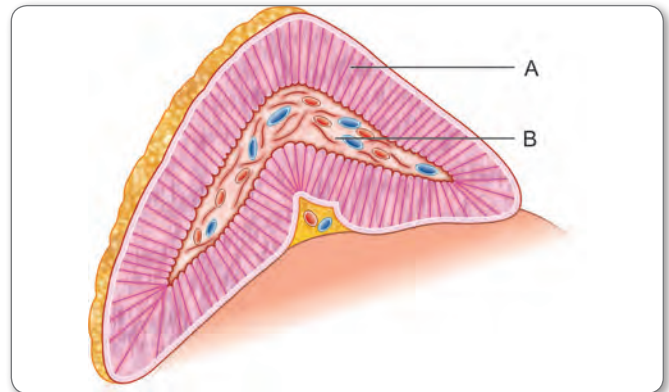
20. A 25 year old pregnant woman at 17 weeks of gestation comes to her OB/GYN for a normal examination. During routine blood tests, her serum α -fetoprotein (AFP) concentration is found to be markedly decreased for her gestational age. Which abnormality will the physician need to rule out based on these low AFP levels?

- a. Spina bifida
- b. Anencephaly
- c. Omphalocele
- d. Down syndrome

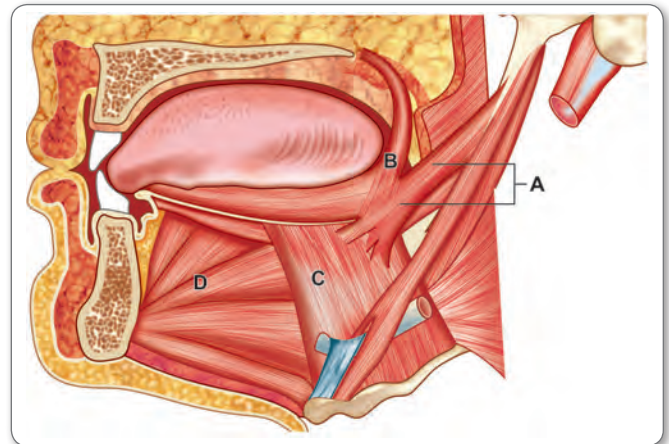
21. Events in the first week of development is given in the figure. A and B occur at



22. Supra renal gland is shown in the figure. A and B develop from

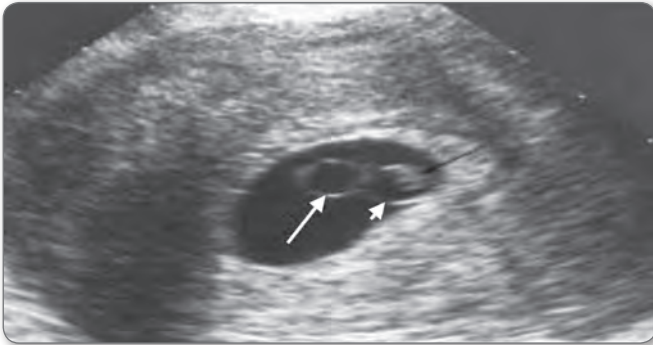


23. Different muscles of tongue are marked. Identify the muscle not developed from somites

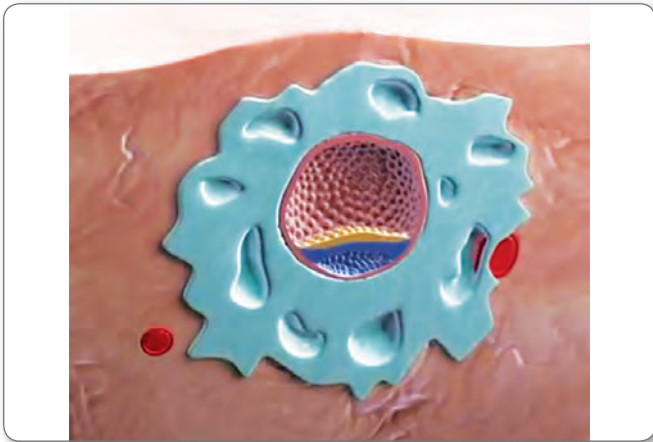




24. Identify the sign shown in the figure



25. Given circulation established at



26. Polar bodies are formed during: (AI 2006, DNB 2005)
- Spermatogenesis
 - Organogenesis
 - Oogenesis
 - Morphogenesis
27. Length of the mature spermatozoon is: (DNB 2002)
- 50-60 microns
 - 10-40 microns
 - 100- 200 microns
 - 300- 500 microns
28. Meiosis in spermatogenesis occurs in which of the following steps? (AIIMS Nov. 2007)
- Primary spermatocyte to intermediate spermatocyte
 - Primary spermatocyte to secondary spermatocyte
 - Secondary spermatocyte to round spermatids
 - Round spermatids to elongated spermatids.
29. Independent assortment of chromosomes occurs at which level: (AIIMS 2015)
- Primordial germ cell to spermatogonia
 - Spermatogonia to primary spermatocyte
 - Primary spermatocyte to secondary spermatocyte
 - Secondary spermatocyte to spermatids
30. Secondary oocyte is: (Recent Question 2013)
- n and N
 - n and 2N
 - 2n and N
 - 2n and 2N
31. One primary oocyte forms how many ova: (Recent Question 2014)
- 1
 - 2
 - 3
 - 4
32. Spermatogenesis occurs at: (AI 2008, DNB 2006)
- Body temperature
 - Temperature lower than core body temperature
 - Temperature higher than core body temperature
 - Temperature does not play role
33. Sperm after formation is stored in: (DNB 2007)
- Sertoli cells
 - Epididymis
 - Rete testis
 - Seminal vesicle
34. Meiosis occurs in human males in: (AIIMS Nov. 2004)
- Epididymis
 - Seminiferous tubules
 - Vas deferens
 - Seminal vesicles
35. Formation of the primary ovary in female fetus takes place by: (DNB 2008, AIIMS Nov. 2006)
- 6th week
 - 8th week
 - 10th week
 - 12th week
36. After entering first meiotic division, primary oocyte remains arrested in which stage: (Recent Question 2013)
- Metaphase
 - Anaphase
 - Diplotene
 - Pachytene
37. Which of the following is correct regarding fertilization and implantation? (AI 2008)
- Fertilization usually occurs in the uterus
 - Implantation occurs 24 hours after fertilization
 - The tubes are lined by ciliated epithelium
 - The cilia beats towards fimbriae
38. Implantation occurs at the stage of: (DNB 2005, AI 1998)
- Zygote
 - Morulla
 - Blastocyst
 - Primary villi
39. Umbilical cord has: (DNB 2001)
- 2 artery and 1 vein
 - 1 artery and 2 vein
 - 2 artery and 2 vein
 - Only one artery
40. The outer layer of blastocyst forms: (Recent Question 2013)
- Primitive streak
 - Yolk sac
 - Embryo proper
 - Trophoblast
41. Which of the following is true regarding the gastrulation? (AI 2002)
- Establishes all 3 germ layers
 - Occurs the caudal end of the embryo prior to its cephalic end
 - Involves hypoblastic cells of the inner mass
 - Usually occurs at 4th week
42. Germ cells derived from: (Recent Question 2013)
- Epiblast
 - Hypoblast
 - Endodermal sinus
 - Neural crest cells
43. Which of the following is true about vertebral column development? (Recent Question 2013)
- Notochord forms the annulus fibrosus
 - Sclerotome forms the nucleus pulposus
 - Sclerotome surrounds the notochord only
 - Sclerotome surrounds the notochord and neural tube
44. Notochord develops in: (DNB 2010)
- 3rd week
 - 3rd month
 - 6th month
 - 10th month
45. All are endodermal origin, except: (DNB 2000)
- Hepatocyte
 - Odontoblast
 - Alveolar lining cells
 - None
46. All the followings are mesodermal in origin, except: (DNB 2002, AI 1998)
- Dilator iris
 - Iris stroma
 - Ciliary body
 - Choroid



47. **Somites developed from:** (DNB 2002, TN 1995)
a. Notochord
b. Intermediate mesoderm
c. Paraxial mesoderm
d. Lateral plate mesoderm
48. **Muscular component of dorsal aorta developed from:** (AI 2011)
a. Axial mesoderm
b. Paraxial mesoderm
c. Intermediate mesoderm
d. Lateral plate mesoderm
49. **Development of spermatozoa (sperm) from spermatogonium takes how much time:** (Recent Question Nov. 2014)
a. 30–35 days
b. 40–45 days
c. 50–55 days
d. 70–75 days
50. **True about spermatid:** (Recent Question July 2015)
a. Derived from primary spermatocyte
b. Derived from secondary spermatocyte
c. Undergoes mitotic division
d. Undergoes meiotic division
51. **Fertilization is complete when:** (Recent Question July 2015)
a. 1st Polar body is formed
b. 2nd polar body is formed
c. Primary oocyte is formed
d. Secondary oocyte is formed
52. **Ion responsible to prevent polyspermy at the time of fertilization in mammals is:** (Recent Question July 2015)
a. Na
b. K
c. Ca
d. Mg
53. **True about primitive streak are all, except:** (Recent Question Dec. 2015)
a. 1st sign of gastrulation
b. Derived from epiblast
c. Appear at cranial end
d. All are true
54. **Which of the following has important role in initiation and maintenance of primitive streak:** (AIIMS Nov. 2007)
a. FGF-8
b. BMP-4
c. EGRF
d. Nodal gene
55. **Auerbach's plexus and Meissner's ganglion cell are derived from:** (AIIMS Nov. 2009)
a. Yolk sac
b. Primordial germ cell
c. Neural crest
d. Fetal GIT
56. **Placenta develops from:** (Recent Question June 2014)
a. Decidua capsularis and chorion frondosum
b. Decidua capsularis and decidua basalis
c. Decidua basalis and chorion frondosum
d. Decidua parietalis and chorion frondosum
57. **Amnion is present on:** (AI 1997)
a. Decidua basalis
b. Fetal surface
c. Maternal surface
d. All of the above
58. **Cytotrophoblasts invades:** (Recent Question Dec. 2012)
a. D parietalis
b. D basalis
c. D capsularis
d. None
59. **Transverse anastomosis of two umbilical arteries is known as:** (Recent Question Nov. 2015)
a. Funis
b. Hobner
c. Hanis
d. Hyrtl's
60. **Buccopharyngeal membrane consists of:** (AIIMS May 2014)
a. Mesoderm and endoderm
b. Ectoderm and mesoderm
c. Ectoderm, mesoderm and endoderm
d. Endoderm and ectoderm
61. **All are seen in mitosis except?** (Recent Question 2016-17)
a. Cytokinesis
b. Separation of chromatids
c. DNA replication
d. Kinetochore formation
62. **Cloacal membrane ruptures at what week of gestation age:** (Recent Question 2016-17)
a. 6 weeks
b. 8 weeks
c. 10 week
d. 12 weeks
63. **Closure of umbilical vessels occurs by:** (Recent Question 2016-17)
a. 3–5 day
b. 7–10 th day
c. 2–3 months
d. 2–3 weeks
64. **Embryo proper is derived from:** (Recent Question 2016-17)
a. Cytotrophoblast
b. Inner cell mass
c. Syncytiotrophoblast
d. Amniogenic cells
65. **All of the following are derivatives of embryonic cartilage of the pharyngeal arch, except:** (Recent Question 2015-16)
a. Mandible
b. Sphenomandibular Ligament
c. Incus
d. Malleus
66. **Which develops from mandibular arch:** (Recent Question 2016-17)
a. Stapes
b. Incus
c. Styloid process
d. Hyoid bone
67. **Greater cornua of hyoid bone is derived from which pharyngeal arch:** (Recent Question 2016-17)
a. 1st arch
b. 2nd arch
c. 3rd arch
d. 4th arch
68. **All of the following statement about intervertebral disc are true, except:** (Recent Question 2015-16)
a. End plates are made of hyaline cartilage
b. Annulus fibrosus is made up of fibrocartilage
c. Annulus fibrosus is derived from notochord
d. Nucleus Pulposus is remnant of notochord
69. **Closure of Neural tube begins from:** (Recent Question 2016-17; DNB 2008)
a. Cervical region
b. Cephalic
c. Podalic
d. Lumbar region
70. **Caudal end of neuropore closes by:** (Recent Question 2016-17)
a. 24th day
b. 27th day
c. 32nd day
d. 40th day
71. **Structure derived from basal lamina of neural tube all EXCEPT:** (Recent Question 2016-17)
a. Somatic efferent nucleus
b. Special visceral efferent
c. General visceral efferent
d. Special afferent nucleus
72. **Derivative of basal plate of neuroectoderm are all, except:** (Recent Question 2016-17)
a. Dentate nucleus
b. Nucleus ambiguus
c. NTS
d. EWN
73. **Tongue muscle develops from:** (Recent Question 2016-17, Recent Question 2012-13)
a. Ectoderm
b. Brachial arch
c. Occipital myotomes
d. Septum transversum



74. Tongue muscle developed from: (Recent Question 2016-17)

- a. Ectoderm
- b. Endoderm
- c. Mesoderm
- d. None

75. Inferior most portion of the IVC develop from:

(Recent Question 2016-17)

- a. Proximal portion of vitelline vein
- b. Right hepaticocardiatic channels
- c. Right supracardinal vein
- d. Posterior intercardinal anastomosis

76. Organ which develops due to testosterone → DHEA conversion is: (Recent Question 2016-17)

- a. Testicles
- b. Seminiferous tubules
- c. Epididymis
- d. Prostate

77. Penile urethra is derived from: (Recent Question 2016-17)

- a. Genital bud
- b. Genital ridge
- c. Urogenital sinus
- d. Genital septum

78. Which of the following is the remnant of Mesonephric tubules in males: (Recent Question 2015-16)

- a. Ductus deferens
- b. Seminal vesicle
- c. Appendix of Epididymis
- d. Paradydimis

79. Tongue muscle developed from: (Recent Question 2018)

- a. Occipital somites
- b. Cervical somites
- c. Endoderm
- d. Ectoderm

80. Sacrococcygeal teratoma is due to: (Recent Question 2018)

- a. Primitive streak
- b. Cloacal membrane
- c. Notochord
- d. Closure of caudal neuropore



Answers with Explanations

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1. Ans. c. Intra embryonic mesoderm

[Ref: Langman's Embryology 13th edition Pg 49-51]

Intra embryonic mesoderm derived from primitive streak
Trophoblast forms Cytotrophoblast, Syncytiotrophoblast
Extra embryonic mesoderm derived from yolk sac > hypoblast or epiblast. Trophoblastic origin is questionable. But best answer among the option is intra embryonic mesoderm (no chance to develop from trophoblast)

2. Ans. A primary yolk sac > epi blast > hypo blast.

Lines from Grays 41th edition – origin of EEM is no means clear. It may arise from epiblast >, hypoblast or yolk sac

The origin of this first mesoblastic extraembryonic layer is by no means clear; it may arise from several sources, including the caudal region of the epiblast, the parietal hypoblast and subhypoblastic cells. The trophoblastic origin of extraembryonic mesoblast is questioned because three is always a complete basal lamina underlying the trophoblast.

Lines from Langman's 13th edition

These cells, derived from yolk sac cells, form a fine, loose connective tissue, the **extraembryonic mesoderm**, which eventually fills all of the space between the trophoblast externally and the amnion.

3. Ans. a. Primitive streak

[Ref: Langman's Embryology 13th edition Pg 65]

Sacrocoxygeal teratoma due to persistence of primitive streak or due to abnormal migration of primitive streak.

4. Ans a. A

[Ref: Langman's Embryology 13th edition pg 153]

- A – Notochord – forms nucleus pulposis
- B – Paraxial mesoderm
- C – Endoderm
- D – Neural groove

5. Ans. b. Epiblast

[Ref: Langman's Embryology 13th edition pg 58]

Primitive streak from caudal part of epiblast

6. Ans. a. supra renal medulla

[Ref: Langman's Embryology 13th edition pg 82]

Supra renal medulla – COLLECTIONS OF SYMPATHETIC GANGLIONS – ALL GANGLIONS from NCC

7. Ans. a, b, e a. Somatic cells not divide by meiosis because number of chromosome reduces to half; b. Occur in germ cell which result in haploid cells; e. Meiosis is needed to produce large number of eggs and sperms

[Ref: – Langman's Embryology 13th edition pg 16,17]

Only germ cells undergo meiosis to produce large number of eggs and sperms (haploid)

One spermatocyte forms 4 spermatids and one primary oocyte forms only one ovum
Germ cells undergo division to form haploid cells

8. Ans. b. Epiblast

[Ref: Langman's Embryology 13th edition Pg 65]

Sacrocoxygeal teratoma due to persistence of primitive streak or due to abnormal migration of primitive streak.

9. Ans. c. Puberty

[Ref: Langman's Embryology 13th edition pg 29]

Spermatogenesis starts by puberty only

10. Ans. d. Secondary oocyte in metaphase arrest undergo fertilization

[Ref: Langman's Embryology 13th edition pg 29]

11. Ans. d. Ectopic tubal pregnancy

[Ref: Langman's Embryology 13th edition Pg 54-55]

Ectopic tubal pregnancy – implantation in fallopian tube.
c/o abdominal pain, with severe abdominal pain on the right side with signs of internal bleeding and amenorrhoea suggestive of Ectopic tubal pregnancy.

12. Ans. d. Choriocarcinoma

High hCG – molar pregnancy, multiple pregnancy

[Ref: – Langman's Embryology 13th edition pg 56]

13. Ans. c. 5th week

[Ref: Langman's Embryology 13th edition pg 80]

By 5th week – 42-44 pairs of somites

After 5th week 37 pairs of somites

14. Ans. d. Detrusor

Detrusor – smooth muscle from splanchnopleuric lateral mesoderm

[Ref: – Langman's Embryology 13th edition pg 80]

15. Ans. b. Somato pleuric mesoderm

Somatopleuric mesoderm forms appendicular skeleton

[Ref: Langman's Embryology 13th Edition Pg 83]

16. Ans. b. Mesoderm only

Haemangioma – tumour in the blood vessels – blood vessels from mesoderm only

[Ref: – Langman's Embryology 13th edition pg 83]

17. Ans. d. Tertiary villi develop by the end of third week

By 8th day trophoblast differentiate into cyto and syncytio layer
Amnion from epiblast



Secondary villi – extra embryonic mesoderm invading into primary villi (cyto and syncytio layer)

[Ref: – Langman'S Embryology 13th edition pg 109-110]

18. Ans. c. Placenta previa

Placenta previa – abnormally located placenta at the lower portion of uterus over the internal os.

19. Ans. d. Oesophageal atresia

Oesophageal atresia, duodenal atresia, tracheo-oesophageal fistula, anencephaly results in polyhydramnios

[Ref: Langman'S Embryology 13th edition pg 119]

20. Ans. d. Down syndrome

AFP level low in down syndrome
AFP level elevated in Neural tube defects

21. Ans.

A – Advanced morulla – entering the uterine cavity – occurs at 4th day

B – Implantation at 6-7th day

[Ref: Langman's Embryology 13th edition pg 46]

22. Ans. A. Supra renal cortex from – intermediate mesoderm

- B – Supra renal medulla – NCC

[Ref: Langman's Embryology 13th edition pg 82-83]

23. Ans. b

[Ref: – Langman's Embryology 13th edition pg 291-292]

- A – Styloglossus – from Occipital Somites
- B – PALATOGLOSSUS – FROM NCC
- C – Hyoglossus - FROM OCCIPITAL SOMITES
- D – Genioglossus - FROM OCCIPITAL SOMITES

24. Ans. Double bleb sign

25. Ans. Uteroplacental circulation is shown in the figure – established at 12th day

[Ref: – Langman S Embryology 13th edition pg 51]

26. Ans. c. Oogenesis

[Ref: A.K Dutta Human Embryology, 6th ed.]

Polar bodies are formed during oogenesis.

27. Ans. a. 50–60 microns

[Ref: A.K Dutta Human Embryology, 6th ed.]

Length—50–60 micron.

28. Ans. b. Primary spermatocyte to secondary spermatocyte

[Ref: A.K Dutta Human Embryology, 6th ed.]

Meiosis occurs during conversion of primary to secondary spermatocyte.

29. Ans. c. Primary spermatocyte to secondary spermatocyte

Independent assortment – random distribution of homologous chromosomes during meiosis.

In spermatogenesis – meiosis 1 occurs at primary spermatocyte to secondary spermatocyte.

Meiosis 2 is not reduction division.

Law states that alleles of one gene separating independently/ randomly from alleles of another gene so inheritance pattern of one trait/character will not affect the inheritance of another.

30. Ans. b. n and 2N

Primary oocyte – 2n and 2N

Secondary oocyte – n and 2N

Spermatid – n and N

31. Ans. a. 1

One primary oocyte forms one ovum and 3 polar body

One primary spermatocyte forms 4 spermatids.

32. Ans. b. Temperature lower than core body temperature

Spermatogenesis occurs at Temperature lower than core body temperature

33. Ans. b. Epididymis

[Ref: Langman 12 edition pg 21]

34. Ans. b. Seminiferous tubules

[Ref: A.K Dutta Human Embryology, 6th ed.]

Organ	Function
Testes	Seminiferous tubules Form sperm. Spermatogenesis occurs in Seminiferous tubules Second part of semen derived from testes Sertoli cells secrete testosterone
Epididymis	Store sperm. Maturation occurs
Prostate gland	Accessory gland produce milky secretion rich in acid phosphatase First part of semen derived from prostate
Seminal vesicle	Secrete alkaline fluid which is rich in fructose and prostaglandin Last part semen from seminalvesicle.

35. Ans. c. 10th week

[Ref: Langman, 12th ed. pg 21]

- Gametes are derived from primordial germ cells (PGCs) that are formed in the epiblast during the second week and that move to the wall of the yolk sac
- During the fourth week these cells begin to migrate from the yolk sac toward the developing gonads, where they arrive by the end of the fifth week.
- Oogonia undergoes mitotic division and some differentiated to primary oocyte at 10–12th week.

36. Ans. c. Diplotene

**37. Ans. c. The tubes are lined by ciliated epithelium**

[Ref: A.K.Datta Human Embryology, 6th ed.]

Fertilization occurs at the ampulla of the uterine tube 24 hrs after the ovulation.

Implantation occurs at the posterior wall of the uterus usually 6th or 7th day after fertilization.

Tubes are lined by ciliated columnar epithelium.

Ciliary beats towards the uterine cavity.

38. Ans. c. Blastocyst

[Ref: A.K.Datta Human Embryology, 6th ed.]

Implantation occurs at blastocyst stage

39. Ans. a. 2 artery and 1 vein

[Ref: A.K.Datta Human Embryology, 6th ed.]

40. Ans. d. Trophoblast

Blastocyst consists of embryo proper and outer covering trophoblast (tropho – nutrition)

41. Ans. a. Establishes all 3 germ layers

[Ref: A.K.Datta Human Embryology, 6th ed.]

Gastrulation

Involves the epiblast cells.

Occurs at cranial end

Occurs at 3rd week

42. Ans. a. Epiblast

All the germ layers ectoderm, mesoderm and endoderm derived from epiblast

43. Ans. d. Sclerotome surrounds the notochord and neural tube

Axial skelton (vertebral column) develop from sclerotome

Sclerotome (vertebral column) surrounds the notochord (nucleus pulposus) and neural tube (spinal tube)

44. Ans. a. 3rd week

[Ref: A.K.Dutta Human Embryology, 6th ed.]

Notochord Development

Primitive streak (15th day) primary organizer of differentiation – form at the end of second week and beginning of third week

Notochord – at 3rd week

45. Ans. b. Odontoblast

[Ref: A.K.Datta Human Embryology, 6th ed.]

Odontoblast from neural crest cells

46. Ans. a. Dilator iris

[Ref: A.K.datta Human Embryology, 6th ed.]

Iris muscles developed from neuroectoderm

47. Ans. c. Paraxial mesoderm

[Ref: A.K.Datta Human Embryology, 6th ed.]

Somites developed from paraxial mesoderm

Urogenital system developed from intermediate mesoderm.

48. Ans. d. lateral plate mesoderm

[Ref – Langman's 13th edition pg 160]

Smooth muscles of dorsal aorta from lateral mesoderm.

49. Ans. d. 70–75

74 days to complete spermatogenesis.

50. Ans. b. Derived from secondary spermatocyte

[Ref: Textbook of Human Embryology, pg 24]

Spermatids are derived from secondary spermatocyte.

Spermatid – donot undergo mitosis and meiosis

51. Ans. b. 2nd polar body is formed

[Ref: IB Singh, 9th ed. pg 40]

Polar body - 2 – rarely formed. Formed Only during fertilization

52. Ans. c. Ca

Release of calcium ions from ovum leads to exocytosis of cortical granules

Cortical granules along the perivitelline membrane prevent polyspermy.

53. Ans. c. Appear at cranial end

[Ref: Langman's 11th ed. pg 54-63]

Primitive streak appears at caudal end.

54. Ans. d. Nodal gene

[Ref: Langman's 11th ed. pg 67-71]

Primitive streak initiated and maintained by nodal gene

55. Ans. c. Neural crest

Enteric plexus derived from neural crest

56. Ans. c. Decidua basalis and Chorion frondosum

[Ref: Textbook of Embryology, pg 712]

Placenta - Decidua basalis (maternal part) and Chorion frondosum (fetal part)

57. Ans. b. Fetal surface

[Ref: IB Singh Embryology, 7th ed. pg 80]

Amnion lies inside and face fetal side

Decidua basalis face the maternal side.

58. Ans. b. D basalis

Syncytiotrophoblast invades uterine blood vessels

Cytotrophoblast invades deciduas basalis.



59. Ans. d. Hyrtl's

[Ref: William's Obstetrics pg 99]

Hyrtl's anastomosis – 2 umbilical arteries anastomose with each other.

60. Ans. d. Endoderm and ectoderm

[Ref: Langman's 12th ed. pg 78]

Buccopharyngeal membrane – no mesoderm, consists of ectoderm and endoderm.

61. Ans. c. DNA replication

[Ref: Internet]

DNA replication occurs neither during mitosis or meiosis. Occurs during interphase. Interphase is the period between two mitotic divisions. Kinetochore formed during mitosis. Chromatids are also separated in mitosis.

Cytokinesis occurs in mitosis

Mitosis (equation division)	Meiosis (reduction division)
Occurs in somatic cells	Occurs in germ cells
Completes in one sequences	Completes in two sequences.
Crossing over of chromatids does not take place	Meiosis I and II
Daughter cells are identical and they have same number of chromosomes as parent cell	Crossing over of chromatids takes place
	Daughter cells are not identical and they have half the number of chromosomes

62. Ans. b. 8th week

[Ref: Langman's 12th/e pg. 79]

At the end of the seventh week, the cloacal membrane ruptures, creating the anal opening for the hindgut and a ventral opening for the urogenital sinus.

63. Ans. a. 3 – 5 day

[Ref: Langman's 12th/e pg. 197]

Ductus arteriosus closes within one or two days after birth. Umbilical vein and ductus venosus closes within two to five days after birth.

64. Ans. b. Inner cell mass

[Ref: Langman's 12th/e pg. 38]

Outer cell mass forms trophoblast
Inner cell mass forms embryoblast

65. Ans. b. Sphenomandibular ligament

[Ref: Langman's 12th/e pg. 264; Internet]

Ventral part of meckel's cartilage forms mandible.
Dorsal part of meckel's cartilage forms malleus and incus.

66. Ans. b. Incus

[Ref: Langman's 12th/e pg. 264]

Incus develop from first arch.

67. Ans. c. 3rd arch

[Ref: From ROAMS 13th/e pg. 269]

Greater horn of hyoid develop from 3rd arch.

68. Ans. d. Nucleus pulposus remnant of notochord

[Ref: IB Singh's Textbook of Human Histology 6th/e pg. 96]

69. Ans. a. Cervical region

[Ref: Langman's Embryology 12th/e pg. 66]

Closure of neural tube begins at cervical region
Cranial neuropore closes by 25th day
Caudal neuropore closes by 28th day

70. Ans. b. 27th day

[Ref: Langman's 12th/e pg.287]

71. Ans. d. Special afferent nucleus

[Ref: Langman's 12th/e pg. 299]

Motor nucleus arise from basal plate, sensory nucleus arise from alar plate.

72. Ans. c. NTS

[Ref: Langman's 12th/e pg.299]

Nucleus tractus solitarius is sensory arise from alar plate.

73. Ans. c. Occipital myotomes

[Ref: Langman's 12th/e pg.273]

Occipital myotomes forms intrinsic and extrinsic muscles of tongue.

74. Ans. c. Mesoderm

[Ref: Langman's 12th/e pg.273]

Occipital somites derived from somites – paraxial mesoderm.

75. Ans. c. Right supra cardinal vein

[Ref: Langman's 12th/e pg. 193]

From caudal to cranial IVC developed from right posterior cardinal vein, right supra cardinal vein, supra cardinal – sub cardinal anastomosis, right sub cardinal vein, anastomosing channel between sub cardinal and right hepatocardinal vein.

76. Ans. d. Prostate

[Ref: Langman's 12th/e pg. 248]

Testosterone stimulates the development of mesonephric duct (efferent tubules, epididymis, vas, seminal vesicles)



Dihydrotestosterone—stimulates external genitalia and prostate

77. Ans. c. Urogenital sinus

[Ref: Langman's 12th/e pg.253]

Urethra derived from urethral part of vesicourethral canal and pelvic and phallic part of definitive urogenital sinus.

78. Ans. d. Paradydimis

[Ref: Langman's 12th/e pg. 244]

Mesonephric tubules remnant in male—efferent tubules and paradydimis.

79. Ans. a. Occipital somites

Tongue muscle – develop from occipital somites
Extra ocular muscle – from pre occipital somites
Diaphragm – cervical somites

80. Ans. a. Primitive streak

- Sacrococcygeal teratoma is due to abnormal migration of primoidal germ cells
- Sometimes remnants of primitive streak persist in this sacrococcygeal region and form sacrococcygeal teratoma

4



UPPER LIMB



OSTEOLOGY OF UPPER LIMB

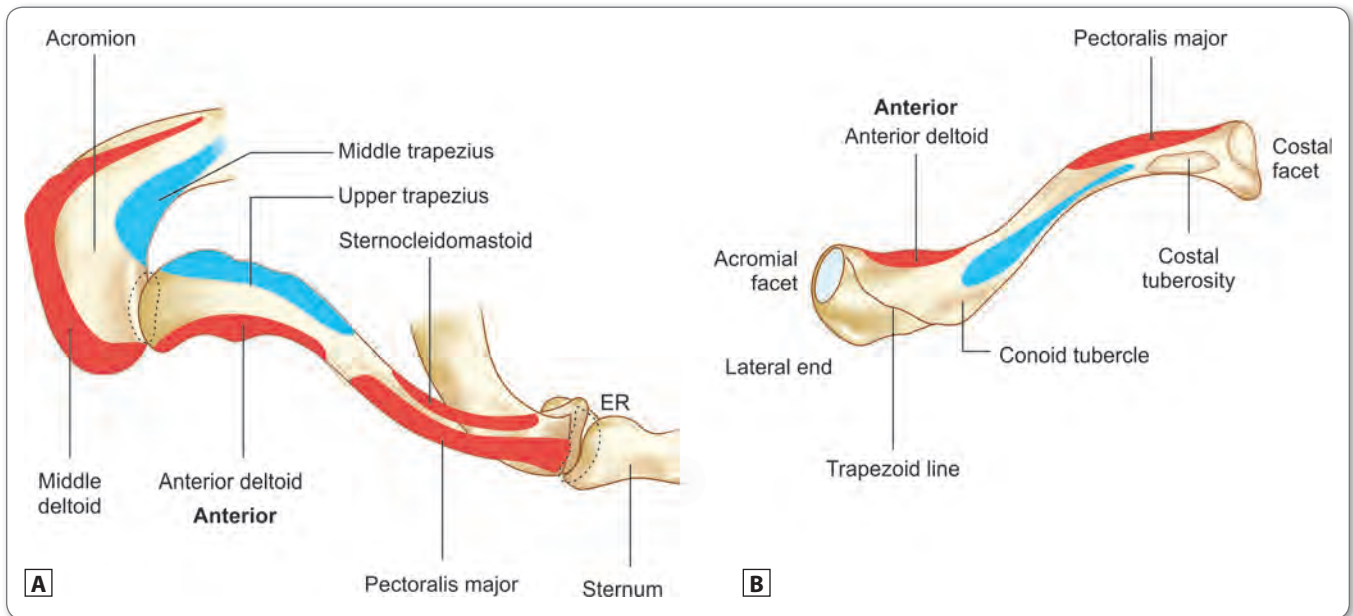
DEVELOPMENT OF UPPER LIMB

- By the **end of 4th week** upper limb buds appear adjacent to specific spinal segments
- Regulated by **hox** genes
- Lower limb buds appear **2 days later**
- Bones of limb formed by endochondral ossification and derived from **somatic layer** of lateral mesoderm
- Muscles of limb derived from **myotome** of somites
- By 7th week upper limb rotate **90% laterally** so that extensor muscle lie on the lateral and posterior surface & thumb laterally.
- Lower limb rotates 90% **medially** placing extensor muscle on anterior surface and great toe medially
- Radius bone – **preaxial bone** and radial artery – pre axial artery
- Ulna bone – **post axial bone** and ulnar artery – post axial artery
- Cephalic vein – pre axial vein
- Basilic vein – post axial vein

- Modified long bone
 - Because **no medullary cavity**
 - Ossify by means of membrane (**intramembranous ossification**)
 - Pierced by subcutaneous nerves (supraclavicular nerves)
- First bone to start ossification in the body by 5th or 6th week and last bone to complete ossification by 21st year
- Subcutaneous long bone placed horizontally
- Nutrient foramen is found in lateral end of subclavian groove.
- Nutrient artery – suprascapular artery
- Muscles **originating** from clavicle
 - Sternocleidomastoid
 - Sternohyoid
 - Anterior fibers of deltoid
 - Pectoralis major
- Muscles **inserting** to the clavicle
 - Trapezius
 - Subclavius

CLAVICLE

- Also known as **collar bone** and is present between axial skeleton and appendicular skeleton



Figs 1A and B: Clavicle. (A) Superior surface; (B) Posterior surface



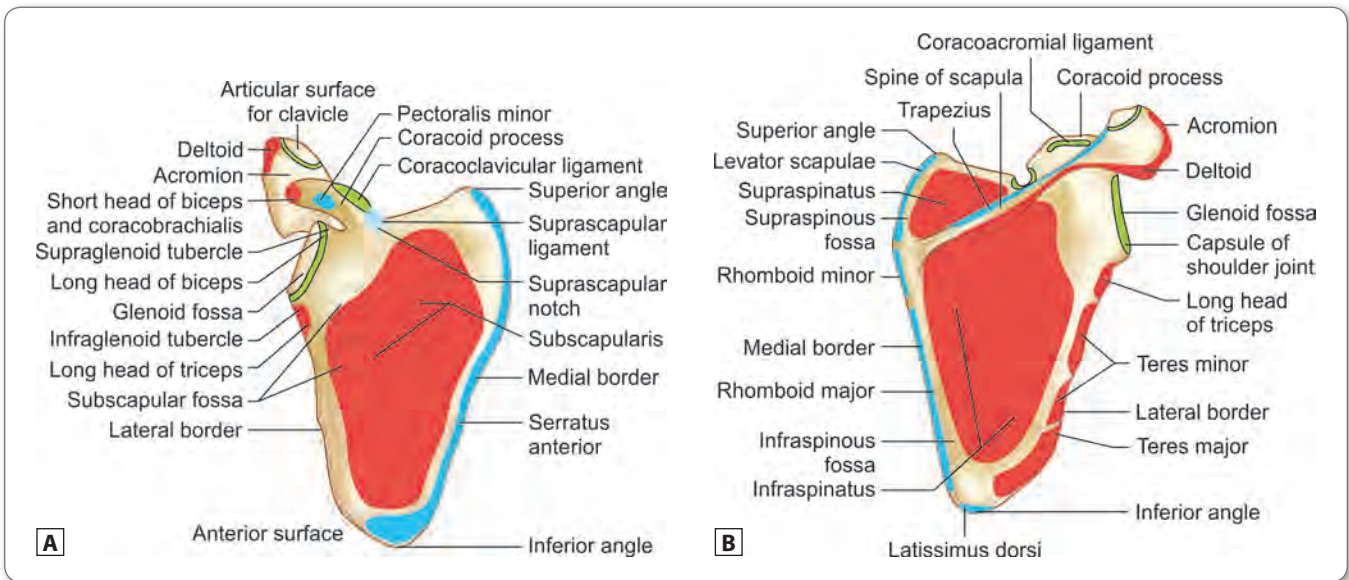
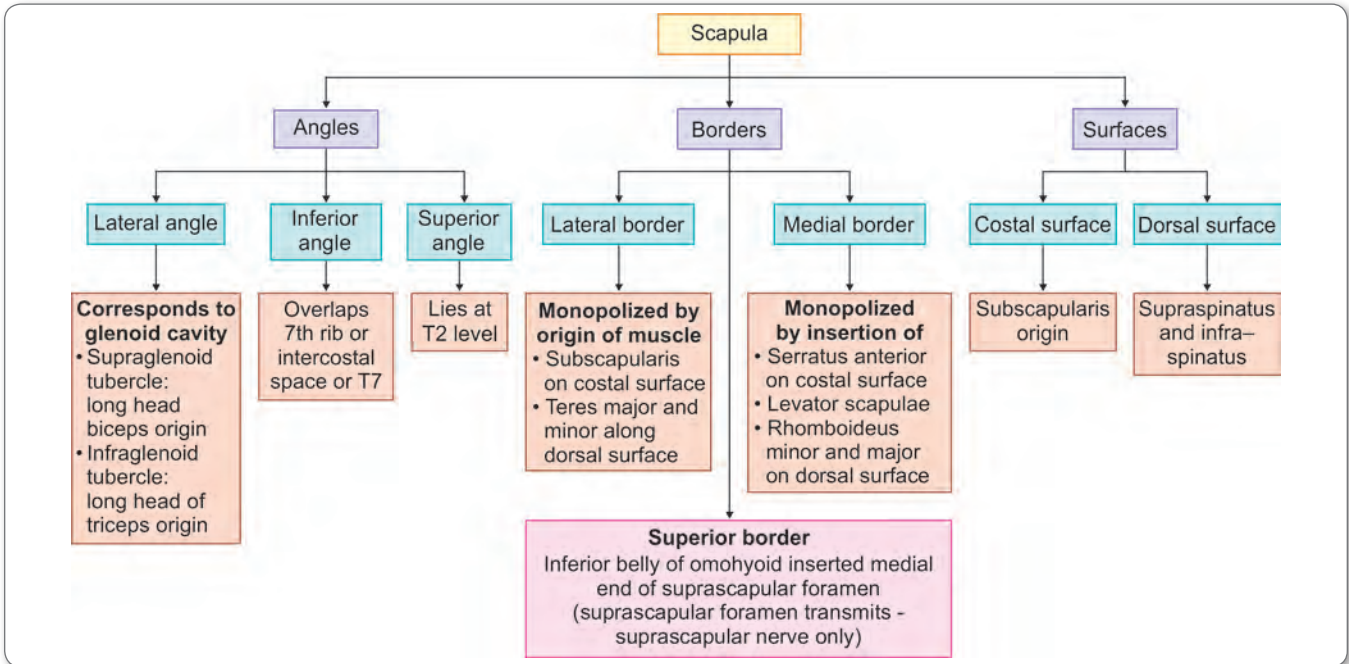
Clinical Aspect

Fracture Clavicle

- Due to fall on outstretched hand or fall on the shoulder
- Common bone to get fractured and the most common site of fracture is junction of medial 2/3rd and lateral 1/3rd
- Results in upward displacement of proximal end and downward displacement of distal fragment
- It may injure the lower trunk of brachial plexus, subclavian artery hemorrhage and thrombosis of subclavian vein leading to pulmonary embolism.



SCAPULA



Figs 2A and B: Scapula. (A) Anterior view; (B) Posterior view

- Spine of scapula: Upper lip insertion to trapezius and lower lip origin to posterior fibers of deltoid
- **Acromion** process: Middle fibers of deltoid origin
- Coracoid process: Pectoralis minor, tip of process gives attachment to Coracobrachialis and short head of Biceps [Mnemonic PCB – Pakistan Cricket Board]
- Scapular notch: Notch converted into foramen by transverse scapular ligaments. Transmits suprascapular nerve
- **Supraglenoid tubercle:** Long head of **biceps** origin
- **Infraglenoid tubercle:** Long head of **triceps** origin

- Movements of scapula
 - Protraction – serratus anterior and pectoralis minor
 - Retraction – trapezius and rhomboideus

Clinical Aspect

Winging of scapula is due to-

- Serratus anterior palsy seen in injury to **long thoracic nerve of Bell**.
- Palsy of trapezius muscle

So, winging of scapula due to serratus anterior > trapezius muscle



HUMERUS

Head

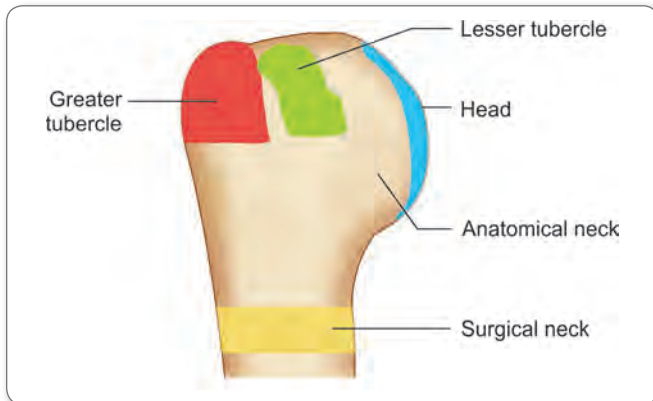
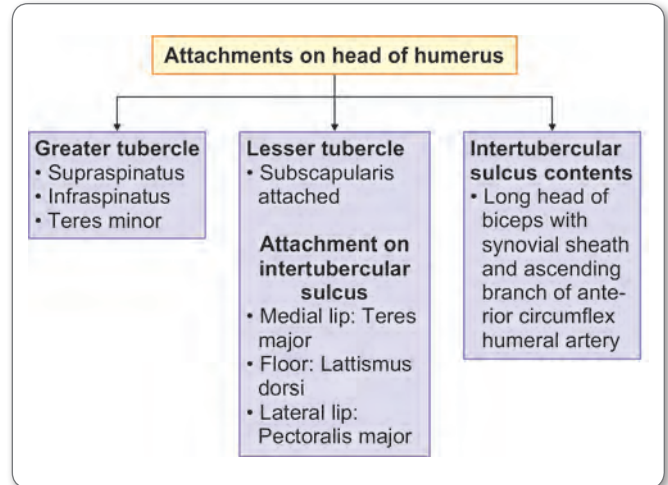


Fig. 3: Head of humerus



- **Anatomical neck:** Articular margin between head and upper end of humerus
- **Surgical neck:** Constricted area situated below the tubercles and that is the common site of fracture. **Axillary nerve** and posterior circumflex humeral vessels related through it.

Shaft

- Spiral groove transmits **radial nerve and profunda brachii vessels**
- Brachialis on the anterior surface and medial and lateral head of triceps on the posterior surface
- Deltoid tuberosity: Triangular elevation on the lateral aspect of middle of the shaft provides insertion to deltoid
- Medial supracondylar ridge: Pronator teres
- Lateral supracondylar ridge: Brachioradialis and extensor carpi radialis longus origin.

Lower End of Humerus

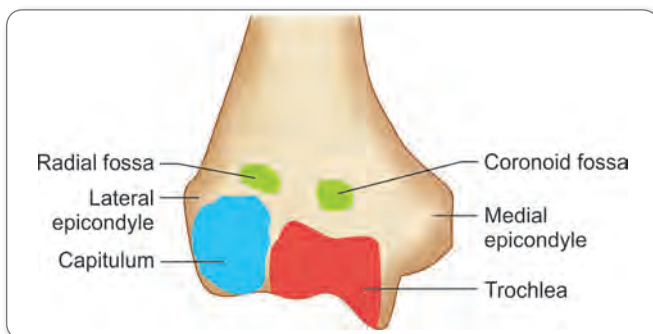
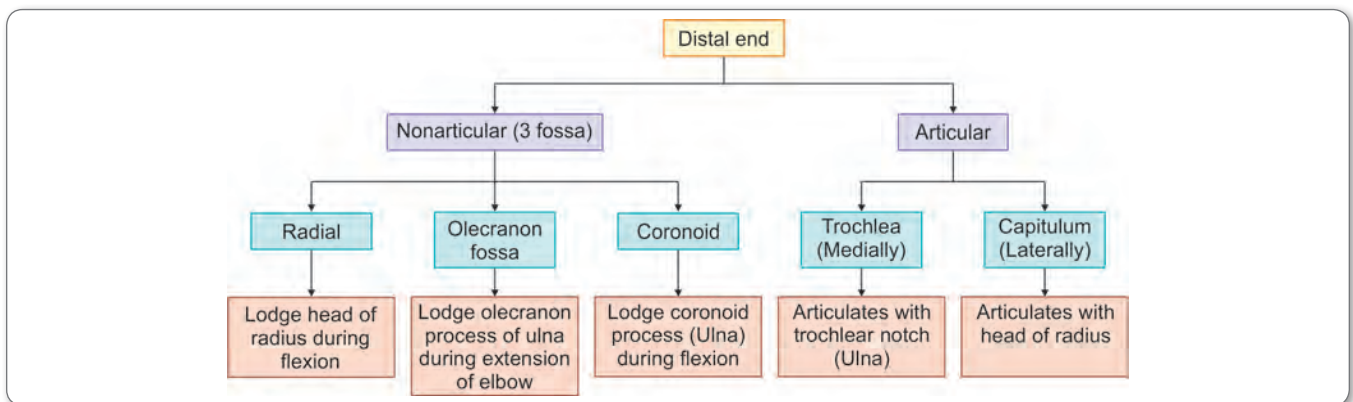
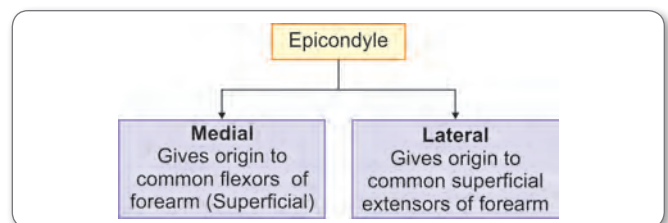


Fig. 4: Lower end of humerus

Epicondyle of Humerus



- **Lateral epicondyle:** Projects from the capitulum and provides the origin to the supinator and extensor muscles. It is the attachment site for the radial collateral ligament



- **Medial epicondyle:** Projects from trochlea and has **groove** on the back **for ulnar nerve** and superior ulnar collateral artery. Provides attachment for common flexors, pronator teres and ulnar collateral ligament.

Nerves in Relation to Humerus

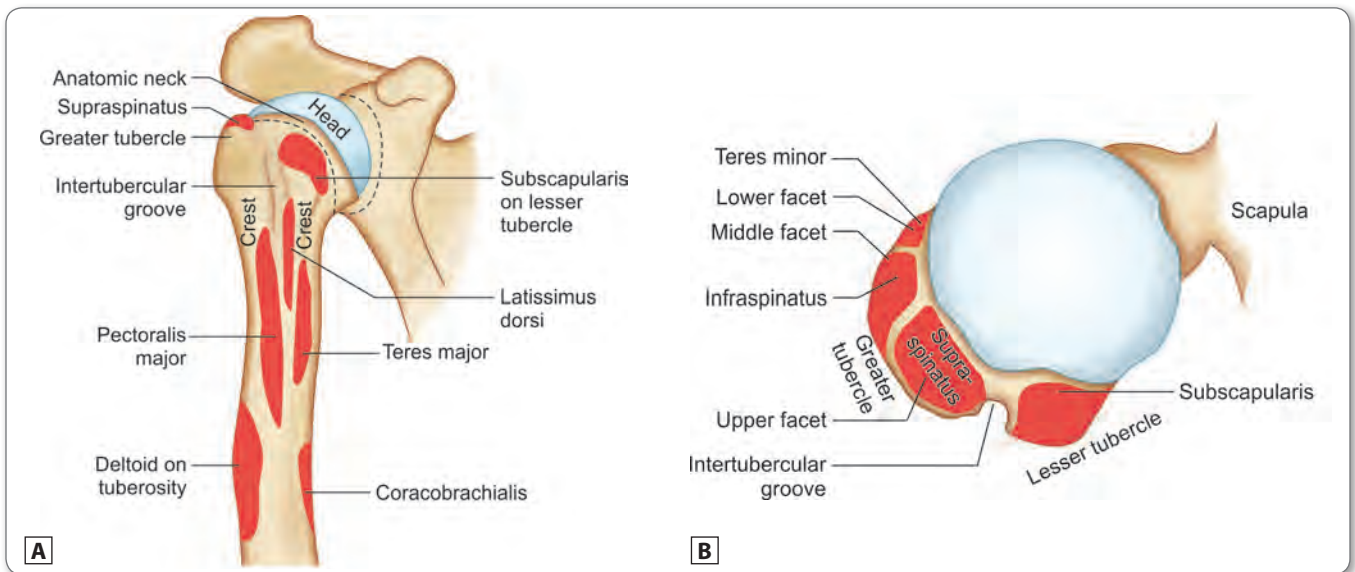
Table 1: Nerves closely related to Humerus

Nerve	Related to
Axillary nerve	Surgical neck
Radial nerve	Mid shaft and spiral groove of humerus
Ulnar nerve	Groove behind medial epicondyle of humerus

Nutrient foramen is directed distally and situated near the attachment of coracobrachialis posterior to deltoid tuberosity
 Nutrient artery – profunda brachii artery.

Clinical Aspect

- **Fracture of surgical neck:** May injure the axillary nerve and posterior humeral circumflex artery as they pass through quadrangular space
- **Fracture of the shaft** of humerus injure the **radial nerve** and profunda humeral artery
- **Supracondylar fracture:** Fracture of distal end of humerus. Common in children when falls on the outstretched hand with elbow flexed. Most commonly injured nerve – **anterior interosseous nerve > median nerve**
- **Fracture of medial epicondyle:** Injures the **ulnar nerve**
- **Cubital tunnel syndrome:** Compression of ulnar nerve behind the **medial epicondyle**. Tunnel is formed by medial epicondyle, ulnar collateral ligament and two heads of flexor carpi ulnaris and transmits **ulnar nerve** and superior ulnar collateral artery.

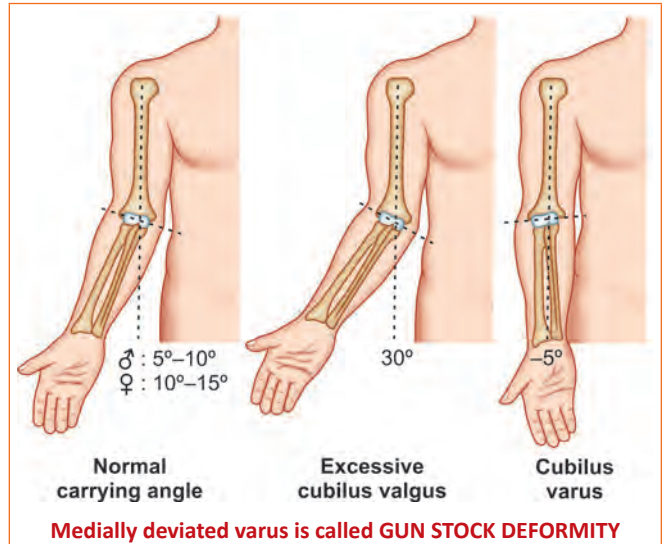


Figs 5A and B: Humerus: Anterior (A) and Superior; (B) Views

REMEMBER

Carrying angle: Forearm deviated away from upper arm in extended and supinated position forming carrying angle measures about 163°

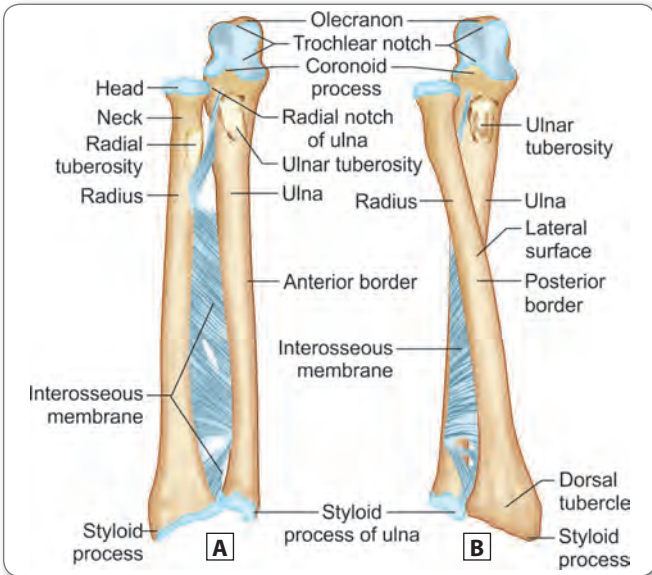
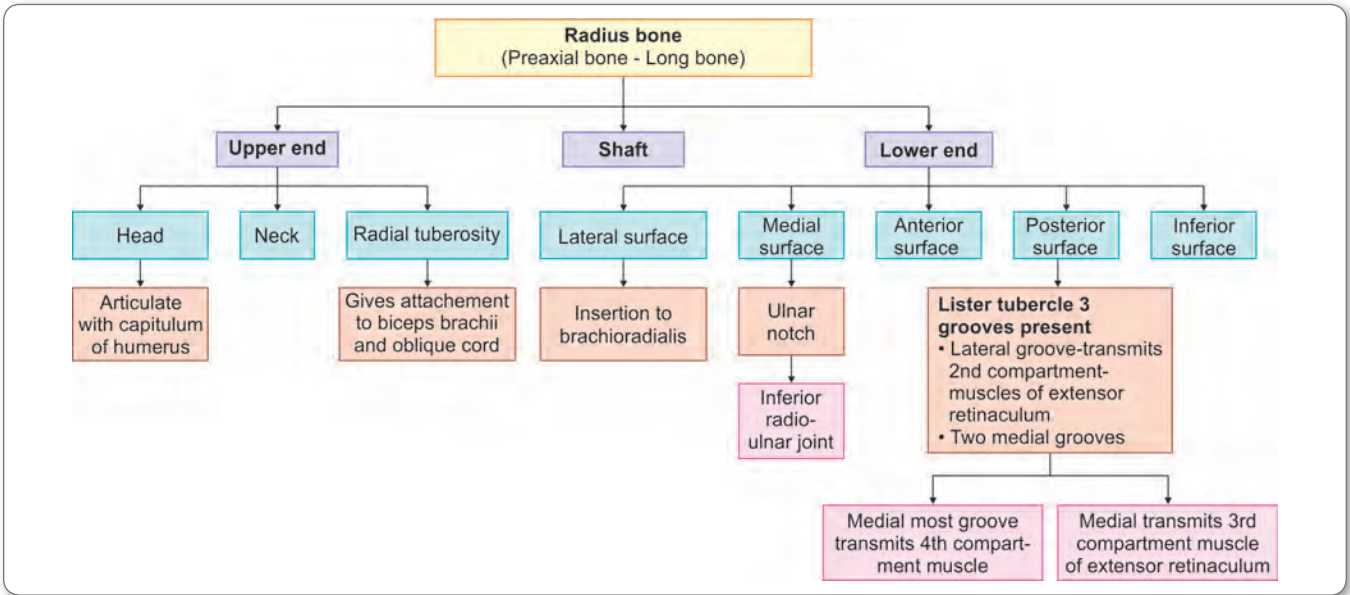
Clinical Aspect





RADIUS AND ULNA

Radius



Figs 6A and B: (A) Right-radius and ulna in supination: Anterior view; (B) Right-radius and ulna in pronation: Anterior view

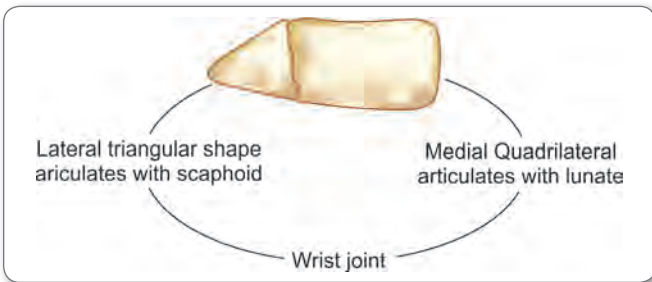
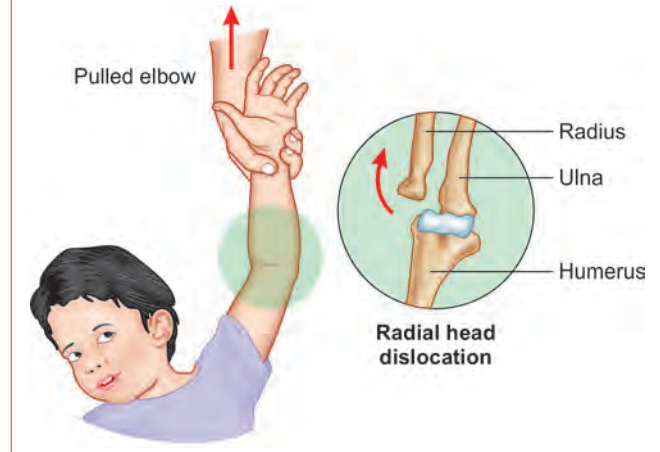


Fig. 7: End of radius that articulates with carpal bones to form wrist joint

- **Head:** Articulates with capitulum of humerus and radial notch of ulna
- **Radial tuberosity:** Provides attachment to biceps
- **Styloid process:** Situated in the distal end. Situated 1 cm distal to ulna and provides attachment to brachioradialis
- **Distal end:** Articulates with proximal row of carpal bones scaphoid, lunate and triquetrum but excludes pisiform.

Clinical Aspect

- **Colles fracture:** Fracture of distal radius. Distal fragment is displaced posteriorly producing classical dinner fork deformity
- **Smith fracture:** Reverse of Colles. Distal fragment is displaced anteriorly.
- **Nurse maid elbow: Pulled elbow** – subluxation of radial head when the child is lifted by the wrist. Occurs due to the tear of annular ligament.

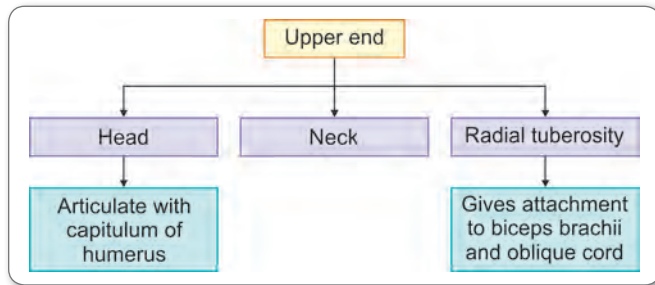




Ulna

Upper End of Ulna

- **Olecranon process:** Projection on the back of elbow, receives triceps tendon
- **Coronoid process:** Situated below the trochlear notch and provides insertion of brachialis
- **Ulnar tuberosity:** Located distal to coronoid process and provides insertion of brachialis
- **Head:** Articulates with articular disc of distal radioulnar joint.



HIGH YIELD POINTS

Oblique cord is degenerated remnant of **flexor pollicis longus**.

Lower End of Ulna

- Head, styloid process
- Head of ulna articulates with ulnar notch in radius and forms inferior radioulnar joint.

HIGH YIELD POINTS

Ulna does not take part in wrist joint

Interosseous Membrane

- Connective tissue between radius and ulna
- Gap in the proximal border transmits posterior interosseous vessels and pierced distally by anterior interosseous vessels.

Muscles Originating from Radius

- Flexor digitorum superficialis
- Flexor pollicis longus
- Extensor pollicis brevis.

Muscles Inserting on Radius

- Pronator teres
- Supinator
- Pronator quadratus (originates from ulna)
- Brachioradialis—on the lateral surface of styloid process.

Muscles Originating from Ulna

Flexor Muscles

- Flexor digitorum profundus and flexor pollicis longus (occasional head)

- Pronator teres
- Flexor digitorum superficialis
- Flexor carpi ulnaris.

Extensor Muscles

- Abductor pollicis longus
- Extensor pollicis longus
- Extensor indicis
- Extensor carpi ulnaris
- Supinator.

Mnemonic

Muscles Inserting on Ulna

Triceps
Anconeus
Brachialis
(Mn–BAT)

Clinical Aspect

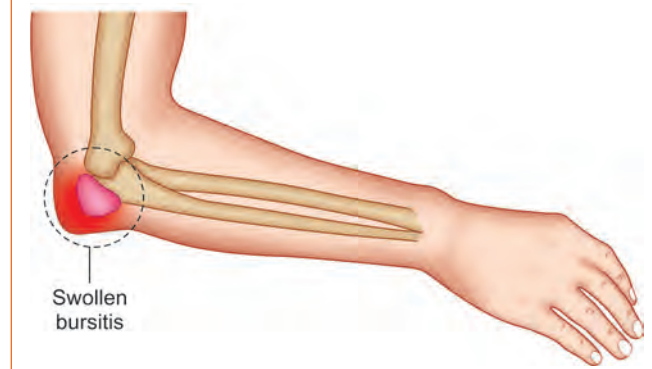
Monteggia and Galeazzi fracture

- Monteggia fracture: Fracture of upper ulna with radial head dislocation
- Galeazzi fracture: Fracture of lower radius with dislocation of distal radioulnar joint.



Students Elbow or Olecranon Bursitis

It is a condition where there is swelling, redness and inflammation of the bursa that protects the bone at the posterior side of the elbow.





CARPAL BONES

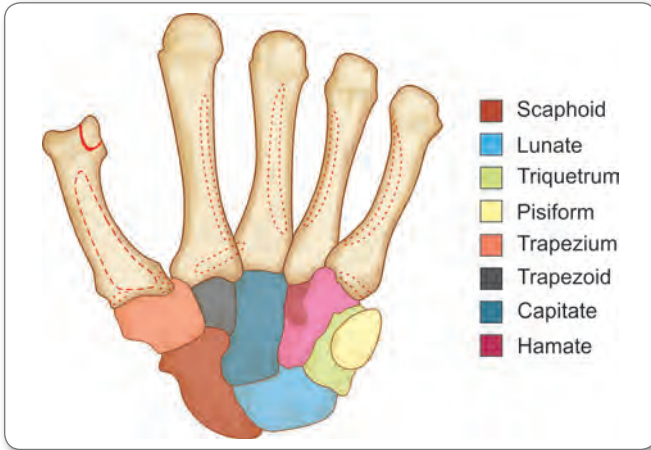


Fig. 8: Carpal bones

- **Proximal rows:** Scaphoid, lunate, triquetrum and pisiform
- **Distal rows:** Trapezium, trapezoid, capitate and hamate
- Ossification center of carpal bones appear after birth in spiral manner.
 - **Capitate largest** (MN – Casual Leave) bone and hamate wedge shaped 1st year
 - Triquetrum – 3rd year
 - Lunate semilunar shape – 4th year, most commonly displaced bone
 - Scaphoid boat shape – 5th year, **mostly fractured bone**
 - Trapezium – 6th year
 - Trapezoid – 7th year
 - Pisiform – 12th year, **sesamoid bone** and it articulates with only one bone triquetrum.

Table 2: Characteristics of carpal bones

Characteristics	Ossify	Fuse	Comment
Proximal row			
Scaphoid: Boat shaped, 80% of surface is articular (not the waist)	5th; 5 years	14–16 years	<ul style="list-style-type: none"> • Lies beneath the anatomic snuffbox • Distal (to waist) blood supply (radial artery); proximal pole is susceptible to necrosis if injured
Lunate: moon shaped	4th; 4 years	14–16 years	<ul style="list-style-type: none"> • Dislocation often missed • Blood supply in palmar fractures need ORIF to protect against osteonecrosis; dorsal fractures treated nonsurgically
Triquetrum: Pyramid shaped	3rd; 3 years	14–16 years	
Pisiform: Large sesamoid bone	8th; 9–12 years	14–16 years	<ul style="list-style-type: none"> • In the FCU tendon; TCL attaches

Contd...

Characteristics	Ossify	Fuse	Comment
Distal row			
Trapezium: Most radial	6th; 5–6 years	14–16 years	<ul style="list-style-type: none"> • Articulates with 1st metacarpal; TCL attaches, FCR
Trapezoid: Wedge shaped	7th; 5–6 years	14–16 years	<ul style="list-style-type: none"> • Articulate with 2nd metacarpal
Capitate: Largest carpal bone	1st; 1 year	14–16 years	<ul style="list-style-type: none"> • First to ossify
Hamate: Has hook	2nd; 1–2 years	14–16 years	<ul style="list-style-type: none"> • TCL, FCU attach to the hook

TCL – Transverse Carpal Ligament

Ossification: Each from a single center counterclockwise (anatomic position) starting with capitate.

HIGH YIELD POINTS

- First carpal bone to ossify – capitate
- Largest carpal bone – capitate
- Sesamoid carpal bone – pisiform (formed from Flexor carpi ulnaris)
- Most commonly fractured carpal bone – scaphoid
- Most commonly displaced carpal bone – lunate.

REMEMBER

- **Carpal tunnel borders:** Roof: Transverse carpal ligament; Lateral wall: scaphoid and trapezium; Medial wall: Pisiform and hamate contents: Median nerve flexor tendons
- **Guyon's canal:** Roof: Volar carpal ligament; Floor: TCL; Lateral wall: Hamate (hook); medial wall: pisiform contents: **Ulnar nerve and artery**
- **Anatomic snuffbox:** Between tendons of EPL and EPB; Contents: Radial artery (scaphoid directly deep to snuffbox)

Metacarpal Bones

- Miniature long bones: 5 in number, numbered from lateral to medial side
- These bones have one epiphysis and one diaphysis (long bones have one diaphysis and 2 epiphysis)
- Epiphysis of all metacarpal bones are directed toward head, **except in first (located towards base)**
- 1st metacarpal is more anterior and medially rotated. Base of 1st metacarpal is convexo-concave & articulate with trapezium, base of 2nd metacarpal bone is mortized between trapezium and capitate, third with capitate, 4th and 5th with hamate.

Note

- **Abberent epiphysis – (not always present) – present at the head of 1st metacarpal bone.**



Clinical Aspect

- **Fracture of scaphoid:** Occurs when falling on the outstretched hand. Damages radial artery
- **Fracture of hamate:** Damage the ulnar nerve and ulnar artery
- **Bennett's fracture:** Fracture of base of metacarpal of the thumb
- **Boxers fracture:** Fracture of neck of 5th metacarpal
- **Ulnar tunnel (Guyon's canal):** Formed by pisiform bone, hook of hamate and pisohamate ligament. Transmits ulnar nerve and artery. Guyon canal syndrome – entrapment syndrome of ulnar nerve in the Guyon canal.

Table 3: Ossification Centers in Upper Limb

Bones	Ossification centers
Clavicle	Two primary and one secondary
Scapula	One primary and seven secondary
Humerus	One primary and three secondary centers for upper end and four secondary centers for lower end
Radius	One primary center and two secondary centers
Ulna	One primary center and two secondary centers one for each end
Phalanges	One primary center for proximal, middle and distal phalanges each and secondary centers for bases of all phalanges appear in about 2 nd year

MUSCLES OF UPPER LIMB

MUSCLES OF PECTORAL REGION

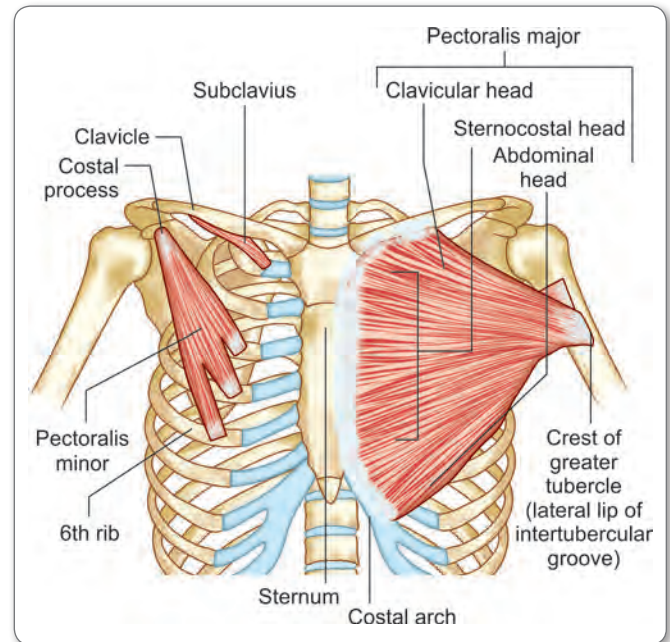


Fig. 9: Muscles of pectoral region

Table 4: Muscles of Pectoral region: Their origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve Supply	Action
Pectoralis major (most commonly absent in congenital anomalies)	<ul style="list-style-type: none"> • From anterior surface of medial half of clavicle • Sternum and upper 6 costal cartilage 	Lateral lip of bicipital groove	Medial and lateral pectoral nerve	Flexion, adduction and medial rotation of shoulder joint
Pectoralis minor	From 3rd 4th and 5th rib	Coracoid process	Medial and lateral pectoral nerve	Depression and protraction of scapula
Serratus anterior (Boxers muscle)	From upper 8 ribs by 8 digitations	Medial border of scapula	Long thoracic nerve	Overhead abduction Protraction of scapula (so nerve injury results in winging of scapula)



Clinical Aspect

Poland Syndrome

- Congenital syndrome
- In most affected individuals absence of sternal portion of pectoralis major as well as absence of pectoralis minor
- Associated with abnormally short, webbed fingers of the hand



MUSCLES OF BACK

122

UPPER LIMB

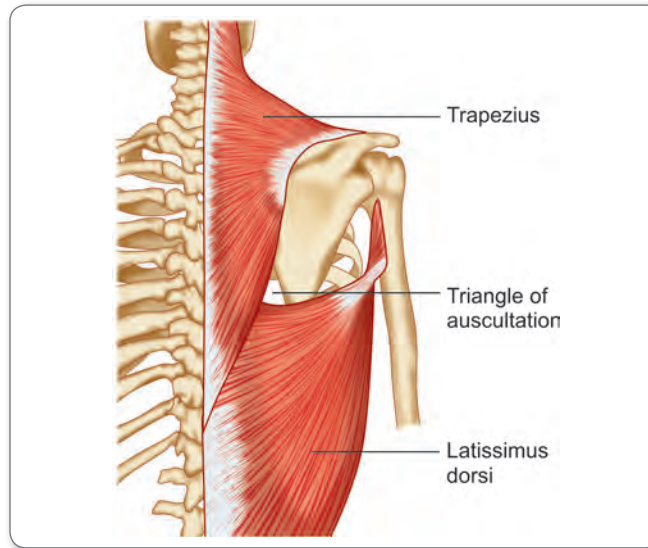


Fig. 10: Muscles of back

Table 5: Muscles of back: Their origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Trapezius	<ul style="list-style-type: none"> External occipital protuberanc, Superior nuchal line Ligamentum nuchae from the spine of C7 to T12 spine 	<ul style="list-style-type: none"> Upper fibers – posterior border of lateral 1/3 clavicle Middle fibers – medial border of acromion Lower fibers – upper lip of crest of spine <p>(Note: Cutting of lower fibers results in winging of scapula)</p>	Spinal part of accessory Proprioceptive from ventral rami of – C3, C4	<ul style="list-style-type: none"> Elevation of scapula Retraction of scapula Over head abduction
Latissimus dorsi (climbers muscle)	<ul style="list-style-type: none"> Lower 6 thoracic spines Outer lip of iliac crest Lower 4 ribs Inferior angle of scapula 	Floor of bicipital groove	Thoracodorsal nerve	<ul style="list-style-type: none"> Extension Adduction Medial rotation of shoulder joint

HIGH YIELD POINTS

Latissimus dorsi is anatomically muscle of upper limb but is migrated to trunk for functional reasons.

- Levator scapulae – supplied by C3, C4 – Elevation of scapula
- Rhomboids – dorsal scapular nerve – retracts the scapula

ROTATOR CUFF MUSCLES

- Musculotendinous cuff formed by blending of tendons of four muscles namely: **subscapularis, supraspinatus, infraspinatus, teres minor (Mn: SITS)**. Remember that teres major does not forms the cuff.
- Their tendons, while crossing the shoulder joint, become flattened and blend with each other on one hand, and with the capsule of the joint on the other hand, before reaching the points of insertion
- Fuses with joint capsule and provides mobility and reinforces the capsule. Anteroinferiorly capsule becomes weak and shoulder dislocation is more common in anteroinferior side
- Cuff is deficient **inferiorly**
- Subscapularis is called as **forgotten muscle** because of deep location

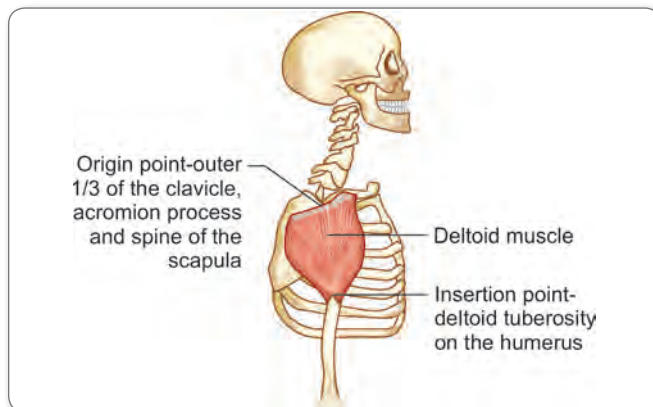


Fig. 11: Deltoid muscle



- Most common rotator cuff muscle affected is supraspinatus. Patient experiences difficulty in initiating abduction
- Keep the head of humerus in glenoid fossa during movements and stabilizes the shoulder joint.

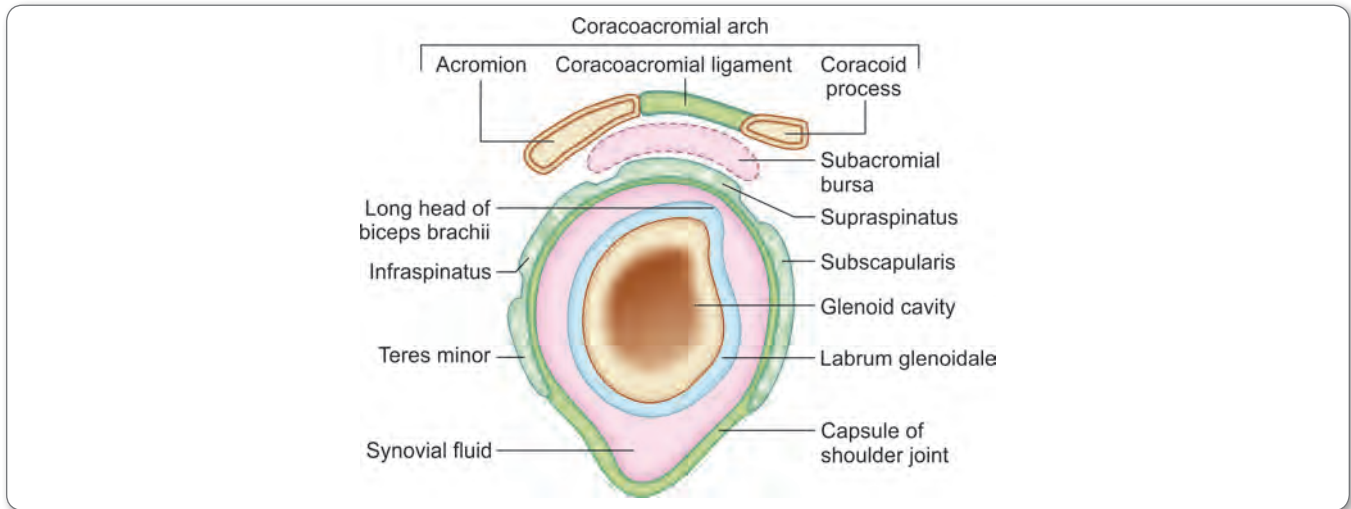


Fig. 12: Rotator cuff muscles

Clinical Aspect

Painful arc syndrome (Impingement syndrome): Pain in shoulder during mid range of glenohumeral abduction caused by tear, inflammation or calcification of supraspinatus tendon and subacromial bursitis.

Table 6: Muscles of scapular region: Their origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Deltoid	Ant-fibers: Anterior border of lateral third of clavicle Mid fibers: Lateral border acromion (multipinnate) Post fibers: Lower lip of crest of spine	Deltoid tuberosity	Axillary nerve	Anterior fibers: Flexion and medial rotation of shoulder joint Middle fibers: 15–90° of abduction of shoulder joint Post fibers: Extension and lateral rotation of shoulder joint
Supraspinatus	Supraspinous fossa	Greater tubercle	Suprascapular nerve	Initiate the abduction
Infraspinatus	Infraspinous fossa	Greater tubercle	Suprascapular nerve	Lateral rotation of shoulder joint
Teres minor	Upper part of lateral border of scapula on dorsal surface	Greater tubercle	Axillary nerve	Lateral rotation of shoulder joint
Teres major	Lower part of lateral border of scapula on dorsal surface	Medial lip of bicipital groove	Lower subscapular nerve	Extension Adduction Medial rotation of shoulder joint
Subscapularis (Forgotten muscle of rotator cuff)	Costal surface of scapula	Lesser tubercle	Upper and lower subscapular nerve	Adduction Medial rotation of shoulder joint

MUSCLES OF ARM

Flexor Compartment

- **Brachial intermuscular septum:** Portion of deep fascia consists of medial and lateral intermuscular septa which divide the arm into flexor and extensor compartments.

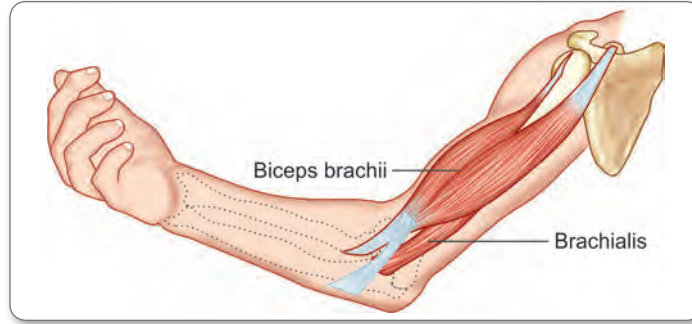


Fig. 13: Biceps brachii and brachialis

Table 7: Muscles of arm: Their origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Coracobrachialis	From the tip of coracoid process	Middle of humerus	Musculocutaneous nerve	Flexion of shoulder joint and adducts the shoulder joint
Biceps	<ul style="list-style-type: none"> Long head: Supraglenoid tubercle Short head: Tip of Coracoid 	Radial tuberosity	Musculocutaneous nerve	Flexion of shoulder joint, elbow joint and powerful supinator
Brachialis	Lower anterior surface of humerus	Coronoid process of ulna and Ulnar tuberosity	Musculocutaneous nerve and radial nerve	Flexion of elbow joint

REMEMBER

Bicipital aponeurosis: Originates from the medial border of biceps and forms the roof of cubital fossa.

Table 8: Origin, insertion, nerve supply and action of triceps muscles

Muscle	Origin	Insertion	Nerve supply	Action
Triceps	Long head: infraglenoid tubercle Lateral and medial head: posterior surface of humerus	Olecranon process	Radial nerve	Extension of elbow joint

Posterior Compartment

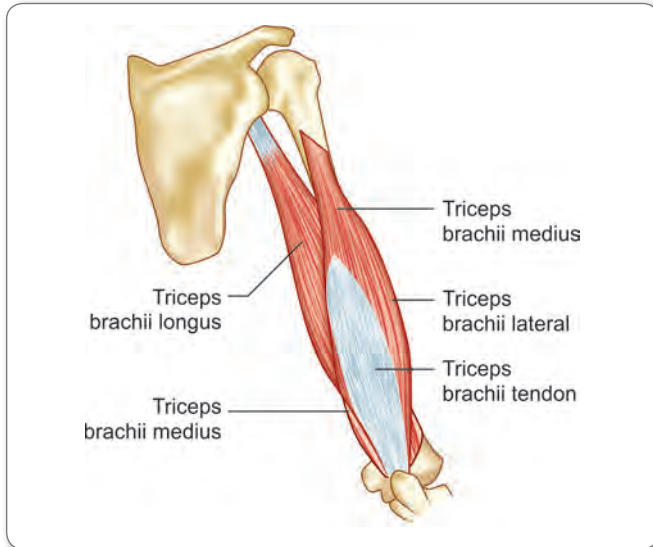


Fig. 14: Triceps

MUSCLES OF FOREARM

Flexors – Superficial Compartment

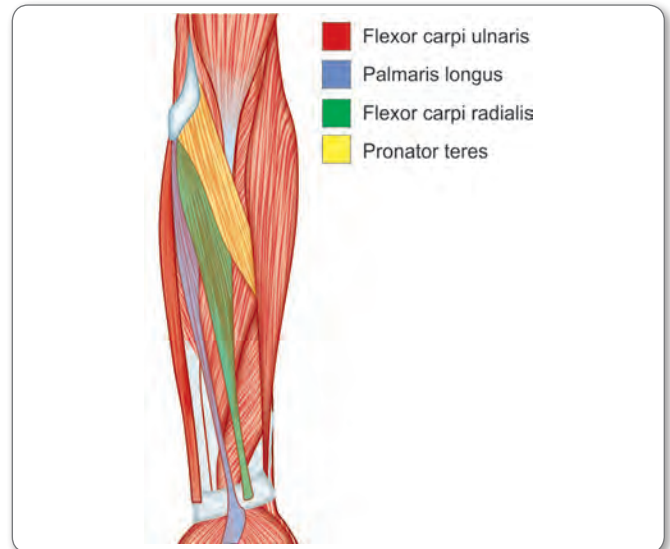


Fig. 15: Superficial flexor muscles



Table 9: Superficial flexor muscles: Origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Pronator teres	Humeral head – medial supracondylar ridge and from ulna	Middle of radius	Median nerve	Pronation and weak flexor of forearm
Flexor carpi radialis	Medial epicondyle of humerus	Base of 2 nd /3 rd metacarpal bones	Median nerve	Weak flexor and abducts (radial deviation)the wrist
Palmaris longus	Medial epicondyle of humerus	Palmar aponeurosis and flexor retinaculum	Median nerve	Weak flexor of wrist
Flexor carpi ulnaris	Medial epicondyle of humerus and medial olecranon and posterior border of ulna	Pisiform bone and hook of hamate and 5 th metacarpal	Ulnar nerve	Weak flexor and adducts (ulnar deviation)the wrist
Flexor digitorum superficialis	Medial epicondyle of humerus, coronoid process, oblique line of radius	Divides into 4 tendons and insert to middle phalanx	Median nerve	Flex the wrist, metacarpophalangeal and proximal interphalangeal joint

Deep Flexors Compartment

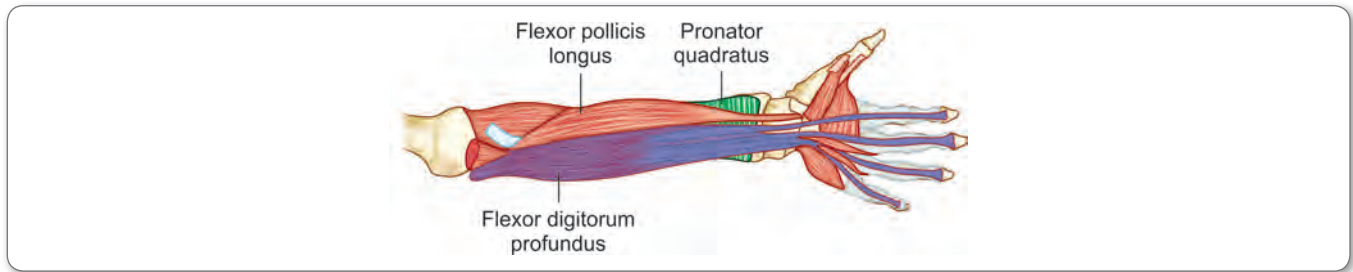


Fig. 16: Deep flexor muscles

Table 10: Deep flexor muscles—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Flexor digitorum profundus	Anteromedial surface of ulna and interosseous membrane	Divided into 4 tendons and Distal phalanx	Anterior interosseous nerve and ulnar nerve	Flex the wrist, metacarpophalangeal and proximal interphalangeal joint and distal interphalangeal joint
Flexor pollicis longus	Anterior surface of radius and interosseous membrane and coronoid process	Distal phalanx of thumb	Anterior interosseous nerve	Flex the wrist and interphalangeal joint of wrist
Pronator quadratus	Anterior surface of distal ulna	Anterior surface of distal Radius	Anterior interosseous nerve	Pronates forearm

REMEMBER

Pronation and Supination

- These are the movements of radius over the stationary ulna
- Occurs at **humeroradial, proximal and distal radio-ulnar joints**
- Supination—palm faces forward, pronation—radius rotates over the ulna and palm faces backward
- Supination movement is stronger movement than pronation.



HIGH YIELD POINTS

Radial Bursa

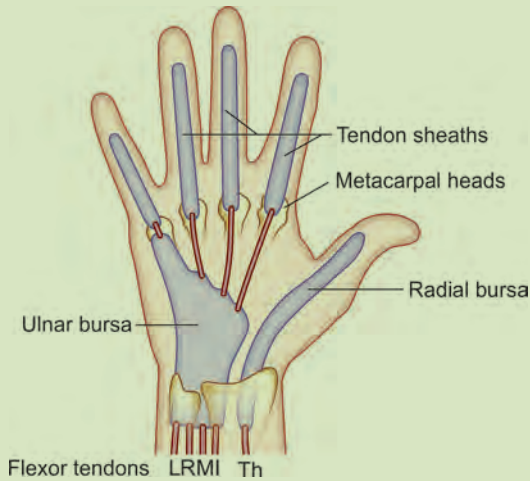


Fig. 17: Radial and ulnar bursae

- Synovial sheath **over flexor pollicis longus**
- Extension—2.5 cm, proximally flexor retinaculum and distally with digital synovial sheath of the thumb.

Ulnar Bursa

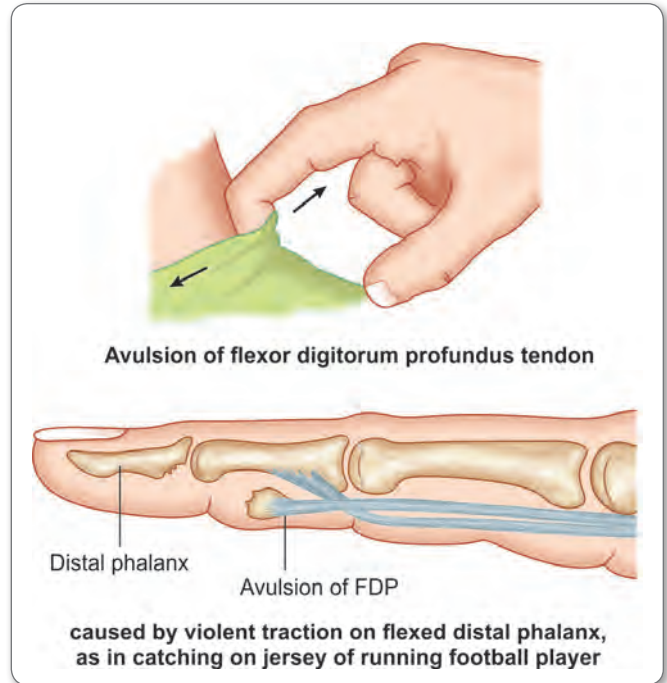
- Common synovial sheath for **superficialis and profundus**
- Extension—2.5 cm proximally flexor retinaculum and distally with digital synovial sheath of the little finger and blind diverticula along the metacarpal bone without communicating with digital synovial sheath of other finger.



Clinical Aspect

Tenosynovitis

- Inflammation of synovial sheath of the digits
- Infection of 2nd, 3rd, 4th digits is confined to digits because they have separate synovial sheath. But rupture of proximal end of these synovial sheath allows the infection to spread to mid palmar space
- Synovial sheath of little finger is usually continuous with ulnar bursa. So the infection spread to common synovial sheath
- Infection of ulnar bursa spreads to **forearm space of Parona**, which is in continuity with mid palmar space
- Likewise the infection of thumb spread via radial bursa
 - Sometimes radial and ulnar bursae communicate with each other and allow the infection to spread from one finger to another – horse shoe abscess.
- Whitlows or Felon is the infection and inflammation of pulp space of finger.
 - **Jersey finger** –injury to FDP tendon at its attachment to distal phalanx. Often occurs in American foot ball when a player grabs another player’s jersey with the tips of finger while that player is running away



Extensor Compartment

Superficial Extensors

- Most of the superficial extensors except three (brachioradialis, extensor carpi radialis longus and anconeus) take common origin from the lateral epicondyle of humerus
- Most of the superficial extensors except three (brachioradialis, extensor carpi radialis longus and anconeus – supplied by radial nerve) are supplied by posterior interosseous nerve.

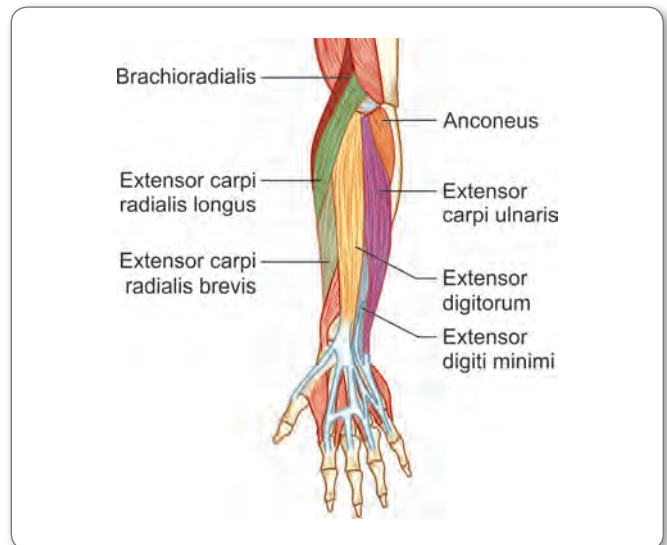


Fig. 18: Superficial extensor muscle



Table 11: Superficial extensor muscles—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerves supply	Action
Brachioradialis	Lateral supracondylar ridge of humerus	Base of styloid process of radius	Radial nerve	Weak flexor of forearm
Extensor carpi radialis longus	Lateral supracondylar ridge of humerus	Dorsum of the base of 2 nd metacarpal	Radial nerve	Extensor of wrist and radial deviation (abduction)
Extensor carpi radialis brevis	Lateral epicondyle of humerus	Dorsum of the base of 3 rd metacarpal	Posterior interosseous nerve	Extensor of wrist and radial deviation (abduction)
Extensor digitorum	Lateral epicondyle of humerus	Divides into 4 tendons and form dorsal digital expansion	Posterior interosseous nerve	Extensor of wrist and metacarpophalangeal joint
Extensor digiti minimi	Lateral epicondyle of humerus	Dorsal digital expansion to little finger	Posterior interosseous nerve	Extends little finger
Extensor carpi ulnaris	Lateral epicondyle of humerus	Base of the 5 th metacarpal bone	Posterior interosseous nerve	Extensor of wrist and ulnar deviation (adduction)
Anconeus	Behind Lateral epicondyle	Upper part of posterior surface of ulna and olecranon process	Radial nerve	Anconeus assists triceps in extending elbow and stabilizes it Abduct the ulna during pronation In some books, it is given as helping in screwing movements

- Mobile wad of henry is group of following three muscles in posterior compartment of forearm:
 - Brachioradialis
 - Extensor carpi radialis longus
 - Extensor carpi radialis brevis

Deep Extensors

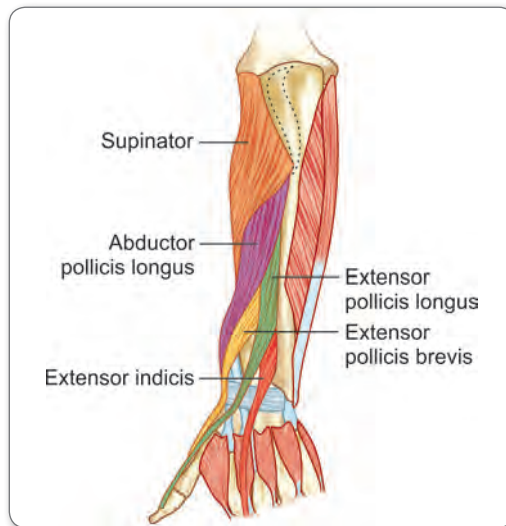


Fig. 19: Deep extensor muscles

Table 12: Deep extensor muscles—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Supinator	Supinator crest and supinator fossa of ulna	Lateral surface of radius	Posterior interosseous nerve	Supination of forearm
Abductor pollicis longus	Upper third of posterior surface of radius and ulna and from interosseous membrane between them	Lateral side of base of 1 st metacarpal bone	Posterior interosseous nerve	Abducts the thumb
Extensor pollicis brevis	Middle-third of posterior surface of radius and from interosseous membrane	Proximal phalanx of thumb	Posterior interosseous nerve	Extends metacarpophalangeal joint of thumb

Contd...



Muscles	Origin	Insertion	Nerve supply	Action
Extensor pollicis longus	Middle-third of posterior surface of ulna and from interosseous membrane	Base of distal phalanx of thumb	Posterior interosseous nerve	Extension of interphalangeal joint of thumb
Extensor indicis	Middle-third of posterior surface of ulna and from interosseous membrane	Dorsal digital expansion to index finger	Posterior interosseous nerve	Extends little finger

Dorsal Digital Expansion

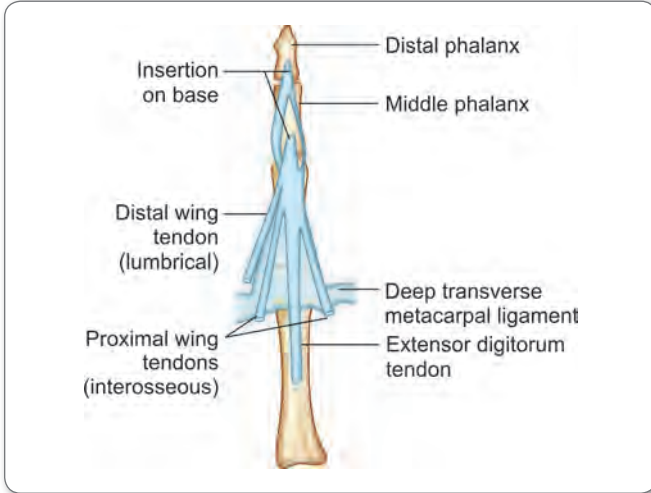


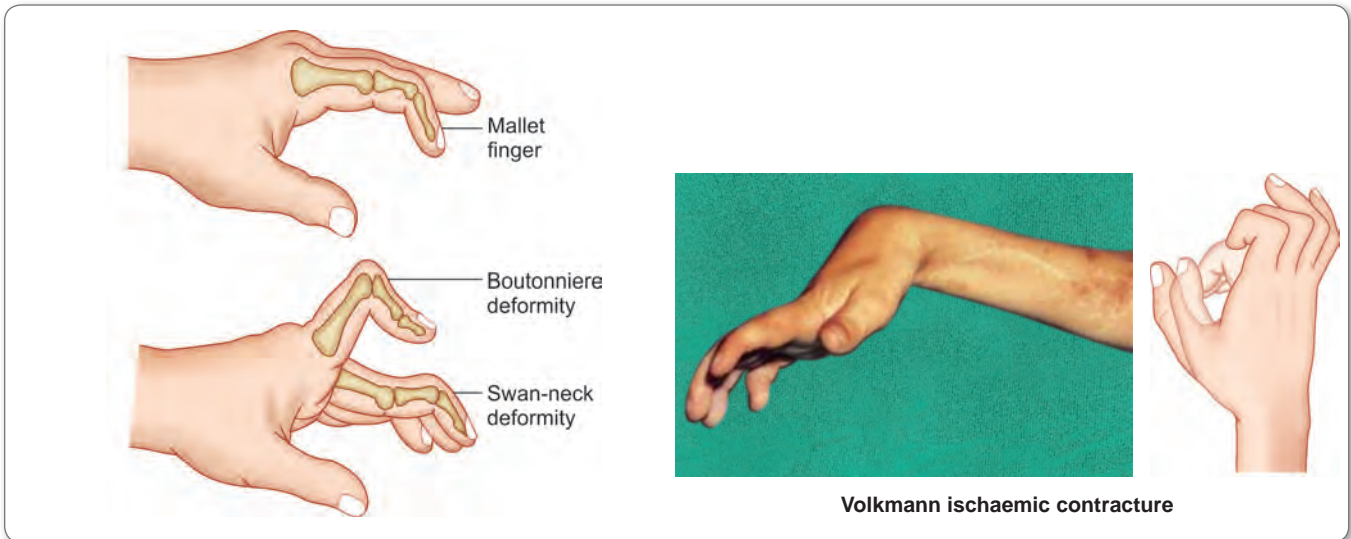
Fig. 20: Dorsal digital expansion

- Extensor tendons cover the metacarpal head and proximal phalanx and forms dorsal digital expansion
- Base of expansion over metacarpal head and apex close to distal end of proximal phalanx.
- Then it trifurcates into median and lateral bands
- Median band attaches to base of middle phalanx
- Lateral band extends distally and unite before insertion into base of distal phalanx

- On lateral side, expansions are thickened by lumbricals and interosseous whereas on medial side by interosseous only
- These attachments are called as wing tendons.

Clinical Aspect

- **Mallet finger (base ball finger):** Finger with permanent flexion of the distal phalanx due to avulsions of lateral band of extensor tendon
- **Boutonniere deformity:** Abnormal flexion of middle phalanx and hyperextension of distal phalanx due to avulsion of central band of the extensor tendon to the middle phalanx
- **Tennis elbow:** Lateral epicondylitis—inflammation of extensor tendons from the lateral epicondyle of humerus. More common in tennis player and violinists
- **Golfer's elbow:** Medial epicondylitis—inflammation of flexor tendons from the medial epicondyle of humerus
- **Volkmann ischemic contracture:** Ischemic muscular contracture (flexion deformity) of the fingers due to ischemic necrosis of the forearm flexor group muscles. Occurs mostly due to pressure injury like tight cast.
- **Dupuytren contracture:** Progressive shortening and thickening of palmar aponeurosis producing fingers are pulled toward the palm.
- **Swan neck deformity:** The deformity arises from hyperextension of the proximal interphalangeal joint, while the distal interphalangeal joint is flexed





MUSCLES OF PALM

- Palmaris brevis—panculus carnosus derivative—supplied by superficial branch of ulnar nerve.

Muscles of Thenar Eminence

- Abductor pollicis brevis—supplied by median nerve
- Flexor pollicis brevis—hybrid muscle. Superficial head supplied by median nerve and deep head by deep branch of ulnar nerve

- Opponens pollicis—supplied by median nerve
- Adductor pollicis—supplied by deep branch of ulnar nerve.

Muscles of Hypothenar Eminence

- Abductor digiti minimi—deep branch of ulnar nerve
- Flexor digiti minimi—deep branch of ulnar nerve
- Opponens digiti minimi—deep branch of ulnar nerve.

Table 13: Thenar and Hypothenar muscles—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Abductor pollicis brevis	Flexor retinaculum, Scaphoid, trapezium	Base of proximal phalanx of thumb	Median nerve	Abducts the thumb
Flexor pollicis brevis	Flexor retinaculum, trapezium	Base of proximal phalanx of thumb	Superficial head by median nerve Deep head – deep branch of ulnar nerve	Flexes the metacarpophalangeal joint of thumb
Opponens pollicis	Flexor retinaculum, trapezium	Lateral side of first metacarpal	Median	Opposes thumb to other digits (flex the metacarpal bone of thumb)
Adductor pollicis	Capitate and base of 2 nd and 3 rd metacarpal (oblique head). Palmar surface of 3 rd metacarpal(transverse head)	Medial side of base of proximal phalanx of thumb	Ulnar	Adducts thumb
Palmaris brevis	Flexor retinaculum and palmar aponeurosis	Skin of medial side of palm	Ulnar	Wrinkles skin on medial side of palm
Abductor digiti minimi	Pisiform and tendons of flexor carpi ulnaris	Medial side of base of proximal phalanx of little finger	Ulnar	Abducts the little finger
Flexor digiti minimi	Flexor retinaculum and hook of hamate	Medial side of base of proximal phalanx of little finger	Ulnar	Flex the proximal phalanx of little finger
Opponens digiti minimi	Flexor retinaculum and hook of hamate	Medial side of 5 th metacarpal bone	Ulnar	Oppose the little finger

Lumbricals

- Take origin from four tendons of flexor digitorum profundus. Numbered from lateral side to medial side
- Joins the radial margin of dorsal digital expansion as distal wing tendon
- Lumbricals—link muscle. Connecting deep flexor tendons to extensor tendons of the finger via dorsal digital expansion.



Interosseous

- Four palmar and 4 dorsal interosseous
- Numbered from lateral side to medial side
- Palmar interosseous—unipennate arise from their own metacarpal bone
- Dorsal interosseous—bipennate arise from adjacent metacarpal bone
- Palmar interosseous do not attach to third finger, because middle finger in midline does not require adduction
- Though thumb possesses adductor pollicis, it is supplemented by 1st palmar interosseous
- Dorsal interosseous attach to middle three fingers on both sides, not attach to little finger and thumb as they possess separate abductor.

Palmar interossei	Dorsal interossei
<ul style="list-style-type: none"> • 4 in number • Unipennate • Adducts the fingers 	<ul style="list-style-type: none"> • 4 in number • Bipennate • Abducts the fingers

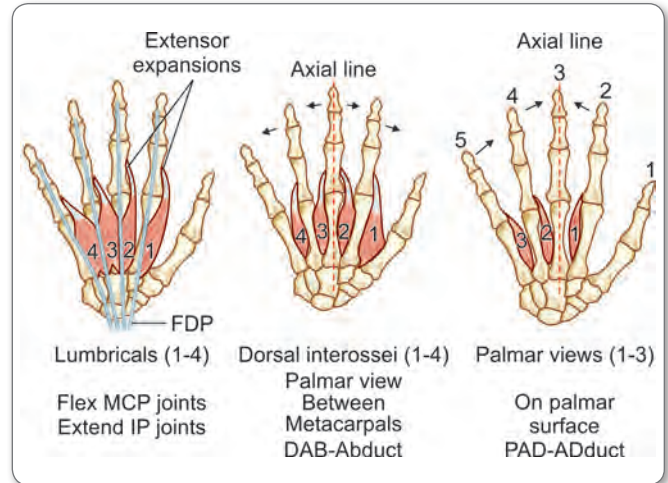


Fig. 21: Lumbricals and interossei muscles

Table 14: Lumbricals and interosseous muscles—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Lumbricals 4 in number	1 st and 2 nd – unipennate From profundus tendon of index and middle finger 3 rd and 4 th – bipennate From profundus tendon of middle, ring and little finger	Radial side of dorsal digital expansion	1 st and 2 - median nerve 3 rd and 4 - deep branch of ulnar nerve	Flexion of metacarpophalangeal joint Extension of interphalangeal joints
Palmar interosseous Unipennate 4 in number	1 st – from ulnar side of base of 1 st metacarpal 2 nd – ulnar side of 2 nd metacarpal 3 rd and 4 th radial side of 4 th and 5 th metacarpal	Corresponding sides of dorsal digital expansion	Deep branch of ulnar nerve	Flexion of metacarpophalangeal joint Extension of interphalangeal joints Adductors of fingers
Dorsal interosseous Bipennate. 4 in number	From adjacent metacarpal bones	First two attach to radial side of proximal phalanx of index and middle finger and blend with dorsal digital expansion 3 rd and 4 th to ulnar side of proximal phalanx of middle and ring finger and blend with dorsal digital expansion	Deep branch of ulnar nerve	Flexion of metacarpophalangeal joint Extension of interphalangeal joints Abductors of fingers

JOINTS OF UPPER LIMB

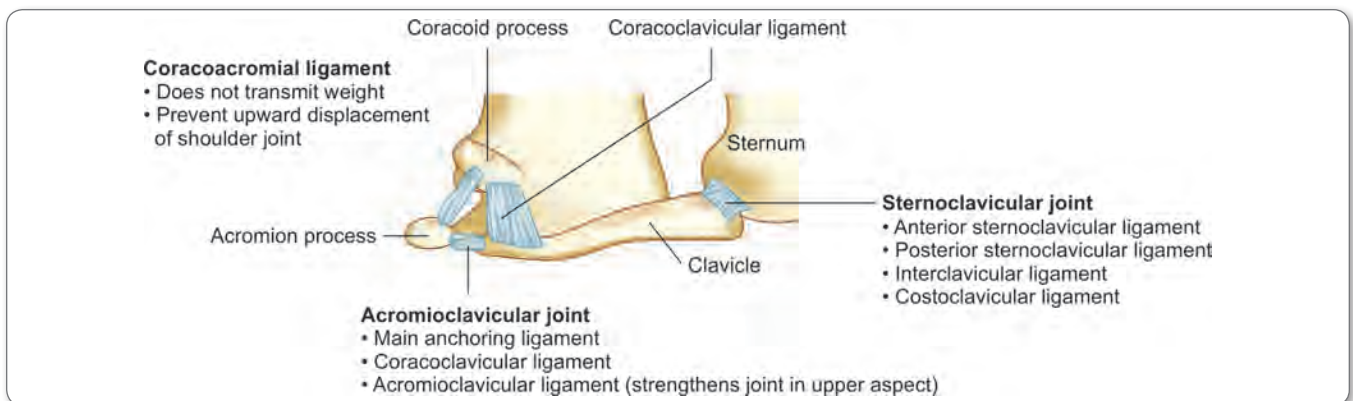


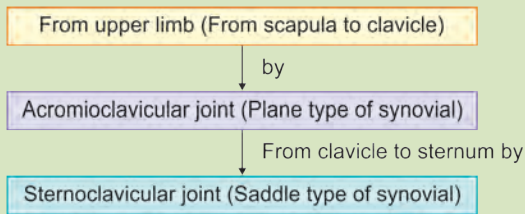
Fig. 22: Ligaments transmitting weight from upper limb to trunk



HIGH YIELD POINTS

Transmission of Weight from Upper Limb to Trunk

- Weight of hand transmitted to radius via wrist joint
- From radius weight transmitted to ulna via interosseous membrane
- From ulna weight transmitted to humerus via elbow joint
- From humerus weight transmitted to scapula via shoulder joint
- From scapula weight transmitted to clavicle via acromioclavicular joint (coracoclavicular ligament and acromioclavicular ligament)
- From clavicle weight transmitted to sternum and rib via sternoclavicular joint (sternoclavicular ligament, costo clavicular ligament and inter clavicular ligament)



Movements of Scapula

- Elevation of scapula—levator scapulae and trapezius
- Depression—pectoralis minor and serratus anterior
- Protraction—serratus anterior and pectoralis minor
- Retraction—rhomboides major and minor and trapezius.

SHOULDER JOINT—BALL AND SOCKET VARIETY

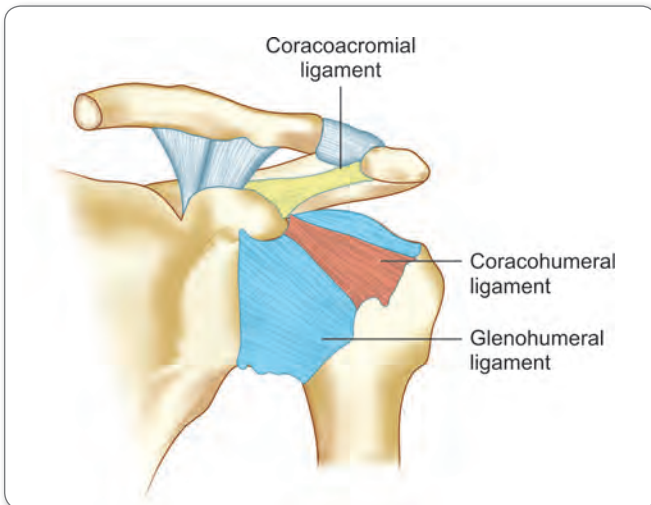


Fig. 23: Shoulder joint

Ligaments

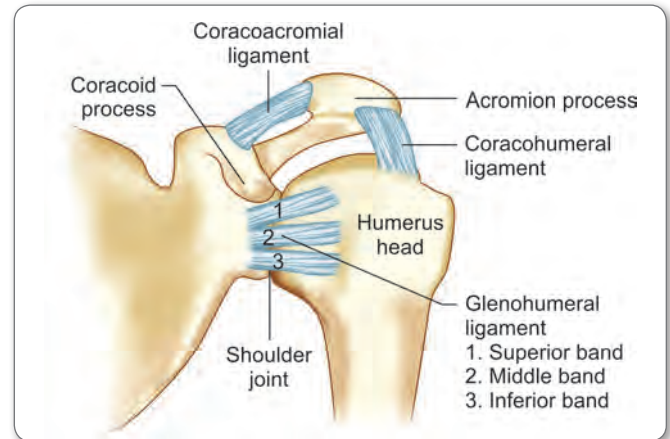


Fig. 24: Ligaments of the shoulder joint

- Glenohumeral ligaments
 - Superior band—from glenoid cavity to upper part of lesser tubercle of humerus
 - Middle band—from glenoid cavity to lower part of lesser tubercle
 - Inferior band—from glenoid cavity to lower part of anatomical neck of humerus
- Coracohumeral ligaments
- Transverse humeral ligament.

Subacromial Bursa

- Largest bursa of the body, situated below the coracoclavicular arch and the deltoid muscle
- Below the bursa, there are tendons of supraspinatus and the greater tubercle of the humerus
- Protects the supraspinatus tendon against friction with the acromion
- During overhead abduction, the greater tubercle of the humerus passes under the acromion; this is facilitated by presence of this bursa.

Table 15: Movements at shoulder joint

Abductors	Supraspinatus (0°–15°) initiation of abduction Middle fibers of deltoid (15°–90°) Over head abduction - Serratus anterior and trapezius (cause lateral rotation of scapula so that glenoid cavity faces upwards)
	Note:
	<ul style="list-style-type: none"> • 0–90% abduction occurs at shoulder joint • 90–120% abduction due to lateral rotation of humerus • 120–180% abduction due to lateral rotation of scapula • During abduction - Humerus and scapula move in ratio of 2:1

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Adductors	Pectoralis major Latissimus dorsi	Accessory Muscles: Teres major, Coracobrachialis, Short head of biceps, Long head of triceps
Flexion	Anterior fibers of deltoid Coracobrachialis Pectoralis major	
Extension	Posterior fibers of deltoid Teres major Latissimus dorsi Long head of triceps	
Medial rotation	Pectoralis major Deltoid (anterior fibers) Teres major Latissimus dorsi	
Lateral rotation	Deltoid (posterior fibers) Teres minor Infraspinatus	

Clinical Aspect

- ‘**Luxatio erecta**’ is another name of inferior dislocation of shoulder.
- Shoulder joint is the most common joint which undergoes dislocation (or recurrent dislocations) in our body
- **Rotator interval** or Rotator cuff interval, is a triangular space between the tendons of **subscapularis** and **supraspinatus**
- **Supraspinatus** muscle is most commonly involved in **Impingement syndrome** (Swimmer’s shoulder), so it is also called supraspinatus syndrome.

ELBOW JOINT

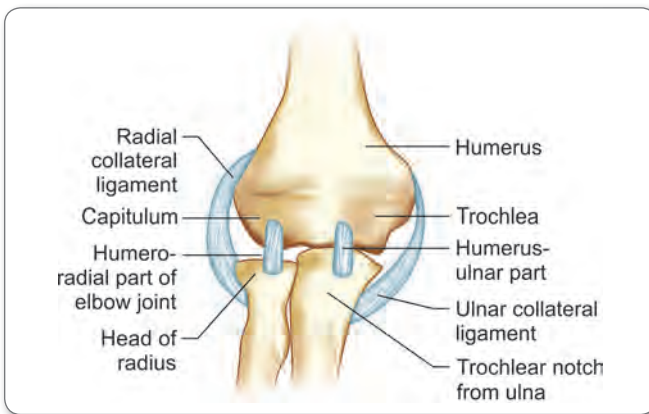


Fig. 25: Elbow joint

- Hinge joint
- Consists of humeroulnar (trochlea from humerus and trochlear notch from ulna) and humeroradial part (capitulum from humerus and head of radius)
- Ligaments—ulnar and radial collateral ligament

- Movements
 - Flexion—biceps, brachialis main flexors, brachioradialis and all superficial flexors (origin from medial epicondyle—crosses elbow joint in front) are weak flexors
 - Extension—triceps

RADIOULNAR JOINT

- Superior radioulnar joint—pivot type, between head of radius and radial notch of ulna
- Middle radioulnar joint—syndesmosis, between interosseous border of radius and ulna, radius and ulnar shaft connected by two syndesmoses, an oblique cord and an interosseous membrane
- Inferior radioulnar joint—pivot, between ulnar notch of radius and head of ulna
- Movements—pronation and supination (movement of radius over stationary ulna)
 - Supination—supinator, biceps
 - Pronation—pronator teres and quadratus

WRIST JOINT

Synovial Biaxial (Ellipsoid)

- Proximally—inferior surface of distal radius
- Distally—Scaphoid, Lunate, Triquetral
- Note:** Ulna bone does not take part in wrist joint
- Adduction of wrist joint (ulnar deviation)
 - Flexor and extensor carpi ulnaris simultaneous action
- Abduction (radial deviation)
 - Flexor and extensor carpi radialis
- Muscles producing flexion at the wrist joint
 - Flexor carpi radialis
 - Flexor carpi ulnaris
 - Palmaris longus
- Muscles producing extension at the wrist joint
 - Extensor carpi radialis longus
 - Extensor carpi radialis brevis
 - Extensor carpi ulnaris

CARPOMETACARPAL JOINT OF THUMB—SADDLE

- Between trapezium and base of first metacarpal bone
- Possesses separate joint cavity from other carpometacarpal joint
- Note:** Second to fifth carpometacarpal joints are synovial ellipsoid joint between the carpus and 2nd – 5th metacarpal bone.

METACARPOPHALANGEAL JOINT

- Ellipsoid joint
- Between metacarpal bones and articular base of proximal phalanges



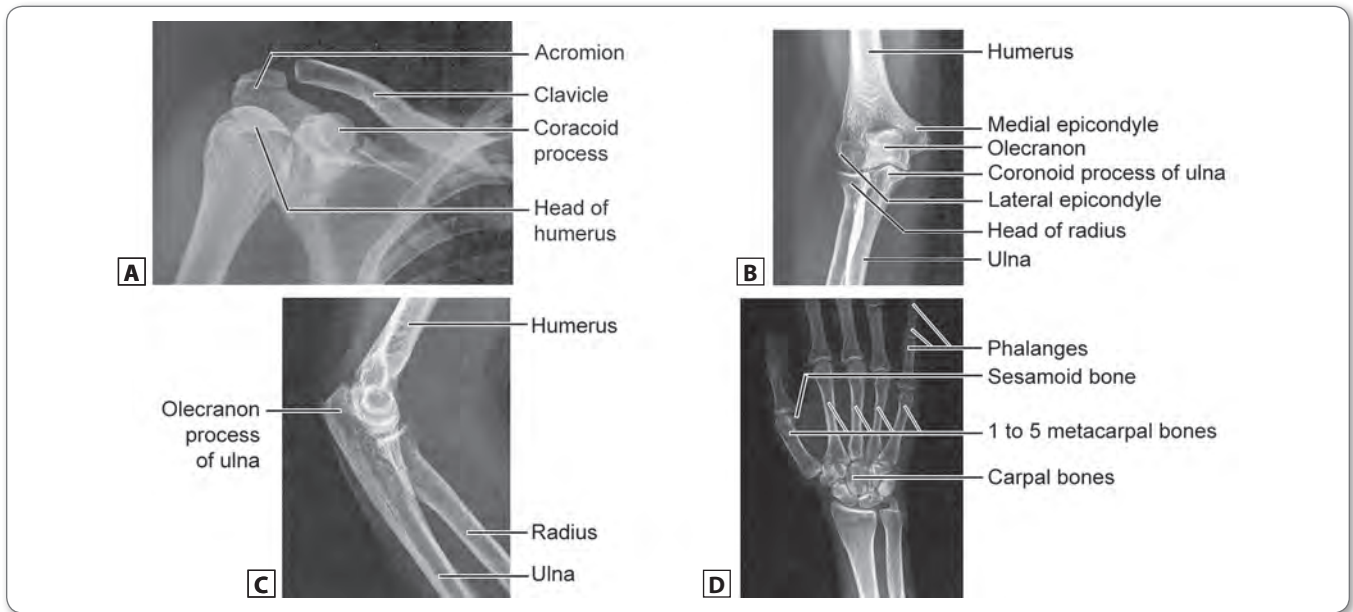
- Movements
 - Flexion—lumbricals and interossei
 - Extension—extensors of the fingers
 - Adduction—palmar interossei
 - Abduction—dorsal interossei.

- Flexion of proximal interphalangeal joint—flexor digitorum superficialis
- Flexion of distal interphalangeal joint—flexor digitorum profundus
- Flexion of thumb—flexor pollicis longus
- Extension of proximal interphalangeal joint—extensor digitorum, lumbricals and interossei
- Extension of distal interphalangeal joint—extensor digitorum, lumbricals and interossei
- Extension of thumb—extensor pollicis longus and brevis

INTERPHALANGEAL JOINTS

- Uniaxial joint – hinge joint
- Movements

RADIOLOGICAL ANATOMY OF JOINTS OF UPPER LIMB



Figs 26A to D: (A) Anteroposterior view of the shoulder joint; (B) Anteroposterior view of the elbow joint; (C) Lateral view of the elbow joint and (D) Anteroposterior view of the hand

NERVES OF UPPER LIMB

SEGMENTAL INNERVATION IN UPPER LIMB

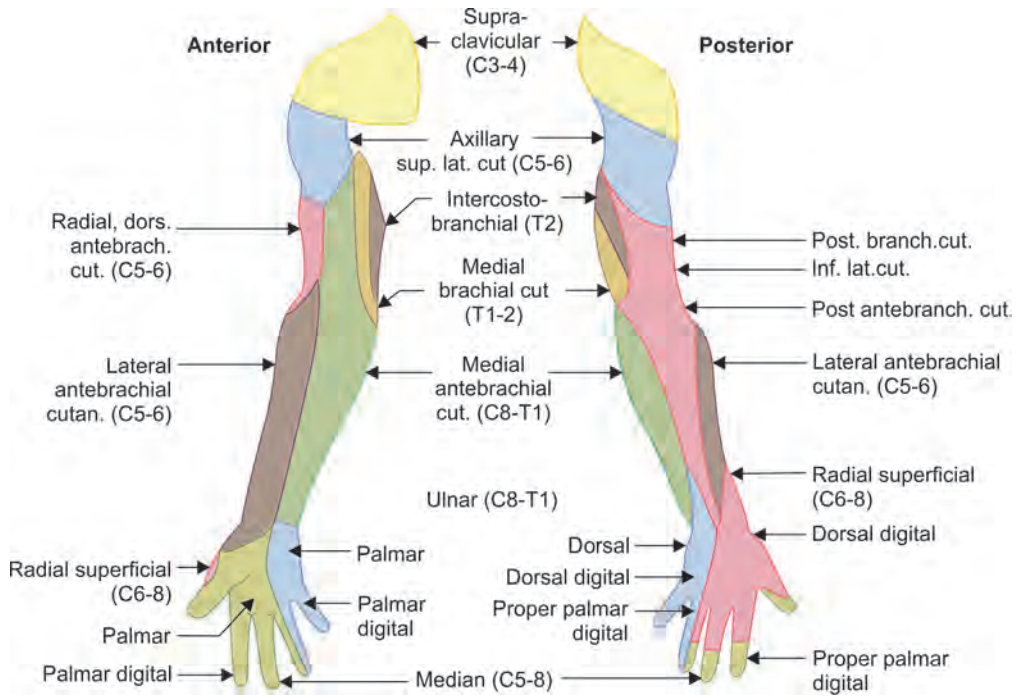
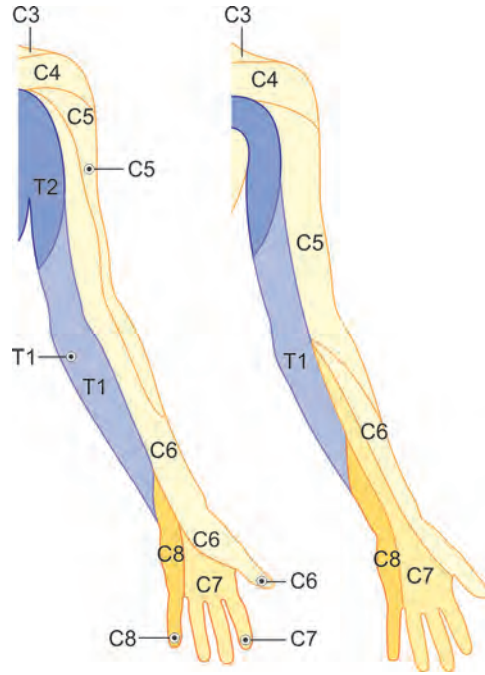
Shoulder	
Flexion, abduction, lateral rotation extension, adduction, medial rotation	C5, C6, 7, 8
Elbow	
Flexion – biceps reflex	C5,6
Extension – triceps reflex	C6,7,8
Forearm	
Pronation	C7,8
Supination	C6
Wrist	
Flexion/extension	C7,8
Fingers/thumb – long tendons	
Flexion/extension	C7,8
Hand – small muscles	
All movements	T1



DERMATOME OF UPPER LIMB

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UPPER LIMB





REFLEXES

Biceps jerk – c5,6	<ul style="list-style-type: none"> • Elbow flexed at right angle & slightly pronated • Finger placed over the biceps tendon • Tap by hammer produce flexion and supination of forearm
Triceps jerk – c6-c8	<ul style="list-style-type: none"> • Arm flexed at right angle and supported by wrist • Triceps tendon tapped by hammer which produce extension of elbow
Radial jerk – c7,8 It is periosteal reflex not tendon reflex	<ul style="list-style-type: none"> • Elbow flexed at right angle and forearm in midprone position • Radial styloid process struck with hammer • Elicits contraction of brachioradialis (flexion of elbow)

BRACHIAL PLEXUS

- Formed by ventral rami of C5, C6, C7, C8, T1
- Roots pass between scalenus anterior and medius muscles
- Enclosed by axillary sheath along with axillary vessels. This sheath is formed by prolongation of prevertebral fascia.

Trunk

- Upper trunk is formed by C5, 6
- Middle trunk formed by C7
- Lower trunk formed by C8, T1.

Divisions

- Each trunk is divided into anterior and posterior division

Cord

- Lateral cord: Anterior division of upper trunk and middle trunk
- Posterior cord: Posterior division of all trunks
- Medial cord: Anterior division of lower trunk.

Note:

- Roots and trunks are situated in the neck
- Division passing behind the clavicle
- Cords and branches situated in axilla.

Branches from Root

- Dorsal scapular nerve (C5): Supplies levator scapulae, rhomboid minor and rhomboid major
- Long thoracic nerve C5, 6, 7: Runs on serratus anterior and supplies it.



Clinical Aspect

During radical mastectomy and stab wound the long thoracic nerve gets injured and results in winging of scapula.

Branches from the Upper Trunk

- Suprascapular nerve C5-C6 passes through suprascapular foramen (suprascapular artery passes above the foramen) and supplies supraspinatus and infraspinatus
- Nerve to subclavius C5 innervate subclavius.

Note: Suprascapular nerve sometimes arises from C5 root - Grays 41th edition

- **So branch from trunk of brachial plexus nerve to subclavius > suprascapular nerve**

Branches from Lateral Cord

Lateral Pectoral Nerve C5-7

Pierces the costocoracoid membrane of clavipectoral fascia and supplies pectoralis major and pectoralis minor.

Musculocutaneous Nerve C5-C7

Pierces coracobrachialis and supplies muscle of anterior compartment of arm.

Lateral Root of Median Nerve

Branches from Medial Cord

- Medial pectoral nerve C8-T1: Passes between axillary vein and axillary artery. Supplies pectoralis major and minor
- Medial cutaneous nerve of arm C8-T1: Present on the medial side of axillary vein. Innervate the medial side of arm
- Medial cutaneous nerve of forearm C8-T1: Present between axillary artery and axillary vein.
- Ulnar nerve C7-T1: Present between axillary artery and axillary vein
- Medial root of median nerve.

Branches from Posterior Cord

- Upper subscapular nerve C5-C6: Innervates upper part of subscapularis
- Thoracodorsal nerve C7-8 supplies **latissimus dorsi**
- Lower subscapular nerve C5-C6 innervates **lower part of subscapularis and teres major**
- Axillary nerve C5-C6 innervates **deltoid and teres minor**
- Radial nerve C5 -T1 largest branch of brachial plexus.



Table 16: Supraclavicular and infraclavicular nerves

Supraclavicular nerves	Infraclavicular nerves
I. Branches from root <ul style="list-style-type: none"> Long thoracic nerve (Nerve of Bell) C5, C6, C7 Dorsal scapular nerve (Nerve to rhomboids) C5 	I. Lateral cord branches <ul style="list-style-type: none"> Musculocutaneous nerve C5, C6, C7 Lateral pectoral nerve C5, C6, C7 Lateral root of median nerve C5, C6, C7
II. Branches from trunks <ul style="list-style-type: none"> Suprascapular nerve C5, C6 Nerve to subclavius C5, C6 	II. Medial cord branches <ul style="list-style-type: none"> Medial pectoral nerve C5, T1 Medial cutaneous nerve of arm C8, T1 Medial cutaneous nerve of forearm C8, T1 Ulnar nerve C7, C8, T1 Medial root of median nerve C8, T1
	III. Posterior cord branches <ul style="list-style-type: none"> Upper subscapular nerve Thoracodorsal nerve (nerve to latissimus dorsi) C6, C7, C8 Lower subscapular nerve C5, C6 Axillary nerve C5, C6, Radial nerve C5, C6, C7, C8, T1

Mnemonic

- Lateral cord branches: LML
- Medial cord branches: 4MU
- Posterior cord branches: ULNAR

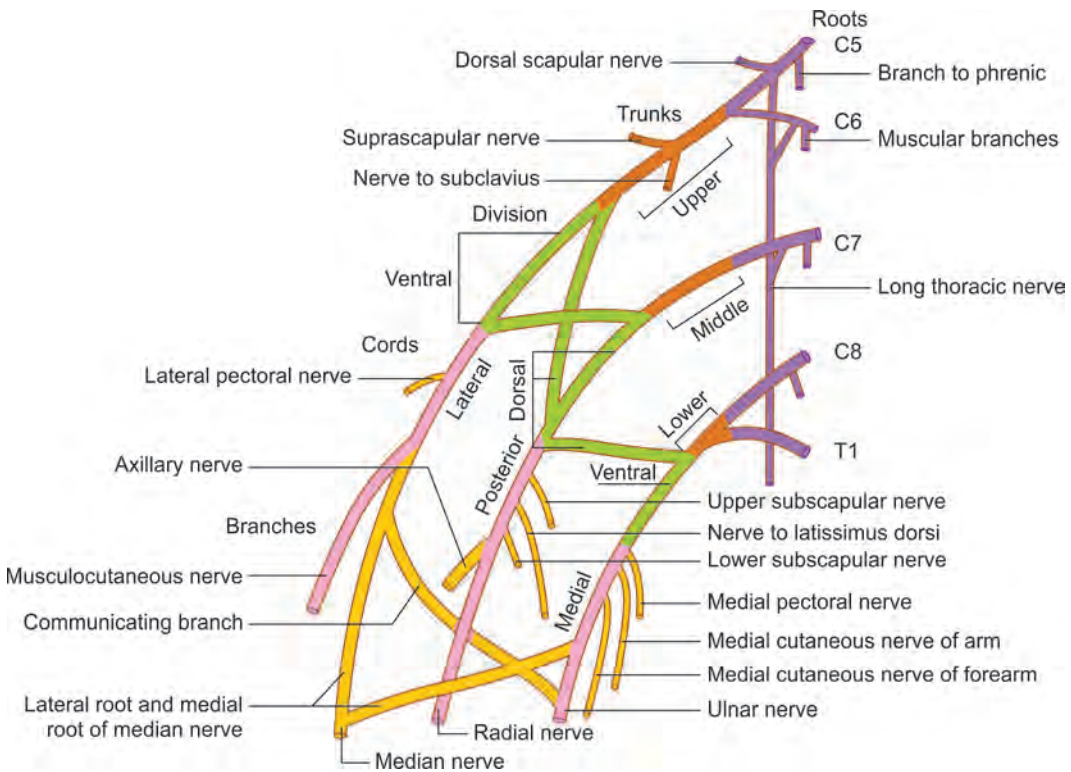


Fig. 27: Right brachial plexus



Clinical Aspect

Brachial Plexus Injury

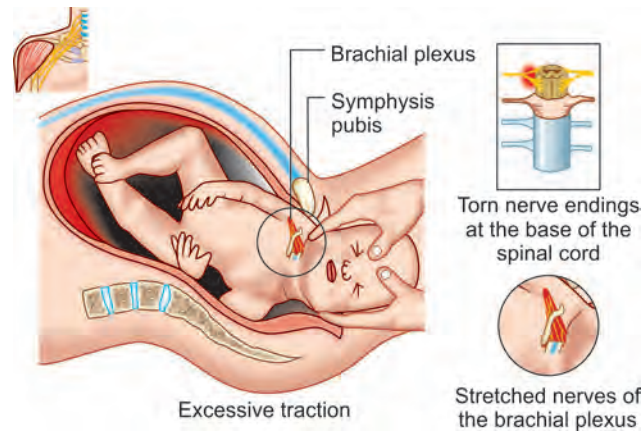


Fig. 28: Brachial plexus injury

Erb's Palsy

- Upper trunk injury C5–C6,—due to fall on the shoulder, obstetric complication (birth injury)
- Lesion in the erb's point
- Erb's point is a meeting place of six nerves. C5 root, C6 root, anterior and posterior division from the upper trunk, suprascapular nerve and nerve to subclavius.

Mnemonic

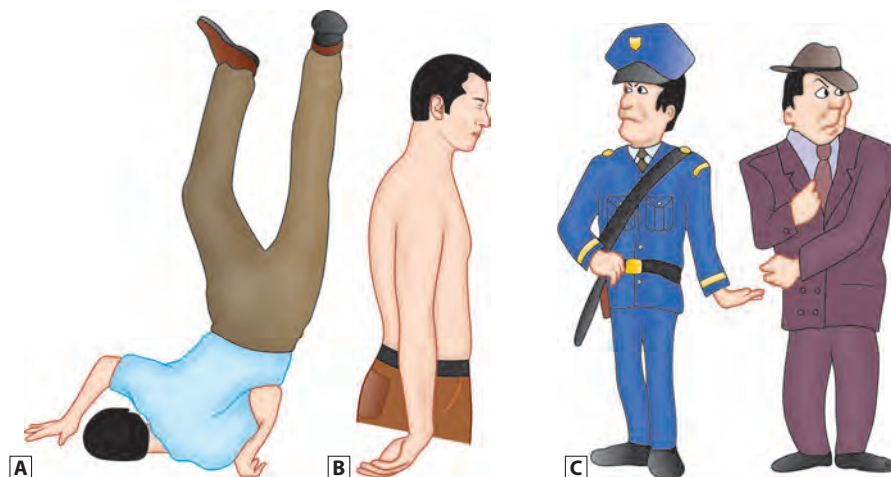
- Nerves affected in ERB'S PALSY – (**SuperR MAN** mnemonic)
- **M**usculocutaneous nerve
- **A**xillary nerve
- **N**erve to subclavius
- **S**uprascapular nerve
- **R**adial nerve

Muscles Affected in Erb's Palsy

- Biceps (Flexor of elbow joint, supinator), brachialis (Flexor of elbow joint) affected due to involvement of musculocutaneous nerve. Coracobrachialis is not affected because it is supplied by nerve root C5-C7
- Deltoid (abductor of shoulder joint) and teres minor (lateral rotator of shoulder joint) are affected due to involvement of axillary nerve
- Subclavius affected due to involvement of nerve to subclavius
- Supra spinatus (initiate the abduction) and infraspinatus (lateral rotator of shoulder joint) affected due to suprascapular nerve
- Brachioradialis (Flexor of elbow joint), supinator (supinates the forearm), extensor carpi radialis longus (extends the wrist, but other extensor muscles prevent wrist drop) affected due to radial nerve.

Deformity

- **Effects:** Waiter's tip deformity/Policeman tip deformity



Figs 29A to C: Deformities due to Erb's palsy

Contd...



- **Forearm:** Extended (Biceps palsy) and pronated (biceps palsy)
- **Arm:** Adducted (deltoid and supraspinatus palsy) and medially rotated (Infraspinatus and teres minor palsy)
- **Loss of sensation:** Lower part of deltoid

Klumpke's Paralysis

Lower trunk involved C8-T1—due to hyperabduction injury, pancoast tumor, CA of breast and cervical rib

Nerves affected: Ulnar, Median (C8, T1 affected)

Muscles affected: All intrinsic muscles of hand

Effects: Ape thumb deformity, claw hand deformity, horner's syndrome

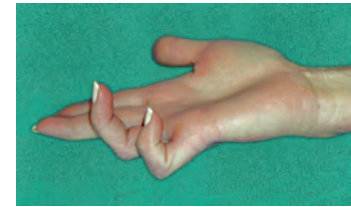
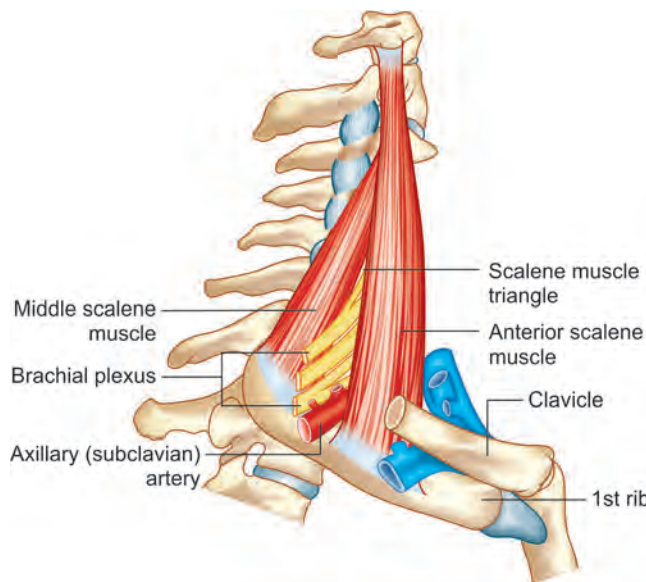


Fig. 30: Deformities due to klumpke's paralysis

	Erb's	Klumpke's
Injury to	Upper trunk (C5,C6)	Lower trunk (C8,T1)
Cause	Undue separation of head from shoulder, e.g. Birth injury, Fall, anesthesia, Blow to shoulder	Hyperabduction of arm
Nerves affected	Musculocutaneous, Axillary, Nerve to subclavius, Suprascapular nerve, radial nerve	Median, ulnar and T1 sympathetic
Deformity	Policeman hand/ Waiter's tip hand deformity	Claw hand deformity
Position of arm	Arm is adducted and medially rotated	Vasomotor/trophic changes mainly

Brachial Plexus Block

Trunk of brachial plexus – passing in scalene triangle which is between scalenus anterior and medius. So block can be given by passing needle lateral to scalenus anterior muscle



AXILLARY NERVE

- Leaves the axilla and enters the posterior compartment of arm through the quadrangular space along with posterior circumflex vessels
- Axillary nerve supplies: Deltoid, teres minor and also gives upper lateral cutaneous nerve of arm (corresponds to lower half of deltoid) and also supplies to shoulder joint
- Axillary nerve obeys Hiltons law – nerve supplying the joint also supplies muscles acting in the joint and also skin overlying in it
- Fracture of surgical neck of humerus affects the axillary nerve and results in weakness of abduction of shoulder joint and lateral rotation of shoulder joint. Bandage like sensory loss over lower part of the deltoid called regimental badge.

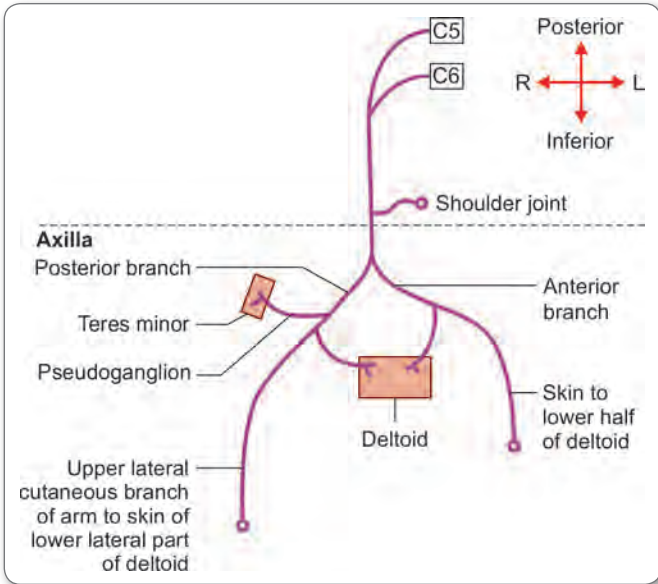


Fig. 31: Course of axillary nerve

- The nerve and artery enters the spiral groove between the long and medial head of triceps
- It descends downward and laterally in the naked contact of the bone between lateral and medial head of triceps

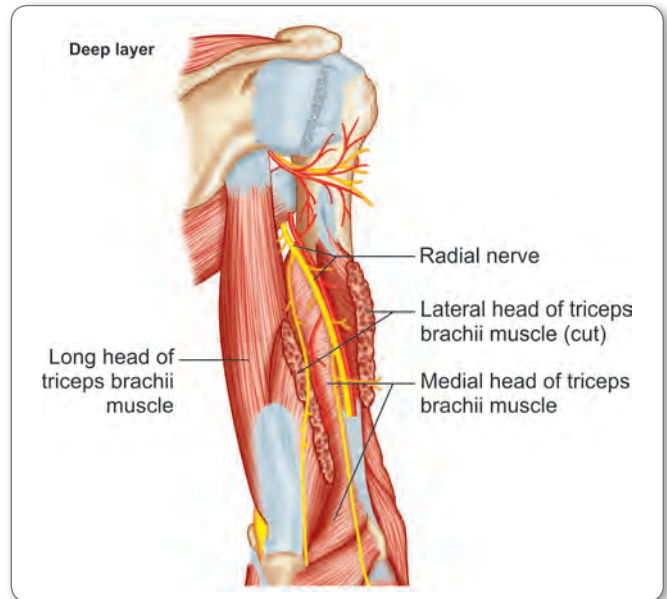
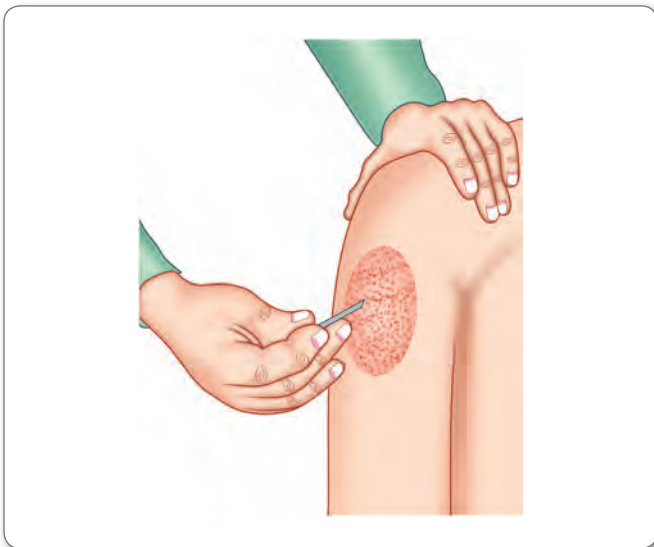


Fig. 32: Radial nerve course and relations

- Then it pierces the lateral part of intermuscular septum and enters the anterior compartment of lower arm where the nerve descends between brachioradialis and extensor carpi radialis longus laterally and brachialis medially
- On reaching the lateral epicondyle, the nerve divides into superficial branch and deep terminal branch.

Regimental Badge Anaesthesia



Branches

- Branches in the axilla: Branch to medial head and long head of triceps and posterior cutaneous nerve of arm
- Branches in spiral groove: **Branch to medial and lateral head of triceps (nerve to medial head supplies anconeus)**, posterior cutaneous nerve of forearm and lower lateral cutaneous nerve of arm
- Branches in lower part of arm: Branch to **brachioradialis, extensor carpi radialis longus and brachialis.**

RADIAL NERVE – C5 TO T1

- Largest branch of brachial plexus
- Continuation of posterior cord of brachial plexus.

Course and Relations

- Radial nerve along with profunda brachii artery leaves the axilla through lower triangular space

Superficial Terminal Branch—Sensory Branch

Descends Under the Cover of Brachioradialis and Passes

- Over the roof of anatomical snuff box. Divides into 5 dorsal digital nerves to supply the lateral part of dorsum of hand and lateral 3 ½ digits – dorsum excluding distal and middle phalanges which is supplied by median nerve



Deep Terminal Branch—Pure Motor Branch

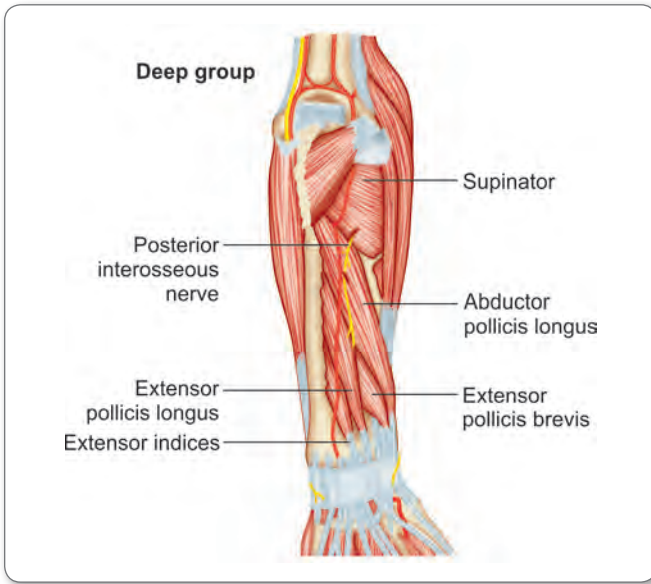


Fig. 33: Course of deep terminal branch

- Pierces supinator and enter the posterior compartment of forearm. Supplies the all extensors of forearm except brachioradialis, extensor carpi radialis longus and anconeus.

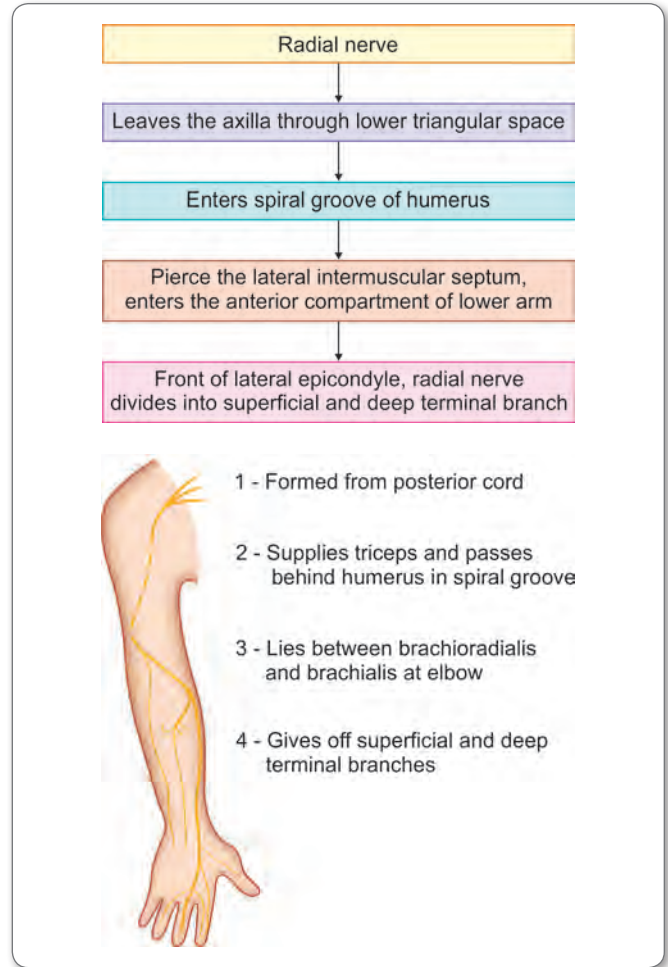


Fig. 34: Course of radial nerve

Clinical Aspect

Radial nerve injury in the axilla due to Crutch palsy and Saturday night palsy.

Crutch palsy



Radial nerve injury in axilla



Radial nerve palsy

- Compression of radial nerve in the axilla due to use of crutches by polio patients and due to Saturday night palsy.
- Loss of extension of elbow (triceps involvement)

Contd...



- Loss of wrist extension – wrist drop
- Loss of finger extension – finger drop
- Extension of interphalangeal joint not affected because that is the action of lumbricals and interosseous (supplied by median and ulnar nerve)
- Sensory loss on the posterior surface of arm, forearm, lateral part of dorsum of hand and dorsum lateral 3½ digits – excluding distal & middle phalanges which is supplied by median nerve and loss of sensation over anatomical snuff box.

Features of Radial Nerve Palsy Below Spiral Groove - Due to Saturday night palsy or IM injection

- **Triceps and anconeus muscle spared** because these muscles supplied by radial nerve at the axilla and at spiral groove
- **Extension of elbow is normal**
- Loss of wrist extension – wrist drop
- Loss of finger extension – finger drop
- Extension of interphalangeal joint not affected because that is the action of lumbricals and interosseous (supplied by median and ulnar nerve)
- Sensory loss in the lateral part of dorsum of hand and lateral 3½ digits – dorsum excluding distal and middle phalanges which is supplied by median nerve and loss of sensation over anatomical snuff box.

Features of Low Radial Nerve Palsy – Injury of radial nerve below the elbow joint before dividing into superficial and deep branch

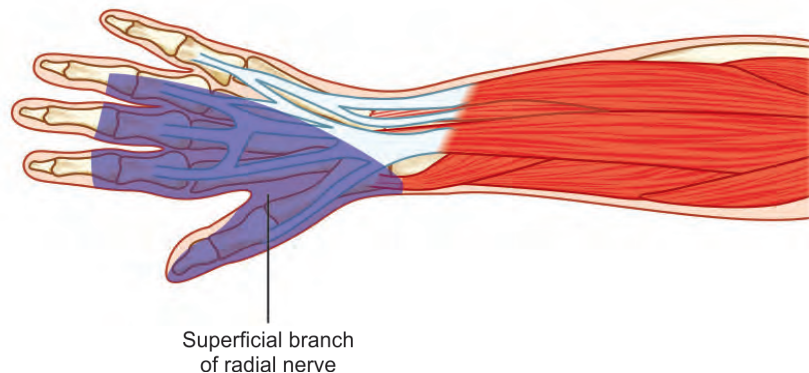
- **Mainly due to entrapment syndrome**
- **Triceps, anconeus, brachioradialis, extensor carpi radialis longus and brachialis are spared**
- Rest of the muscles supplied by posterior interosseous nerve are paralyzed
- **Extension of elbow – normal**
- **Extension of wrist – normal because of ECRL**
- Finger drop – **loss of extension of metacarpophalangeal joint**
- Extension of interphalangeal joint not affected because that is the action of lumbricals and interosseous (supplied by median and ulnar nerve)
- Sensory loss in the lateral part of dorsum of hand and lateral 3½ digits – dorsum excluding distal and middle phalanges which is supplied by median nerve and loss of sensation over anatomical snuff box.

Features of Posterior Interosseous Nerve Palsy

- Wrist extension not affected because extensor carpi radialis longus and brevis are supplied by radial nerve
- Only one extension lost in PIN is extension at metacarpophalangeal joint. So patient have finger drop not wrist drop
- No sensory loss, because it is motor nerve.

Note – posterior interosseous nerve injury is common in Monteggia fracture dislocation

Wartenberg Syndrome – Chiralgia Parasthetica



Compressive neuropathy of superficial branch of radial nerve as it exits the brachioradialis muscle.

Note

Wartenberg sign – Inability to adduct small finger towards ring finger



Clinical Aspect

Patient with wrist drop is Given Cock - Up Wrist Splint



MEDIAN NERVE

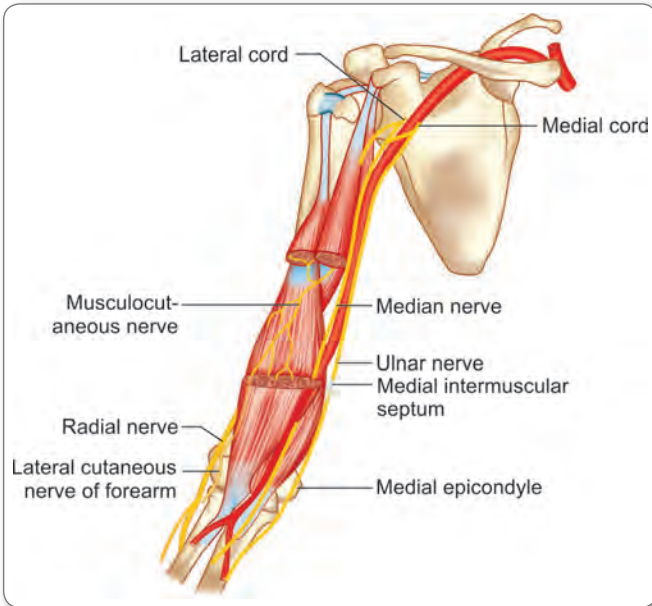


Fig. 35A: Course of median N. in arm

- Formed by **median root of median nerve** (branch of medial cord) and **lateral root of median nerve** (branch of lateral cord)
- Descends along the lateral side of axillary artery and brachial artery
- In the middle of the arm, nerve from lateral side cross to medial side

- Then proceeds along the medial side of brachial artery
- Median nerve is the **most medial** structure in the cubital fossa
- Leaves the cubital fossa between superficial and deep head of **pronator teres**
- Enters the forearm under the tendinous arch of flexor digitorum superficialis



Fig. 35B: Course of the median N. in forearm

- In the forearm, it descends between superficialis and profundus
- In the forearm, it is accompanied median artery which is branch from anterior interosseous artery
- In the wrist, it lies between the tendon of flexor carpi radialis and palmaris longus and passes below the carpal tunnel

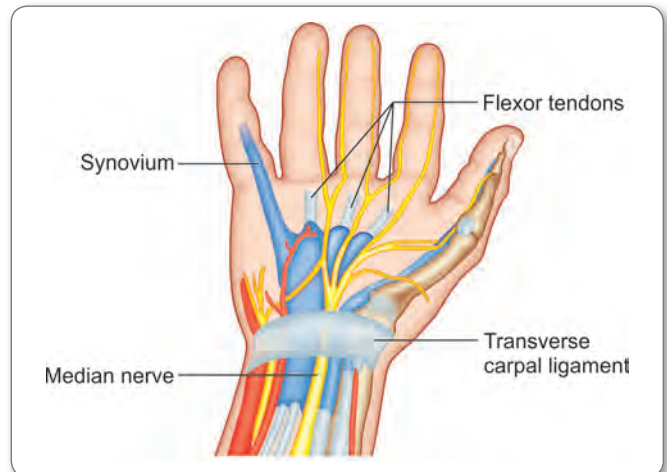
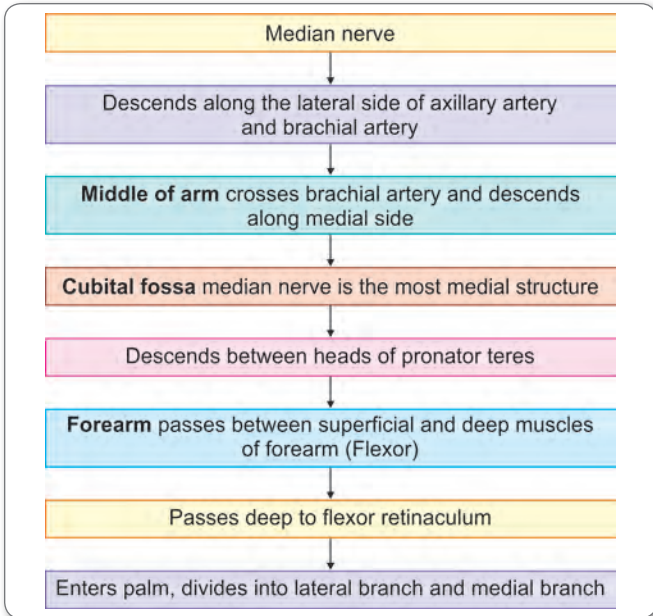


Fig. 35C: Course of the median N. in wrist



- Distal to flexor retinaculum, median nerve divides into recurrent branch, lateral branches and medial branches
- Recurrent branch - supplies thenar eminence muscles
- Lateral branch gives three proper palmar digital branch, which supplies two sides of thumb and lateral side of index finger
- Medial branch is divided into two common palmar branches. Each common palmar branch divides into two proper palmar branches. Thus the medial branch supplies adjacent sides of index and middle finger and middle and ring finger.

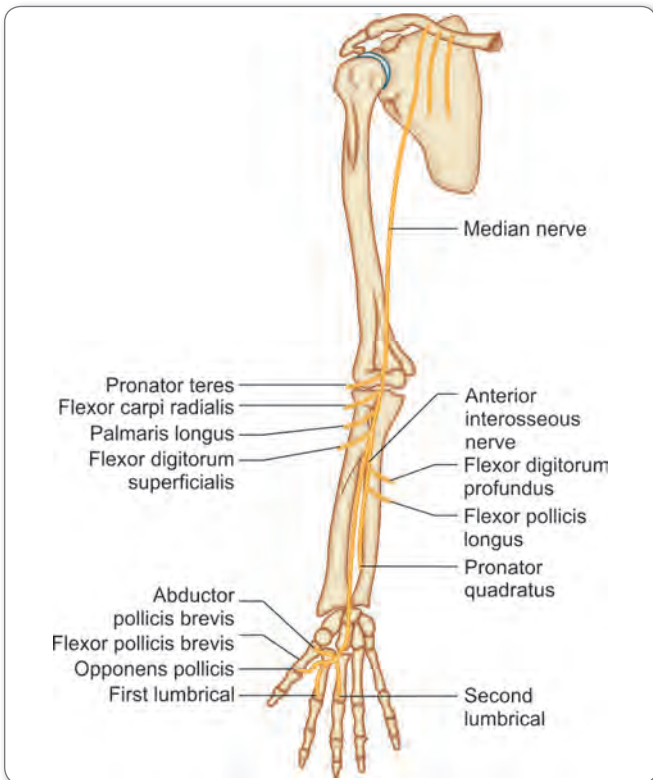


Fig. 36: Course of median nerve

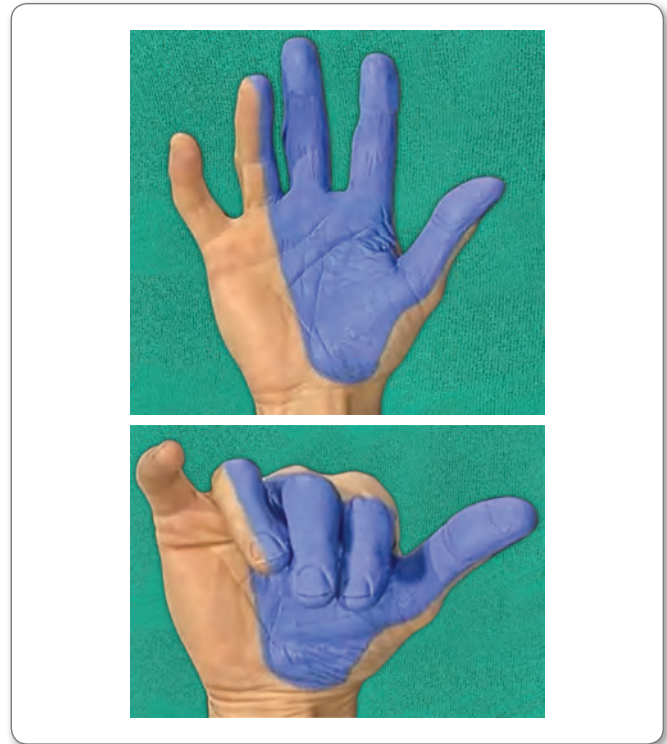


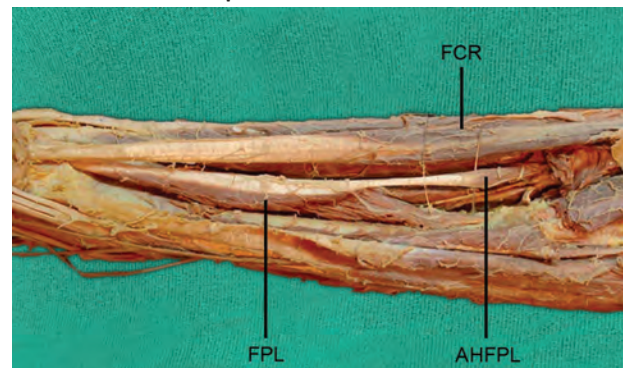
Fig. 37: Sensory distribution of median nerve

Branches

- No branches in axilla
- No branches in the arm
- Branches in the forearm: Branch to pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum superficialis (all superficial flexors except flexor carpi ulnaris)
- Anterior interosseus nerve: Branch from median nerve arises distal to pronator teres—supplies flexor pollicis longus, flexor digitorum profundus (lateral half) and pronator quadratus

Clinical Aspect

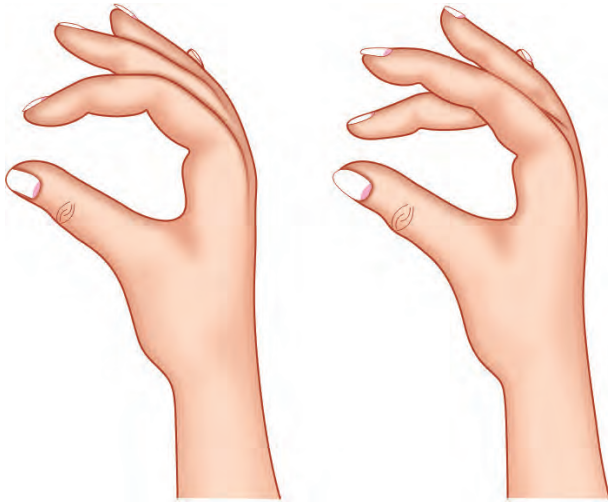
Anterior interosseous nerve palsy causes weakness of pinch grip
GANTZER MUSCLE – ACCESSORY HEAD OF Flexor pollicis longus
 This muscle often compress AIN



Contd...



Kiloh – nevin sign – ok sign

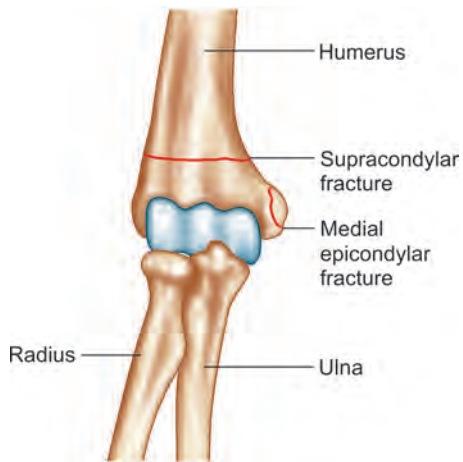


- Due to anterior interosseous nerve palsy
 - Patient is not able to make perfect O. loss of flexion of thumb and index finger flexion.
-
- Recurrent Branch in the palm: Supplies to 5 muscles—branch to abductor pollicis brevis, flexor pollicis brevis, opponens pollicis and 1st and 2nd lumbricals. (**Mnemonic—LOAF**)



Clinical Aspect

Median nerve injury around the elbow: Supracondylar fracture, pronator teres entrapment syndrome
 Most common nerve injured in supra condylar fracture – anterior interosseous nerve > median nerve



Features

- Loss of pronation
- Paralysis of all wrist flexors except flexor carpi ulnaris and medial half of flexor digitorum profundus
- Ulnar deviation on attempted flexion due to involvement of flexor carpi radialis

Contd...

- Loss of interphalangeal joint, flexion of index finger (pointing index deformity), index and middle finger (benediction hand), loss of flexion of terminal phalanx of thumb



"Hand of benediction"
Median nerve injury

- Paralysis of LOAF muscles
- Thenar eminence atrophy
- Ape thumb deformity due to involvement of opponens pollicis



- Sensory loss in the thenar eminence and sensory loss on lateral 3 and half digits – palmar aspect and also distal & middle phalanx of lateral 3 ½ digits on the dorsum of hand.

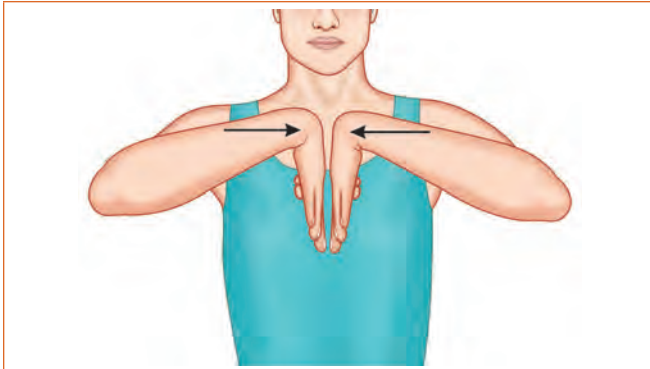
Wrist Slash injury

- Injury of **medial nerve** in wrist due to **suicidal cuts**.
- All the muscles of forearm are spared
- Terminal branches of median nerve medial and lateral branches are involved
- Paralysis of LOAF muscles
- Thenar eminence atrophy.
- Ape thumb deformity due to involvement of opponens pollicis
- Sensory loss in the thenar eminence and sensory loss on lateral 3 and half digits – palmar aspect and also distal & middle phalanx of lateral 3 ½ digits on the dorsum of hand.

Carpal Tunnel Syndrome

- **Compression of median nerve:** Reduced space of carpal tunnel due to inflammation of synovial sheath of flexor tendons or arthritic changes in the carpal tunnel
- **Phallens test:** It is used to diagnose the carpal tunnel syndrome. Size of carpal tunnel is reduced by holding the affected hand with wrist full flexed or extended for 30–60 seconds, appearance of numbness or parasthesia of lateral 3½ fingers suggests carpal tunnel syndrome

Contd...



- Paralysis of LOAF muscles
- Thenar eminence atrophy
- Ape thumb deformity due to involvement of opponens pollicis
- Sensory supply to thenar eminence is maintained (because palmar cutaneous branch of median nerve – pass above the flexor retinaculum) and sensory loss on lateral 3 and half digits – palmar aspect and also distal & middle phalanx of lateral 3 ½ digits on the dorsum of hand.

ULNAR NERVE

- Branch from medial cord of brachial plexus
- Descends along the medial side of axillary artery and situated between axillary artery and axillary vein
- Ulnar nerve descends along the medial side of brachial artery
- Near the middle of the arm, nerve pierce the medial intermuscular septum and appears in the interval between medial epicondyle and olecranon process
- Nerve lodges in the groove behind the medial epicondyle

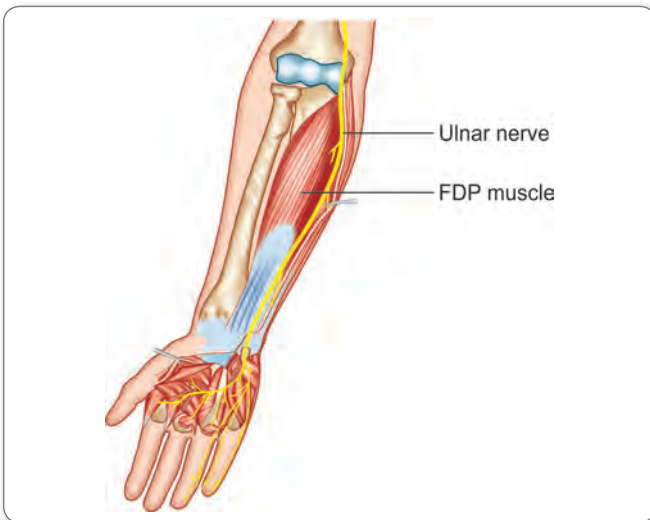


Fig. 38: Ulnar nerve

- Nerve enters the forearm between two heads of flexor carpi ulnaris and descends along the medial side of forearm
- In the upper third of forearm, nerve deeply placed rest on the flexor digitorum profundus.
- In the lower third of forearm nerve become superficial and accompanied by ulnar artery on the radial side

- Ulnar nerve and artery pass superficial to retinaculum on the radial side of pisiform bone
- On reaching the proximal part of hypothenar eminence, nerve divides into superficial and deep branch
- Superficial branch supplies palmaris brevis muscle and gives one proper and one common branch. Common branch in turn divides into two proper branches and in turn supplies the two sides of little finger and ulnar side of ring finger
- Deep branch supplies all the muscles of palm except LOAF muscles

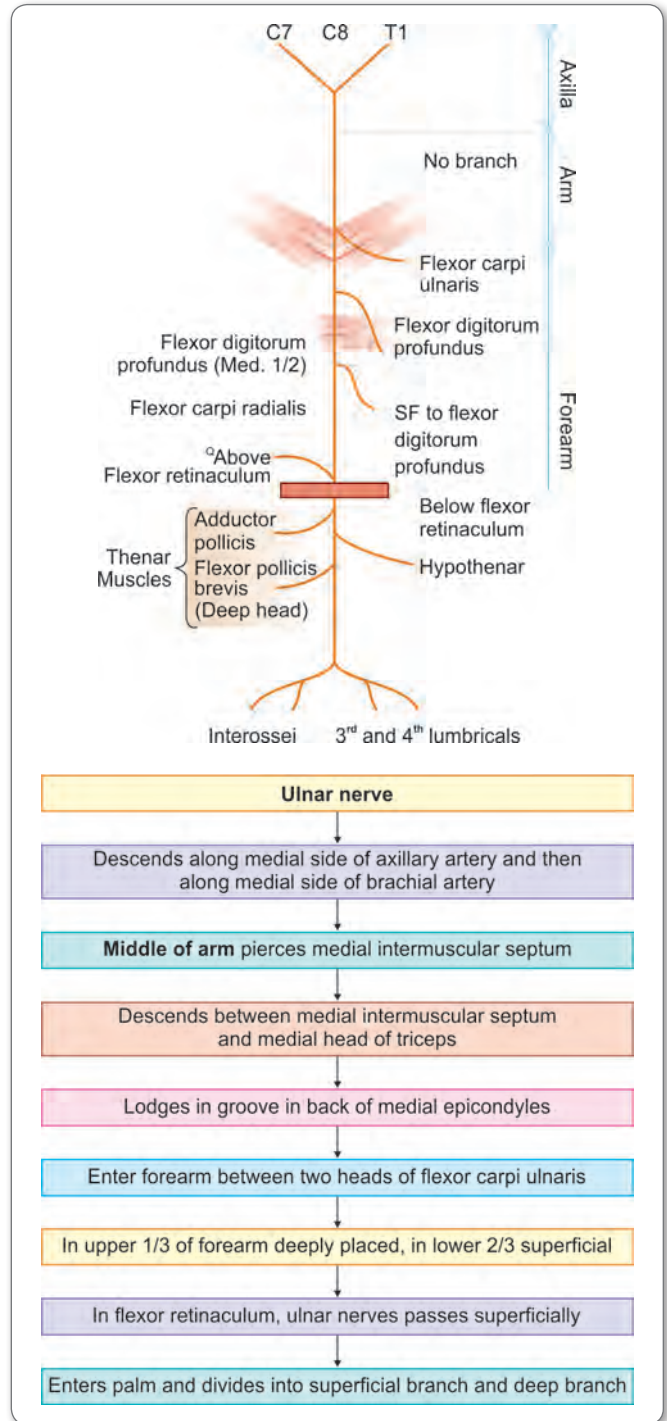


Fig. 39: Course of ulnar nerve



Branches

- No branch in the axilla
- No branch in the arm
- Branches in the forearm: Branch to flexor carpi ulnaris and branch to medial half of flexor digitorum profundus
- In the hand: All intrinsic muscles except three thenar and first two lumbricals.
- Cutaneous branch: Dorsal branch—supplies the dorsal aspect of medial 1½ fingers excluding distal two phalanx of ring finger and terminal phalanx of little finger
- Palmar cutaneous branch

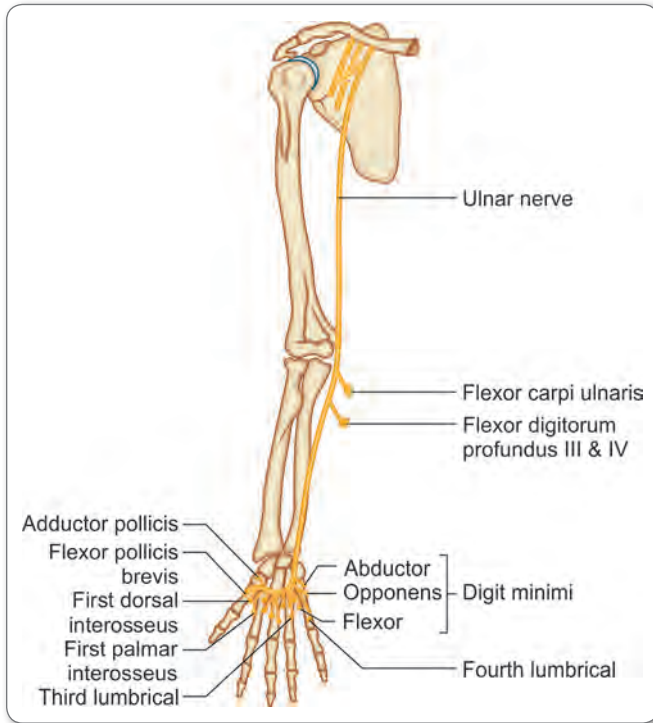


Fig. 40: Branches of ulnar nerve



Clinical Aspect

Cubital tunnel syndrome

Compression of ulnar nerve behind the medial epicondyle. Tunnel is formed by medial epicondyle, ulnar collateral ligament and 2 heads of flexor carpi ulnaris and transmits ulnar nerve and superior ulnar collateral artery

Ulnar tunnel (Guyon's canal)

Formed by pisiform bone, hook of hamate and pisohamate ligament. Transmits ulnar nerve and artery. Guyon canal syndrome – entrapment syndrome of ulnar nerve in the guyon canal

Features of cubital tunnel syndrome

- Ulnar nerve compressed behind the medial epicondyle
- Radial deviation of wrist due to unopposed action of flexor carpi radialis
- Paralysis of all muscles of palm supplied by deep branch of ulnar nerve

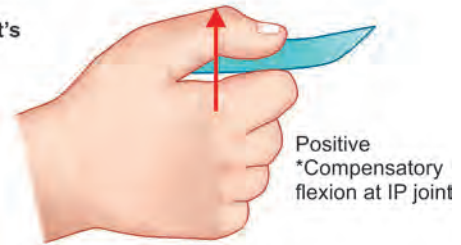
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- Wasting of hypothenar eminence
- **Loss of abduction of fingers is due to involvement of dorsal interossei**
- **Loss of adduction of fingers is due to involvement of palmar interossei (card test – positive)**
- Loss of adduction of thumb is due to adductor pollicis (froment test positive)

Adductor pollicis



Froment's test



- Claw hand (not more pronounced)—extension of metacarpophalangeal joint and flexion of interphalangeal joints
 - In ulnar claw hand—ring and little finger affected (3rd and 4th lumbrical only supplied by ulnar nerve)
 - Complete claw hand—median nerve and ulnar nerve injury
 - Isolated median nerve injury does not produce claw hand because palmar and dorsal interossei supplied by ulnar nerve
- Loss of sensation over the palmar and dorsal surfaces of medial third of palm and on the medial 1 and half fingers

Features of Ulnar Nerve below the Wrist

- **Ulnar paradox—**
 - Proximal injury of ulnar nerve at elbow appears to produce less degree of claw hand than at wrist. This is known as ulnar paradox.
 - Claw hand (extension of metacarpophalangeal joint and flexion of interphalangeal joints) become more visible at the wrist injury because nerve supply to flexor digitorum profundus spared. Flexor digitorum profundus produce interphalangeal joint flexion. So severe claw hand.
 - Ulnar nerve injury at the elbow affect the nerve supply to profundus tendon. So flexion of interphalangeal joint is affected. Less degree of claw hand.
- **Paralysis of all muscles of palm supplied by deep branch of ulnar nerve**
 - **Loss of abduction of fingers—due to involvement of dorsal interossei**
 - **Loss of adduction of fingers—due to involvement of palmar interossei**
 - Loss of adduction of thumb—due to adductor pollicis

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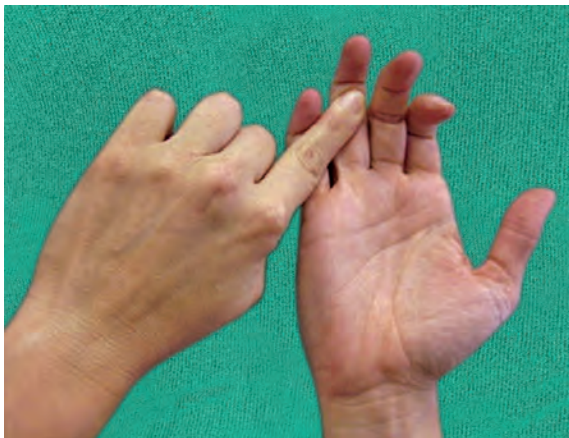
- Dorsal cutaneous branch of ulnar nerve is spared—no sensory loss on the medial aspect of ulnar nerve
- Loss of sensation over medial one and half fingers (little finger and ulnar side of ring finger).

Signs of Ulnar Nerve Palsy

Wartenberg sign: Inability to adduct small finger towards ring finger



Pollock s sign: Weakness of distal interphalangeal joint flexion due to loss of FDP function on little finger and ring finger



Martin–Gruber Connection

Connection between the median nerve (and sometimes the anterior interosseous nerve) and ulnar nerve in the forearm. Present in 17% of individuals.

REMEMBER

Tests to Detect Ulnar Palsy

- Book test (**Froment test**): Involvement of adductor pollicis. So subject is not able to hold paper between thumb and index finger. Hence, compensatory flexion of interphalangeal joint (**positive froment sign**) occurs to hold the book
- Card test (to test Palmar interossei)-adduction of fingers (PAD)
- **Egawa’s test** (to test dorsal interossei)- adduction of fingers (DAB)
- Ulnar claw hand (**main en griffe**)

MUSCULOCUTANEOUS NERVE

- Branch from lateral cord of brachial plexus
- Supplies anterior compartment of arm muscles [coracobrachialis, brachialis, biceps (**Mn-BBC**)]
- After supplying these muscles, nerve continues as lateral cutaneous nerve of forearm.

Clinical Aspect

Injury of musculocutaneous nerve leads to:

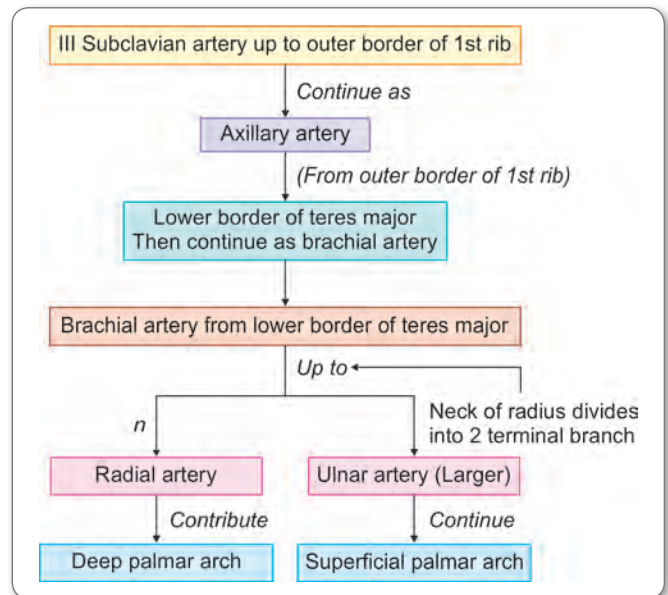
- Loss of flexion of elbow joint
- Loss of supination—biceps paralysis
- Loss of cutaneous sensation on lateral side of forearm.

REMEMBER

Cutaneous Innervations of Upper Limb

- Medial cutaneous nerve of arm → medial cord of brachial plexus
- Upper lateral cutaneous nerve of arm → axillary nerve
- Lower lateral cutaneous nerve of arm → radial nerve
- Posterior cutaneous nerve of arm → radial nerve
- Posterior cutaneous nerve of forearm → radial nerve
- Lateral cutaneous nerve of forearm → musculocutaneous nerve.

BLOOD VESSELS OF UPPER LIMB



AXILLARY ARTERY

- Continuation of third part of subclavian artery at the outer border of first rib and ends at the lower border of teres major and then continue as brachial artery
- Enclosed in axillary sheath along with axillary vein and brachial plexus



- Pectoralis minor muscle divide the axillary artery into three parts. First part proximal to the artery, second part behind and third part distal to the muscle.

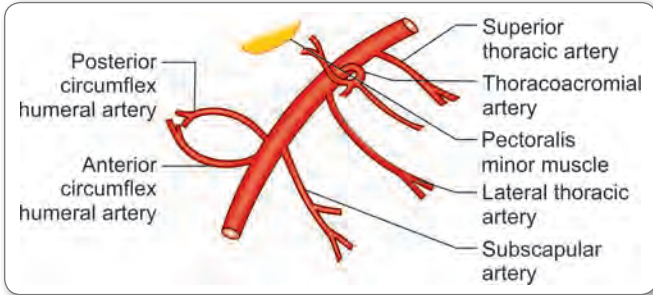


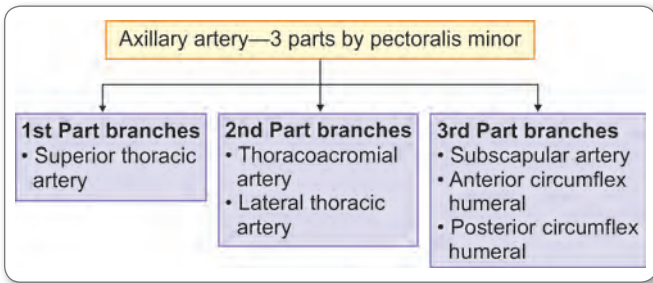
Fig. 41: Axillary artery

Relations of Second Part of Axillary Artery

- Medially: Medial cord of brachial plexus
- Laterally: Lateral cord of brachial plexus
- Posteriorly: Posterior cord of brachial plexus.

Relations of Third Part of Axillary Artery

- Medially: Axillary vein
Between axillary artery and vein, medial cutaneous nerve of forearm and ulnar nerve
Medial to axillary vein: Medial cutaneous nerve of arm
- Posteriorly: Axillary nerve and radial nerve
- Laterally: Musculocutaneous nerve and coracobrachialis.



Branches

Superior Thoracic Artery

Branches from 1st part. Supplies mammary gland, first two anterior intercostal spaces and adjacent muscles.

Thoracoacromial Artery

Branches from the second part. Pierces the clavipectoral fascia and divided into pectoral, clavicular, acromial and deltoid branches

Lateral Thoracic Artery

- Branch from the 2nd part. Supplies the pectoralis major, pectoralis minor, serratus anterior and axillary lymph nodes
- Gives rise to lateral mammary branches.

Subscapular Artery

- Largest branch of axillary artery. Descends along the axillary border of scapula and divides into thoracodorsal artery (supplies thoracodorsal nerve and latissimus dorsi and lateral thoracic wall) and circumflex scapular artery, which passes through lower triangular space and anastomose with branches of dorsal scapular artery and suprascapular artery
- Anterior circumflex humeral wind around the surgical neck of humerus and anastomose with posterior circumflex humeral artery
- Posterior circumflex humeral runs along with axillary nerve through quadrangular space and anastomose with anterior circumflex humeral artery and also to the ascending branch of the profunda brachii artery.



Clinical Aspect

Axillary artery is ligated between thyrocervical trunk and subscapular artery, blood reach the axillary artery distal to ligation through scapular anastomosis.

Scapular Anastomosis – collateral circulation

- Block at the outer border of first rib – collateral circulation established between thyrocervical trunk (suprascapular artery), dorsal scapular artery – branch of subclavian artery with subscapular artery, posterior circumflex humeral artery – branch of axillary artery
- Collateral anastomoses are observed around the scapula between branches of subclavian artery and axillary artery.
- Arteries participating in anastomosis
 - Suprascapular artery: Branch of first part of subclavian artery
 - Dorsal scapular artery: Branch from third part of subclavian artery
 - Subscapular artery and its branch circumflex scapular artery branch of axillary artery
 - Circumflex humeral artery branch of axillary artery
- Major anastomosis present over subscapular, suprascapular and infraspinous fossa. And the two channels are:
 - Subclavian artery – suprascapular artery – circumflex scapular artery – subscapular artery – axillary artery
 - Subclavian artery – dorsal scapular artery – subscapular artery – axillary artery
- Minor anastomosis around the acromion process
 - Suprascapular artery – branch of subclavian artery
 - Thoracoacromial artery and posterior circumflex humeral artery - branch of axillary artery.

BRACHIAL ARTERY

- Extends from inferior border of teres major to neck of radius where it bifurcates into radial and ulnar artery
- Brachial artery is medial to median nerve up to middle of the arm and after that median nerve crosses brachial artery and median nerve becomes medial to the artery
- In the cubital fossa, situated lateral to median nerve
- And at the level of neck of radius, brachial artery divides into ulnar and radial artery.

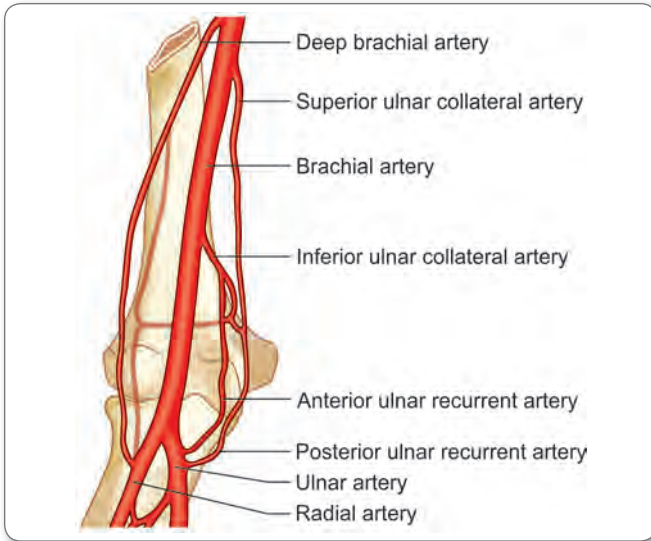


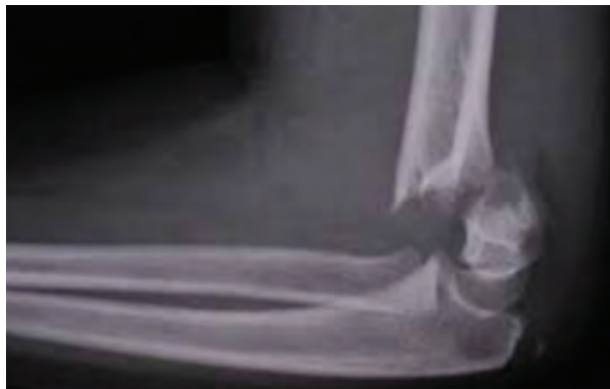
Fig. 42: Course of brachial artery

Branches

- Profunda brachii
 - Descends along with radial nerve through lower triangular space and enters the spiral groove and gives ascending branch which is anastomose with descending branch of posterior circumflex humeral artery
 - Divides into middle collateral (anastomose with interosseous recurrent artery) and radial collateral (anastomose with radial recurrent artery of the radial artery)
- Muscular branch
- Nutrient branch to humerus
- Ascending or deltoid branch
- Nutrient branch to humerus
- Superior ulnar collateral— anastomose with posterior ulnar recurrent branch of ulnar artery
- Inferior ulnar collateral— anastomose with posterior ulnar recurrent branch of ulnar artery.

Clinical Aspect

- Posterior circumflex humeral artery anastomoses with ascending branch of profunda humeral artery. By this anastomosis, blood reaches the profunda humeral artery when brachial artery is ligated at its origin.
- In the supracondylar fracture of humerus – distal condylar fragment displaced in anterior direction leads to tear of brachial artery. It is then leads to Volkmann ischemic contracture -



- Volkmann's ischemic contracture – permanent flexion contracture of the hand at wrist and claw like deformity of fingers.



Volkmann ischaemic contracture

RADIAL ARTERY

- Branch of brachial artery and descends laterally under the cover of brachioradialis muscle and it lies on supinator and flexor pollicis longus
- Winds around the tendons of abductor pollicis longus and extensor pollicis brevis over the surface of scaphoid and trapezium bone
- Runs through anatomical snuff box and enters the palm by passing between two heads of first dorsal interosseous and divides into princeps pollicis artery and deep palmar arch.

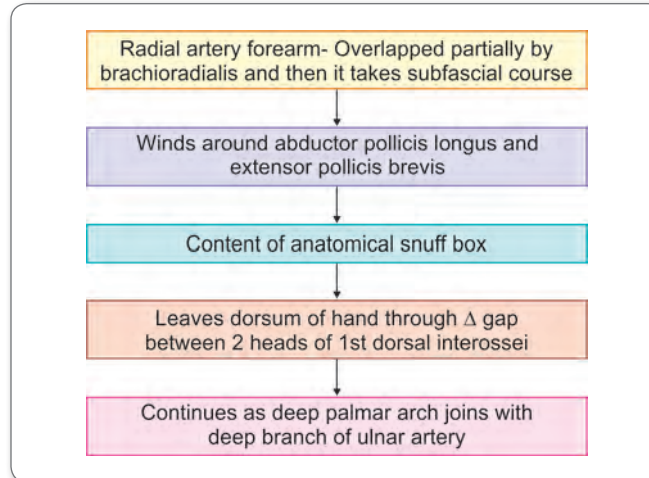


Fig. 43: Course of radial artery

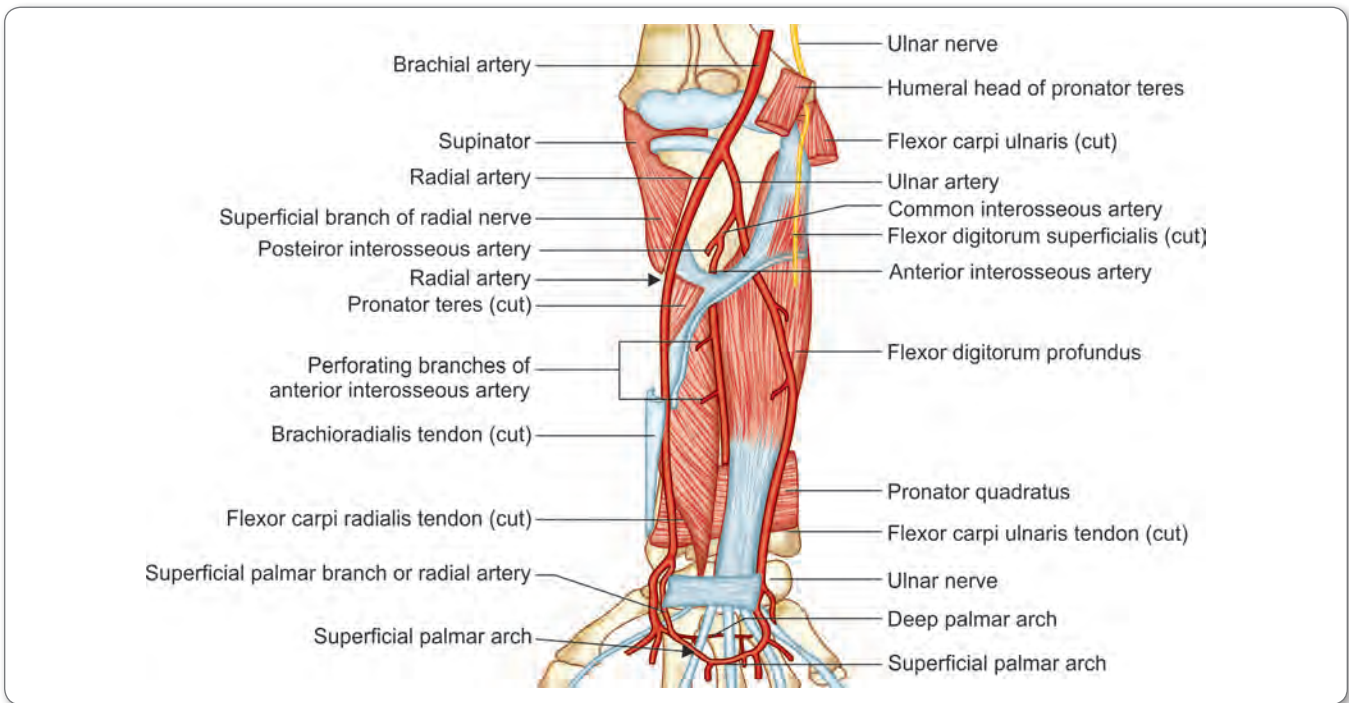


Fig. 44: Radial artery and its branches

Branches

- Radial recurrent artery takes part in anastomosis around elbow joint
- Muscular branches
- Palmar carpal branch—forms carpal anastomosis
- Dorsal carpal branch—forms carpal anastomosis
- Superficial palmar branch—joins with ulnar artery and complete the superficial palmar arch
- First dorsal metacarpal branch
- Arteria princeps pollicis—supplies thumb
- Arteria radialis indicis—supplies index finger.

ULNAR ARTERY

- Largest branch of brachial artery
- It lies behind the ulnar head of pronator teres and lies between flexor digitorum superficialis and flexor digitorum profundus in lower 2/3 of forearm, ulnar artery in subfascial course
- Enters the hand superficial to flexor retinaculum and then continue as superficial palmar arch
- Also gives deep palmar branch which anastomoses with deep palmar arch of radial artery.



Branches

- Anterior ulnar recurrent artery takes part in anastomosis around elbow joint
- Posterior ulnar recurrent artery takes part in anastomosis around elbow joint
- Common interosseous artery
 - Anterior interosseous: **Pierces the interosseous membrane** and forms the carpal arch and gives median artery, which supplies median nerve
 - Posterior interosseous gives **interosseous recurrent artery**
- Palmar carpal branch forms carpal anastomosis
- Dorsal carpal branch forms carpal anastomosis
- Muscular branch

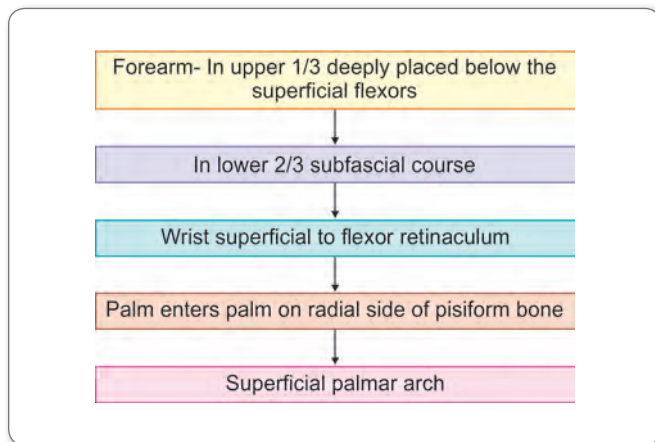


Fig. 45: Course of ulnar artery

Anastomosis Around Elbow Joint

- In front of medial epicondyle—inferior ulnar collateral and branch from superior ulnar collateral artery (both are branch from brachial artery) anastomosis with anterior ulnar recurrent artery from ulnar artery
- Behind medial epicondyle—superior ulnar collateral and branch from inferior ulnar collateral artery (both are branches from brachial artery) anastomosis with posterior ulnar recurrent branch of ulnar artery
- In front of lateral epicondyle—the radial collateral (branch of profunda brachii) anastomosis with radial recurrent branch of radial artery
- Behind the lateral epicondyle—posterior descending branch of profunda brachii anastomose with interosseous recurrent artery from posterior interosseous branch of ulnar artery
- Above the olecranon fossa—middle collateral branch of profunda brachii anastomose with transverse branch from inferior collateral artery.

Superficial and Deep Palmar Arch

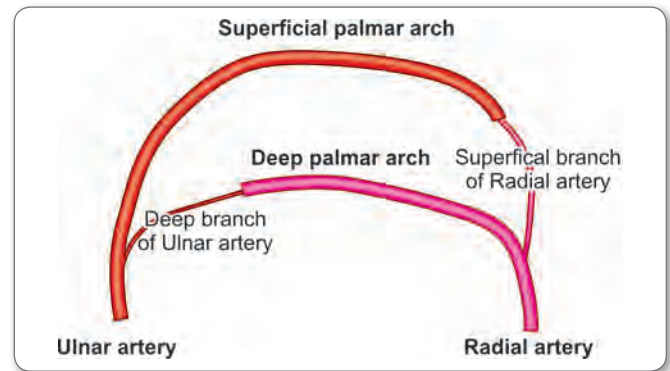


Fig. 46: Superficial and deep palmar arch

Table 17: Superficial and deep palmar arch

Superficial palmar arch	Deep palmar arch
Continuation of ulnar artery	Continuation of radial artery
Completed on lateral side by superficial palmar branch of radial artery, arteria princeps policis, arteria radialis indicis or median artery	Completed by deep branch of ulnar artery
Distally placed	Proximal
Located superficial to long flexor tendons	Located deep to long flexors
Branches : 1 proper and 3 common palmar digital branches. (supply the medial 3 and half fingers)	3 palmar metacarpal arteries and 3 perforating arteries are the branches

Clinical Aspect

Allen Test

- Test to detect the occlusion of ulnar or radial artery
- Instruct the patient to clench his fist, if the patient is unable to do this, close the person's hand tightly
- Using your fingers apply occlusive pressure to both the ulnar and radial arteries to obstruct blood flow to the hand
- While applying occlusive pressure to both arteries, have the patient relax his or her hand and check whether the palm and fingers have blanched. If this is not the case, you have not completely occluded the arteries with your fingers.
- Release the occlusive pressure on the ulnar artery only to determine whether the allen's test is positive or negative
- **Positive Allen test:** If the hand flushes within 5–15 seconds, it indicates that the ulnar artery has good blood flow. This normal flushing of the hand is considered to be positive test.
- **Negative Allen test:** If the hand does not flush within 5–15 seconds, it indicates that ulnar circulation is inadequate or nonexistent in this situation the radial artery supplying arterial blood to that hand should not be punctured.

Note:

- Allen test: Checking the patency of ulnar artery
- Reverse Allen test: Checking the patency of radial artery.



VENOUS DRAINAGE OF UPPER LIMB

Superficial Veins in the Upper Limb

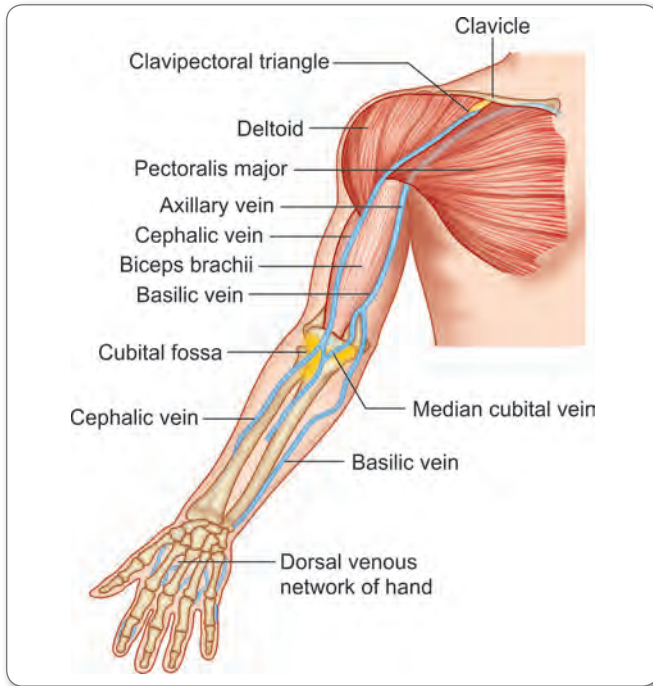


Fig. 47: Superficial veins of the upper limb

Dorsal venous network—network of veins which is formed by dorsal metacarpal veins that receive the dorsal digital veins and continue as cephalic vein and basilic vein.

Cephalic Vein

- Begins from lateral side of dorsal venous network
- Runs on lateral side
- Connected to basilic vein by median cubital vein which forms the roof of cubital fossa
- Pierce the brachial fascia and lies in the **deltopectoral groove** along with deltoid branch of thoracoacromial artery
- Then it **pierce the clavipectoral fascia** and end in axillary vein.

Note

Cephalic vein:

- Present in deltopectoral groove
- Pierce clavipectoral fascia.

Basilic Vein

- Begins from medial side of dorsal venous network
- Ascends along the ulnar border
- Passes anterior to medial epicondyle
- Pierce deep fascia of arm continue as axillary vein at the lower border of teres major.

Clinical Aspect

- **Applied**
- **Basilic vein preferred for cardiac catheterization**

Median Cubital Vein

- Vein connecting cephalic and basilic vein
- Lies superficial to bicipital aponeurosis and separate it from brachial artery
- Most commonly preferred vein for intravenous injection.

Deep Veins of Arm and Forearm

Follow the course of the arteries, accompanying them as their venae comitantes.

Axillary Vein

- Formed by basilic vein and ascends along the medial side of the axillary artery
- Continue as subclavian vein at the inferior margin of first rib
- Receives thoracoepigastric vein and provide collateral circulation, if IVC becomes obstructed
- Tributaries – cephalic vein, brachial veins (venae comitantes of brachial artery) and veins that correspond to the branches of axillary artery.

Table 18: Tributaries of axillary vein

Cephalic vein	Basilic vein
• Preaxial vein of upper limb	• Postaxial vein of upper limb
• Begins from lateral side of dorsal venous network	• Begins from medial side of dorsal venous network
• Drains into axillary vein	• Continue as axillary vein

BREAST AND MAMMARY GLANDS

BREAST

- Contains mammary glands in superficial fascia
- Extends Vertically—from 2nd to 6th rib in midclavicular line
- Horizontally—from lateral border of sternum to midaxillary line along the 4th rib
- Suspensory ligament of Cooper – which anchor the parenchyma to overlying skin and underlying pectoral fascia
- Growth of malignant cells extend along the ligament and produce dimples
- Nipple—at the level of 4th intercostals space in nulliparous woman and pierced by 15–20 lactiferous ducts
- Areola – ring of pigmented skin around the nipple.

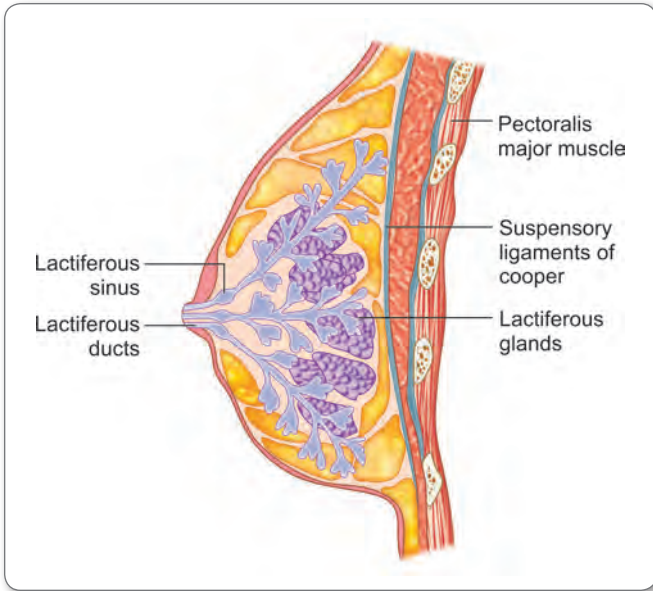


Fig. 48: Mammary structure of breast

REMEMBER

Structures forming mammary bed

- Pectoralis major in medial two-thirds
- Serratus anterior in lateral one-thirds
- External oblique aponeurosis in inferomedial quadrant.

MAMMARY GLAND

- Modified sweat gland
- Axillary tail of spence—tail like prolongation from upper and outer quadrant enters axilla through axillary tail of spence
- Retromammary space—consists of loose connective tissue intervenes between the base of gland and deep fascia covering mammary bed
- Has 15–20 lobes of glandular tissue, separated by fibrous septa that radiate from nipple
- Each lobe opens by lactiferous duct and each duct enlarges to form lactiferous sinus.

Blood Supply

Arterial Supply

- Except anterior and posterior circumflex humeral arteries, other branches of axillary artery supply the gland
- Perforating branch of internal thoracic (mammary) artery
- Posterior intercostals arteries.

Venous Drainage

Veins form circulus venosus and drain into axillary vein, internal thoracic vein and intercostals vein.

Nerve Supply

Anterior and lateral cutaneous branch from 4th to 6th intercostals nerve.

Lymphatic Drainage

- Superficial lymphatics draining the skin excluding nipple and areola
 - From outer part drain into axillary node
 - From upper part drain into supraclavicular nodes
 - From the lower part drain into subdiaphragmatic nodes and then to hepatic nodes
- Lymphatics draining the parenchyma including nipple and areola
 - 75% from gland drain into axillary node
 - 20% drain into parasternal node
 - 5% drain into posterior intercostal node.

Clinical Aspect

- **Mammography:** Radiological examination to screen the breast for tumors
- **Malignant tumor:**
 - Forms the palpable mass in advanced stages
 - Spread to cooper ligaments causing dimpling of skin
 - Peaud orange – pitted breast skin due to **obstruction of subcuticular lymphatics**
 - Cancer may also reach lactiferous duct cause retracted nipple
- **Radical mastectomy:** Extensive surgical removal of the breast and related structures like pectoralis major, minor, axillary lymph nodes. It may injure the long thoracic nerve and produce postoperative swelling of upper limb due to lymphatic obstruction
- **Modified radical mastectomy:** Removal of breast and axillary lymph nodes with preservation of pectoralis major and minor Pectoral group of axillary lymph nodes are 1st to be involved in most cases of CA breast. Upper and outer quadrant of breast is most commonly involved in CA breast.

AXILLA

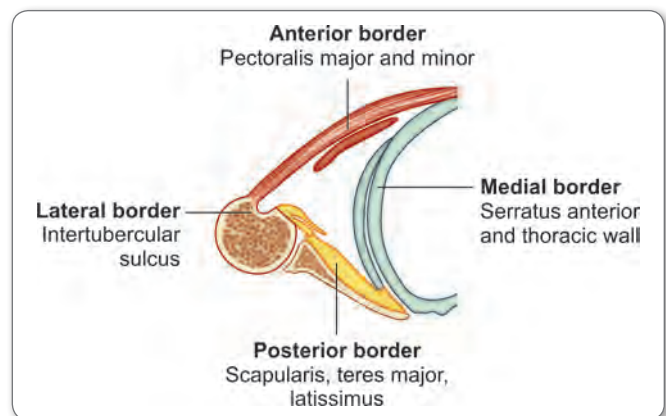


Fig. 49: Borders of axilla



- Pyramid shape between upper part of arm and lateral thoracic wall
- Apex—cervicoaxillary canal—triangular in shape, in front by clavicle, behind by—superior border of scapula, medially by—outer border of first rib. Axillary vessels, brachial plexus and long thoracic nerve pass through the apex
- Base—directed downwards and formed by skin, superficial fascia and axillary fascia
- Anterior wall—pectoralis major, pectoralis minor, subclavius and clavipectoral fascia
- Posterior wall—subscapularis, latissimus dorsi and teres major
- Medial wall—upper 4 to 5 ribs, serratus anterior and long thoracic nerve
- Lateral wall—intertubercular sulcus containing long head of biceps tendon, assisted by short head of biceps and coracobrachialis.

CONTENTS

- Axillary artery and branches
- Axillary vein and tributaries
- Cords of brachial plexus, long thoracic nerve and intercosto-brachii nerve
- Axillary lymph nodes
- Axillary tail of Spence and pad of fat.

FASCIAE OF THE AXILLA AND PECTORAL REGIONS

Clavipectoral Fascia

- Strong sheet of fascia between clavicle and pectoralis minor
 - Its components are costocoracoid ligament (thickening of fascia between coracoid process and first rib), costocoracoid membrane (lies between subclavius and pectoralis minor) and suspensory ligament of axilla – gerdy's ligament (inferior extension of fascia and attached to axillary fascia)
- Above—fascia splits to enclose subclavius and blends with axillary sheath

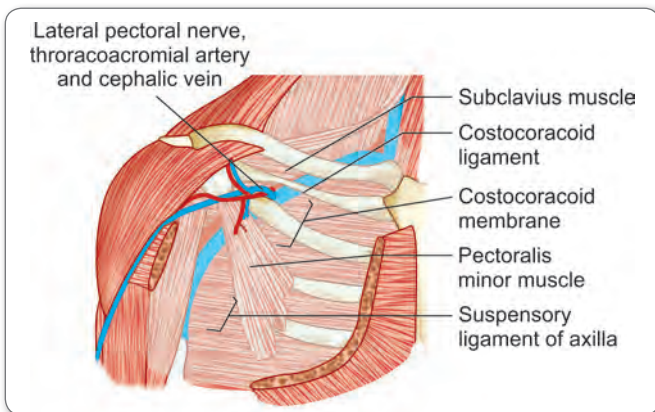


Fig. 50: Components of clavipectoral fascia

- Below—splits and enclose pectoralis minor and continue as suspensory ligament of axilla fuse with axillary fascia
- Medially—fuses with anterior intercostal membrane of upper two spaces
- Laterally—attached to coracoid process.

Mnemonic

Structures piercing clavipectoral fascia (Mn-TLC)

- Cephalic vein
- Lateral pectoral nerve
- Thoracoacromial vessels

Note

- Muscles enclosed by clavipectoral fascia – subclavius and pectoralis minor
- Ligaments derived – costocoracoid ligament, suspensory ligament of axilla (gerdy's ligament)

Axillary Fascia

Deep fascia of axilla. Continuous anteriorly with pectoral fascia and suspensory ligament of axilla (axillary fascia), laterally with brachial fascia.

AXILLARY SHEATH

Prevertebral layer of deep cervical fascia prolong into axilla and enclosing axillary artery and brachial plexus.

Note

Axillary vein lies outside the axillary sheath.

AXILLARY NODES

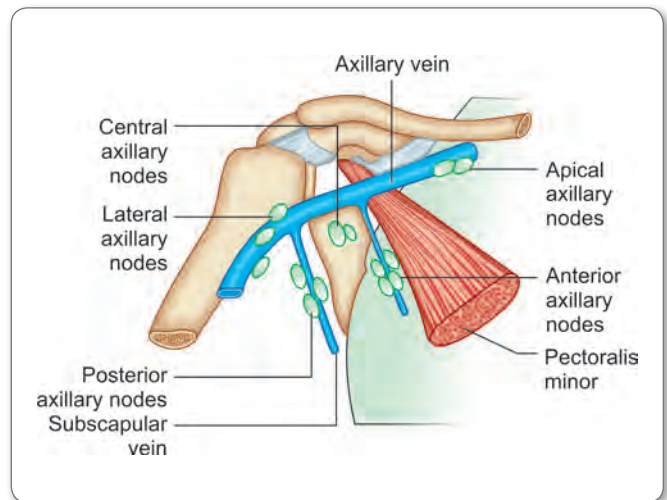


Fig. 51: Axillary nodes



Table 19: Various groups of axillary nodes

	Anterior or pectoral group	Posterior or subscapular group	Lateral group	Central group	Apical group
Location	Along lateral thoracic vein	Along subscapular vessels	Lateral wall posteromedial to axillary vein	Close to base of axilla	Apex of axilla medial to axillary vein
Afferent	Most of the breast	From dorsal part of trunk	From entire upper limb except lymphatics accompany cephalic vein	From anterior, posterior and lateral group	From central group, lymphatics accompanying the cephalic group, upper margin of mammary gland
Efferent	To central group	To central group	To central group	To apical group	Form subclavian trunk

HIGH YIELD POINTS

Subclavian Trunk

- Mostly drain at the junction of subclavian vein and internal jugular vein
- Sometimes joins with right lymphatic duct on right side or thoracic duct on left side.

- Apex—apex of scapula where teres major and minor muscles converge
- Contents—circumflex scapular vessels, branches of subscapular vessels.

TRIANGLES AND SPACES IN UPPER LIMB

QUADRANGULAR SPACE

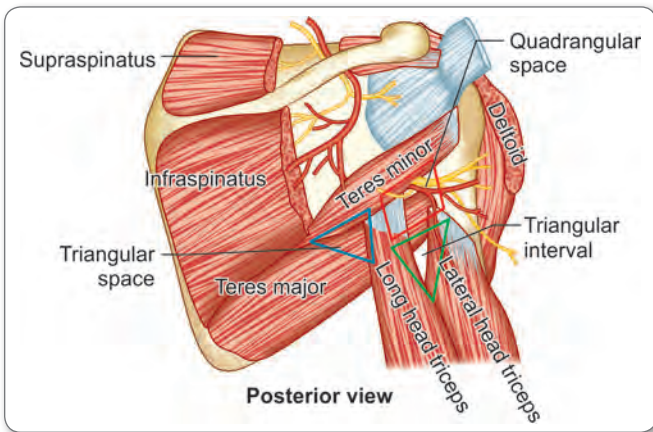


Fig. 52: Quadrangular and triangular space

- Above—subscapularis, lower part of capsule of shoulder joint, teres minor
- Below—teres major
- Medially—long head of triceps
- Laterally—surgical neck of humerus
- Contents—axillary nerve, posterior circumflex humeral vessels.

UPPER TRIANGULAR SPACE

- Above—teres minor
- Below—teres major
- Laterally—long head of triceps

LOWER TRIANGULAR SPACE

- Above—teres major
- Medially—long head of triceps
- Laterally—shaft of humerus
- Contents—radial nerve, profunda brachii vessels.

TRIANGLE OF AUSCULTATION

Small triangle on the back near the inferior angle of scapula.

Boundaries

- Medially—lateral border of trapezius
- Laterally—vertebral border of scapula
- Inferiorly—upper fibers of latissimus dorsi
- Floor—7th rib, 6th and 7th intercostal space and rhomboideus major
- Respiratory sounds can be clearly heard and cardiac orifice lies deep to this triangle.

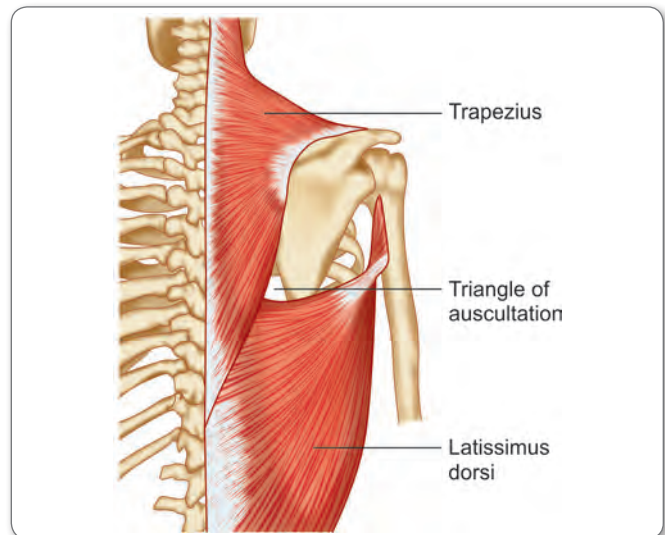


Fig. 53: Triangle of auscultation



LUMBAR TRIANGLE OF PETIT

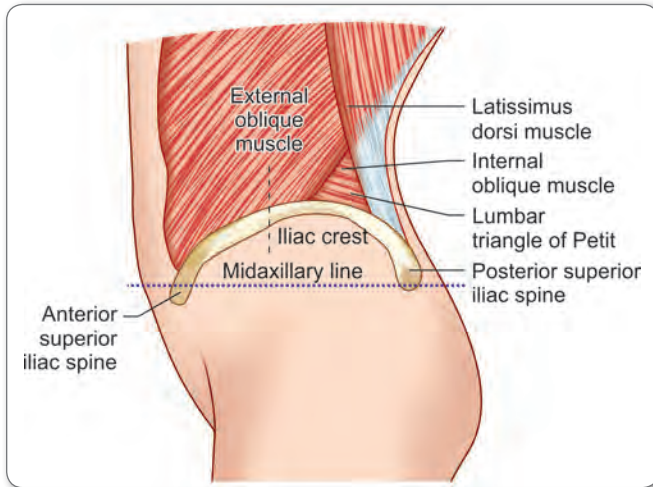


Fig. 54: Lumbar triangle of petit

- Lateral—posterior free border of external oblique
- Medial—anterior border of latissimus dorsi
- Base—iliac crest
- Floor—internal oblique
- Triangle act as site of hernia sometimes.

Note

Lattismus dorsi muscle form the boundary to both lumbar triangle and triangle of auscultation.

CUBITAL FOSSA

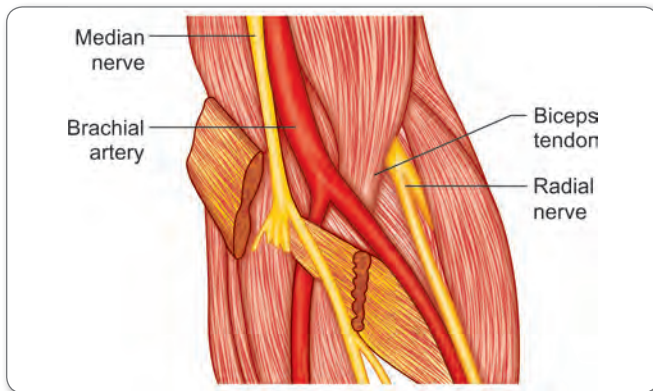


Fig. 55: Cubital fossa

- Triangular space in front of elbow.

Boundaries

- Medially—lateral border of pronator teres
- Laterally—medial border of brachioradialis
- Base—imaginary line connecting the epicondyle of humerus
- Apex—meeting of those two muscles

- Contents from medial to lateral —median nerve, brachial artery, tendon of biceps and superficial branch of radial nerve.
- Floor—brachialis in the upper and medial part, supinator in the lower and lateral part
- Roof—deep fascia of forearm, which is reinforced by **bicipital aponeurosis**. Superficial to that lies median cubital vein, medial and lateral cutaneous nerve of the forearm.

SPACE OF PARONA

- Fascia lined potential space deep to long flexor tendons of the forearm
- In front—flexor digitorum profundus and flexor pollicis longus
- Behind—pronator quadratus and interosseous membrane
- Above—oblique origin of flexor digitorum superficialis
- On each side—the space is limited by outer and inner borders of forearm.

ANATOMICAL SNUFF BOX

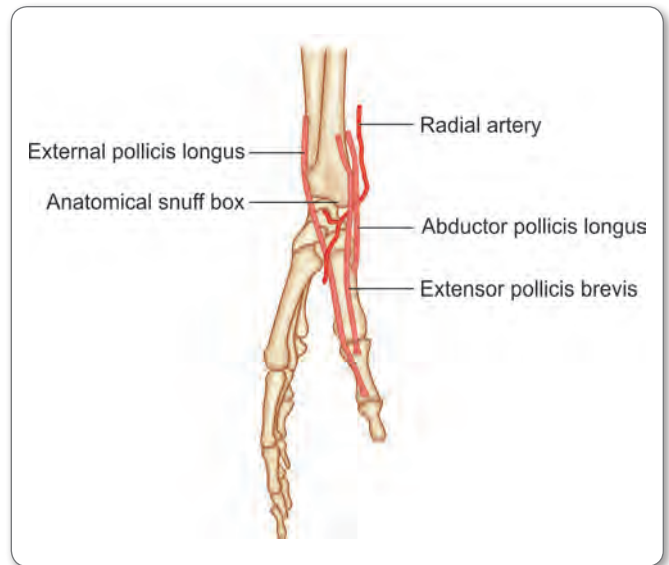


Fig. 56: Anatomical snuff box

Triangular depression on the radial side of the wrist and becomes visible when the thumb is hyperextended.

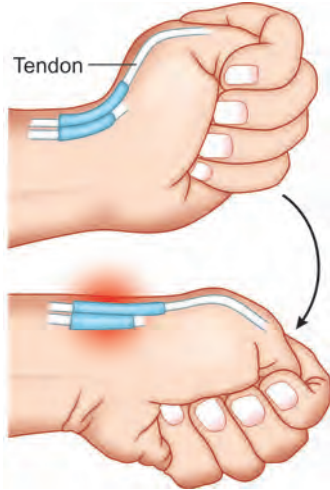
Boundaries

- Laterally (anterior)—abductor pollicis longus, extensor pollicis brevis
- Medially (posterior)—extensor pollicis longus
- Roof—skin, superficial fascia, cephalic vein, superficial branch of radial nerve
- Floor—styloid process of radius, scaphoid, trapezium, first metacarpal bone
- Content—radial artery.



Clinical Aspect

- Dequervain synovitis – inflammation of abductor pollicis longus and extensor pollicis brevis: Finkelstein test positive.
- Finkelstein test – ask the patient to make fist and to give ulnar deviation. Pain in the radius styloid process – test is positive



PALMAR SPACES

Palmar spaces are thenar space (lateral) and mid palmar (medial) space. These spaces are situated deep to palmar aponeurosis.

- Thenar space contains flexor tendons of thumb and index finger
- Mid palmar space contains flexor tendons of medial three finger
- First lumbrical space communicates with thenar space. So infection from thumb and index finger spread to thenar space through first lumbrical canal
- 2nd, 3rd, 4th lumbrical space communicates with midpalmar space. So infection from middle, ring and little finger spread to mid palmar space through 2nd 3rd 4th lumbrical canal.

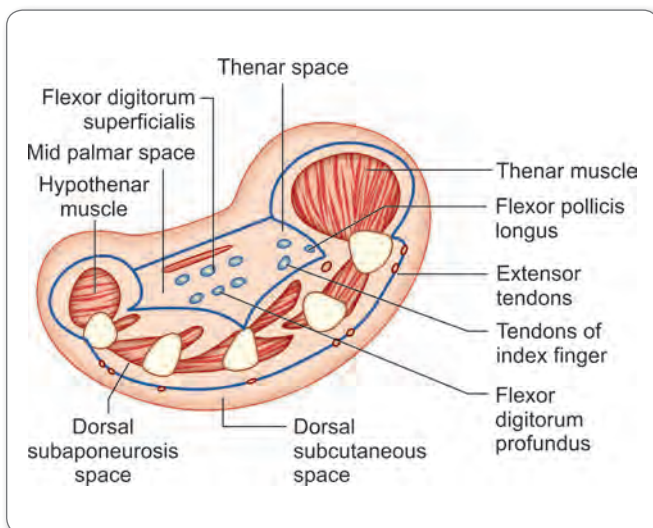


Fig. 57: Palmar space

Table 20: Boundaries of mid palmar and thenar spaces

Boundaries	Mid palmar space	Thenar space
Anteriorly	Flexor tendons of little, ring and middle finger 3 rd and 4 th lumbricals	Flexor tendons of thumb, index finger 1 st and 2 nd lumbricals
Posteriorly	Fascia over interossei and metacarpals	Adductor pollicis transverse head
Laterally	Intermediate palmar septum	Lateral palmar septum and Tendon of flexor pollicis longus
Medially	Medial palmar septum	Intermediate palmar septum
Drainage	Via Incision in 3 rd and 4 th web space	Incision in the first web space

Pulp Space

Space between palmar skin and distal phalanges of all digits of hand.

MISCELLANEOUS TOPICS

EXTENSOR RETINACULUM

- Thickening of deep fascia of forearm
- Attached to radius (laterally) and pisiform, triquetral (medially) and **not attached to ulna**
- Six compartments

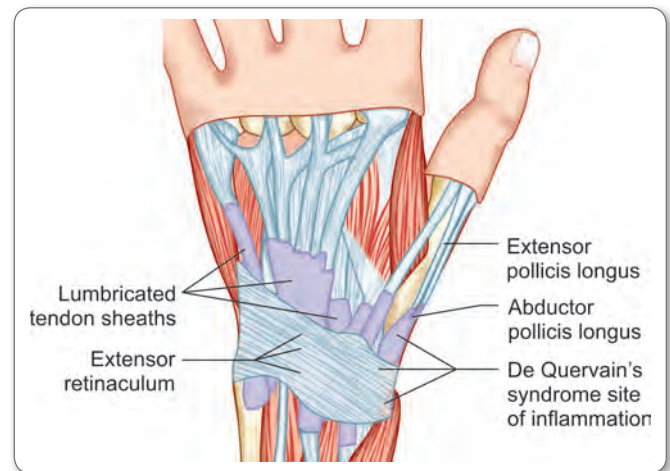


Fig. 58: Extensor retinaculum

- 1st compartment—abductor pollicis longus, extensor pollicis brevis
- 2nd compartment—extensor carpi radialis longus and brevis
- 3rd compartment—extensor pollicis longus
- 4th compartment—extensor digitorum, extensor indices, posterior interosseous nerve and anterior interosseous artery
- 5th compartment—extensor digiti minimi
- 6th compartment—extensor carpi ulnaris.



Clinical Aspect

Dequervain Synovitis: Tenosynovitis at first extensor compartment muscles – Abductor pollicis longus and extensor pollicis involved.



de Quervain's

Intersection syndrome

- Intersection syndrome – Cross over syndrome
- Crossing of 1st and 2nd compartment tendons takes place 4-6 cm proximal to wrist
- Friction between intersecting tendons result in tenosynovitis of ECRB and ECRP.

FLEXOR RETINACULUM

Osteofascial tunnel situated on the anterior surface of the wrist.

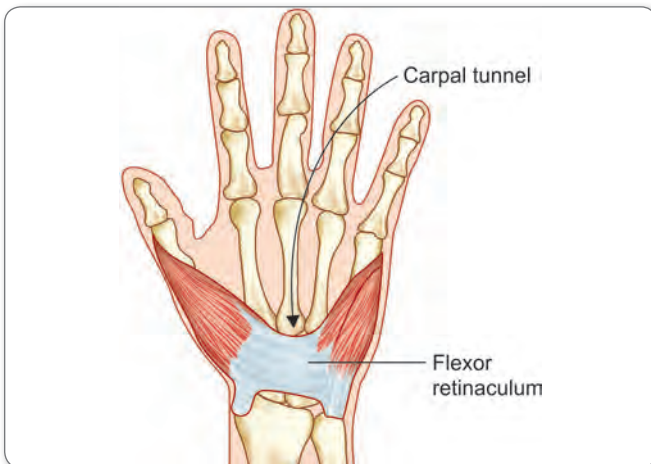


Fig. 59: Flexor retinaculum

Attachments

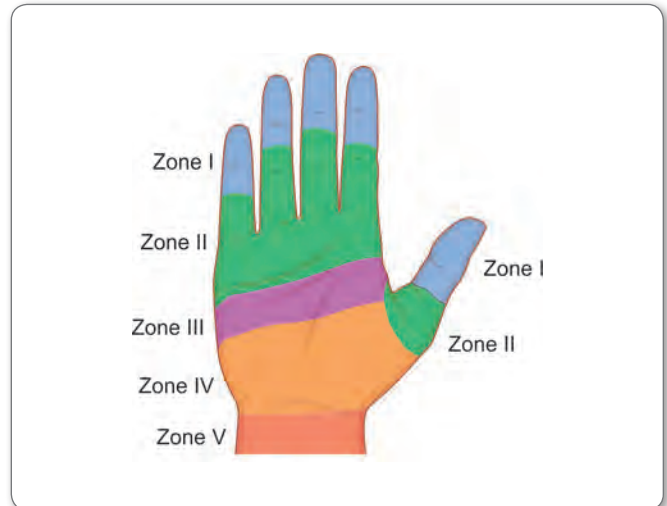
- Medially—pisiform bone and hook of hamate
- Laterally—tubercle of scaphoid and crest of trapezium
- Structures passing deep to retinaculum
 - Median nerve
 - Tendons of flexor digitorum superficialis and profundus enclosed in ulnar bursa
 - Tendon of flexor pollicis longus enclosed in radial bursa

- Structures superficial to retinaculum
 - Palmaris longus tendon
 - Palmar cutaneous branch of median nerve
 - Palmar cutaneous branch of ulnar nerve
 - Superficial palmar branch of radial artery
 - Ulnar nerve and vessels.

HIGH YIELD POINTS

Flexor carpi radialis lies between superficial and deep slip of retinaculum.

Zones of Flexor Tendons of Hand



- **Zone I:** Distal to flexor digitorum superficialis insertion
- **Zone II:** No man's land – between distal palmar crease and insertion of FDS muscle tendon repair is difficult in this region. So it has been called as no man's land.
- **Zone III:** Area of lumbrical muscle
- **Zone IV:** Carpal tunnel
- **Zone V:** Proximal to carpal tunnel.



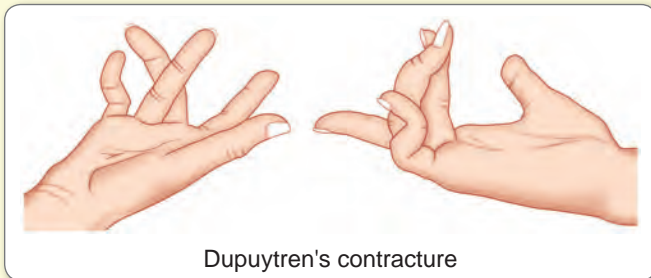
Clinical Aspect

- **Gamekeeper's thumb** is chronic pattern of injury, which leads to loosening of ulnar collateral ligament over a period of time.
- **Skier's thumb** is acute injury to ulnar collateral ligament.
- **Trigger thumb (or Trigger finger)** is locking of thumb/digits in flexion due to constriction of A1 pulley at metacarpophalangeal joint. There is flexor tenosynovitis of proximal interphalangeal joints.
- **Baseball or Drop finger/Mallet finger** is avulsion injury at terminal phalanx due to sudden pull at insertion of extensor tendon resulting in hyperextension at proximal interphalangeal and hyperflexion at distal interphalangeal joints.
- **De Quervain's tenovaginitis** is inflammation of abductor pollicis longus and extensor pollicis brevis tendons.



Chapter at a Glance

- Nerves related to humerus: Axillary nerve (around the neck), radial nerve in the spiral groove and ulnar nerve behind the medial epicondyle.
- Tennis elbow: Lateral epicondylitis
- Golfer's elbow: Medial epicondylitis
- Student's elbow: Olecranon bursitis
- Pulled elbow: Subluxation of radial head
- Colles fracture: Fracture of radius 2 cm above lower end
- Boxer's fracture: Fracture of neck of 5th metacarpal
- Rolando fracture: Fracture of base of 1st metacarpal bone
- Martin-Gruber connections are median and ulnar nerve
- Anterior interosseous nerve is a branch of median nerve
- Pointing finger injury is due to injury of which nerve: median nerve
- Claw hand is due to: median nerve and ulnar nerve
- Ape thumb deformity is seen in median nerve injury
- Nerves forming pseudoganglion: Axillary nerve, Lateral branch of deep peroneal nerve and Posterior interosseous nerve.
- Thickening of palmar aponeurosis – Dupuytren's contracture is a state in which the hand and fingers get affected. This condition forces the fingers to bend inside in the direction of the palm.



- Only rotator cuff muscle not lateral rotator of humerus – supra spinatus
- Bicipital aponeurosis and median cubital vein – roof of cubital fossa
- Cephalic vein – present in deltopectoral groove
- Anterior interosseous artery pierce the interosseous membrane.

Nutrient Artery

Bone	Nutrient artery
Clavicle	Suprascapular artery
Humerus	Profunda brachial artery
Radius and ulna	Anterior interosseous artery

Nerves Involved in

Injury in relation to	Nerve involved
Surgical neck of humerus	Axillary nerve
Inferior dislocation of shoulder	Axillary nerve, radial nerve
Spiral groove fracture	Radial nerve
Medial epicondyle – humerus	Ulnar nerve
Supracondylar fracture	Anterior interosseous nerve > Median nerve
Radius neck fracture	Posterior interosseous nerve
Hook of hamate	Ulnar nerve
Lunate dislocation	Median nerve
Wrist slash injury	Median nerve

Muscles and the Nerves Related

Between two heads of Pronator teres	Median nerve
Between two heads of Flexor carpi ulnaris	Ulnar nerve
Structure piercing supinator muscle	Posterior interosseous nerve, a branch of median nerve
Structure piercing coracobrachialis	Musculocutaneous nerve

List of other Nerves and the Muscles Supplied by it

Long thoracic nerve	Serratus anterior
Medial pectoral nerve	Pectoralis major and minor
Lateral pectoral nerve	Pectoralis major and minor
Upper subscapular nerve	Subscapularis
Lower subscapular nerve	Subscapularis and Teres major
Thoracodorsal nerve	Latissimus dorsi
Suprascapular nerve	Supraspinatus and Infraspinatus
Dorsal scapular nerve	Rhomboideus major and rhomboideus minor
Ventral rami of C3,C4	Levator scapulae

- Allen's test: The Allen's test is performed by having the patient clench their fist several times while the operator occludes the radial and ulnar artery at the wrist. The patient then extends their fingers, palm up, which should show a "blanched" hand. The operator then releases the pressure on the **ulnar artery** and the hand is observed for "blushing". If the color of the hand does not return in 5–10 seconds, the Allen test is considered positive
- Reverse Allen's test: To check the patency of **radial** artery.




Multiple Choice Questions

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UPPER LIMB

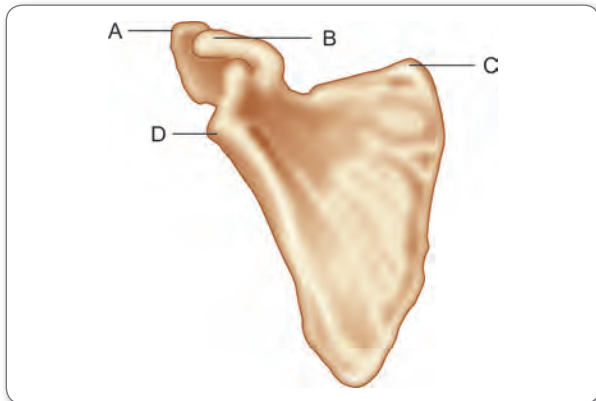
New SARP Series Anatomy

Bones of Upper Limb

1. **False about clavicle:** (DNB Dec. 2012)
 - a. Ossifies into membrane
 - b. Horizontal bone
 - c. No medullary cavity
 - d. Most common site of fracture is the junction of medial 1/3 and lateral 2/3
2. **Muscle attached to coracoids process:**
 - a. Pectoralis major
 - b. Long head of triceps
 - c. Medial head of triceps
 - d. Short head of biceps
3. **Superior angle of scapula lies at which level:** (Recent Question 2015)
 - a. T7
 - b. T12
 - c. T2
 - d. C5
4. **Which of the following is false about scapula?** (Recent Question 2015)
 - a. Root of spine is at T3
 - b. Inferior angle is at T7
 - c. Medial border indicates horizontal fissure
 - d. Lateral angle bears glenoid cavity
5. **Long head of biceps attached to:** (AI 2007)
 - a. Coracoids process
 - b. Supraglenoid tubercle
 - c. Acromion process
 - d. Bicipital groove
6. **Content of bicipital groove is/are** (PGI May 2015)
 - a. Synovial membrane of shoulder joint
 - b. Ascending branch of anterior circumflex artery
 - c. Ascending branch of posterior circumflex artery
 - d. Radial artery
 - e. Coracobrachialis
7. **Which of the following is not intracapsular?** (Recent Question 2015)
 - a. Coronoid fossa
 - b. Radial fossa
 - c. Olecranon fossa
 - d. Lateral epicondyle
8. **Which nerve is not related to humerus?** (Recent Question 2015)
 - a. Axillary
 - b. Radial
 - c. Ulnar
 - d. Musculocutaneous
9. **About radial bone true is:** (AI 2012)
 - a. Radial groove present
 - b. Major contributions to wrist joint
 - c. Radial artery lies medial to styloid process of radius
 - d. Medial bone of forearm
10. **Interosseous membrane between radius and ulna is pierced by which structure:**
 - a. Posterior interosseous nerve
 - b. Posterior interosseous artery
 - c. Anterior interosseous nerve
 - d. Anterior interosseous artery
11. **True about blood supply of scaphoid:** (Recent Question 2015)
 - a. Mainly through ulnar artery
 - b. Major supply from ventral surface
 - c. Major supply from dorsal surface
 - d. Proximal supply in antegrade fashion
12. **Which is the largest carpal bone?** (Recent Question 2014)
 - a. Trapezoid
 - b. Scaphoid
 - c. Lunate
 - d. Capitates
13. **Most commonly fractured carpal bone**
 - a. Hamate
 - b. Lunate
 - c. Scaphoid
 - d. Capitates
14. **Articulation of pisiform bone is with:** (Recent Question 2015)
 - a. Triquetral
 - b. Lunate
 - c. Scaphoid
 - d. Trapezoid
15. **Pressure on hook of hamate when hand is hyperextended will damage:** (Recent Question 2015)
 - a. Ulnar nerve
 - b. Superficial branch of ulnar nerve
 - c. Median nerve
 - d. Musculocutaneous nerve
16. **Which of the following has a single ossification center only?**
 - a. Clavicle
 - b. Carpals
 - c. Metacarpals
 - d. Metatarsals
17. **Ossification center for lunate appears at:** (Recent Question 2013)
 - a. Birth
 - b. 2nd year
 - c. 4th year
 - d. 6th year
18. **False about 1st metacarpal:** (AI 2012)
 - a. Shortest and stoutest of all metacarpals
 - b. Does not articulate with any other metacarpal
 - c. Rotate medially through 90 degree with respect to other metacarpal
 - d. Base is formed by condylar articular surface for scaphoid
19. **20 year old male sustained fracture as shown in x ray. Most commonly affected nerve is**

 - a. Ulnar
 - b. Median
 - c. Radial
 - d. Musculocutaneous nerve



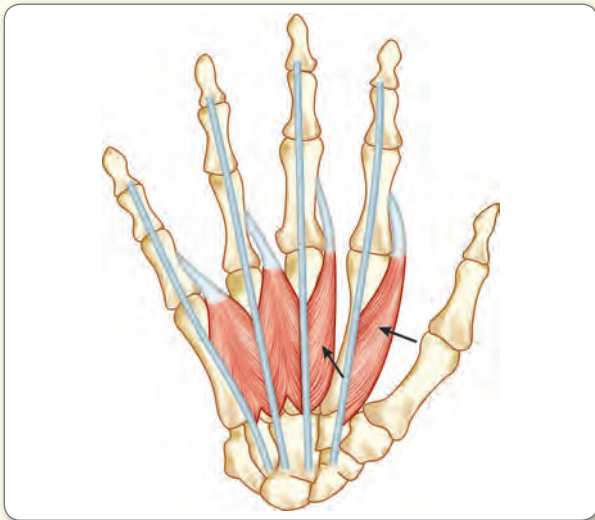
20. Which of the following structures is palpable in the infraclavicular fossa: (AIIMS 2017)



- a. A
b. B
c. C
d. D

Muscles of Upper Limb

21. Action of the given muscle (Recent Question 2018)



- a. Flexion of MCP joint
b. Extension of MCP joint
c. Flexion of IP joint
d. Abduction of MCP joint

22. 'Dropped shoulder' occurs due to paralysis of:

(Recent Question 2014)

- a. Teres minor
b. Deltoid
c. Teres major
d. Trapezius

23. Trapezius is attached to all structures, except: (AI 2000)

- a. First rib
b. Clavicle
c. Scapula
d. Occiput

24. True about trapezius are all, except:

- a. Elevates the scapula
b. Originates for C7
c. Supplied by cranial part of accessory nerve
d. Causes over-head abduction

25. Most common injured muscle in rotator cuff is:

(Recent Question 2015)

- a. Supraspinatous muscle
b. Infraspinatous muscle
c. Teres minor
d. Subscapularis

26. Not an abductor of shoulder:

- a. Deltoid
b. Trapezius
c. Supraspinatus
d. Latissimus dorsi

27. True about serratus anterior is: (DNB 2007, AI 94)

- a. Originates from the lower four ribs
b. Bipennate muscle
c. Supplied by subscapular nerve
d. Helps in forced inspiration

28. All of the following muscles retract the scapula, except:

(AIIMS May 2011, 2010)

- a. Trapezius
b. Rhomboid major
c. Rhomboid minor
d. Levator scapulae

29. A 50-yr-old female has undergone mastectomy for Ca Breast. After mastectomy, patient is not able to extend, adduct and internally rotate the arm. Nerve supply to which of the following muscles is damaged: (AIIMS May 2012)

- a. Pectoralis major
b. Teres minor
c. Latissimus dorsi
d. Long head of Triceps

30. The knowledge about the biomechanics of the rotator cuff muscles has increased exponentially. The role of one of the rotator cuff muscles had been ignored and less importance has been attached to its role; it is also known as the 'forgotten muscle'. Which of the following is that muscle? (AIIMS May 2013)

- a. Supraspinatus
b. Infraspinatus
c. Teres minor
d. Subscapularis

31. After radical mastectomy there was injury to the long thoracic nerve. The integrity of the nerve can be tested at the bedside by asking the patient to:

(AI 2004)

- a. Shrug the shoulders
b. Raise the arm above the head on the affected side
c. Touch the opposite shoulder
d. Lift a heavy object from the ground

32. Muscle of arm with additional supinator action:

- a. Brachialis
b. Biceps
c. Coracobrachialis
d. Triceps

33. In a vehicular accident, the musculocutaneous nerve was completely severed, but still the person was able to weakly flex the elbow joint. All of the following muscles are responsible for this flexion, except: (AIIMS 2004)

- a. Brachioradialis
b. Flexor carpi radialis
c. Ulnar head of pronator teres
d. Flexor carpi ulnaris

34. Which of the following is not the muscles of superficial anterior compartment of forearm?

- a. FDS
b. FPL
c. FCR
d. Palmaris longus

35. Muscles majorly involved in tight grip of hand are:

(Recent Question 2014)

- a. Short flexors
b. palmaris
c. Long flexors
d. Lumbricals

36. Pronator quadratus has same nerve supply as: (AIIMS 2003)

- a. FDS
b. Palmaris longus
c. FPL
d. FDP for ring finger

37. Winging of scapula is due to:

(AIIMS 2002)

- a. Paralysis of serratus anterior
b. Paralysis of trapezius
c. Both a and b
d. None



38. The action of the anconeus muscle is: (DNB 1999, AI 1994)
a. Screwing movements b. Elbow flexion
c. Forearm supination d. Adduction
39. Which among the following muscles receives dual nerve supply? (Recent Question 2015)
a. Flexor digitorum profundus
b. Flexor digitorum superficialis
c. Palmaris longus
d. Extensor carpi radialis
40. Muscle which cover both elbow and shoulder joint:
a. Biceps b. Brachialis (DNB 2003)
c. Coracobrachialis d. Triceps
41. Which muscle of extensor compartment flexes the elbow: (Recent Question 2014)
a. ECRL b. ECU
c. Anconeus d. Brachioradialis
42. De-Quervain's tenosynovitis affects:
a. F PL and FPB b. EPL and APL
c. EPB and APL d. FDP and FDS
43. False statement regarding adductor pollicis muscle:
a. Has 2 heads (AIIMS 2008)
b. Supplied by median nerve
c. Causes adduction of thumb
d. Arterial supplies is from arteria princeps pollicis
44. The muscle of hand that contains a sesamoid bone is:
a. Flexor pollicis brevis b. Flexor pollicis longus
c. Opponens pollicis d. Adductor pollicis
45. Which muscle originates from tendon of other muscle? (Recent Question 2013)
a. Palmaris longus b. FCR
c. Lumbricals d. Adductor pollicis
46. Which flexor muscle is attached to hook of hamate?
a. Flexor pollicis brevis b. Flexor pollicis longus
c. Flexor digiti minimi d. Flexor carpi ulnaris
47. Which of the following is not supplied by C8 T1: (DNB 2004, AIIMS 1998)
a. Abductor pollicis brevis b. Extensor indicis
c. Palmar interossei d. 3rd and 4th Lumbricals
48. Function of lumbricals are: (PGI 2003)
a. Flexion at MCP joint b. Extension at IP joints
c. Adduction of the fingers d. Abduction of the fingers
49. Patient is not able to adduct ring and index finger with less flexion at MCP. Which palmar interossei are affected
a. 1st and 2nd b. 1st and 3rd
c. 2nd and 3rd d. 2nd and 4th

Joints of Upper Limb

50. Which muscle has no action at shoulder joint? (Recent Question 2013)
a. Teres major b. Pectoralis minor
c. Subscapularis d. Trapezius
51. Carpometacarpal joint of thumb: (Recent Question 2015)
a. Saddle b. Hinge
c. Ball and socket d. Pivot
52. While carrying a heavy suitcase, the downward dislocation of glenohumeral joint is resisted by the following muscles, except: (AIIMS 2002)
a. Deltoid b. Coracobrachialis
c. Short head of biceps d. Latissimus dorsi
53. All of the following structures may be compressed during flexion and abduction of shoulder joint, except:
a. Suprascapular nerve (DNB 2003, AI 1999, AIIMS 1998)
b. Long head of biceps tendon
c. Supraspinatus tendon
d. Subacromial-bursa
54. Shoulder abduction involves all the following, except: (AI 2010)
a. Movement of sternoclavicular joint
b. Medial rotation of scapula
c. Acromioclavicular joint movement
d. Elevation of humerus
55. All the muscles used to abduct the shoulder, except: (Recent Question 2014)
a. Deltoid b. Supraspinatus
c. Serratus anterior d. Pectoralis major
56. A/E causes flexion of forearm? (PGI Dec 2006)
a. Brachialis b. Brachioradialis
c. Anconeus d. Pronator teres
e. Biceps brachialis
57. When a heavy object in hand is lowered, the extension at elbow is brought about by: (DNB 2005, AIIMS 2003)
a. Active shortening of the extensors
b. Passive shortening of the extensors
c. Active lengthening of the flexors
d. Active shortening of the flexors
58. Adduction of hand at wrist is done by? (PGI 2K)
a. Flexor carpi radialis
b. Flexor carpi logus
c. Flexor digittorum profundus
d. Flexor carpi ulnaris
e. Flexor digittorum superficialis

Nerves of Upper Limb

59. Little finger of hand corresponds to which of the following dermatomes: (AI 2012)
a. C6 b. C7
c. C8 d. T1

Brachial Plexus Questions

60. A patient is suffering from loss of sensations along the medial border of forearm and clawing of hand. which cord or trunk of brachial plexus is involved? (JIPMER Nov 2015)
a. Upper trunk
b. Lower trunk
c. Lateral cord
d. Posterior cord
61. A 19-year-old boy fell from motor bike on his shoulder. The doctor diagnosed him a case of Erb paralysis. The following signs and symptoms will be observed except: (AIIMS 2002)
a. Loss of abduction at shoulder joint
b. Loss of lateral rotation
c. Loss of pronation at radioulnar joint
d. Loss of flexion at elbow joint
62. All the following muscles undergo paralysis after injury to C5 and C6 spinal nerve except:
a. Biceps b. Coracobrachialis
c. deltoid d. teres minor



63. A young boy who was driving motor cycle at a high speed collided with tree and thrown on his right shoulder. Though there was no fracture, his right arm was medially rotated and forearm pronated, the following facts concerning this patient are correct, except: (AIIMS 2004)
- Injury at erb point
 - Lesion of C5, C6
 - Median and ulnar nerve were affected
 - Supraspinatus, infraspinatus, subclavius, biceps paralysed
64. Injury to upper trunk of brachial plexus following is/are seen: (PGI May 2012)
- Supination of forearm
 - Pronation of forearm
 - Inability to initiate the abduction of shoulder
 - Decreased sensation of medial hand
 - Paralysis of deltoid muscle
65. False regarding Klumpke's paralysis is: (AI 2008)
- Claw hand deformity
 - Intrinsic muscles of hand involved
 - Horner's syndrome
 - Upper trunk of brachial plexus involved
66. Initiation of abduction at shoulder joint is affected by injury to which of the following nerve?
- Axillary nerve
 - Spinal accessory nerve
 - Long thoracic nerve
 - Suprascapular nerve
67. Which among the following is a branch from the trunk of brachial plexus? (AI 2011)
- | | |
|----------------------------|------------------------|
| a. Suprascapular nerve | b. Long thoracic nerve |
| c. Anterior thoracic nerve | d. Nerve to subclavius |
68. Small muscles of hand are supplied by: (PGI 2000)
- | | |
|-------|-------|
| a. C4 | b. C5 |
| c. C6 | d. C8 |
| e. T1 | |

Long Thoracic Nerve

69. Following surgical removal of firm nodular swelling in the right breast and exploration of right axilla, on examination patient was found to have winged scapula. Most likely this could have occurred due to injury of: (AIIMS 2003)
- | | |
|------------------------|--------------------------------|
| a. Subscapular nerve | b. Coracoid process of scapula |
| c. Long thoracic nerve | d. Circumflex scapular artery |

Axillary Nerve

70. Injury to axillary nerve results in: (PGI Nov. 2011)
- Atrophy of deltoid muscle
 - Loss of overhead abduction
 - Loss of rounded contour of shoulder
 - Loss of sensation of lower part of arm on lateral side
 - Loss of sensation in inner forearm
71. Axillary nerve is accompanied by which artery:
- Axillary
 - Subscapular
 - Anterior circumflex humeral
 - Posterior circumflex humeral

Musculocutaneous Nerve

72. All the following are features of musculocutaneous nerve injury at axilla, except: (AI 1998)
- Loss of flexion at shoulder joint
 - Loss of flexion at elbow
 - Loss of supination of forearm
 - Loss of sensation on radial side of fore arm

Radial Nerve

73. True about radial nerve: (PGI May 2010)
- Branch of posterior cord
 - Nerve of extensor compartment of forearm
 - Arise from C5-T1
 - Anterior interosseous nerve is branch of it
 - Supply skin of extensor compartment
74. Patient is brought to the emergency with history of trauma to right upper limb. Extension of metacarpo phalangeal joint is lost. There is no wrist drop, and extension of IP joint is normal. The most likely the nerve involved is: (DNB 2009, AI 1999)
- | | |
|-----------------|---------------------------------|
| a. Ulnar nerve | b. Median nerve |
| c. Radial nerve | d. Posterior interosseous nerve |
75. A bookshelf falls on a person's arm laterally. He presents with inability to extend his wrist. On examination he is unable to make a strong hand grip and there is loss of sensation on dorsum of the hand and fingers. Which of the following nerve is injured: (AIIMS Nov. 2012)
- | | |
|--------------------------|------------------------|
| a. Brachial plexus | b. Radial nerve injury |
| c. Posterior cord injury | d. Ulnar nerve injury |
76. All the following are affected in low radial nerve palsy, except: (AI 2011)
- Extensor carpi radialis longus
 - Extensor carpi radialis brevis
 - Finger extensors
 - Sensation on dorsum of hand
77. Which of the following movements of thumb are not affected in radial nerve injury: (PGI June 2009)
- | | |
|---------------|--------------|
| a. Opposition | b. Abduction |
| c. Adduction | d. Extension |
| e. Flexion | |
78. The following muscles are supplied by radial nerve below the spiral groove, except: (AIIMS 2009)
- Brachialis
 - Brachioradialis
 - Extensor carpiradialis longus
 - Anconeus
79. Injury to radial nerve in lower part of spiral groove: (AI 2003)
- Spare nerve supply to the extensor carpi radialis longus
 - Results in paralysis of anconeus muscle
 - Extension of elbow joint intact
 - Weakness pronation movement
80. Which of the following the low radial nerve injury is not true? (AI 2008)
- Loss of nerve supply to brachioradialis
 - Loss of nerve supply to extensor carpi radialis brevis
 - Loss of nerve supply to extensor pollicis brevis
 - Loss of sensation over 1st dorsal web space



Median Nerve

81. **True regarding median nerve:** (PGI June 2009)
 a. Lateral and posterior cord
 b. Lateral and medial cord
 c. Lateral to axillary artery in axilla
 d. Lateral to brachial artery in cubital fossa
 e. Deep to pronator teres head
82. **Compression of nerve within the carpal tunnel produces inability to:** (AIIMS 2006)
 a. Abduct the thumb
 b. Adduct the thumb
 c. Flex the distal phalanx of thumb
 d. Oppose the thumb
83. **All are responsible for pronator syndrome, except:** (PGI Dec. 2009)
 a. Struthers ligament b. Bicipital aponeurosis
 c. Pronator quadratus d. FDS
84. **Which nerve escapes entrapment syndrome?**
 a. Femoral nerve b. Radial nerve
 c. Ulnar nerve d. Median nerve
85. **Muscles supplied by median nerve:** (PGI Dec. 2008)
 a. Opponens pollicis b. Abductor pollicis brevis
 c. Flexor pollicis brevis d. First lumbrical
 e. Adductor pollicis
86. **Boy present with complaints of hypoesthesia and wasting of thenar eminence. The nerve most likely to damage is:** (AIIMS 2002)
 a. Musculocutaneous nerve b. Median nerve
 c. Ulnar nerve d. Radial nerve
87. **The nerve supply of nail bed of index finger is:**
 a. Superficial branch of radial nerve
 b. Deep branch of radial nerve
 c. Median nerve
 d. Ulnar nerve
88. **Patient is not able to adduct his thumb, the nerve involved is characterized by:**
 a. Having root value of C7,C8,T1
 b. Arise from medial cord of brachial plexus
 c. Arise from lateral cord of brachial plexus
 d. Arise from posterior cord of brachial plexus
 e. Supplies 1st two lumbricals

Ulnar Nerve

89. **All of the following shows ulnar nerve injury, except:**
 a. Clawing of medial 2 digits
 b. Abductor pollicis palsy
 c. Adductor pollicis palsy
 d. Weak grip
90. **Superficial branch of ulnar nerve supplies:** (Recent Question 2013)
 a. Abductor pollicis b. Palmaris brevis
 c. Abductor digiti minimi d. Opponens pollicis
91. **A boy presents with injury to medial epicondyle of the humerus. Which of the following would not be seen?**
 a. Weakness of the ulnar deviation and flexion (AIIMS 2002)
 b. Complete paralysis of the IIIrd and IVth digits
 c. Atrophy of the hypothenar eminence
 d. Decreased sensation of the hypothenar eminence

92. **Patient presents with numbness in little and ring finger along with atrophy of hypothenar eminence. Which of the following is injured?** (AIIMS Nov. 12)
 a. Posterior cord of brachial plexus
 b. Palmar cutaneous branch of ulnar nerve
 c. Deep branch of ulnar nerve
 d. Ulnar nerve before division into superficial and deep
93. **False regarding ulnar nerve:** (PGI May 2010)
 a. C7 fibers come from lateral cord
 b. C7,8T1
 c. No branch in arm
 d. Pass between supinator heads
 e. Lies superficial to FDP and flexor retinaculum
94. **Deep branch of ulnar nerve supplies:** (PGI Nov. 2009)
 a. Adductor pollicis
 b. Flexor digitorum superficialis
 c. 1st lumbrical
 d. 3rd lumbrical
 e. Palmaris brevis
95. **Ulnar nerve injury at arm leads to all, except:** (AIIMS Nov. 2007)
 a. Sensory loss of the medial 1/3rd of hand
 b. Weakness of hypothenar muscles
 c. Claw hand
 d. Adducted thumb
96. **Ulnar nerve injury causes:** (PGI Dec. 2007)
 a. Weakness of adduction of thumb
 b. Froment sign
 c. Thenar eminence atrophy
 d. Pointing index
 e. 4th and 5th finger clawing
97. **Ulnar nerve injury at wrist spares which muscle?** (DNB 2008)
 a. Opponens pollicis b. Palmar interossei
 c. Dorsal interossei d. Adductor pollicis

Blood Vessels of Upper Limb

98. **Cephalic vein drains into:** (Recent Question 2013)
 a. Brachial vein b. Subclavian vein
 c. Axillary vein d. IVC
99. **Superficial veins of the upper limb are located in which plane?** (Recent Question 2014)
 a. Subcutaneous b. Intrafascial
 c. Subfascial d. Intramuscular
100. **Anastomosis of subscapular artery are formed by all, except:**
 a. Transverse cervical artery
 b. Suprascapular artery
 c. 1st part of subclavian artery
 d. 2nd part of axillary artery
101. **Occlusion occurs at 2nd part of axillary artery, blood flow is maintained by anastomosis between:** (AIIMS Nov. 2007)
 a. Anterior and posterior circumflex humeral artery
 b. Circumflex scapular and posterior circumflex humeral artery
 c. Deep branch of transverse cervical artery and subscapular artery
 d. Anterior circumflex and subscapular artery



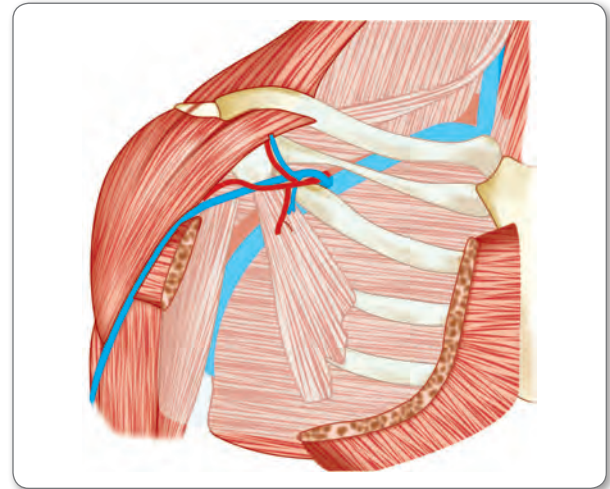
- 102. Posterior interosseous artery is a branch of:** (Recent Question 2015)
- Radial artery
 - Ulnar artery
 - Brachial artery
 - Axillary artery
- 103. Recurrent interosseous artery is a branch of?** (Recent Question 2014)
- Anterior interosseous artery
 - Posterior interosseous artery
 - Common interosseous artery
 - Radial recurrent artery
- 104. Deep palmar arch is formed by:** (Recent Question 2014)
- Mainly radial artery and partly ulnar artery
 - Mainly ulnar artery and partly ulnar artery
 - Ulnar artery and radial artery equally
 - A or B
- 105. True about deep palmar arch:** (Recent Question July 2015)
- Main contribution by ulnar artery
 - Lies superficial to lumbricals
 - Gives three perforating arteries
 - Gives four palmar metacarpal arteries

Mammary Gland

Breast

- 106. Breast is a** (Recent Question 2015)
- Endocrine gland
 - Modified sweat gland
 - Modified sebaceous gland
 - Holocrine gland
- 107. All are true about mammary gland, except:**
- Is a modified sweat gland (Recent Question Dec. 2013)
 - Extends from 2nd to 6th rib vertically
 - Supplied by internal mammary artery
 - Nipple is supplied by 6th intercostal nerve
- 108. In breast, coopers ligament extends from subcutaneous tissue to:** (AIIMS 1993, DNB 2001)
- Pectoral muscle
 - Pectoral fascia
 - Alveoli
 - Montgomery tubercle
- 109. Breast is supplied by:** (PGI May 2012)
- Lateral thoracic artery
 - Internal mammary artery
 - Musculophrenic artery
 - Superior thoracic artery
 - Superior epigastric artery
- 110. How many lactiferous ducts open in nipple:** (Recent Question 2015)
- 0–10
 - 15–20
 - 25–50
 - 50–75
- 111. All pierce the clavipectoral fascia, except:** (Recent Question 2015)
- Lateral pectoral nerve
 - Lateral thoracic artery
 - Cephalic vein
 - Thoraco acromial artery
- 112. Clavipectoral fascia splits to enclose subclavius and pectoralis minor, and continues as:** (Recent Question 2015)
- Axillary sheath
 - Costocoracoid ligament
 - Costoclavicular ligament
 - Suspensory ligament

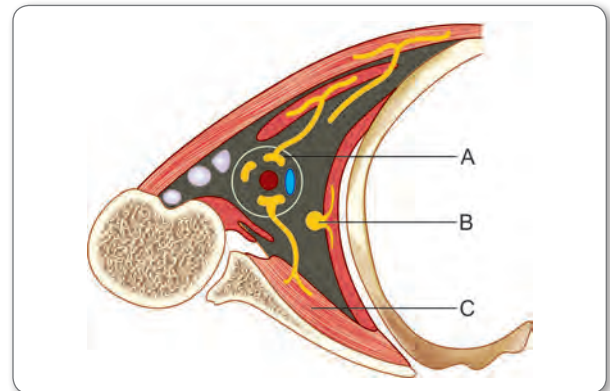
- 113. Which of the following pierce the given structure** (AIIMS Nov 2016)



- Thoracoacromial artery, cephalic vein, medial pectoral nerve
- Lateral thoracic artery, basilic vein, lateral pectoral nerve
- Internal thoracic artery, basilic vein, medial pectoral nerve
- Thoraco acromial artery, cephalic vein, lateral pectoral nerve

Axilla and Contents

- 114. Below is the picture of cross section of axilla, identify the marked structures**



- Medial cord of brachial plexus, long thoracic nerve of bell, subscapularis
 - Lateral cord of brachial plexus, long thoracic nerve, serratus anterior
 - Posterior cord of brachial plexus, nerve to serratus anterior, subscapularis
 - Lateral cord of brachial plexus, long thoracic nerve, subscapularis
- 115. All are contents of axilla, except:** (Recent Question 2013)
- Axillary tail of breast
 - Axillary vessels
 - Axillary sheath
 - Roots of brachial plexus
- 116. Posterior wall of axilla is formed by all, except:** (Recent Question 2015)
- Teres major
 - Subscapularis
 - Supraspinatus
 - Latissimus dorsi

**117. Anterior wall of axilla is formed by:**

- a. Pectoralis major b. Humerus
c. Latissimus dorsi d. Teres major

118. Location of level III axillary lymph node in relation to pectoralis minor is: (AI 2012)

- a. Anterior b. Posterior
c. Superior d. Inferior

119. Lateral most content of cubital fossa: (Recent Question 2014)

- a. Biceps tendon b. Radial nerve
c. Brachial artery d. Median nerve

120. Lateral boundary of cubital fossa is formed by:

- a. Medial border of pronator teres (Recent Question 2015)
b. Lateral border of pronator teres
c. Medial border of brachioradialis
d. Lateral border of brachioradialis

Anatomical Snuff Box**121. The medial boundary of the anatomical snuffbox is formed by the:** (Recent Question 2014)

- a. Ext. Pollicis brevis b. Ext Carpi radialis longus
c. Extensor pollicis longus d. Ext Carpi radialis brevis

122. Anatomical snuff box not formed by: (AIIMS 2010)

- a. Extensor pollicis longus
b. Extensor pollicis brevis
c. Abductor pollicis longus
d. Abductor pollicis brevis

123. Structures not pass under flexor retinaculum:

- a. Ulnar nerve (PGI May 2013)
b. Median nerve
c. Flexor digitorum superficialis
d. Flexor digitorum profundus
e. Radial artery

124. 3rd extensor compartment in wrist:

- a. Extensor pollicis brevis (PGI Dec. 2008)
b. Extensor carpi radialis longus
c. Extensor carpi radialis brevis
d. Extensor pollicis longus
e. Abductor pollicis longus

Space**125. Boundaries of quadrilateral space include all, except:**

- (Recent Question 2014)
a. Teres major b. Long head of triceps
c. Neck of humerus d. Deltoid

126. Triangle of auscultation is formed by all, except:

- (AIIMS Nov. 2008)
a. Medial border of scapula
b. Lateral border of vertebral column
c. Latissimus dorsi d. Trapezius

127. Contents of midpalmar space are all, except: (AI 2012)

- a. 2nd lumbrical b. FDP of 3rd finger
c. 1st umbrical d. FDP of 4th finger

128. Infections of index finger spread to: (Recent Question 2014)

- a. Mid palmar space b. Radial bursa
c. Thenar space d. Dorsum of hand

Scapula and Shoulder Region**129. Winging of scapula is due to weakness/paralysis of:**

(Recent Question 2016-17;
DNB Pattern June' 2009, 2010, 2012-13)

- a. Serratus anterior
b. Deltoid
c. Teres minor
d. Latissimus dorsi

130. Muscles used in climbing tree: (Recent Question 2016-17)

- a. Teres minor
b. Serratus anterior
c. Trapezius
d. Latissimus dorsi

131. Which of the following muscles does NOT take part in the formation of rotator cuff? (Recent Question 2015-16)

- a. Infraspinatus b. Teres major
c. Supraspinatus d. Subscapularis

132. Suprascapular nerve gets compressed in:

- a. Neck of humerus fracture (Recent Question 2016-17)
b. Posterior dislocation of shoulder
c. Anterior dislocation of shoulder
d. Rotator cuff injury in tennis player

Forearm and Hand**133. Adductor pollicis muscle is supplied by which nerve :**

(Recent Question 2016-17, Recent Question 2013)

- a. Deep branch of ulnar nerve
b. Superficial branch of ulnar nerve
c. Median nerve
d. Radial nerve

134. No Man's land in palm: (Recent Question 2016-17)

- a. Zone 2 b. Zone 3
c. Zone 1 d. Zone 4

135. In Carpal tunnel syndrome, Durcan's test is used to asses:

(Recent Question 2016-17)

- a. Parasthesia in response to compression
b. Numbness and tingling sensation in digits of radial side
c. Failure to determine separation of at least 4 mm
d. Increase in resting pressure in on positioning

136. Attachment on lateral border of scapula is:

(Recent Question 2015)

- a. Teres minor b. Infraspinatus
c. Subscapularis d. Long head of triceps

137. True about abduction at shoulder joint: (PGI 2015)

- a. Supraspinatus initiates abduction
b. Serratus anterior and trapezius also help in abduction
c. Multipennate deltoid clavicular fiber is main abductor
d. Axillary nerve injury has no effect of abduction
e. Musculotendinous cuff stabilizes shoulder joint

138. Adduction of hand at wrist is done by: (PGIC 2000)

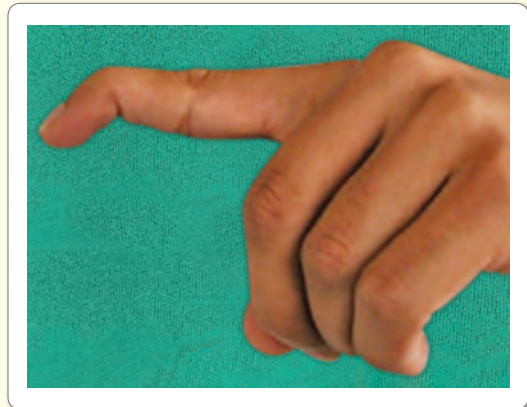
- a. Flexor carpi radialis
b. Palmaris longus
c. Flexor digitorum profundus
d. Flexor carpi ulnaris
e. Flexor digitorum superficialis



- 162. Ulnar paradox means:** (Recent Question 2016)
a. High level injury- less severe claw hand
b. Low level injur- less severe claw hand
c. High level injury- more severe claw hand
d. Low level- more severe claw hand
- 163. TRUE about Guyon's canal:** (PGIC 2011)
a. Convey ulnar nerve
b. Lies at wrist
c. Lies behind medial epicondyle
d. Located between 2 heads of pronator teres
e. Located between 2 heads of flexor carpi ulnaris
- 164. Following an incised wound in the front of wrist, the subject is unable to oppose the tips of the little finger and the thumb. The nerve(s) involved is/are:** (NBEP Pattern 2014)
a. Ulnar nerve alone b. Median nerve alone
c. Median and ulnar nerves d. Radial and ulnar nerves
- 165. Largest branch of brachial plexus is:** (Recent Question 2013)
a. Ulnar b. Medial
c. Radial d. Axillary
- 166. Ulnar collateral nerve is:** (Recent Question 2013)
a. Branch of ulnar nerve
b. Branch of radial nerve supplying medial head of triceps
c. Branch of radial nerve supplying long head of triceps
d. Branch of radial nerve supplying lateral head of triceps
- 167. Lower lateral cutaneous nerve of arm is branch of:** (Recent Question 2014)
a. Radial nerve b. Axillary nerve
c. Median nerve d. Musculocutaneous nerve
- 168. Finger by which all three major nerves of the upper limb can be tested:** (PGIC)
a. Index b. Ring
c. Thumb d. Middle
e. Little
- 169. All are true about proximal humerus attachment, except:**
a. Supraspinatus at lesser tubercle (Recent Question 2013)
b. Subscapularis at lesser tubercle
c. Teres minor at greater tubercle
d. Infraspinatus at greater tubercle
- 170. Deltoid muscle causes all, except:** (Recent Question 2015)
a. Flexion shoulder
b. Extension of shoulder
c. Internal rotation of shoulder
d. Adduction of shoulder
- 171. After surgery on right side of neck, a person could not raise his arm above head and also could not shrug the shoulder. What are the possible causes:** (PGIC 2013)
a. Damage to spinal accessory nerve
b. Paralysis of trapezius muscle
c. Injury to axillary nerve
d. Paralysis of latissimus dorsi
e. Paralysis of deltoid muscle
- 172. Biceps brachii does NOT arise from:** (Recent Question 2015)
a. Supraglenoid tubercle b. Glenoid labrum
c. Coracoid process d. Front of humerus
- 173. Intracapsular but extrasynovial is:** (Recent Question 2015)
a. Long head of triceps brachii
b. Long head of biceps brachii
c. Short head of biceps brachii
d. Medial head of biceps brachii
- 174. Muscle NOT supplied by musculocutaneous nerve:** (Recent Question 2012)
a. Biceps
b. Extensor carpi radialis longus
c. Brachialis
d. Coracobrachialis
- 175. Coracobrachialis is pierced by which nerve:** (Recent Question 2013)
a. Axillary b. Median
c. Musculocutaneous d. Ulnar
- 176. True about anconeus muscle is:** (Recent Question 2014)
a. Posterior forearm muscle
b. Helps in screwing movement
c. Helps in forearm supination
d. Supplied by ulnar nerve
- 177. Muscle in extension compartment of forearm which causes flexion of elbow?** (Recent Question)
a. Brachioradialis
b. Abductor pollicis longus
c. Extensor pollicis longus
d. Extensor carpi radialis longus
- 178. The nerve supply to pronator muscle of distal radioulnar joint is:** (JIPMER 2003)
a. Median nerve
b. Ulnar nerve
c. Anterior interosseous nerve
d. Posterior interosseous nerve
- 179. All of the following muscles have dual nerve supply, except:** (Recent Question 2015)
a. Subscapularis b. Pectoralis major
c. Pronator teres d. Flexor digitorum profundus
- 180. Teres major is supplied by:** (Recent Question 2014)
a. Upper subscapularis nerve
b. Lower subscapularis nerve
c. Dorsal scapular nerve
d. Axillary nerve
- 181. Anatomically a muscle of upper limb, but functionally related to the trunk is:** (AIIMS 2013)
a. Rhomboideus major b. Latissimus dorsi
c. Trapezius d. Levator scapulae
- 182. A man cannot do abduction and internal rotation of arm. Which of the following muscle is responsible for the both movements?** (PGIC 2013)
a. Pectoralis major b. Subscapularis
c. Deltoid d. Supraspinatus
e. Teres major
- 183. Which of the following statement(s) is TRUE regarding axillary artery?** (PGIC 2015)
a. Start from upper border of clavicle
b. Ulnar nerve lies medially to distal 1/3 of artery
c. Radial nerve lies posteriorly distal 1/3 of artery
d. Axillary vein lies laterally to proximal 1/3 of the artery
e. End at lower border of pectoralis minor
- 184. In a subclavian artery block at the outer border of first rib all of the following arteries help in maintaining the circulation to upper limb, except:** (AIIMS 2008,2011)
a. Thyrocervical trunk
b. Suprascapular
c. Subscapular
d. Superior thoracic



- 185. Interosseous membrane of forearm is pierced by:**
a. Brachial artery (Recent Question 2013)
b. Anterior interosseous artery
c. Posterior interosseous artery
d. Ulnar recurrent artery
- 186. Axillary artery is divided into three parts by:**
(Recent Question 2015)
a. 1st rib b. Clavicle
c. Pectoralis minor muscle d. Teres minor muscle
- 187. Branches of brachial artery are all, except:**
(Recent Question 2014)
a. Profunda brachii b. Superior ulnar collateral
c. Inferior ulnar collateral d. Radial collateral
- 188. Artery forming anastomosis around the surgical neck of humerus is a branch of:**
(Recent Question 2014)
a. 1st part of axillary artery b. 2nd part of axillary artery
c. 3rd part of axillary artery d. Subclavian artery
- 189. All of the following are postaxial veins, except:**
a. Cephalic vein b. Basilic vein
c. Axillary vein d. Subclavian vein
- 190. Boundaries of upper triangular space include all, except:**
(Recent Question 2012)
a. Teres minor b. Teres major
c. Subscapularis d. Triceps
- 191. Structure related to deltopectoral groove:**
(Recent Question 2015)
a. Axillary artery b. Cephalic vein
c. Basilic vein d. Radial nerve
- 192. WRONG about clavipectoral fascia:** (PGIC)
a. Situated under clavicular portion of the pectoralis minor
b. Fuses with the deep cervical fascia superiorly
c. Costocoracoid membrane is a modification
d. Continue downward to join the axillary fascia
e. Laterally joins fascia over the short head of the biceps brachii
- 193. Fascia around nerve bundle of brachial plexus is derived from:** (AIIMS 2008)
a. Prevertebral fascia b. Clavipectoral fascia
c. Deep cervical fascia d. Pectoral fascia
- 194. All are contents of cubital fossa, except:**
(Recent Question 2012)
a. Median nerve b. Biceps tendon
c. Brachial artery d. Ulnar nerve
- 195. Bicipital aponeurosis lies over which structure in cubital fossa:** (Recent Question 2015)
a. Median cubital vein b. Radial nerve
c. Brachial artery
d. Anterior interosseous artery
- 196. Lymphatic drainage of upper outer quadrant of breast:**
(Recent Question 2013)
a. Anterior axillary
b. Posterior axillary
c. Para tracheal
d. None of the above
- 197. All are true regarding axillary lymph nodes, except:**
(AIPG 2013)
a. Posterior group lies along subscapular vessels
b. Lateral group lies along lateral thoracic vessels
c. Apical group lies along axillary vessels
d. Apical group is terminal lymph nodes
- 198. Peau d'orange appearance orange occurs due to:** (AIIMS 2015)
a. Haematogenous dissemination
b. Adherence of Cooper's ligament
c. Blockade of sub-dermal lymphatics
d. Chest wall fixation
- 199. Which muscle does NOT take part in dorsal digital expansion?** (Recent Question 2013)
a. Interossei b. Lumbricals
c. Extensor digitorum d. Adductor pollicis
- 200. 'Mallet finger' is a common traumatic lesion resulting in flexion deformity of distal interphalangeal joint. The basic pathology of this condition is:** (UPSC)
a. Avulsion fracture of middle phalanx
b. Rupture of collateral slips of extensor expansion
c. Rupture of central slip of extensor expansion
d. Dislocation of distal interphalangeal joint
- 201. Card test is done to check the function of:** (AIIMS 2015)
a. Lumbricals
b. Palmar interossei
c. Dorsal interossei
d. Adductor pollicis
- 202. Radial bursa is the synovial sheath covering the tendon of:** (Recent Question 2013)
a. FDS b. FDP
c. FPL d. FCR
- 203. A patient with supracondylar fracture, unable to flex the thumb. The nerve involved is:** (AIIMS May 2018)
a. Deep branch of ulnar nerve
b. Posterior interosseous nerve
c. Anterior interosseous nerve
d. Superficial branch of ulnar nerve
- 204. All of the following bones are involved in wrist joint formation; except:** (AIIMS May 2018)
a. Scaphoid
b. Ulna
c. Radius
d. Triquetrum
- 205. Identify the deformity shown in the figure:** (AIIMS May 2018)



- a. Mallet finger
b. Swan neck deformity
c. Boutonniere deformity
d. Jersey finger deformity



206. Jersey finger which muscle involved (AIIMS May 2018)

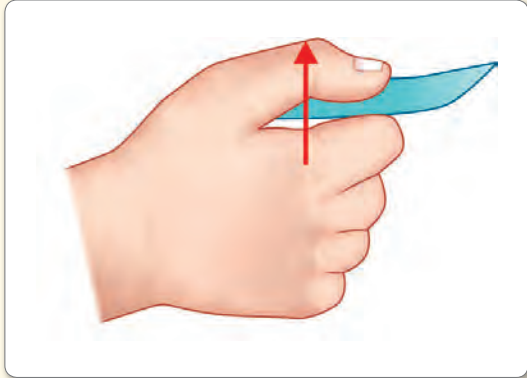
- a. FDP
- b. FDS
- c. Extensor Policis
- d. Extensor digiti minimi

207. Young boy met with RTA, there is angular deformity in middle third of arm. Abduction of finger possible. Unable to dorsi flex the wrist. Possible nerve injury

(Recent Question June 2018)

- a. Median nerve
- b. Ulnar nerve
- c. Radial nerve
- d. Posterior interosseous nerve

208. Froment sign is seen in (Recent Question June 2018)



- a. Ulnar nerve palsy
- b. Posterior interosseous nerve palsy
- c. Radial nerve palsy
- d. Median nerve palsy

209. Supinator is supplied by same nerve as

(Recent Question June 2018)

- a. Extensor digitorum
- b. Brachioradialis
- c. Brachialis
- d. Pronator quadratus

210. Identify the nerve supply of marked muscle

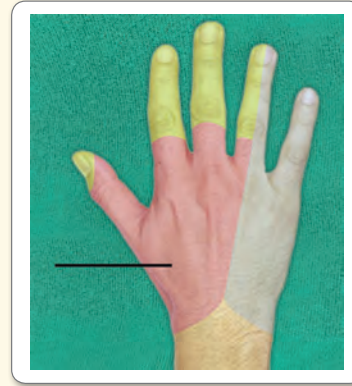
(Recent Question 2019)



- a. Median
- b. AIN
- c. PIN
- d. Ulnar

211. Cutaneous innervation of marked area is given by

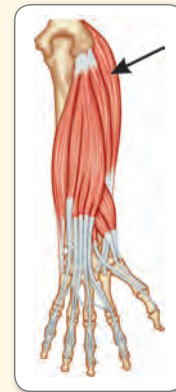
(Recent Question 2019)



- a. Radial nerve
- b. Posterior interosseous nerve
- c. Median nerve
- d. Ulnar nerve

212. Identify the marked muscle in the given diagram

(Recent Question 2019)



- a. Brachioradialis
- b. Extensor carpi radialis longus
- c. Extensor carpi ulnaris
- d. Flexor carpi radialis

213. Which of the following muscles is/are supplied by posterior interosseous nerve: (PGI May 2018)

- a. Extensor carpi ulnaris
- b. Extensor carpi radialis longus
- c. Extensor carpi radialis brevis
- d. Extensor digitorum
- e. Brachioradialis

214. Which of the following is/are muscle form rotator cuff except: (PGI May 2018)

- a. Teres minor
- b. Teres major
- c. Subscapularis
- d. Supraspinatus
- e. Infraspinatus

215. Long thoracic nerve

(PGI Dec 2018)

- a. C5
- b. C6
- c. C7
- d. C8
- e. T1

216. Erb's palsy

(PGI Dec 2018)

- a. C5,6
- b. C8,T1
- c. Forearm supinated
- d. Arm adducted and internally rotated
- e. Associated with birth injuries



Answers with Explanations

Bones of Upper Limb

- 1. Ans. d. Most common site of fracture is the junction of medial 1/3 and lateral 2/3**

[Ref: Last Anatomy 12th ed. Pg 97,98]

Common fracture site junction between medial 2/3 and lateral 1/3

- 2. Ans. d. Short head of biceps**

[Ref: BDC 5th/ed. Vol. 1 p. 411]

Muscles attached to coracoid process – mn PCB (Pakistan Cricket Board)

- Pectoralis minor
- Coracobrachialis
- Short head of Biceps

- 3. Ans. c. T2**

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3 pg 8]

- 4. Ans. c. Medial border indicates horizontal fissure**

[Ref: Gray's Anatomy 40th ed p 819, Instant Anatomy by Robert H. Whitaker, Neil R. Borley 4th ed p 199]

Root at T3

Inferior angle at T7

- 5. Ans. b. Supraglenoid tubercle**

[Ref: Last Anatomy 12th ed. Pg 58]

Supra glenoid tubercle – long head of biceps
Infra head tubercle – long head of triceps

- 6. Ans. a, synovial membrane of shoulder joint b. Ascending branch of anterior circumflex artery**

[Ref: Last Anatomy 12th ed. Pg 101 102]

Contents of Bicipital Groove

Long head of biceps with synovial sheath

Ascending branch of anterior circumflex artery

- 7. Ans. d. Lateral epicondyle**

[Ref: BDC 6th/ed. Vol. 1 p. 14]

Capsule of the elbow joint attached proximally in the continuous line which excludes two epicondyles but includes three fossa (radial, coronoid and olecranon fossa)

- 8. Ans. d. Musculocutaneous**

[Ref: Clinical Anatomy 2nd/ed. p. 813]

Nerves Related to Humerus

Surgical neck – axillary nerve

Spiral groove – radial nerve

Behind medial epicondyle – ulnar nerve

- 9. Ans. b. Major contributions to wrist joint**

Radial groove in humerus bone

Radius bone takes part in wrist joint along with scaphoid and lunate

Bone present laterally

Radial artery is palpated against the anterior surface of lower end of radius

So Radial artery is medial to styloid process of radius. But best answer a > c

- 10. Ans. d. Anterior interosseus artery**

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3 pg 74]

Anterior interosseous artery pierce the interosseous membrane and joins with posterior interosseous artery and form the carpal anastomosis

- 11. Ans. c. Major supply from dorsal surface**

Major blood supply through dorsal branch of radial artery via dorsal surface

Blood vessels reach the distal row in retrograde fashion

Minor blood supply to scaphoid is from palmar branch of radial artery

- 12. Ans. d. Capitates**

[Ref: Essentials of Human Anatomy by AK datta 5th ed. volume 3 pg 20]

- 13. Ans. c. Scaphoid**

[Ref: BDC 6th ed. vol. I / 26]

- 14. Ans. a. Triquetral**

[Ref: BDC 6th ed. vol. I / 25; Snell's 8th ed / 402]

- 15. Ans. a. Ulnar nerve**

[Ref: Gray's Anatomy 40th edition pg 897]

- 16. Ans. b. Carpals**

[Ref: Gray's Anatomy 39th ed. /102]

- 17. Ans. c. 4th year**

Ossification center for lunate – 4th year

- 18. Ans. d. Base is formed by condylar articular surface for scaphoid**

Short and stout

Does not articulate with other metacarpal bone

Rotated medially 90°, so that first metacarpal bone moves freely with respect to other

Base is saddle shaped and articulate with trapezium



19. Ans. c. Radial nerve

X ray showing fracture of shaft of humerus
Most commonly affected nerve – radial nerve

20. Ans. b. B

- A – acromion process
 - B – coracoid process
 - C – superior angle of scapula
 - D – infra glenoid tubercle
- Tip of coracoid process palpable 2.5cm below the junction of lateral ¼ & medial ¾ of the clavicle

Muscles of Upper Limb

21. Ans. a. Flexion of MCP joint

Given muscle – lumbricals
Action – flexion of MCP joint
Extension of IP joint

22. Ans. d. Trapezius

[Ref: Gray's 41st ed. /817]
Dropped shoulder is due to paralysis of trapezius
Actions of trapezius—elevation of scapula along with levator scapula
Overhead abduction along with serratus anterior
Retracts with scapula along with rhomboids

23. Ans. a. First rib

[Ref: Gray's 41st ed. pg 816-817]
Origin from occipital bone, C7 and T1 to 12
Insertion to clavicle and scapula

24. Ans. c. Supplied by cranial part of accessory

[Ref: BDC 6th/ed. Vol. 1 p. 62]
Supplied spinal part of accessory

25. Ans. a. Supraspinatus muscle

[Ref: BDC 6th ed. vol. 1 / 68-69]
Most frequent ruptured muscle in rotator cuff is supraspinatus

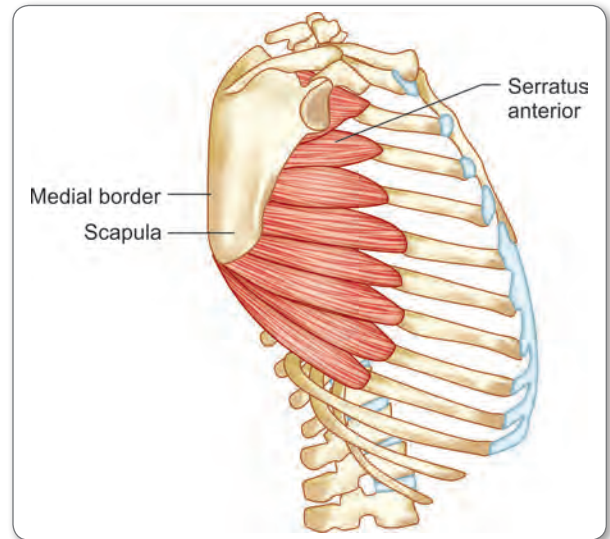
26. Ans. d. Latissimus dorsi

[Ref: Gray's 39th/ed. p. 829]
0 to 15 – supraspinatus
15 to 90 – deltoid
90 to 180 – trapezius and serratus anterior

27. Ans. d. Helps in forced inspiration.

[Ref: Last anatomy 12th edition pg 42]

Serratus Anterior



Origin	8 fleshy digitations from outersurface of upper 8 ribs (multi pinnate)
Insertion	Medial border of scapula and inferior angle
Nerve Supply	Long thoracic nerve of bell C5,6,7.
Action	Over head abduction along with trapezius Protraction of scapula Helps in forced inspiration (accessory muscle of inspiration)

28. Ans. d. Levator scapula

[Ref: Last Anatomy, 12th ed. pg 42]
Retraction of scapula – trapezius and rhomboids major and minor

29. Ans. c. Latissimus dorsi

[Ref: Last Anatomy, 12th ed. pg 40]
Action of latissimus dorsi – extension, adduction and medial rotation of arm
Action of pectoralis major – flexion, adduction and medial rotation of arm

30. Ans. d. Subscapularis

[Ref: Last Anatomy, 12th ed. pg 44,45]
Forgotten muscle of rotator cuff group – subscapularis because of deep location

31. Ans. b. Raise the arm above the head on the affected side

[Ref: Last Anatomy, 12th ed. pg 42 43]



Long thoracic nerve injury—serratus anterior paralysis
Shrug the shoulders—elevation of scapula—test to detect the trapezius and levator scapulae
Raise the arm above the head on the affected side—overhead abduction—trapezius and serratus anterior
Touch the opposite shoulder—flexion of shoulder joint—pectoralis major and anterior fibers of deltoid
Lift a heavy object from the ground—initiation of abduction of shoulder joint—supraspinatus

32. Ans. b. Biceps

[Ref: BDC 6th/ed. Vol. 1 p. 88]

Biceps is the power supinator of forearm
Flexion of elbow joint

33. Ans. c. Ulnar head of pronator teres

[Ref: Last Anatomy 12th ed. pg 64 65]

Superficial flexors have common origin from medial epicondyle
So all muscles originating from medial epicondyle are weak flexors
Only ulnar head of pronator teres here not having origin from medial epicondyle

34. Ans. b. FPL

[Ref: Last Anatomy 12th ed. pg 68,69]

FPL, FDP and pronator quadratus are deep muscles

35. Ans. c. Long flexors

[Ref: Gray's Anatomy 39th ed. p 931,932, Anatomy of human movement: structure and function 5th ed p 120]

Long finger flexors (attach to middle and distal phalanx) and intrinsic muscles help to grip the object
FDS, FDP, FPL Provide major power than short muscles of hand
So long flexors > lumbricals

36. Ans. c. FPL

[Ref: Last Anatomy, 12th ed. pg 68, 69]

Pronator quadratus, FPL and FDP for index and middle finger supplied by anterior interosseous nerve

37. Ans. c. Both a and b

[Ref: Last Anatomy, 12th ed. pg 39,40, 42,43]

Winging of scapula is due to both trapezius and serratus anterior paralysis
Winging when the arm by side of body—trapezius paralysis
Winging when patients push the resistance—serratus anterior palsy.
If one answer is required, then serratus anterior > trapezius

38. Ans. a. Screwing movements

[Ref: Last Anatomy, 12th ed. pg 76]

Action of anconeus extension of elbow and screwing movement (occurs during pronation)
Supplied by radial nerve

39. Ans. a. Flexor digitorum profundus

[Ref: Gray's 41st ed. /851]

Flexor digitorum profundus supplied by anterior interosseous nerve (median nerve) and ulnar nerve

40. Ans. a. Biceps

[Ref: BDC 6th ed. vol. 1 / 96-97]

Both short head and long head of biceps crosses both shoulder and elbow joint
Triceps only long head crosses shoulder and elbow joint not medial and lateral head.

41. Ans. d. Brachioradialis

[Ref: BDC 6th/ed. Vol. 1 p. 134]

Brachioradialis (shunt muscle) is muscle present in the extensor compartment but it is the weak flexor of elbow joint.

42. Ans. c. EPB and APL

[Ref: Maheshwari, 4th/ed. p. 294]

De – quervain tenosynovitis is due to inflammation of synovial sheath of APL and EPB

43. Ans. b. Supplied by Median nerve

[Ref: Grays Anatomy, 40th ed, 2008, Page 918]

Adductor pollicis had superficial and deep head
Supplied by deep branch of ulnar nerve

44. Ans. d. Adductor pollicis

[Ref Gray's Anatomy, 39th ed./918, 1523]

Both heads converge into tendon and insert into base of proximal phalanx of thumb with sesamoid bone

45. Ans. c. Lumbricals

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 91]

Lumbricals take origin from profundus tendon

46. Ans. d. Flexor carpi ulnaris

[Ref: BDC 6th/ed. Vol. 1 p. 25]

Flexor carpi ulnaris attached to pisiform bone and then to hook of hamate and 5th metacarpal

47. Ans. b. Extensor indices

[Ref: Last Anatomy, 12th ed. pg 84]

Small muscles in the hand supplied by C8,T1

48. Ans. a. Flexion at MCP joint, b. Extension at IP joints

[Ref: Last Anatomy 12th ed. pg 86]

Action of lumbricals – flexion of MCP joint and extension of IP joint



49. Ans. c. 2nd and 3rd

Ref grays 41th edition, pg – 884
 No palmar interossei for middle finger
 So index finger – 2nd palmar interossei
 Ring finger – 3rd palmar interossei

Joints of Upper Limb

50. Ans. b. Pectoralis minor

[Ref: Last Anatomy, 12th ed. pg 39]
 Pectoralis minor depress and protracts the scapula

51. Ans. a. Saddle

[Ref: Last Anatomy, 12th ed. pg 91]

52. Ans. d. Latissimus dorsi

[Ref: Last Anatomy, 12th ed. pg 40 41]
 Muscles which originate above the joint and insert below prevent the downward dislocation of shoulder joint
 All the muscles except latissimus dorsi satisfy the above condition

53. Ans. a. Suprascapular nerve

[Ref: Grays Anatomy, 40th ed. pg 813]
 Suprascapular nerve not related to joint cavity
 Supraspinatus tendon inserted to greater tubercle, long head of biceps intra capsular origin, sub acromial bursa above the joint cavity compressed during flexion and abduction of shoulder joint
 Supraspinatus tendon > long head of biceps > sub acromial bursa

54. Ans. b. Medial rotation of scapula

[Ref: Last Anatomy 12th ed. pg 47-50]
 Humeral elevation permits elevation upto 90*
 At this point, lateral rotation of humerus make the head to lie deep to coracoacromial arch
 Then lateral rotation of scapula turn the glenoid cavity to face almost directly up
 So abduction takes place partly at shoulder joint and also at sternoclavicular joint and acromioclavicular joint.

55. Ans. d. Pectoralis major

[Ref: Last Anatomy, 12th ed. pg 49-50]
 0 to 15* - supraspinatus
 15 to 90* - middle fibers of deltoid
 90 to 180 * - serratus anterior and trapezius

56. Ans. c. Anoneus

[Ref: Grays Anatomy 40th ed. pg 845-850]
 Muscles taking origin from medial epicondyle superficial flexors of forearm which cross the elbow joint so they are

weak flexors. Humeral head of pronator teres, flexor carpi radialis, Palmaris longus, flexor carpi ulnaris, flexor digitorum superficialis are weak flexors
 Brachioradialis – shunt muscle – weak flexor

57. Ans. c. Active lengthening of the flexors

[Ref: Grays Anatomy 38th ed. pg 843]
 Heavy object in hand
 Lowered with gravity – extension of elbow joint by active lengthening of flexors
 Lifted against gravity – extension of elbow joint by active shortening of extensors

58. Ans. d. Flexor carpi ulnaris

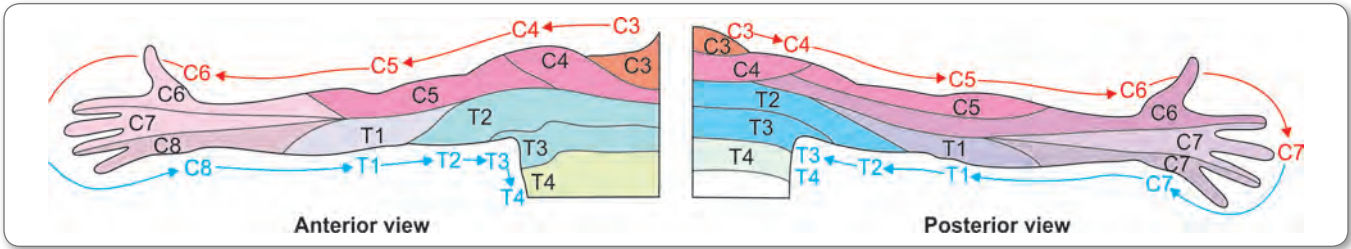
[Ref: BDC 4th ed. volume 1 pg 153]
 Adduction of wrist (ulnar deviation) done by flexor carpi ulnaris, extensor carpi ulnaris

Joints	Type
Sternoclavicular	Atypical synovial -Saddle
Acromioclavicular	Atypical synovial -Plane
Shoulder	Ball and socket
Elbow	Hinge
Superior Radioulnar joint	Pivot
Radioulnar joint	Syndesmosis
Inferior Radioulnar joint	Pivot
Wrist	Synovial
Carpometacarpal joint of thumb	Saddle joint
Metacarpophalangeal joint	Synovial Biaxial (Ellipsoid)
Interphalangeal joint	Hinge

Nerves of Upper Limb

59. Ans. c. C8

[Ref: Clinically Oriented Anatomy of K.L. Moore 5th ed. pg 746]
 C3 and C4 nerves supply the region at the base of the neck extending laterally over the shoulder.
 C5 nerve supplies the arm laterally (i.e., on the superior aspect of the abducted limb).
 C6 nerve supplies the forearm laterally and the thumb.
 C7 nerve supplies the middle and ring fingers (or middle three fingers) and the middle of the posterior surface of the limb.
 C8 nerve supplies the little finger, the medial side of the hand, and the forearm (i.e., the inferior aspect of the outstretched limb).
 T1 nerve supplies the middle of the forearm to the axilla.
 T2 nerve supplies a small part of the arm and the skin of the axilla. (This is not indicated on the Keegan and Garrett map; however, pain experienced during a heart attack, considered to be mediated by T1 and T2, is commonly described as radiating down the medial side of the left arm.



Shade brachial plexus

60. Ans. b. lower trunk

Loss of sensations along the medial border of forearm and clawing of hand – branch from medial cord – medial cord is anterior division of lower trunk

61. Ans. c. Loss of pronation at radioulnar joint

[Ref: Grays Anatomy 40th ed. pg 822]

Forearm is pronated at radioulnar joint, other options are correct

62. Ans. b coracobrachialis

[Ref: Grays Anatomy 40th ed.]

Coracobrachialis supplied by Musculocutaneous nerve with root value C5,C6,C7

63. Ans. c. Median and ulnar nerve were affected

[Ref: Grays Anatomy 40th ed. pg 822]

Features suggestive of erbs palsy, median and ulnar nerve are not affected

64. Ans. b. Pronation of forearm, c. Inability to initiate the..., e. Paralysis of deltoid muscle

[Ref: Grays Anatomy 40th ed. pg 822]

Upper trunk injury – erb s palsy, decreased sensation along medial hand is by ulnar nerve which is not affected in erb's palsy

65. Ans. d. Upper trunk of brachial...

[Ref: Grays Anatomy 40th ed., 2008, Page 848]

Klumpkes paralysis is due to lower trunk injury C8,T1

66. Ans. d. Suprascapular nerve

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 57]

Initiation of abduction (0 to 15) – supraspinatus – suprascapular nerve
15 to 90 abduction – middle fibers of deltoid – axillary nerve
90 to 180 – trapezius and serratus anterior – spinal accessory nerve and long thoracic nerve

67. Ans. d nerve to subclavius > a supra scapular nerve

C5 C6 (A.K.Datta Essentials of Human Anatomy part II 5th ed)

Nerve to subclavius – small and arise near the junction of fifth and sixth cervical ventral rami

68. Ans. d. C8, e. T1

All small muscles supplied by C8, T1

Long Thoracic Nerve

69. Ans. c. Long thoracic nerve

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3 pg 43]

Winging of scapula due to serratus anterior (more prominent when the subject pushes the resistance)—supplied by long thoracic nerve

Winging of scapula also due to trapezius palsy—which is differentiated from serratus anterior palsy by keeping upper limb by side of the body.

Axillary Nerve

70. Ans. a. atrophy of deltoid muscle, c. loss of rounded contour of shoulder joint

Axillary nerve injury – deltoid palsy (loss of round contour of shoulder) – loss of 15° to 90° of abduction

Axillary nerve gives upper lateral cutaneous nerve of arm

71. Ans. d. Posterior circumflex humeral

[Ref: Essentials of Human Anatomy by AK datta 5th ed. volume 3, pg 58]

Axillary nerve and posterior circumflex humeral artery leaves through quadrangular space

Musculocutaneous Nerve

72. Ans. a. Loss of flexion at shoulder joint

[Ref: Grays Anatomy 40th ed. pg 828]

Musculocutaneous nerve supplies biceps, coracobrachialis, brachialis

So musculocutaneous nerve injury – loss of flexion at elbow (biceps, brachialis) and supination (biceps palsy), musculocutaneous nerve continue as lateral cutaneous nerve of forearm
Flexion of shoulder joint – clavicular part of pectoralis major and anterior fibers of deltoid



Radial Nerve

73. **Ans. a. Branch of posterior cord, b. Nerve of extensor compartment..., c. Arise from C5-T1, e. supplies skin of extensor compartment**

[Ref: Grays Anatomy 40th ed. pg 856]

Posterior interosseous nerve is branch from radial nerve
Anterior interosseous nerve – from median nerve

74. **Ans. d. Posterior interosseous nerve**

[Ref: Gray Anatomy 40th ed. pg 856]

No wrist drop – radial nerve is not correct option – radial nerve supplies extensor carpi radialis longus – so no wrist drop
Extension of IP joint by lumbricals supplied by Ulnar and median nerve normal
Posterior interosseous nerve palsy – Extension of metacarpophalangeal jt is lost

75. **Ans. b. Radial nerve injury**

[Ref: Gray Anatomy 40th ed. pg 857]

No wrist extension – loss of sensation along dorsum of hand and fingers suggest radial nerve injury

76. **Ans. a. Extensor carpi radialis longus**

[Ref: Gray Anatomy 40th ed. pg 857]

Extensor carpi radialis longus supplied by radial nerve above the elbow
All the extensors of forearm supplied by posterior interosseous nerve except extensor carpi radialis longus, brachio radialis, anconeus supplied directly by radial nerve

77. **Ans. a. Opposition, c. Adduction, e. Flexion**

[Ref: Essentials of Human Anatomy – AK Dutta 4th ed. volume.3 pg 3]

Opposition by opponens pollicis supplied by median nerve
Adduction by adductor pollicis supplied by deep branch of ulnar nerve
Flexion by flexor pollicis longus supplied by anterior interosseous nerve, flexor pollicis brevis – supplied by median nerve

78. **Ans. d. Anconeus**

[Ref: Gray's Anatomy 40th ed. pg 829,837]

After spiral groove it gives branches to Brachialis, Brachioradialis and Extensor carpi radialis longus. Anconeus supplied by nerve to medial head of triceps in the spiral groove

79. **Ans. c. Extension of elbow joint intact**

[Ref: (A.K.Datta Human Anatomy 5th ed. part I)]

Injury to radial nerve results in the paralysis of Extensor carpi radialis longus
Muscles spared is triceps, anconeus
So elbow extension is not affected
Difficulty in supination due to involvement of supinator muscle

80. **Ans. a. Loss of nerve supply to brachioradialis**

Features of Low Radial Nerve Palsy

Elbow extension is preserved
Extensor carpi radialis longus, brachio radialis, anconeus supply preserved
Sensory loss over the first dorsal web space

Median Nerve

81. **Ans. b. Lateral and medial cord, c. Lateral to axillary artery..., e. Deep to pronator teres...**

Branch from medial and lateral cord
Medial to brachial artery in the cubital fossa

82. **Ans. d. Oppose the thumb**

Flex the distal phalanx of thumb is by flexor pollicis longus – anterior interosseous nerve
Adduction of thumb – adductor pollicis – deep branch of ulnar nerve
Abduction of thumb – abductor pollicis longus by radial nerve
Oppose by thumb – opponens pollicis – median nerve

83. **Ans. c. Pronator quadratus**

84. **Ans. a. Femoral nerve**

[Ref: (A.K.Datta Textbook of Anatomy, 5th ed. 1st part)]

Median nerve – Entrapment syndrome

Pronator Syndrome

Causes

Under Struther ligament
Under Bicipital aponeurosis
Aponeurotic edge of deep head of Pronator teres
Under tendinous arch connecting Flexor digitorum superficialis.

Ulnar Nerve - Entrapment Syndrome

Cubital tunnel syndrome – Causes – Compressed behind the tendinous arch connecting two heads of Flexor carpi ulnaris.

Radial Nerve - Entrapment Syndrome

Radial tunnel syndrome

- Sharp medial border of Extensor carpi radialis brevis
 - Arcade of Frohse – Free aponeurotic proximal edge of superficial part of Supinator.
- Wartenberg's syndrome – Entrapment of radial nerve due to scissoring effect of Brachioradialis and Extensor carpi radialis brevis as it emerges 6cm above styloid process.

85. **Ans. a. Opponens pollicis, b. Abductor pollicis brevis, c. Flexor pollicis..., d. First lumbrical**

86. **Ans. b. Median nerve**

87. **Ans. c. Median nerve**

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 103,104]



Ulnar Nerve

88. Ans. a. Having root value of C7, C8, T1, b. Arise from medial cord of brachial plexus

Adductor pollicis – ulnar nerve – supplies 3,4 th lumbrical, branch from medial cord

89. Ans. b. Abductor pollicis palsy

[Ref: BDC 6th ed. vol. I / 109-110, 120]

Abductor pollicis longus supplied by posterior interosseous nerve

90. Ans. b. Palmaris brevis

[Ref: Gray Anatomy 40th ed. pg: 589]

91. Ans. b. Complete paralysis of III and IV digits

Medial epicondyle fracture – ulnar nerve injury – hypothenar atrophy and decreased sensation and ulnar deviation on flexion

92. Ans. d. Ulnar nerve before division into superficial and deep

Atrophy and numbness due to involvement of superficial and deep branch of ulnar nerve

93. Ans. d. Pass between supinator heads

Ulnar nerve C7, 8, T1 –no branch in arm, superficial to FDP and flexor retinaculum

94. Ans. a. Adductor pollicis d. 3rd lumbrical

Deep branch of ulnar nerve supplies flexor digiti minimi, abductor digiti minimi, opponens digiti minimi, 3rd and 4th lumbricals, 4 dorsal interossei and 4 palmar interossei

95. Ans. d. Adducted thumb

Ulnar nerve supplies adductor pollicis so palsy leads to abducted thumb

96. Ans. a. Weakness of adduction of thumb, b. Froment sign, e. 4th and 5th finger clawing

Thenar eminence atrophy – median nerve, pointing index deformity – median nerve injury

97. Ans. a. Opponens pollicis

[Ref: (I.B. Singh Textbook of Anatomy 6th ed)]

Ulnar nerve injury at wrist produce paralysis of the following muscles

Hypothenar muscles (Abductor digiti minimi, Flexor digiti minimi and Opponens digiti minimi)

Palmar and Dorsal interossei muscles

Adductor pollicis.

3rd and 4th lumbricals

Deep head of Flexor pollicis brevis

Palmaris brevis

Blood Vessels of Upper Limb

98. Ans. c. Axillary vein

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 27,28]

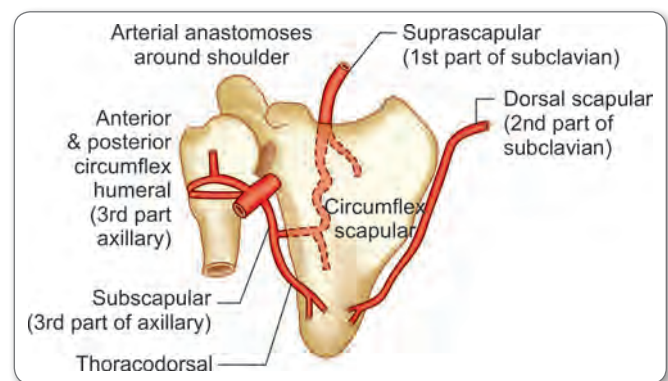
99. Ans. a. Subcutaneous

[Ref: Gray's Anatomy 39th ed p 490, Clinical Anatomy by Regions by Richard Snell 9th ed p 370]

100. Ans. d. 2nd part of axillary artery

[Ref: BDC 6th ed. vol. I/73]

Subscapular artery anastomosis with transverse cervical and supra scapular (branches of first part of subclavian artery)



101. Ans. c. Deep branch of transverse cervical artery and subscapular artery

Anastomosis is between first part of subclavian artery and 3rd part of axillary artery

Anterior, posterior circumflex humeral artery, Circumflex scapular and subscapular artery are branches from axillary artery

102. Ans. b. Ulnar artery

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 75]

Common interosseous artery branch from ulnar artery

103. Ans. b. Posterior interosseous artery

[Ref: Gray's anatomy 40th ed ch 49, AK Datta 5th ed. volume 3, pg 75]

Recurrent interosseous artery branch of Posterior interosseous artery

104. Ans a. Mainly radial artery and partly...

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 94]

105. Ans. c. Gives three perforating arteries

Deep palmar mainly by radial arter

Lies deep to long flexors and lumbricals

Gives perforating branches and palmar metacarpal arteries.



Mammary Gland

Breast

106. Ans. b. Modified sweat gland

[Ref: Keith Moore 6th/ed. p. 100]

107. Ans. d. Nipple is supplied by 6th intercostal nerve

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 36]

Nipple is supplied by 4th intercostals nerve

108. Ans. b. Pectoral fascia

[Ref: Last Anatomy 12th ed. pg 56-58]

Suspensory ligament of Cooper which anchor the dermis of skin to pectoral fascia

109. Ans. a. Lateral thoracic artery, b. Internal mammary artery, d. Superior thoracic artery

[Ref: Grays Anatomy 40th ed. pg 931-932]

Breast supplied by internal thoracic, posterior intercostal artery, superior thoracic artery, lateral thoracic artery, thoracoacromial artery, subscapular artery.

110. Ans. b. 15 – 20

[Ref: BDC 6th ed. volume 1 pg 35]

111. Ans. b. Lateral thoracic artery

[Ref: BDC 4th/ed. Vol. I p. 46-47]

Lateral thoracic artery not pierce the clavipectoral fascia

112. Ans. d. Suspensory ligament

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 42]

Cubital Fossa

Below – splits and enclose pectoralis minor and continue as suspensory ligament of axilla

113. Ans. d. Thoraco acromial artery, cephalic vein, lateral pectoral nerve

Clavipectoral fascia pierced by Thoraco acromial artery, cephalic vein, lateral pectoral nerve

Axilla and Contents

114. Ans. a. Medial cord of brachial plexus, long thoracic nerve of bell, subscapularis

- A – Medial cord
- B – long thoracic nerve
- C – subscapularis

115. Ans. d. Roots of brachial plexus

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 49]

Roots of brachial plexus not content, only cords of brachial plexus and their branches are the contents.

116. Ans. c. Supraspinatus

[Ref: BDC 6th ed. vol. I /47; Gray's Anatomy, 39th ed/ 841]

Posterior wall formed by teres major, subscapularis, latissimus dorsi

117. Ans. a. Pectoralis major

[Ref: Gray's Anatomy 39th ed p 841, 40th ed ch: 46]

118. Ans. c. Superior

[Ref: Clinical Anatomy 11th ed. / 160-161]

Based on location with respect to pectoralis minor,

- Low group at level 1 – below the muscle
- Middle group at level 2 – behind muscle
- Upper at level 3 – above the muscle
- Rotters node – nodes intervening between pectoralis minor and major

119. Ans. b. Radial nerve

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 66]

From medial to lateral, median nerve, brachial artery, biceps tendon and radial nerve

Mn – MBBR

120. Ans. c. Medial border of brachioradialis

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 65,66]

Lateral boundary – medial border of brachioradialis

Medial boundary – lateral border of pronator teres

Anatomical Snuff Box

121. Ans. c. Extensor pollicis longus

[Ref: Gray's 41st ed. /790]

122. Ans. d. Abductor pollicis brevis

[Ref: Gray's Anatomy 41st ed. /790]

Lateral boundary – abductor pollicis longus and extensor pollicis brevis

Medial boundary – extensor pollicis longus

Flexor and Extensor Retinaculum

123. Ans. a. Ulnar nerve e. radial artery

[Ref: BDC 6th ed. vol. I / 113]

Ulnar nerve and vessels are superficial to flexor retinaculum

Radial artery not pass below flexor retinaculum

**124. Ans. d. Extensor pollicis longus**

[Ref: Last Anatomy 12th ed. pg 77,78]

Space**125. Ans. d. Deltoid**

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. vol 3, pg 58]

Boundaries

- Above – subscapularis, lower part of capsule of shoulder joint, teres minor
- Below – teres major
- Medially – long head of triceps
- Laterally – surgical neck of humerus

126. Ans. b. Lateral border of vertebral column

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 54]

Medially – lateral border of trapezius

Laterally – medial (vertebral) border of scapula

Inferiorly – upper fibers of latissimus dorsi.

Floor – 7th rib, 6th and 7th intercostal space and rhomboideus major

127. Ans. c. 1st lumbrical

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 96]

1st lumbricals related to thenar space

128. Ans. c. Thenar space

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3, pg 96]

Infection of thumb and index finger spread to thenar space.

Infection of middle, ring and little finger spread to mid palmar space.

Scapula and Shoulder Region**129. Ans. a. Serratus anterior**

[Ref: BDC-I 6th /e pg. 44, 57, 90]

Winging of scapula is due to serratus anterior.

130. Ans. d. Latissimus dorsi

[Ref: BDC-I 6th /e pg. 62]

Muscles of upper limb used for climbing latissimus dorsi and biceps.

131. Ans. b. Teres major

[Ref: BDC-I 6th /e pg. 144]

Teres major is not rotator cuff muscle.

132. Ans. d. Rotator cuff injury

[Ref: BDC-I 6th /e pg. 56, 144]

Supra scapular nerve gets compressed in fractured scapula, tear of rotator cuff of shoulder arthrodesis.

Forearm and Hand**133. Ans. a. Deep branch of ulnar nerve**

[Ref: BDC -I 6th /e pg.120]

Adductor pollicis supplied by deep branch of ulnar nerve.

134. Ans. a. Zone 2**135. Ans. a. Parasthesia in response to compression**

Durkan s test is a medical procedure to diagnose a patient with carpal tunnel syndrome.

Examiner presses thumb over carpal tunnel and hold for 30 seconds. Onset of pain or paresthesia in median nerve distribution within 30 seconds is positive for test.

136. Ans. a. Teres minor

- Lateral border of scapula gives origin to teres minor muscle
- Long head of triceps arises from the infraglenoid tubercle on the lateral border of scapula
- Infraspinatus attaches to the dorsal surface and subscapularis to the ventral surface of scapula

137. Ans. a. Supraspinatus initiates abduction; b. Serratus anterior and trapezius also help in abduction; e. Musculotendinous cuff stabilizes shoulder joint

- Both supraspinatus initiate abduction
- Serratus anterior and trapezius also help in overhead abduction
- The multipennate acromial (not clavicular) fibres of deltoid are the powerful abductors of arm at the shoulder joint
- Axillary nerve injury paralyses the deltoid, hence abduction is affected.
- Musculotendinous rotator cuff stabilizes the shoulder joints

138. Ans. d. Flexor carpi ulnaris

- Flexor carpi ulnaris causes flexion at the wrist and ulnar deviation (adduction)
- Flexor carpi radialis – flexion and radial deviation

139. Ans. b. Coracoacromial ligament

- Coraco acromial ligament prevent upward dislocation of shoulder joint

140. Ans. c. Median

- Radial nerve (branch from posterior cord)and median nerve (branch from medial cord and lateral cord) carry all the five root values of brachial plexus

**141. Ans. d. C4 root is post fixed to plexus**

- Contribution by C4 is pre-fixed brachial plexus. Post-fixed brachial plexus has T2

142. Ans. a. Levator scapulae and rhomboids

- The dorsal scapular nerve innervates the rhomboid muscles and. Together with C3 and C4 fibres it supplies levator scapulae

143. Ans. d. Dorsal divisions of upper, middle and lower trunks

- Upper, middle and lower trunks dorsal divisions join to form the posterior cord of brachial plexus

144. Ans. b. Long thoracic nerve

- The roots of C-5,6,7 contribute to the long thoracic nerve(of bell) in the neck region (supraclavicular portion of brachial plexus)

145. Ans. a. Teres minor

- Posterior cord branch axillary nerve which supplies teres minor and deltoid muscle

146. Ans. d. Lesion Lead to partial injury of radial nerve

- Upper trunk - C-5,6
- Trunks of brachial plexus pass between scalenus anterior and medius muscle. It lies to the scalenus anterior muscle, where a block can be carried out not on the medial side
- Long thoracic nerve arise from the roots
- Lesion of upper trunk -Erb's palsy leads to injury of radial nerve

147. Ans. b. Most common site of injury is upper trunk, c. Injury may occur during breech delivery, e. Lower trunk injury results in hand deformity

- Brachial plexus is formed by C5-8; T1.Radial nerve is a branch of the posterior cord

148. Ans. a. Weakness of brachioradialis

- Low radial nerve palsy spares brachioradialis

149. Ans. a. Continuation of lateral cord of brachial plexus

- Radial nerve is continuation of the posterior cord of brachial plexus

150. Ans. d. Anconeus

- Radial nerve gives branch to anconeus muscle in the groove - not below

151. Ans. d. Lower lateral cutaneous nerve of arm

- Radial nerve, profundabrachii artery, the lower lateral cutaneous nerve of the arm and the posterior cutaneous nerve of the forearm are given by radial nerve in the radial groove

152. Ans. b. Anterior part of lateral epicondyle

- Radial nerve pass in front of the lateral condyle of humerus divides into two terminal branches

153. Ans. b. Posterior interosseous nerve

- Pin palsy causes finger drop not wrist drop

154. Ans. b. Sensory loss on dorsum of 1st web space

- Radial nerve does not give any motor fibres at the level of wrist
- Superficial cutaneous branch of radial nerve injured at wrist

155. Ans. c. Wasting and weakness of adductor pollicis

- Adductor pollicis – supplied by deep branch of ulnar nerve

156. Ans. a. Median

- Median nerve injury leads to 'benediction hand' deformity, pointing index deformity and ape thumb deformity.

157. Ans. a. Median nerve**158. Ans. b. Addison's disease**

- Addison's disease has not been co-related with carpal tunnel syndrome in clinical studies
- Hypothyroidism increase in the thickness of tendons passing under the floor retinaculum. This compress the median nerve passing through it.
- Diabetes mellitus affects the nerves. So it is prone to any compression injury
- Amyloid deposition takes place in the carpal tunnel. thus compress the median nerve

159. Ans. a. 1st and 2nd lumbricals

- Median nerve supplies first two lumbricals.

160. Ans. a. Opponents pollicis; c. Lateral half of the flexor digitorum profundus; d. superficial head of flexor pollicis brevis

- Opponens pollicis Is median nerve
- Adductor pollicis is supplied by ulnar nerve
- Lateral half of the flexor digitorum profundus is supplied by the median nerve
- The superficial head of flexor pollicis brevis is innervated by the median nerve and the deep part by the deep branch of the ulnar nerve

161. Ans. d. None

- Ulnar nerve gives no branch in the arm

162. Ans. a. High level injury- less severe claw hand

- Ulnar paradox – higher the lesion lesser the degree of claw hand
- Option d also correct
- But best answer is a only

163. Ans. a. Convey ulnar nerve, b. Lies at wrist

- Guyon's canal is located at the wrist . ulnar nerve and artery pass through canal

164. Ans. c. Median and ulnar nerves

- Opponens pollicis and opponens digiti minimi supplied by median nerve ulnar nerve respectively

**165. Ans. c. Radial**

- Radial nerve is the largest branch of brachial plexus.

166. Ans. b. Branch of radial nerve supplying medial head of triceps

- Branch to medial head of triceps lies close to the ulnar nerve as far as the lower third of the arm is called as ulnar collateral nerve

167. Ans. a. Radial nerve

- Lower lateral cutaneous nerve of arm – branch of radial nerve
- Upper lateral cutaneous nerve of arm – axillary nerve

168. Ans. c. Thumb

- Thumb movements are varied and all the three major nerves work for that

169. Ans. a. Supraspinatus at lesser tubercle

- Supraspinatus attach to greater tubercles

170. Ans. d. Adduction of shoulder

- Anterior fibres of Deltoid muscle - flexion and medial rotation
- Posterior fibres of Deltoid muscle - extension and lateral rotation
- Middle fibres - abductor at shoulder joint

171. Ans. a. Damage to spinal accessory nerve, b. Paralysis of trapezius muscle

- Spinal accessory nerve runs very superficial in the posterior triangle of neck
- Injury leads to paralysis of trapezius and sternocleidomastoid muscle and
- Difficulty shrugging the shoulder, as well as overhead abduction

172. Ans. d. Front of humerus

- Humerus not gives origin to biceps

173. Ans. b. Long head of biceps brachii

- Long head of biceps brachii is intracapsular and extrasynovial, but enclosed by a prolongation of synovial membrane.
- Long head of biceps and popliteus intra capsular

174. Ans. b. Extensor carpi radialis longus

- Extensor carpi radialis longus is supplied by radial nerve

175. Ans. c. Musculocutaneous

- Coracobrachialis is pierced and supplied by musculocutaneous

176. Ans. a posterior forearm muscle > b. Screwing movement

- Anconeus assists triceps in extending forearm (major action); stabilizes elbow joint; may abduct ulna during pronation. Some books mention it helps in screwing movements
- It is small muscle on the posterior compartment of forearm
- It is innervated by a branch of the radial nerve

177. Ans. a. Brachioradialis

- Brachioradialis muscle – in extensor compartment but causing elbow flexion

178. Ans. c. Anterior interosseous nerve

- Pronator teres muscle causes pronation at proximal radioulnar joint supplied by median nerve
- Pronation at distal radioulnar joint is carried out by pronator quadratus, supplied by the anterior interosseous nerve

179. Ans. c. Pronator teres

- Pronator teres not hybrid muscle is supplied by median nerve

180. Ans. b. Lower subscapular nerve

- Teres major is supplied by the lower subscapular nerve, which also supplies subscapularis muscle

181. Ans. b. Latissimus dorsi

- Latissimus dorsi is a muscle of upper limb supplied by thoracodorsal nerve branch of brachial plexus but has migrated to the trunk region for better functionality

182. Ans. c. Deltoid

- Anterior fibres of deltoid act for flexion and medial rotation at shoulder joint and posterior fibres for extension and lateral rotation
- Pectoralis major work for adduction
- Subscapularis and teres major muscle are not involved in abduction, though both of the, carry out lateral rotation

183. Ans. b. Ulnar nerve lies medially to distal 1/3 of artery; c. Radial nerve lies posteriorly distal 1/3 of artery

- Start at the outer border of first rib
- Ends at the lower border of teres major
- Axillary vein medial to artery

184. Ans. d. Superior thoracic

- Superior thoracic artery not involved in scapular anastomosis

185. Ans. b. Anterior interosseous artery

- Anterior interosseous artery pierces the interosseous membrane to reach posterior forearm and anastomose with posterior interosseous artery

186. Ans. c. Pectoralis minor muscle

- Axillary artery passes to the pectoralis minor muscle, which divides the artery into three parts

187. Ans. d. Radial collateral

- Radial collateral artery is anterior descending branch of the profunda brachii artery, not a direct of brachial artery

188. Ans. c. 3rd part of axillary artery

- Anterior and posterior circumflex humeral arteries (branches from 3rd part of axillary artery) wind around the neck of humerus

**189. Ans. a. Cephalic vein**

- Cephalic vein is preaxial vein, embryologically, runs with the preaxial bone radius

190. Ans. c. Subscapularis

- Subscapularis is anterior relation of upper triangular space

191. Ans. b. Cephalic vein

- Deltopectoral groove contains cephalic vein

192. Ans. a. Situated under clavicular portion of the pectoralis minor

- Clavipectoral fascia is situated under clavicular portion of the pectoralis major, it splits to enclose pectoralis minor

193. Ans. a. Prevertebral fascia

- Axillary sheath covers brachial plexus which is derived from prevertebral fascia

194. Ans. d. Ulnar nerve

- Ulnar nerve not a content of cubital fossa

195. Ans. c. Brachial artery

- Bicipital aponeurosis derived from biceps tendon passes superficial to the brachial artery and median nerve.
- It lies deep to superficial veins

196. Ans. a. Anterior axillary

- Lymphatics from upper outer quadrant of breast drain into anterior (pectoral) axillary lymph nodes

197. Ans. b. Lateral group lies along lateral thoracic vessels

- Lateral group of axillary lymph nodes lie along the axillary vein

198. Ans. c. Blockade of sub-dermal ligament

- Subcuticular lymphatic obstruction leads to peau d'orange appearance

199. Ans. d. Adductor pollicis

- Dorsal digital expansion is a tendinous modification of extensor digitorum and receives attachment of lumbricals, interossei but not adductor pollicis

200. Ans. b. Rupture of collateral slips of extensor expansion

- 'Mallet finger' describes the characteristic drooping of the finger observed with injury to the extensor digitorum as its insertion at the base of the distal phalanx (the collateral slips)

201. Ans. b. Palmar interossei

- Card test—to check palmar interossei

202. Ans. c. FPL

- Radial bursa is the synovial sheath covering the tendon of flexor pollicis longus

203. Ans. c. Anterior interosseous nerve

Supracondylar fracture – nerve affected ANTERIOR INTEROSSEOUS NERVE

Not able to flex the thumb – muscle affected flexor pollicis longus – supplied by anterior interosseous nerve

204. Ans. b. Ulna

Wrist joint

Synovial Biaxial (Ellipsoid)

Proximally—inferior surface of distal radius

Distally—Scaphoid, Lunate, Triquetral

205. Ans. a. Mallet finger

MALLET FINGER(BASE BALL FINGER) – Finger with permanent flexion of the distal phalanx due to avulsions of lateral band of extensor tendon

BOUTONNIERE DEFORMITY.– Abnormal flexion of middle phalanx and hyperextension of distal phalanx due to avulsion of central band of the extensor tendon to the middle phalanx

206. Ans. a. FDP

Jersey finger – avulsion of FDP TENDON AT DISTAL PHALANX

207. Ans. c. Radial nerve

- Dorsiflexion of wrist not possible – extension of wrist not possible – wrist drop

- Wrist drop is due to radial nerve injury

- Finger drop, not wrist drop seen in posterior interosseous nerve injury

208. Ans. a. Ulnar nerve palsy

Froment test to check the adductor pollicis which is supplied by ulnar nerve

Ulnar nerve normal – patient hold the paper between thumb and index finger – test is negative

In ulnar nerve injury – compensatory flexion at the interphalangeal joint of thumb to hold the paper – froment sign – test is positive

209. Ans. a. Extensor digitorum

- Posterior interosseous nerve supplies all the muscles of posterior compartment of forearm except brachioradialis, extensor carpi radialis longus and anconeus

- Extensor digitorum supplied by posterior interosseous nerve

- Brachialis – hybrid muscle – supplied by musculocutaneous nerve – radial nerve

- Pronator quadratus – anterior interosseous nerve

210. Ans. a. Median nerve

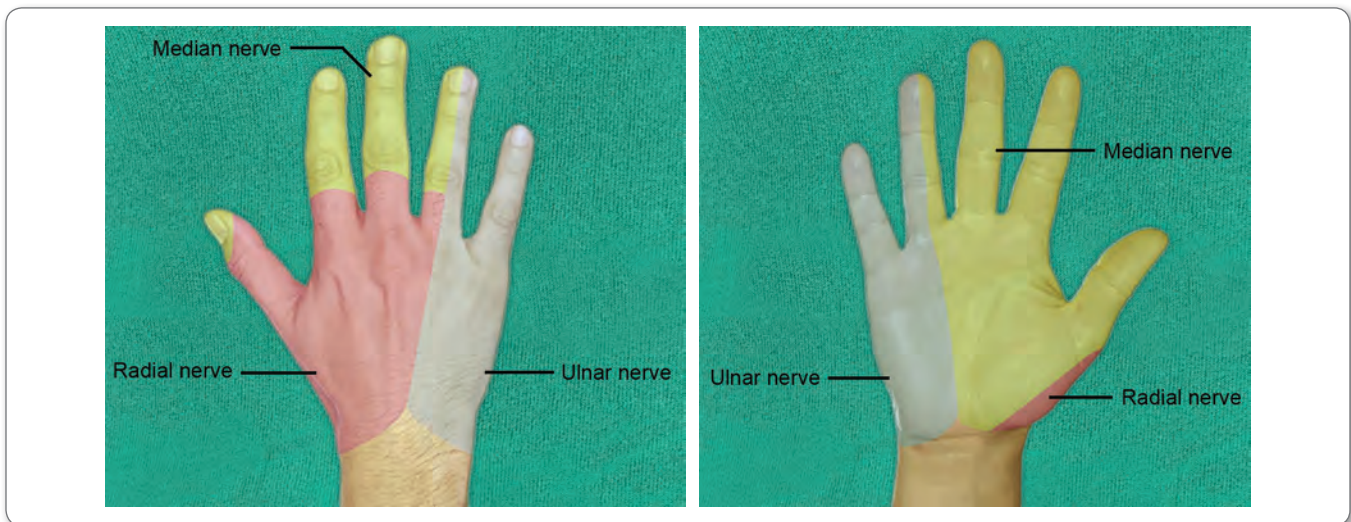
Marked muscle 1st lumbrical

1st two lumbricals supplied by median nerve

3,4 th lumbrical – deep branch of ulnar nerve



211. Ans. a. Radial nerve



212. Ans. b. Extensor carpi radialis longus

Marked muscle is extensor radialis longus

213. Ans. a. Extensor carpi ulnaris, c. Extensor carpi radialis brevis, d. Extensor digitorum

Brachioradialis, extensor carpiradialis longus supplied by radial nerve

214. Ans. b. Teres major

Teres major not part of rotator cuff

215. Ans. a. C5, b. C6, c. C7

Long thoracic nerve – nerve of bell – C5,6,7 – arising from root of brachial plexus

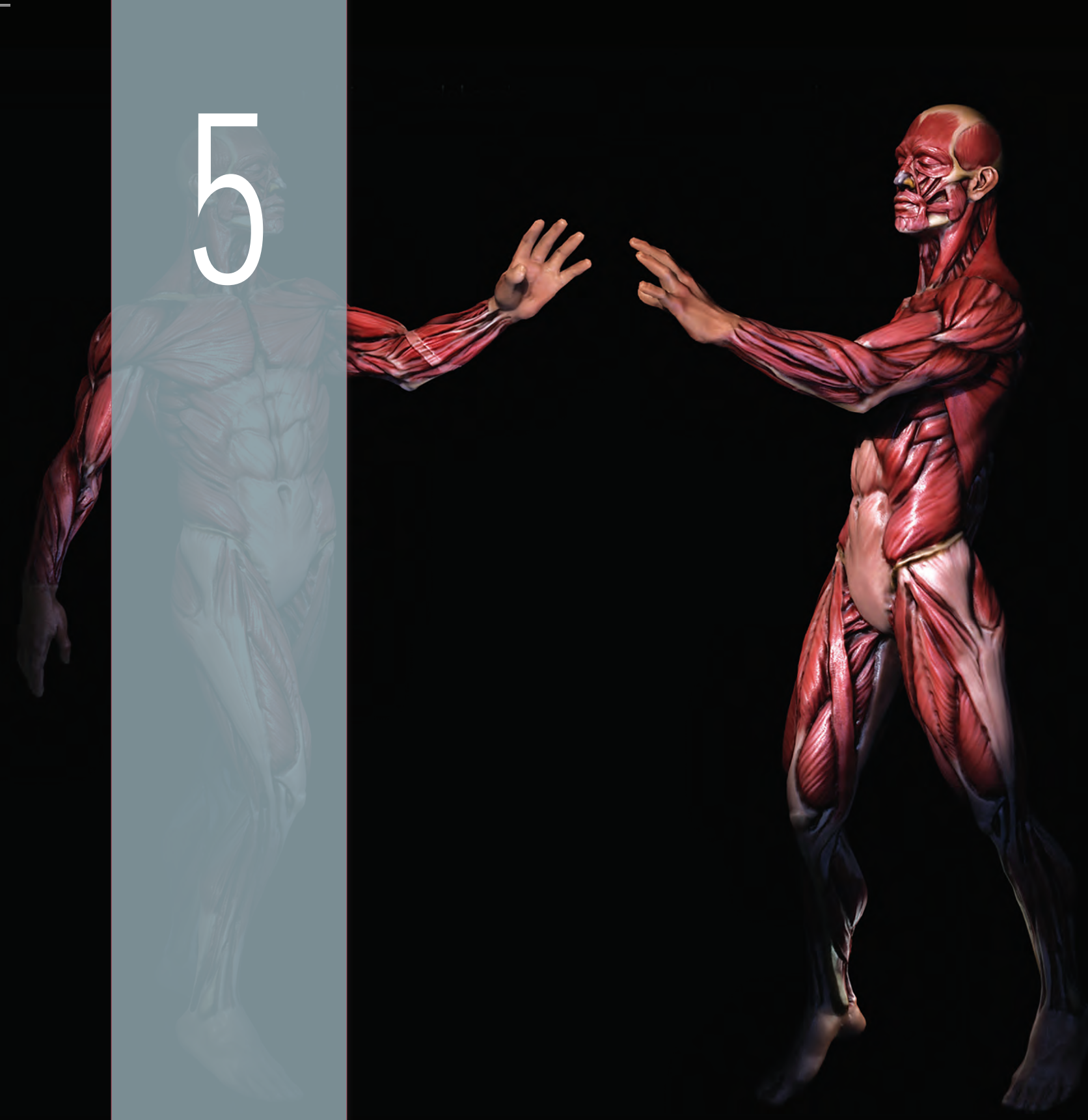
216. Ans. a. C5,6, d. Arm adducted and internally rotated, e. Associated with birth injuries

- Erb's palsy C5,6 – upper trunk injury
- Arm adducted and internally rotated. Elbow extended and forearm pronated
- Erb's palsy associated with birth injuries

NOTES

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5



LOWER LIMB

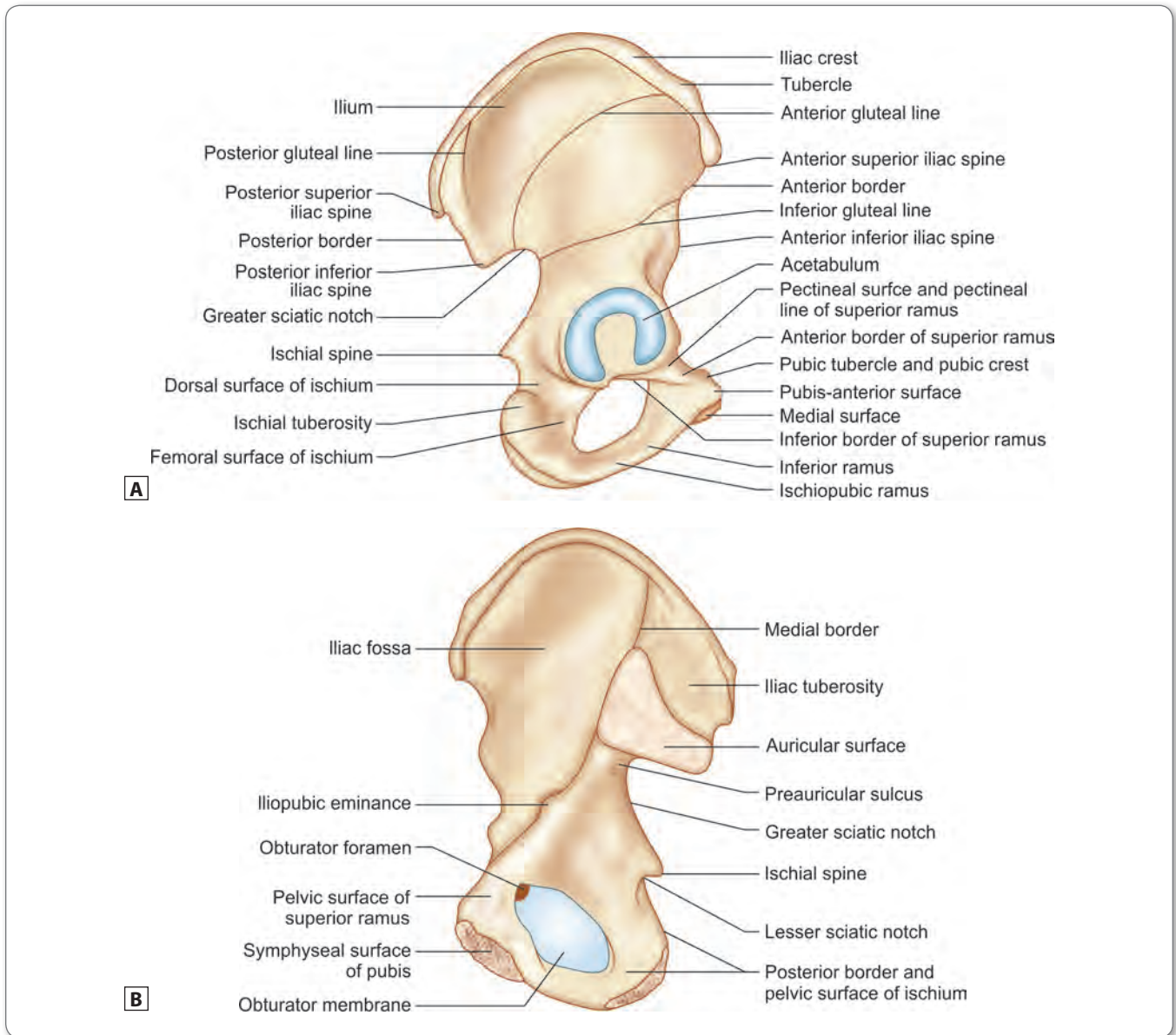


LOWER LIMB DEVELOPMENT

- Lower limb bud appear at the 5th week. (upper limb bud – by the end of 4th week – 2 days later lower limb bud appears)
- Bones derived somatopleuric lateral mesoderm
- Muscles derived from paraxial mesoderm – myotome of somites
- Lower limb rotates 90° medially so that extensor compartment become anterior, flexor compartment – posterior and great toe on medial side
- Pre axial vein – long saphenous vein, post axial vein – small saphenous vein
- Blood supply is derived from 5th lumbar intersegmental artery.

OSTEOLOGY

HIP BONE



Figs 1A and B: Hipbone. **(A)** Lateral view; **(B)** Medial view

Comprises of one dorsal component—ilium and two ventral components—ischium and pubis.



Ilium

- Iliac crest: Upper end extends from anterior superior iliac spine to posterior superior iliac spine
- Anterior superior iliac spine (ASIS): situated at the level of **S1** – attachments – Inguinal ligament and one Sartorius.
- Posterior superior iliac spine (PSIS): situated at **S2**. PIIS – situated at S3
- Anterior inferior iliac spine: Attachments iliofemoral ligament and straight head of rectus femoris
- The highest point of iliac crest at **L4**
- Iliac crest consists of anterior 2/3 ventral segment and posterior 1/3 dorsal segment
- Ventral segment consists of outer lip, intermediate lip and inner lip
- Tubercle of iliac crest: At **L5** – 5 cm behind the anterior superior iliac spine
- Tensor fascia lata extending from anterior superior iliac spine to tubercle of iliac crest
- External oblique in anterior 2/3 of outer lip and leaving gap for base for lumbar triangle and then to latissimus dorsi
- Internal oblique in entire intermediate area of ventral segment
- Transverse abdominis in the anterior 2/3 and quadratus lumborum in posterior one third of inner lip
- Anterior gluteal line arises from greater sciatic notch to tubercle of iliac crest.

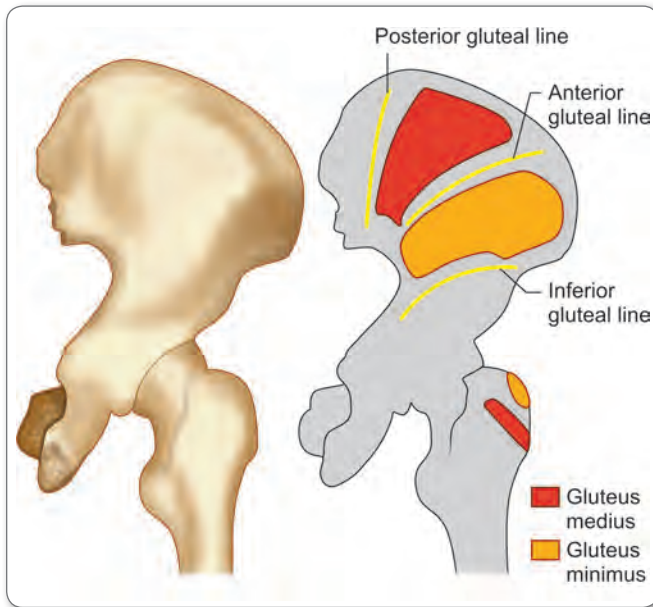
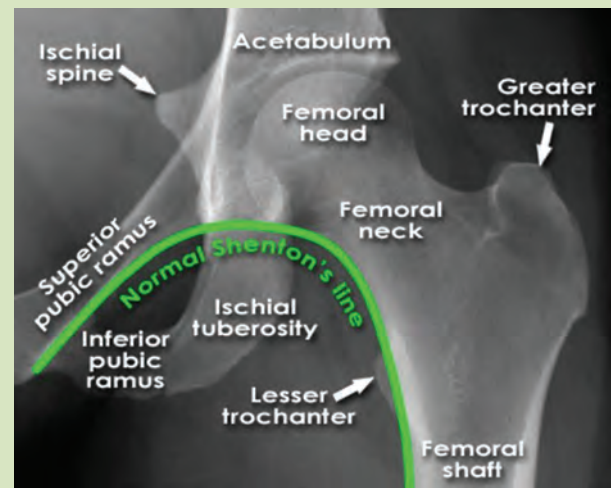


Fig. 2: Gluteal lines

- Posterior gluteal line: From greater sciatic notch to dorsal segment of iliac crest
- Inferior gluteal line: From greater sciatic notch to anterior inferior iliac spine

HIGH YIELD POINTS

- Area behind posterior gluteal line: Origin to gluteus maximus; area between anterior and posterior gluteal line origin to gluteus medius; area between anterior and inferior line origin to gluteus minimus; area below the inferior line origin to reflected head of rectus femoris.
- Posterior/pelvic surface of pubic crest forms the anterior wall of retro pubic space known as **cave of Retzius**, which separates it from bladder.
- Sharp superior border of superior pubic ramus forms pectin pubis or **pectineal line** which extends from pubic tubercle to the iliopubic eminence.
- Inferior margin of superior pubic ramus and medial margin of femur neck together form a smooth and curved line known as **Shenton's line**.



Nelaton's Line

Line drawn by joining anterior superior iliac spine and ischial tuberosity. It passes through the highest part of greater trochanter.

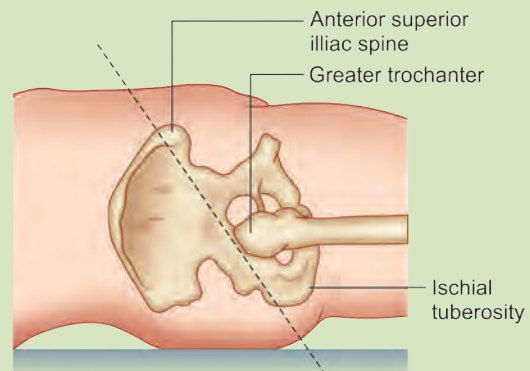


Fig. 3: Nelaton's line



Ischium

Ischial Tuberosity

- Divided into upper quadrilateral and lower triangular area by transverse ridge.
- **Oblique ridge:** Quadrilateral area into upper and lateral area (semimembranosus origin) and lower and medial (semitendinosus and long head of biceps origin).
- Lower triangular part divided by vertical ridge into medial which transmits body weight and lateral part (origin to hamstring part of Adductor Magnus).

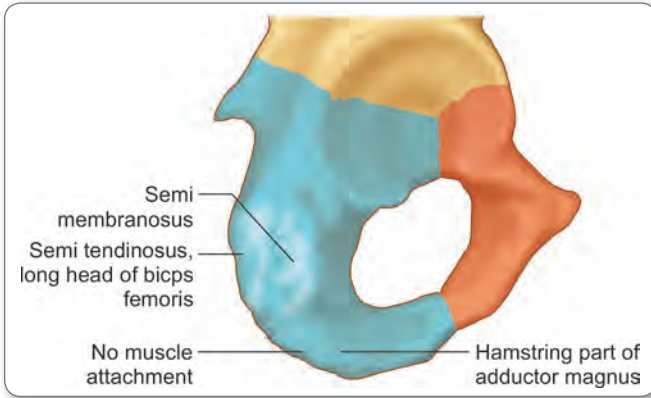
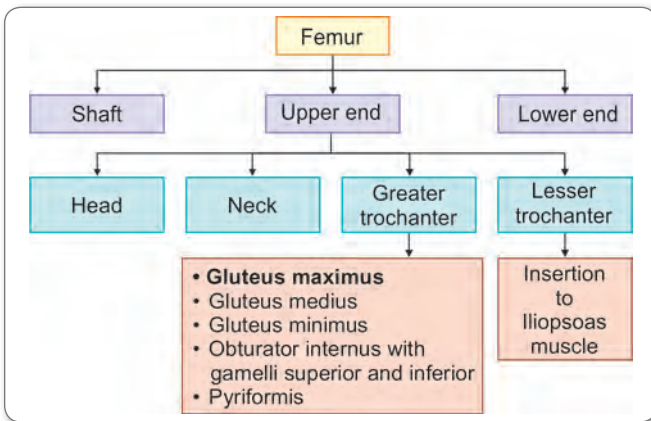


Fig. 4: Structure/division of Ischial tuberosity

FEMUR

- The longest and the strongest bone in the body.
- Length of femur roughly corresponds to 1/4th of the height of individual (In a 6 feet or 72 “ long individual femur length is 45 cm or 18”)



Head

- Forms 2/3rd of sphere and directed medially, upward and slightly fits into acetabulum
- Has depression (fovea capitis femoris) to which ligamentum capitis femoris is attached.

Neck

Connects the head to body and forms the angle 125° with shaft.

Greater Trochanter

It is projection at the junction of neck and shaft. Receives gluteus medius, minimus, piriformis, obturator internus, obturator externus. Superior and inferior gamelli.

Lesser Trochanter

Receives iliopsoas.

HIGH YIELD POINTS

Neck shaft angle (**angle of inclination**) is 125° in adults and in children it is 160°

- It is the common site of fracture
- Angle is increased in coxa valga and decreased in coxa vara.
- Lower end has two condyles : Medial and Lateral
- Femur articulate with patella in front and tibia below to form knee joint.

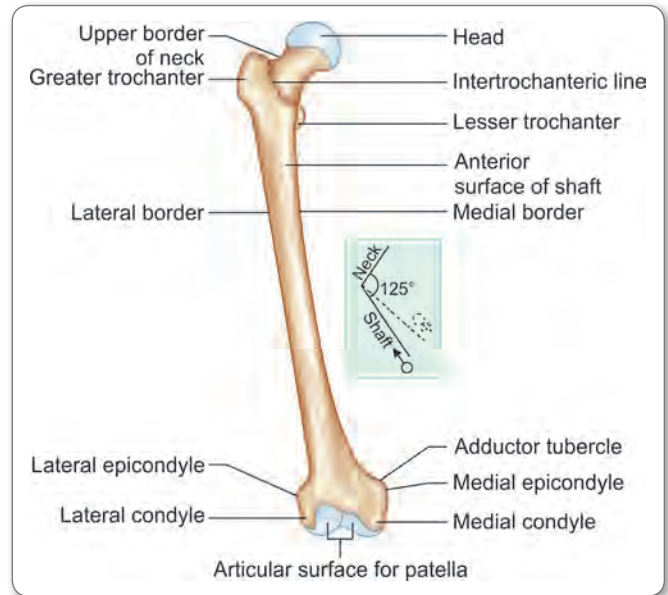
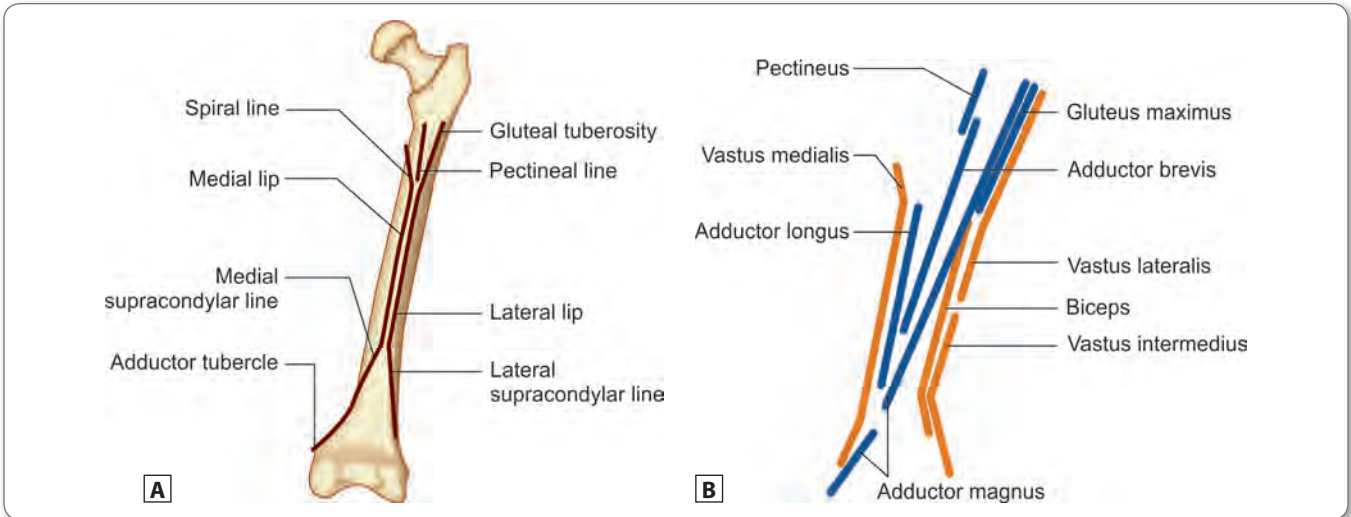


Fig. 5: Femur

Linea Aspera

- **Posterior border** is represented by prominent crest – **linea aspera**
- Consists of medial lip, lateral lip and intermediate lip.
- **Medial lip** continues as **spiral line**
- **Lateral lip** continues as **gluteal tuberosity**, which is considered as **third trochanter**
- On the medial lip – **medial intermuscular septum** attached & medial to that medial lip – vastus medialis attached, intermediate lip – **posterior intermuscular septum**, lateral lip – lateral intermuscular septum & more laterally vastus lateralis
- Area between medial and posterior intermuscular septum: **Adductor brevis in upper part, adductor longus in lower part and lateral to them Adductor Magnus**
- Area between posterior and lateral septum: **Short head of biceps.**



Figs 6A and B: Linea aspera on the surface of the shaft of femur and its attachments

Note: Arrangement of structure in linea aspera from medial to lateral. Vastus medialis, medial intermuscular septum, adductor brevis in upper lip and adductor longus in lower part, adductor magnus, posterior intermuscular septum, short head of biceps femoris, lateral intermuscular septum and vastus lateralis.

- Pectinate line: Extends between lesser trochanter to linea aspera medial lip. Pectineus muscle attached to it
- Adductor tubercle: Prominence on the medial epicondyle. Adductor magnus inserted to it.



Clinical Aspect

- The center of ossification in lower end of femur and even in upper end of tibia seen by X-ray is used as a medicolegal evidence to prove that the newborn (found dead) was nearly full term and was viable.
- In normal knee, the obliquity of the line of quadriceps muscle and its insertion into the tibia, results in an angle called “**Q angle**”. It is normally **15°–20°**. If the angle is increased, there may be lateral subluxation of the patella.
- Ischemic necrosis of neck of femur leads to fracture of neck of femur. Distal fragment is pulled upwards by quadriceps femoris, adductors and hamstring muscles so limb is shortened with lateral rotation.
- Fracture of femur neck is common in post-menopausal women.
- Fractured distal femur injure the popliteal artery because of deep location and close to femur.

PATELLA

- Largest sesamoid bone
- Formed in tendon of quadriceps femoris
- Articulates with femur to form knee joint not with tibia
- Attaches to tibial tuberosity by continuation of quadriceps tendon called patellar ligament.

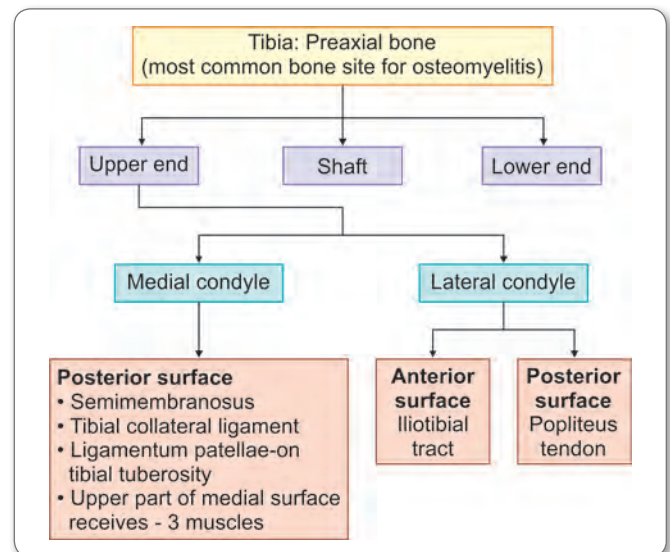


Clinical Aspect

Transverse Patellar Fracture

- Results from blow to knee or due to sudden contraction of quadriceps muscle
- Proximal fragment – pulled superiorly with quadriceps tendon
- Distal fragment – remains with patellar ligament.

TIBIA





HIGH YIELD POINTS

- Sartorius
 - Gracilis
 - Semitendinosus
- Guy ropes muscle

These 3 attachments look like goose leg so called as Pes Anserinus [Another Pes Anserinus-Facial nerve distribution over face]

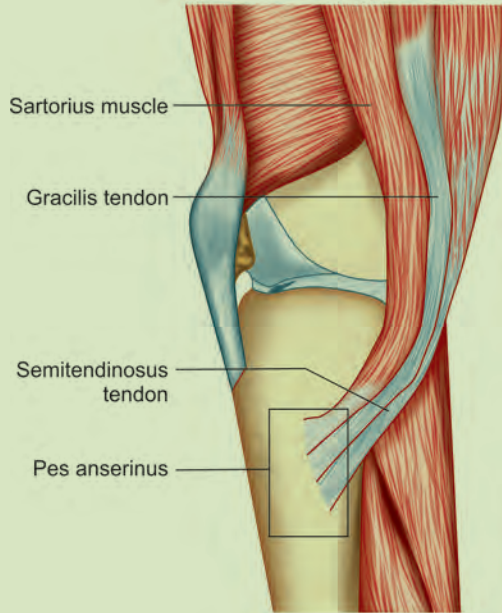
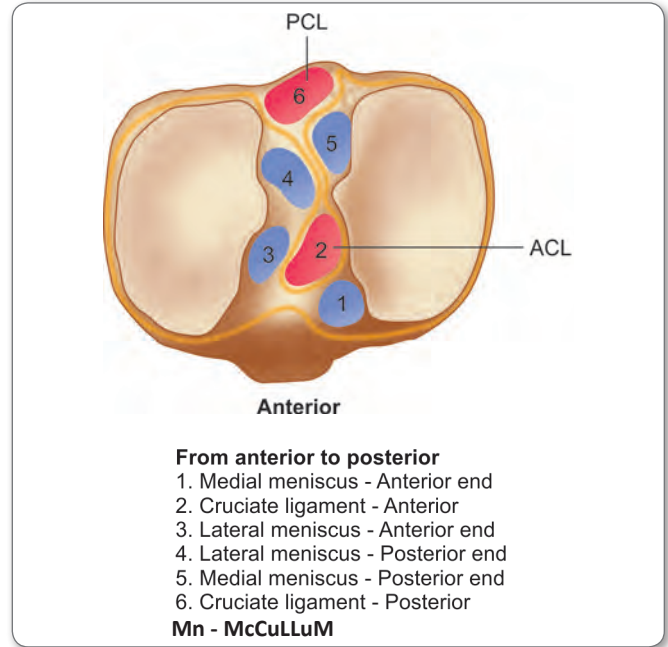


Fig. 7: Guy rope muscles

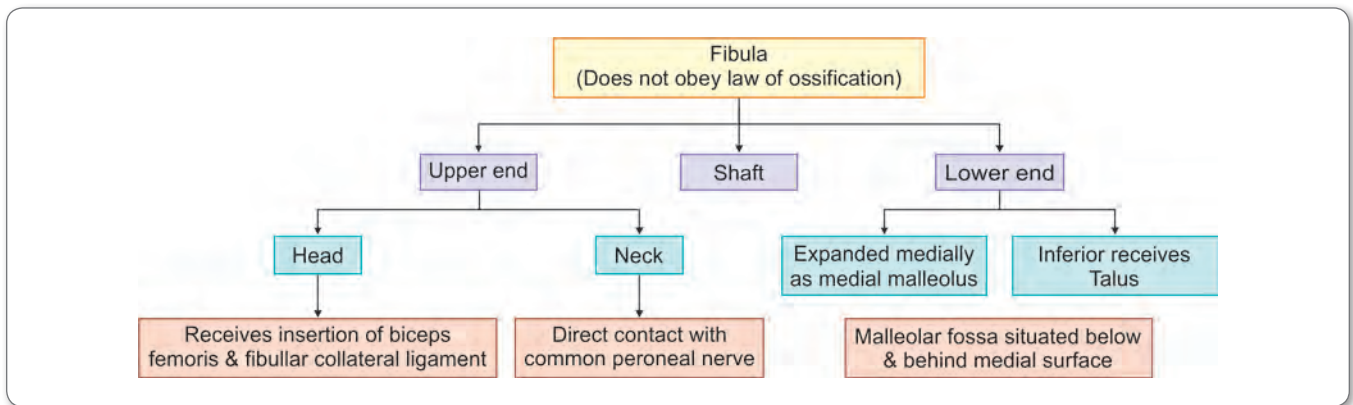
Tibia intercondylar area attachment intercondylar area intervenes between two 2 articulating surfaces, it provides attachment to following structures from anterior to posterior.



Clinical Aspect

The upper end of tibia is one of the most common sites for acute osteomyelitis. The knee joint remains safe because the capsule is attached near the articular margins of the tibia, proximal to the epiphyseal line.

FIBULA





Clinical Aspect

Pott's fractures – (Dupuytren fracture): Fracture of lower end of fibula with fracture of medial malleolus or rupture of deltoid ligament.

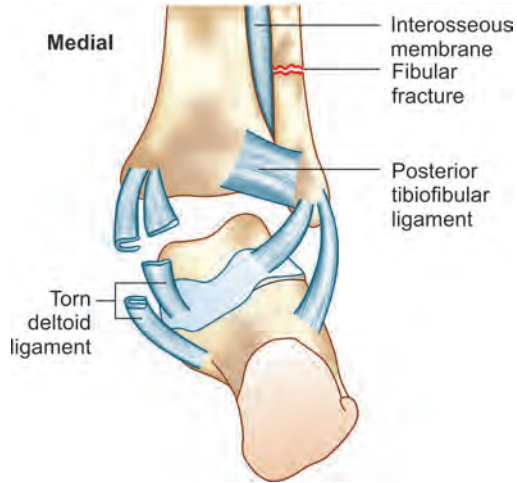


Fig. 8: Pott's fracture

Pilon fracture: T-shaped fracture of distal femur with displacement of condyles.

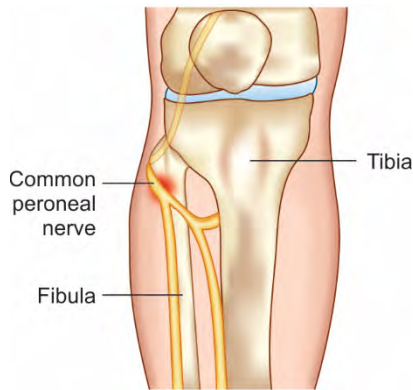


Fig. 9: Injury to common peroneal nerve

Fracture of fibular neck: Injury to common peroneal nerve results in the paralysis of anterior and lateral compartment of leg.

TARSAL BONES

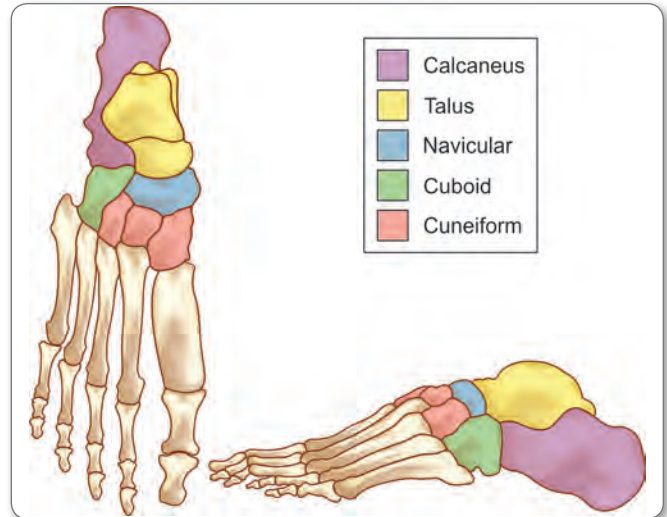
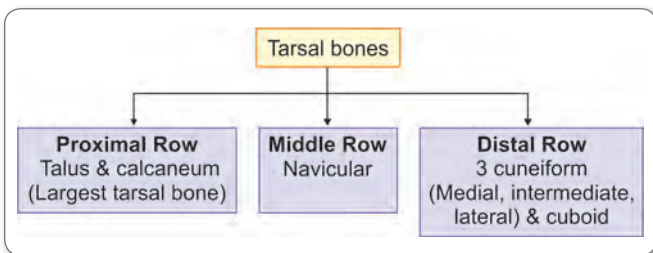


Fig. 10: Tarsal bones

Talus

No muscle attachment.

HIGH YIELD POINTS

Incus and Talus 2 bones with no muscle attachment.

Ligaments Attached to Talus

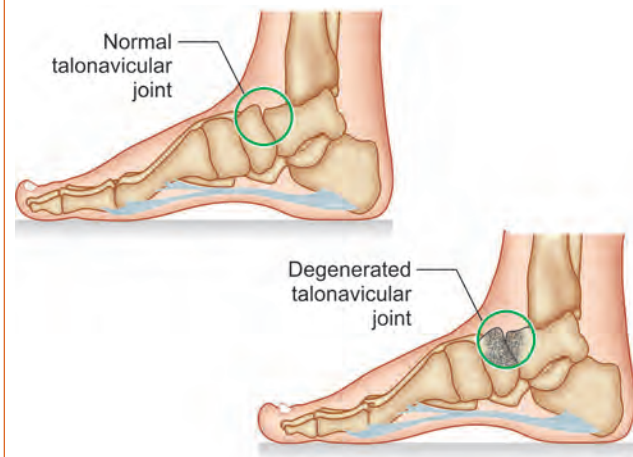
Talus articulates with tibia, fibula, calcaneum and navicular. So the ligaments attaching them are tibiotalar, talofibular, talocalcaneal and talonavicular.

Sustentaculum Tali

- Medial surface of calcaneum is accentuated in anterior superior by Sustentaculum tali
- Upper surface of presents with two facets to articulate with head of talus and lower surface is grooved by flexor hallucis longus
- Medial surface gives attachment to spring ligament, deltoid ligament and slips of tibialis posterior. This surface is also grooved by tendon of flexor digitorum longus.

Clinical Aspect

Muller Weiss Disease



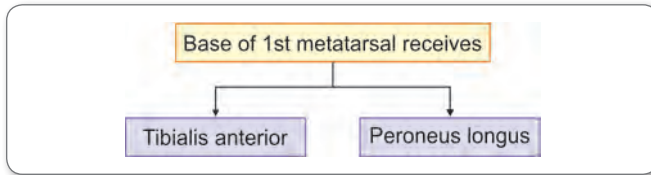
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- Navicular bone – may arise from 2 distinct centers of ossification leads to premature degeneration within talocalcaneonavicular joint – Muller Weiss syndrome
- Tarsal coalition hereditary condition in which there is union of two or more tarsal bones.

METATARSAL BONES

- Five in number
- First shortest and strongest
- Second longest
- Base of fifth metatarsal receives peroneus brevis.



Clinical Aspect

March fracture – metatarsal fracture due to prolonged walking.

OSSIFICATION CENTERS FOR LOWER LIMB

Hip bone	Three primary ossification centres and eight secondary ossification centres
Femur	One primary ossification centre and three secondary ossification centres for upper end and one for lower end
Tibia	One primary and two secondary centres
Fibula	One primary and two secondary centres

- All tarsal bones ossify within 2 or 3 years after birth except talus, calcaneus and cuboid, which ossify in intrauterine life
- All metatarsals are ossified by primary and secondary centers. Secondary centers appear 2 or 3 years after birth.

REMEMBER

Bones	Nutrient arteries
Femur	Profunda femoris artery
Tibia	Posterior tibial artery (largest nutrient artery in the body)
Fibula	Peroneal artery

SEGMENTAL INNERVATION OF LOWER LIMB

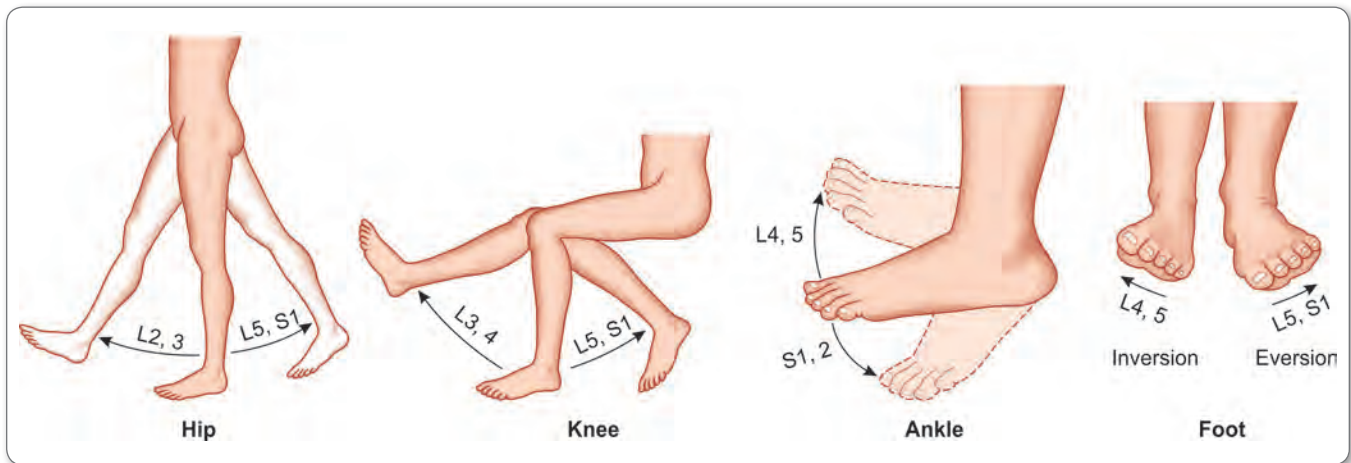


Fig. 11: Segmental innervation of lower limb movements

Reflexes

Knee reflex L2-L4	<ul style="list-style-type: none"> • Patient sitting and knee supported & partially flexed. • Patellar ligament is struck with hammer • Result in extension of knee joint
Ankle reflex (Achilles reflex) S1,2	<ul style="list-style-type: none"> • Patient in sitting position. Lower limb laterally rotated, partially flexed at hip and knee, foot - dorsiflexed • Calcaneal tendon struck with hammer • Results in plantar flexion of foot
Plantar reflex	<ul style="list-style-type: none"> • Foot relaxed • Outer edge of sole – stroked longitudinally with blunt object • Results in flexion of toes • But in UMN lesion – extension of great toe (Babinski sign)



BLOOD AND NERVE SUPPLY OF LOWER LIMB

VENOUS DRAINAGE OF LOWER LIMB

Superficial veins: Great or long saphenous vein (the longest vein in the body) and short saphenous vein.

Great Saphenous Vein

- Begins at the medial end of dorsal venous arch
- Ascends 2.5 cm in front of medial malleolus and along the medial aspect of tibia with saphenous nerve
- And then it passes posterior to medial condyles of tibia and femur and about breadth posterior to patella, then it ascends along the medial side of femur
- Passes through saphenous opening after piercing cribriform fascia and finally drains into femoral vein after piercing femoral sheath.

Structures Accompanying Great Saphenous Vein

- In thigh – medial branch of anterior cutaneous branch of femoral nerve
- Knee – saphenous branch of descending genicular artery
- Leg – saphenous nerve

Great saphenous vein contains approximately 20 valves, more in leg. Tributaries are:

- Superficial epigastric
- Superficial external pudendal
- Superficial circumflex iliac
- Deep external pudendal
- Anterolateral femoral vein
- Posteromedial femoral vein (also called as accessory saphenous vein)
- Anterior leg vein
- Posterior arch vein
- Vein from calf
- Superficial epigastric vein may form lower end of thoracoepigastric vein, this is communicating channel between superior and inferior venae cavae.



Clinical Aspect

- Venesection of great saphenous vein in emergency is usually made at ankle. Care should be taken care not to damage saphenous nerve (great saphenous vein accompanies saphenous nerve)
- Commonly used vein for coronary bypass surgery and vein should be reversed so its valves do not obstruct the blood flow in the graft.

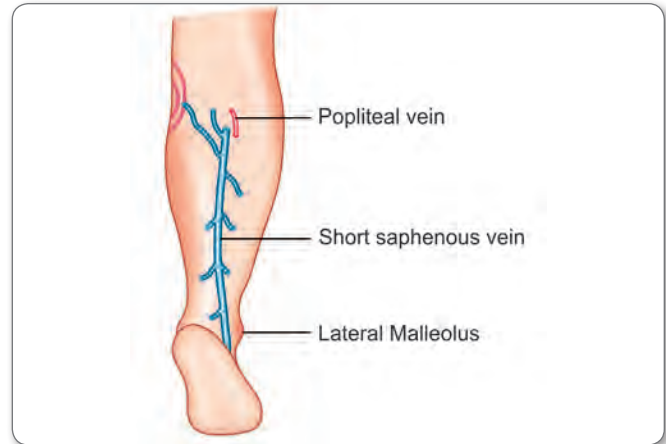
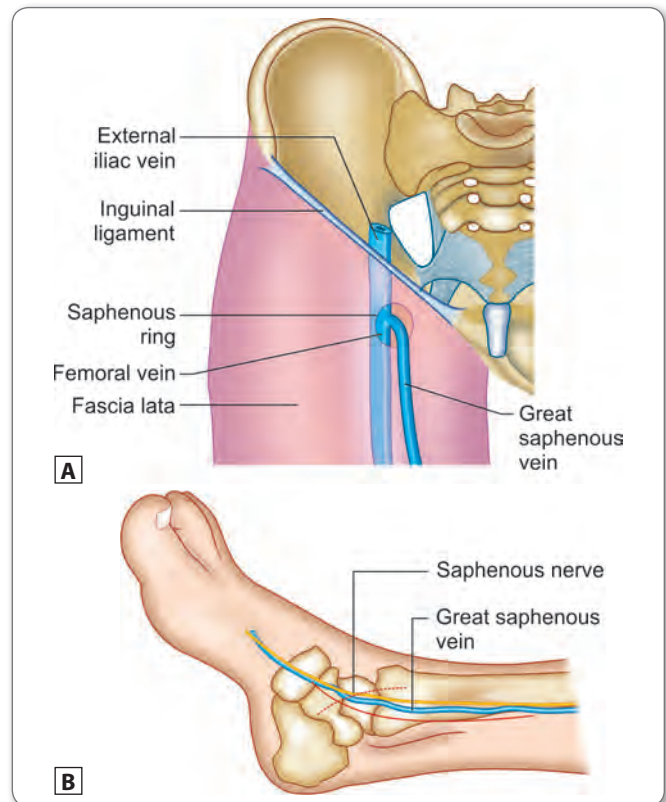


Fig. 12: Course of short saphenous vein

Table 1: Comparison between great and short saphenous vein

Great saphenous vein	Short saphenous vein
<ul style="list-style-type: none"> • Continuation of medial marginal vein • Ascends anterior to medial malleolus • Accompanied by saphenous nerve • Pierces cribriform fascia and drains into femoral vein 4 cm below and lateral to pubic tubercle. 	<ul style="list-style-type: none"> • Continuation of lateral marginal vein • Ascends posterior to lateral malleolus • Accompanied by sural nerve • Drains into popliteal vein



Figs 13A and B: Great saphenous vein



Deep Veins (Accompanying Arteries)

Anterior and Posterior tibial veins

- Peroneal vein
- Popliteal vein
- Femoral vein

Perforating Veins

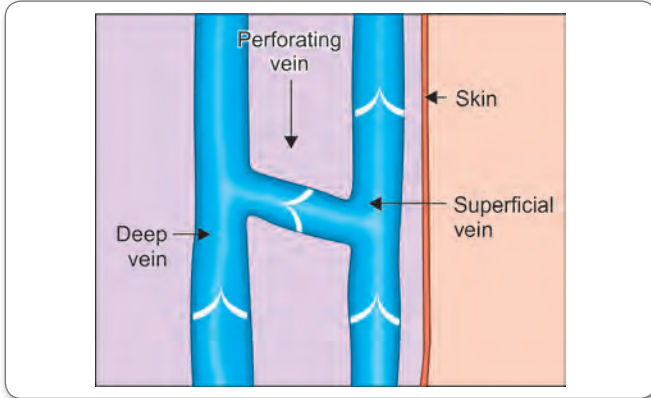


Fig. 14: Perforating veins connect the deep system with the superficial system

- Connects superficial veins to deep veins
- There are total five perforators
 - 3 – Ankles:
 - Upper medial: Situated at the junction of middle-third and lower-third
 - Lower medial: Below and behind medial malleolus
 - Middle: Between the above two
 - 1 – midhunter – in adductor canal
 - 1 – knee – just below the knee.

HIGH YIELD POINTS

Factors facilitating venous return to right atrium

- Rhythmic muscle contraction of calf muscle
- Adjacent artery pulsation
- Valves in perforators
- Sleeves of deep fascia
- Sympathetic tone
- Cardiac pumping plays important role in its own filling by creating suction force
- During inspiration, the diaphragm descends and intra-abdominal pressure rises. This increases the venous return

Gravitational force in arterial pressure during quite standing **does not facilitate venous return** to heart because, with the effect of gravity, increases the same amount of pressure in arteries and in veins. So net pressure gradient during circulation remains unaltered.

INGUINAL LYMPH NODES

Divided into (a) superficial, (b) deep group

Superficial are divided into (1) upper horizontal, (2) lower vertical

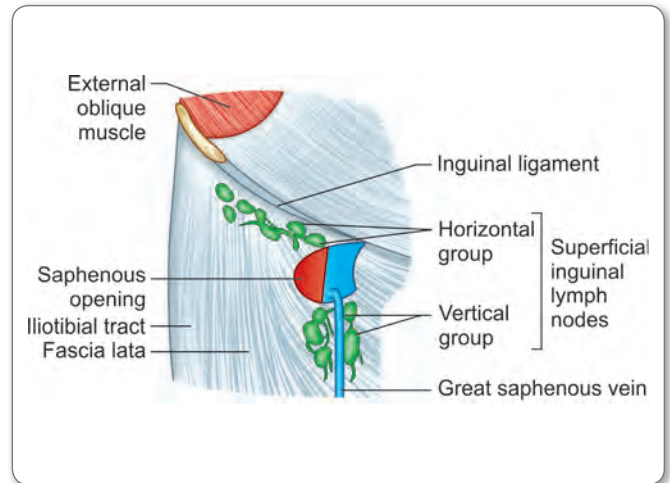


Fig. 15: Inguinal lymph node

Horizontal

Afferent

Medial group

- External genitalia of both sexes penis including prepuce excluding glans penis/clitoris
- Lower end of vagina
- Terminal male urethra
- Lower end of anal canal below the pectinate line
- Lymphatics of uterus which following the round ligament of uterus.

Lateral group

- Anterior abdominal wall below umbilicus
- Gluteal region.

Lower Vertical

Entire lower limb except lateral part of foot, heel and lateral part of back of leg that is lymph vessels along short saphenous vein which is draining into popliteal nodes.

Efferents

To external iliac nodes, some lymphatics drain into deep inguinal nodes.

Deep Nodes

Afferents

- Distal part of spongy urethra and glans penis in male/clitoris in female
- Lymph vessels along deep vessels
- From superficial inguinal nodes and popliteal nodes.

Efferent

External iliac nodes.



ARTERIAL SUPPLY OF LOWER LIMB

Femoral Artery

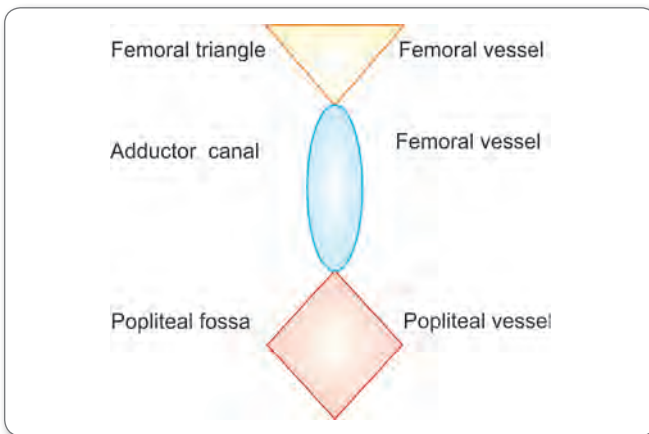


Fig. 16: Femoral artery pathway

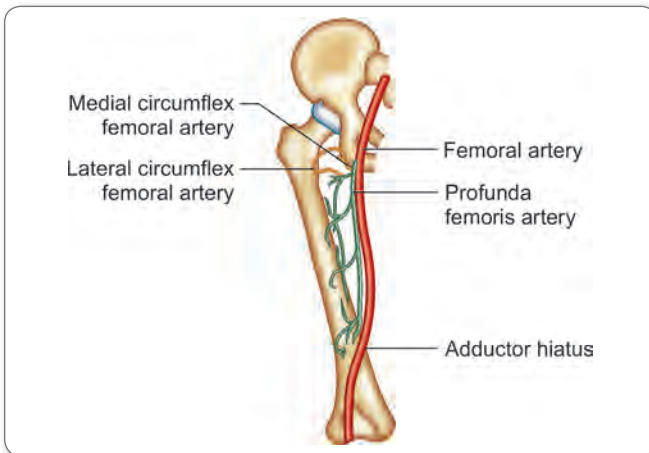


Fig. 17: Course of femoral artery

- Continuation of external iliac artery at mid inguinal point distal to inguinal ligament
- Passes through femoral triangle
- Content of femoral sheath – intermediate compartment and then to adductor canal and to popliteal fossa in the name of popliteal artery
- Branches
 - Superficial epigastric
 - Superficial circumflex iliac
 - Superficial external pudendal
 - Deep external pudendal
 - Profunda femoris artery.

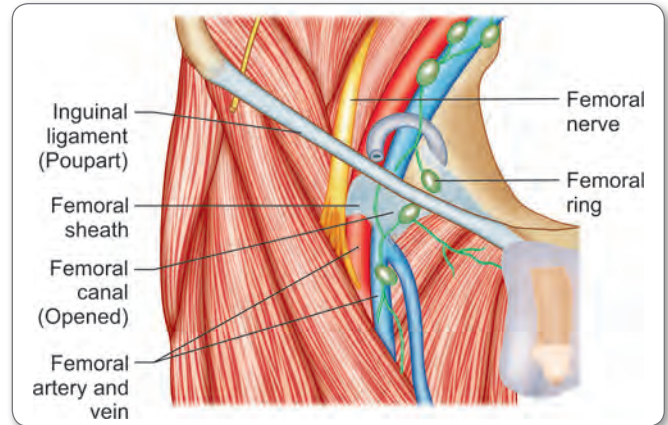


Fig. 18: Femoral artery

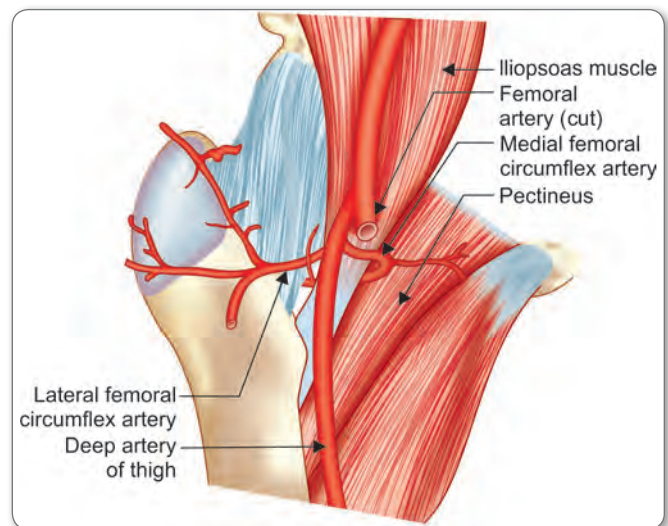


Fig. 19: Arteries of femoral head and neck

Profunda Femoris Artery – Deep Artery of Thigh

- Arises from femoral artery in the femoral triangle
- Gives medial and lateral femoral circumflex artery, muscular branches and perforating arteries
- Lateral circumflex femoral artery: Passes between anterior and posterior divisions of femoral nerve and gives ascending branch (contributes trochanteric anastomosis), transverse branch (contributes to cruciate anastomosis) and descending branch anastomosis with superior lateral genicular branch of superior gluteal artery
- Medial circumflex femoral artery – gives acetabular branch (supply the hip joint), gives ascending branch (contributes trochanteric anastomosis), transverse branch (contributes to cruciate anastomosis)
- Perforating arteries: Four in number. First branch (contributes to cruciate anastomosis)
- Descending genicular artery (branch given in adductor canal) – femoral artery before passing through adductor hiatus, it gives genicular branch which anastomose with knee joint and saphenous branch which supply the medial side of the knee.



Clinical Aspect

Medial circumflex femoral

- Head of femur is chiefly supplied by medial circumflex femoral artery
- Runs through neck to reach head and supplies the neck and head of femur except the small part that receives blood from obturator artery branch.

OBTURATOR ARTERY

- Arises from anterior division of internal iliac artery
- Passes through obturator foramen and divided into anterior and posterior division
- Anterior branch: Descends in front of adductor brevis and gives muscular artery
- Posterior branch: Descends behind the adductor brevis and gives muscular branch, acetabular branch and artery to head of femur.

CORONA MORTIS

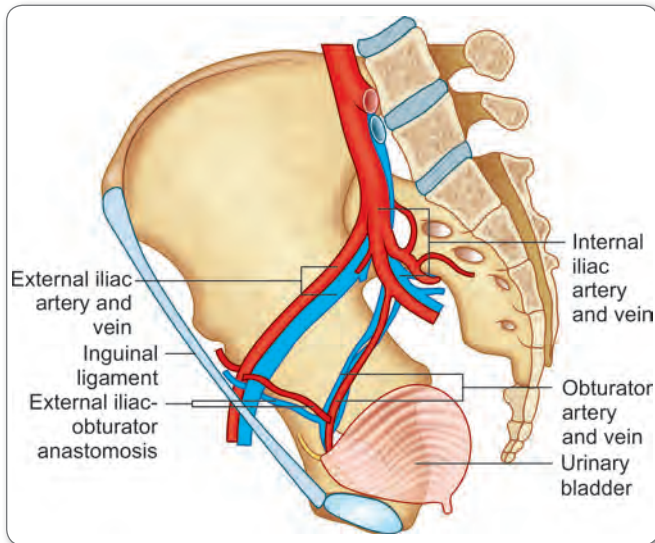


Fig. 20: Corona mortis

- Vascular anastomosis between pubic branch of obturator artery and external iliac artery (inferior epigastric artery) is called as corona mortis because vessels are difficult to identify and injured in surgery resulting in massive hemorrhage
- Aberrant obturator artery – pubic branch of inferior epigastric artery replace obturator artery in some cases and it is called abnormal obturator artery and this is closely related to femoral ring. May be injured during femoral hernia repair surgeries.

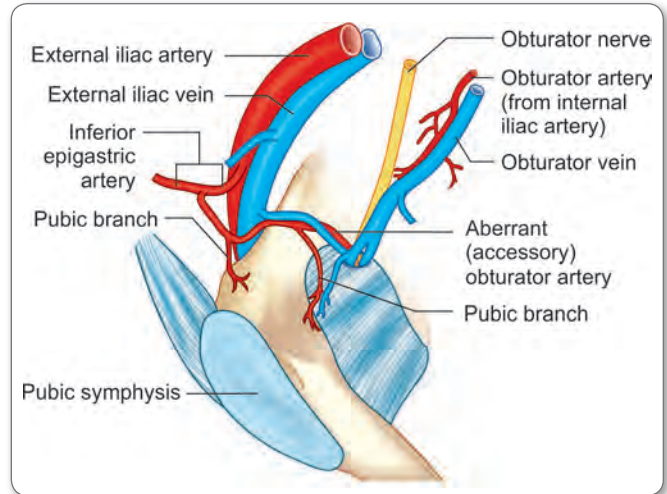


Fig. 21: Aberrant obturator artery

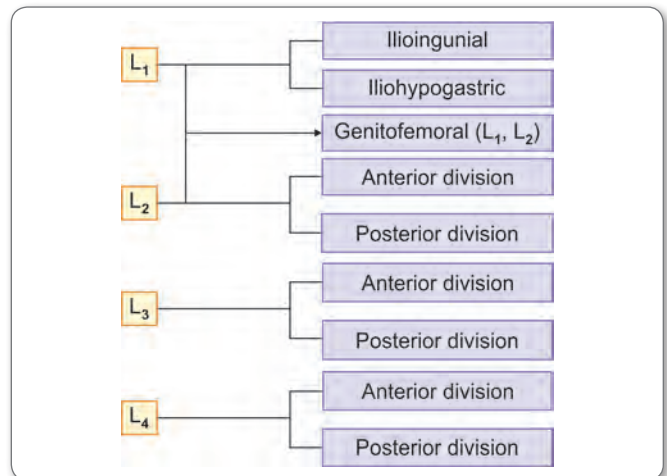
NERVE SUPPLY OF LOWER LIMB

Lumbar Plexus

Table 2: Nerves originating from lumbar plexus

Ilioinguinal nerve	L1
Iliohypogastric nerve	L1
Genitofemoral nerve	L1,2
Femoral nerve	Dorsal branch of ventral rami of L2,3,4
Obturator nerve	Ventral branch of ventral rami of L2,3,4
Lateral femoral cutaneous nerve	Dorsal branch of ventral rami of L2,3
Accessory obturator nerve	Ventral branch of ventral rami of L3,4 Present in 30% of cases

- Ilioinguinal nerve and Iliohypogastric nerve occasionally receive twig from T12





- Lumbar plexus formed by ventral rami of L1, 2, 3 and 4
- L4 joins with L5 forms **lumbosacral trunk**, helps in the formation of sacral plexus
- So L4 – (contribute to lumbar and sacral plexus) called as **nervus furcalis**

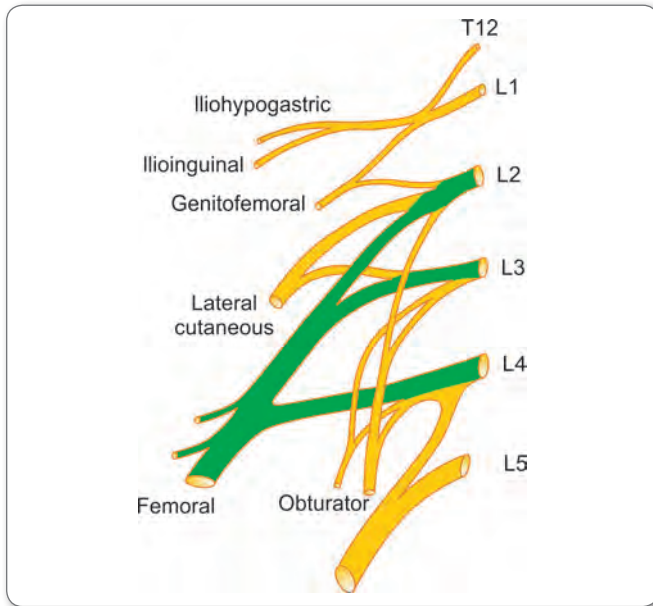


Fig. 22: Lumbar plexus

Lateral Femoral Cutaneous Nerve

- Branch of lumbar plexus. Root value dorsal branch of ventral rami of L2, L3
- Pass behind the inguinal ligament.

Clinical Aspect

Meralgia Paraesthetica

Entrapment neuropathy produced by lateral femoral cutaneous nerve (Because nerve pierces inguinal ligament and is attached to iliac fascia) and cause pain on the lateral side of thigh.

Femoral Nerve

Arises from posterior branch of ventral rami of L2, L3 and L4 lumbar plexus

- Arises within the substance of psoas major and emerge between iliacus and psoas muscle. enters thigh deep to inguinal ligament and lies outside the femoral sheath
- Trunk of the femoral nerve supplies iliacus, psoas and pectineus muscles and divided into anterior and posterior division
- Branches arising from anterior and posterior divisions are given in the Table 3
- Femoral nerve gives muscular branch, cutaneous branch and articular branch to hip joint and knee joint.

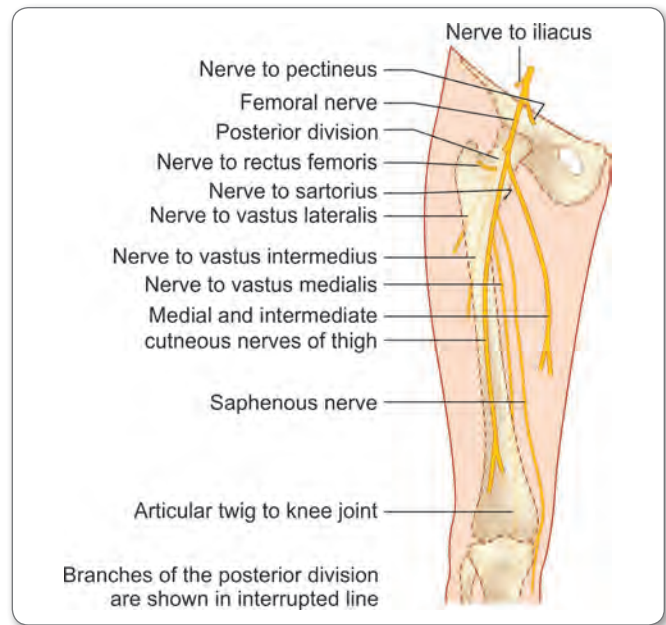


Fig. 23: Division of femoral nerve trunk

Clinical Aspect

Damage to femoral nerve causes loss of flexion of hip joint (sartorius, psoas major, iliacus, pectineus) and loss of extension of knee joint (quadriceps femoris).

Table 3: Femoral nerve trunk

Anterior division	Posterior division
• Intermediate femoral cutaneous nerve	• Branch to vastus lateralis
• Medial femoral cutaneous nerve	• Branch to vastus intermedius and articularis genu
• Branch to sartorius (Muscular branch)	• Branch to vastus medialis
	• Branch (to rectus femoris)
	• Saphenous nerve (Cutaneous nerve)

Articularis genu detached part of vastus intermedius – supplied by, femoral nerve.

Saphenous Nerve

- Branch from posterior division of femoral nerve
- Longest cutaneous branch
- Extend downward along lateral side of femoral artery in femoral triangle and in adductor canal
- Nerve leaves the canal by piercing fascial roof and accompanied by saphenous branch of descending genicular artery
- The nerve may be subject to an entrapment neuropathy as it leaves the adductor canal
- Contributes peripatellar plexus and subsartorial plexus
- It descends along the medial tibial border with the long saphenous vein

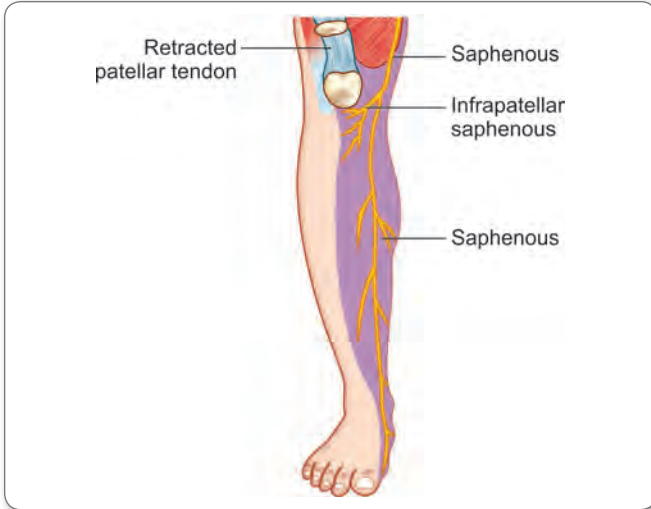


Fig. 24: Saphenous nerve

- So saphenous nerve can be damaged in venesection of great saphenous vein
- Pass in front of ankle and supplies the skin on the dorsum of foot up to ball of the great toe.

Obturator Nerve

- Ventral branch of the ventral rami of L2, L3 and L4
- **Enters the thigh through obturator foramen**
- Divides into anterior and posterior division
- Anterior division descends between adductor longus and adductor brevis supplies gracilis, adductor longus, pectineus, genicular branch to hip joint, vascular and cutaneous branches
- Posterior division descends between adductor brevis and adductor magnus supplies obturator externus, adductor brevis, adductor magnus, genicular branch to knee and vascular branch

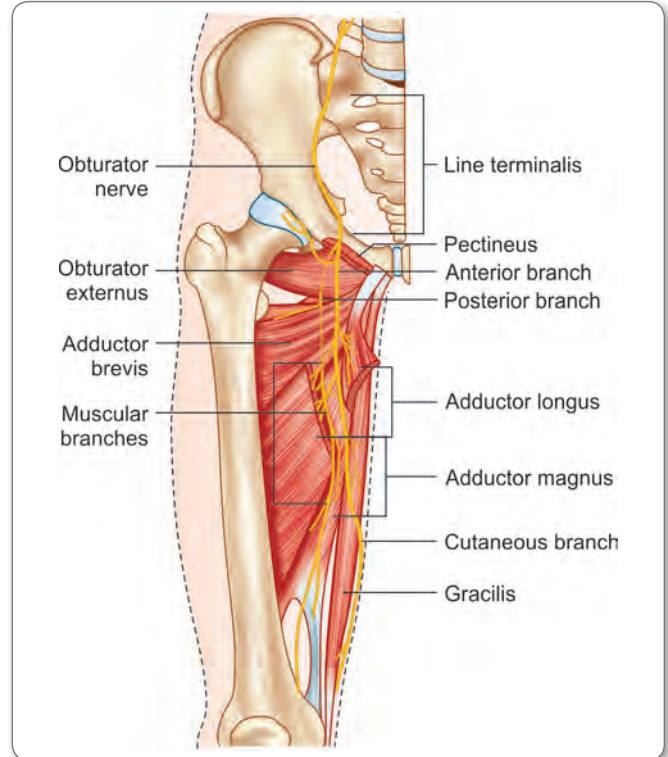


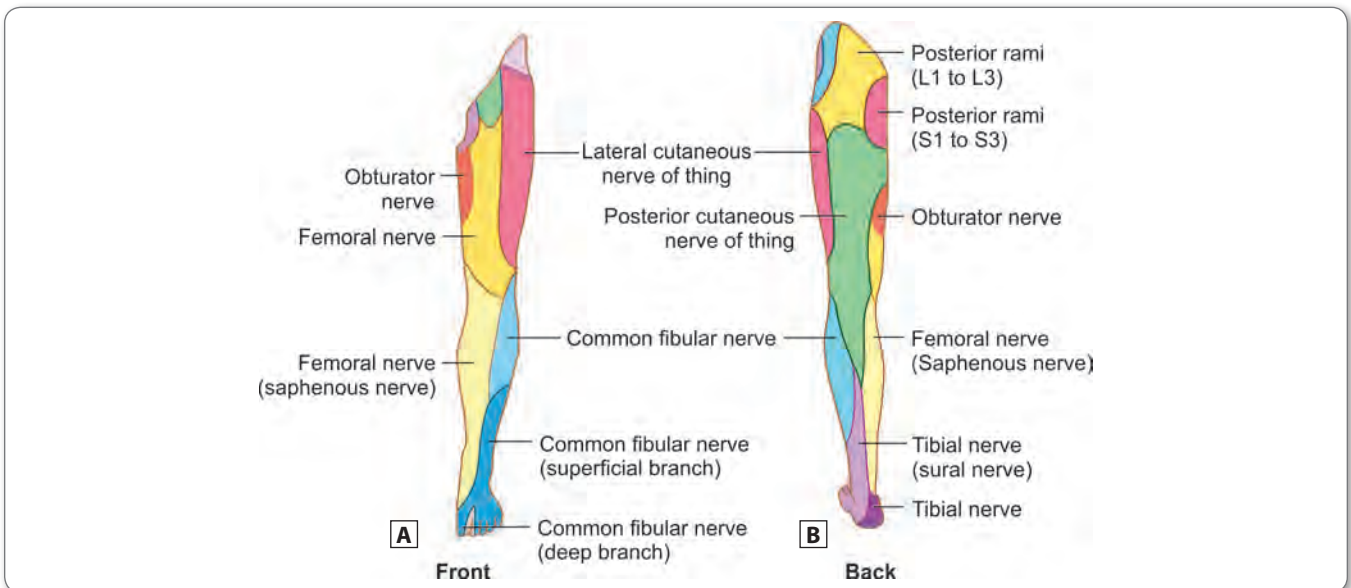
Fig. 25: Course of obturator nerve



Clinical Aspect

Damage to obturator nerve – loss of adduction. Due to unopposed action of abductors lateral swing of the limb occurs during walking.

Cutaneous Innervation of Thigh – Lumbar Plexus



Figs 26A and B: Cutaneous innervation of thigh. (A) Front and (B) Back

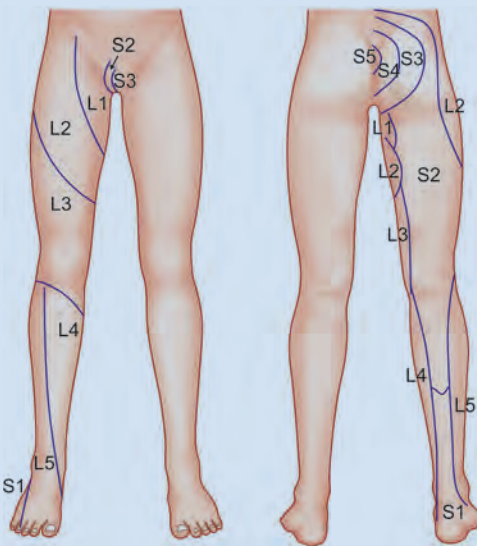


Table 4: Structures supplied by various nerves

Nerve	Supplies
Ilioinguinal nerve L1	Root of penis
Iliohypogastric nerve L1	Upper part of buttock, hypogastric region
Genitofemoral nerve L1,2	Divides lateral to the common and external iliac arteries into femoral and genital branches Genital branch: supplies cremaster, skin over scrotum and labium majus Femoral branch: supplies skin over femoral triangle
Femoral cutaneous nerve (Medial, Lateral and Intermediate)	Lateral femoral cutaneous nerve (Entrapment – Meralgia paresthetica)
Obturator nerve	Medial side of thigh
Posterior cutaneous nerve of thigh S1,2,3	Supplies posterior thigh, popliteal fossa, posteroinferior aspect of buttock, scrotum

REMEMBER

Dermatome of lower limb



- L1 – Inguinal ligament
- L2 – Over lateral side of thigh
- L3 – Over lower medial side of thigh
- L4 – Over lateral side of great toe
- L5 – 1st web space – between first and second toe
- S1 – Lateral side of foot
- S2 – Back of thigh
- S3 – Skin over gluteal fold
- S4 – Perineum
- S5 – Perineum

GENERAL ANATOMY OF LOWER LIMB

FASCIA LATA

- Deep fascia of thigh
- Encloses the thigh like stocking
- Saphenous opening: Oval opening in fascia lata, lies 4 cm below and lateral to pubic tubercle.

ILIOTIBIAL TRACT

- Thickening of fascia lata
- Attached to lateral condyle of tibia
- Gluteus **MAX**imus and Tensor fascia lata inserted into iliotibial tract (**Mnemonic – t max**)
- Maintains knee in extended position.

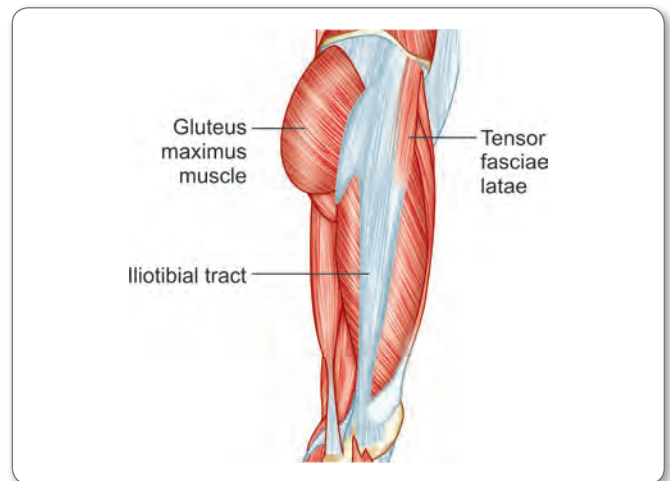


Fig. 27: Iliotibial tract, tensor fasciae late and gluteus maximus

Clinical Aspect

Contracture of iliotibial tract in polio results in these classical deformities

- Lumbar scoliosis
- Pelvic obliquity
- Limb shortening
- Hip – flexion, external rotation and abduction
- Knee – flexion and valgus
- Tibia – external rotation, posterior and lateral subluxation of tibia
- Foot in equines.

FEMORAL TRIANGLE

- Triangle in the upper one-third of front of thigh

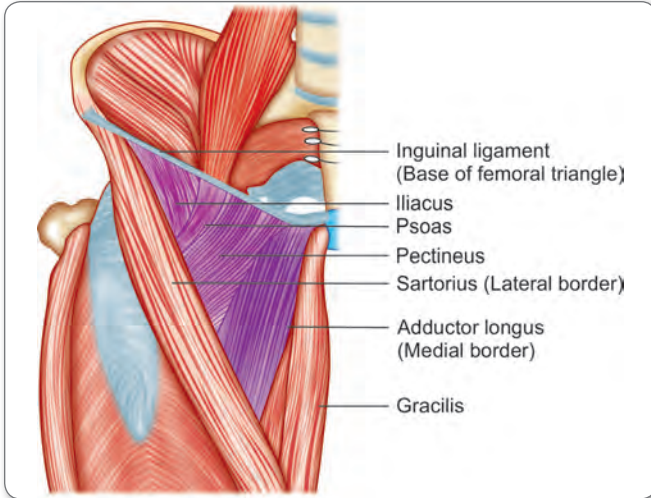


Fig. 28: Femoral triangle

Table 5: Relations of femoral triangle

Laterally	Medial border of Sartorius
Medially	Medial border of adductor longus
Floor	Iliacus, tendon of Psoas major, PECTineus and adductor Longus Mnemonic – Long -PIPe
Roof	Formed by fascia lata
Base	Inguinal ligament
Apex	Meeting point of sartorius and adductor longus
Contents	Femoral artery and its branches Femoral vein and its tributaries Femoral nerve Deep inguinal nodes Part of lateral femoral cutaneous nerve Femoral branch of genitofemoral nerve Fibrofatty tissue

Femoral Sheath

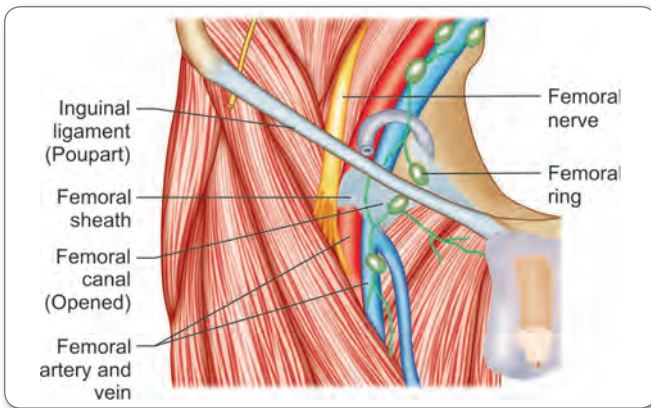


Fig. 29: Femoral sheath

- Funnel-shaped prolongation over proximal femoral vessels
- **Femoral nerve lies outside the sheath**
- In front - transversalis fascia, psoas fascia - behind

- Femoral canal (medial): Femoral canal contains – Lymph nodes of Cloquet, femoral vein intermediate, femoral artery (lateral) with femoral branch of genitofemoral nerve
- Structures piercing are femoral branch of genitofemoral nerve, superficial epigastric, superficial circumflex and superficial external pudendal branch of femoral artery and great saphenous vein.

Femoral Ring

- Upper opening of femoral canal
- Its boundaries are:
 - Anterior: Inguinal ligament
 - Medially: Lacunar ligament
 - Posterior: Pectineus muscle
 - Laterally: Femoral vein

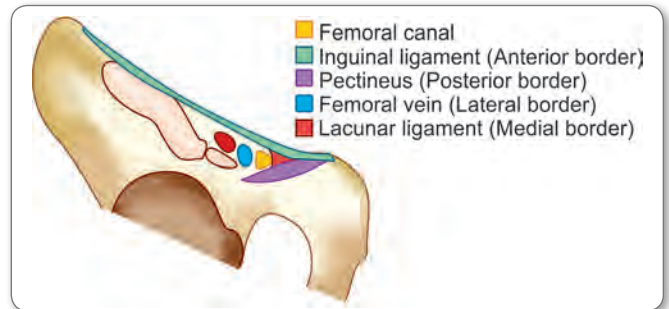


Fig. 30: Boundaries of femoral ring

Clinical Aspect

Femoral hernia

The femoral canal is an area of potential weakness in the abdominal wall through which abdominal contents may bulge out forming a femoral hernia. A femoral hernia is more common in females because the femoral canal is wider. This is associated with the wider pelvis and the smaller size of the femoral vessels, in the female. It is never congenital.

Femoral hernia passes through femoral ring and canal and it lies lateral and inferior to pubic tubercle.

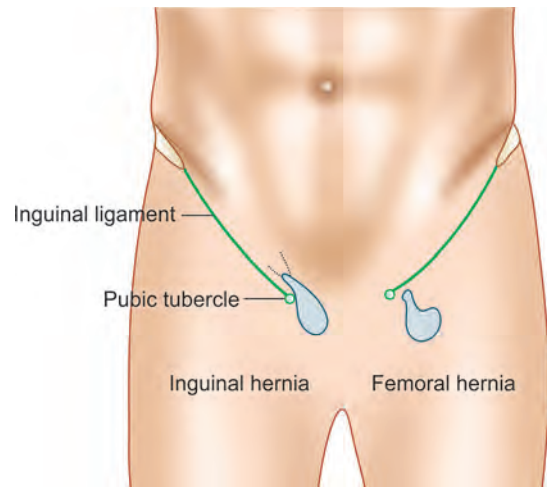


Fig. 31: Femoral and inguinal hernia



Note:

- Femoral hernia: Below and lateral to pubic tubercle
- Inguinal hernia: Above and medial to pubic tubercle
- Strangulation of femoral hernia occurs because of sharp and stiff boundaries of femoral ring
- Hernia comprises a neck and a sac. Coverings are the various layers on the sac. Mostly the content of hernial sac is a loop of bowel.

- Vastus medialis
- Vastus lateralis

MUSCLES IN THE FLEXOR COMPARTMENT

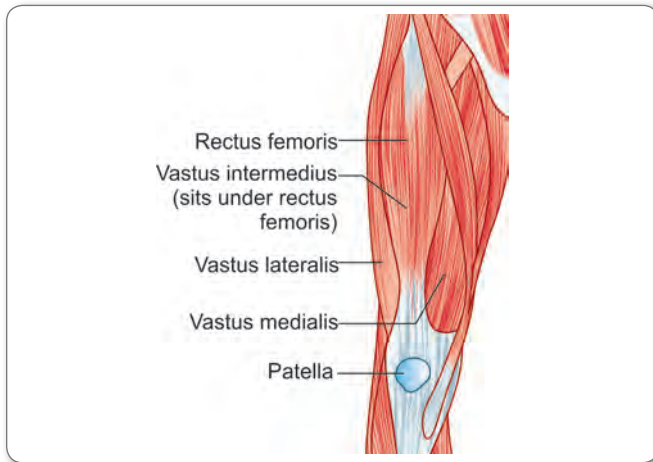


Fig. 32: Flexor compartment muscles

Quadriceps femoris muscles is formed by:

- Rectus femoris
- Vastus intermedius

Table 6: Muscles of front of thigh

Muscles	Attachment	Nerve supply	Action
Psoas major	Arising from sides of lumbar vertebra. Inserted to lesser trochanter	L2,L3	Chief flexor of hip joint
Iliacus	Origin from iliac fossa. Inserted to Lesser trochanter	Femoral nerve	Flexor of hip joint
Sartorius	Origin from – anterior superior iliac spine. Inserted to medial side of tibia – forms part of guy ropes muscle	Femoral nerve	Flexor, abductor, lateral rotator – hip joint Flexor, medial rotation – knee joint
Rectus femoris	Origin from – anterior inferior iliac spine Reflected head – groove above the acetabulum and capsule of hip joint	Femoral nerve	Flexor of hip joint Extensor of knee joint
Vastus muscles	From femur Insertion – forms quadriceps tendon and inserted to tibial tuberosity	Femoral nerve	Extensor of knee joint

ADDUCTOR COMPARTMENT MUSCLES

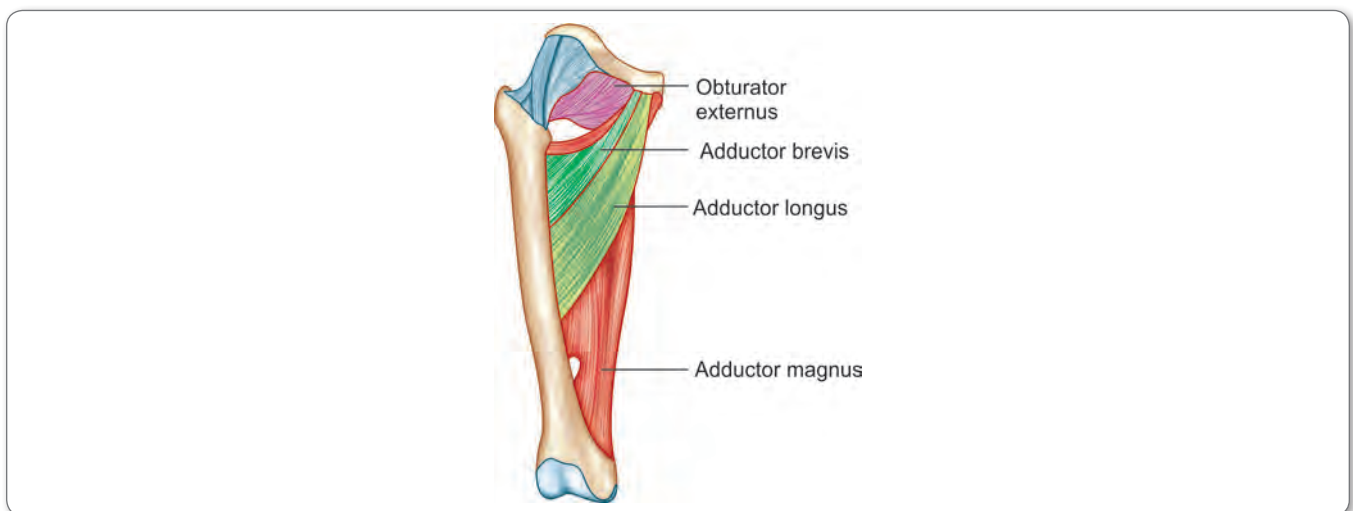


Fig. 33: Adductor compartment muscle



Table 7: Muscles of medial compartment of thigh

Muscle	Origin	Insertion	Nerve supply	Action
Gracilis	Body of pubis and ischiopubic ramus	Upper part of medial surface of tibia	Obturator nerve	Adduction of hip joint Flexion and medial rotation of knee joint
Pectineus	Pectineal line of pubis	Spiral line of femur	Obturator nerve	Adduction and flexion of hip joint
Adductor longus	Body of pubis	Linea aspera	Obturator nerve	Adduction and assist in flexion of hip joint
Adductor brevis	Body and inferior ramus of pubis	Linea aspera	Obturator nerve	Adduction of hip joint
Adductor magnus	Ischiopubic ramus and ischial tuberosity	Linea aspera	Obturator nerve	Adduction of hip joint and extension of hip joint

Gracilis muscle – weak muscle in adductor group. Surgeons often transplant this muscle or part of it to replace the damaged muscle
 Rider’s bone – sesamoid bone formed in tendon of adductor longus.

ADDUCTOR CANAL

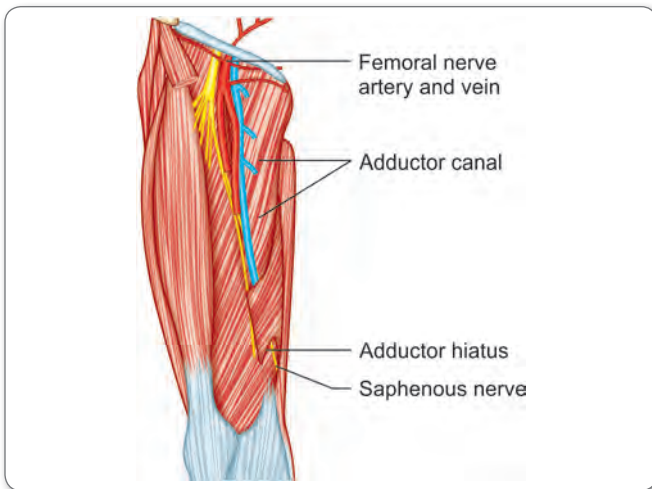


Fig. 34: Adductor canal

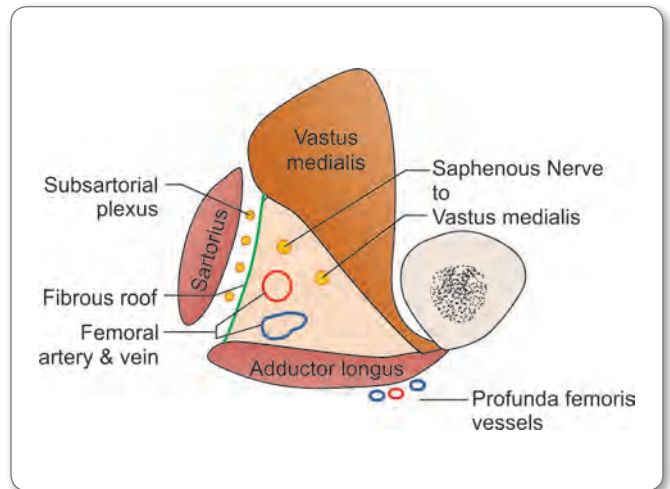


Fig. 35: Contents of adductor canal

- Begins at the apex of femoral triangle and ends at the adductor hiatus
- Boundaries are:
 - **Roof:** Fascia over the adductor longus and adductor magnus and the sartorius muscle and the subsartorial plexus intervene between them. Roof is pierced by the saphenous nerve and the saphenous branch of the descending genicular artery.
 - **Anterolateral:** Vastus medialis
 - **Posteromedial or floor:** Adductor longus in the upper part, adductor magnus.

Contents

- Femoral vessels
- Saphenous nerve
- Nerve to vastus medialis
- Posterior division of obturator nerve
- Terminal part of profunda femoris vessels.

Adductor Hiatus

- Is the aperture in the tendon of insertion of adductor magnus
- Transmits the femoral vessels into popliteal fossa and continue as popliteal vessels.



EXTENSOR COMPARTMENT OF HIP JOINT

Gluteal Region

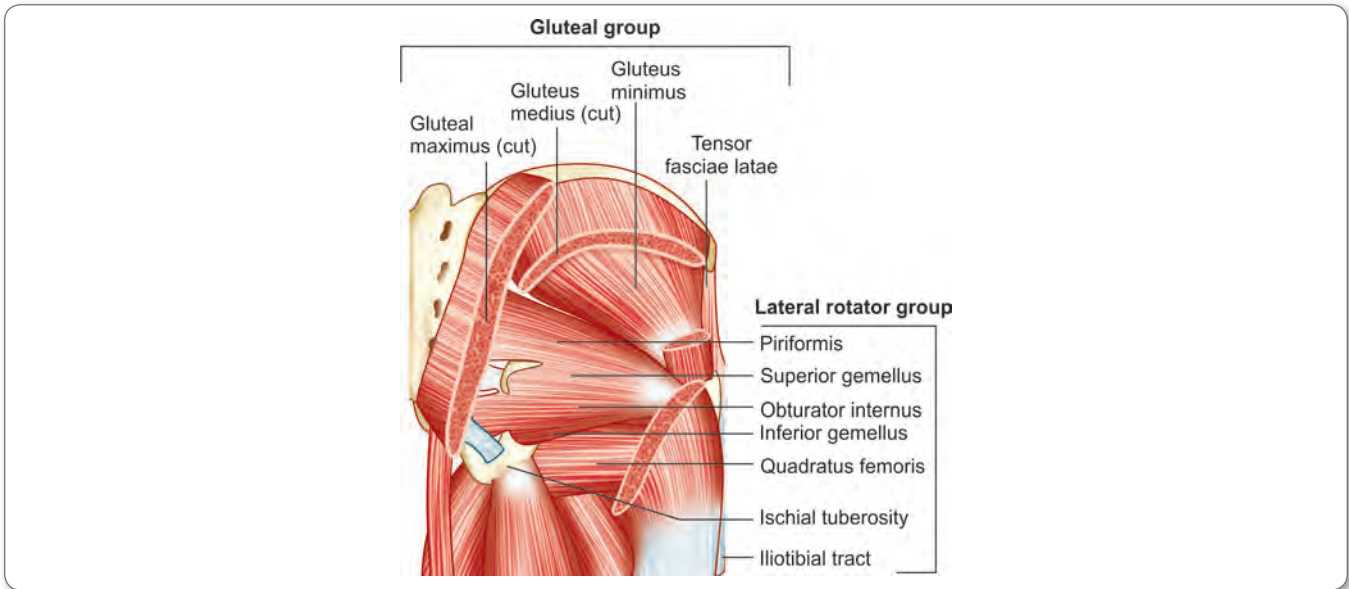


Fig. 36: Extensor compartment gluteal: Group and lateral rotator group

Table 8: Muscles of gluteal region

Muscles	Attachment	Nerve supply	Action
Gluteus maximus	From – ilium, sacrum, coccyx and sacro tuberos ligament. Inserted to gluteal tuberosity and tensor fascia latae	Inferior gluteal nerve	Extensor of hip joint during extreme hip movements Chief lateral rotator of hip joint
Gluteus medius and gluteus minimus	Medius and minimus inserted to greater trochanter	Superior gluteal nerve	Abductor of hip joint and medial rotator of hip joint & stabilize the pelvis
Piriformis	Origin: Sacrum and gluteal surface of ileum Insertion – greater trochanter	S1, S2	Lateral rotator of hip joint
Superior gemelli	Origin: Ischial spine Inserted to – greater trochanter	Nerve to obturator internus	Lateral rotator of hip joint
Inferior gemelli	Origin: At the upper end of ischial tuberosity Insertion – greater trochanter	Nerve to quadratus femoris	Lateral rotator of hip joint
Obturator internus	Origin: Ischiopubic rami and obturator membrane Insertion: Greater trochanter	Nerve to obturator internus	Lateral rotator of hip joint
Quadratus femoris	Origin: From external surface of ischial tuberosity Insertion: Intertrochanteric crest	Nerve to quadratus femoris	Lateral rotator of hip joint



Clinical Aspect

Piriformis Syndrome

- Piriformis muscle irritates and place pressure on underlying structure sciatic nerve
- And cause pain along the course of sciatic nerve. This referred pain is called as sciatica



REMEMBER

Table 9: Structures under cover of gluteus maximus

Muscles	Nerves
<ul style="list-style-type: none"> • Gluteus medius • Gluteus minimus • Reflected head of the rectus femoris • Piriformis • Obturator internus with two gemelli • Quadratus femoris • Obturator externus • Origin of the four hamstrings from the ischial tuberosity • Insertion of the upper or pubic fibers of the adductor magnus 	<ul style="list-style-type: none"> • Superior gluteal • Inferior gluteal • Sciatic • Posterior cutaneous nerve of thigh • Nerve to the quadratus femoris • Pudendal nerve • Nerve to the obturator internus • Perforating cutaneous nerves
Vessels	Bones and Joints
<ul style="list-style-type: none"> • Superior gluteal vessels • Inferior gluteal vessels • Internal pudendal vessels • Ascending branch of the medial circumflex femoral artery • Trochanteric anastomoses • Cruciate anastomoses • The first perforating artery 	<ul style="list-style-type: none"> • Ilium • Ischium with ischial tuberosity • Upper end of femur with the greater trochanter • Sacrum and coccyx • Hip joint • Sacroiliac joint
Bursa	Ligaments
<ul style="list-style-type: none"> • Trochanteric bursa of gluteus maximus • Bursa over the ischial tuberosity • Bursa between the gluteus maximus and vastus 	<ul style="list-style-type: none"> • Sacrotuberous • Sacrospinous • Ischiofemoral

TENSOR FASCIAE LATAE

- Origin—outer lip of iliac crest
- Triangular muscle attached to iliotibial tract
- Action is to pull the iliotibial tract (so assisting gluteus maximus in extending the knee joint)
- Supplied by superior gluteal nerve
- Action: Abduction and medial rotation.

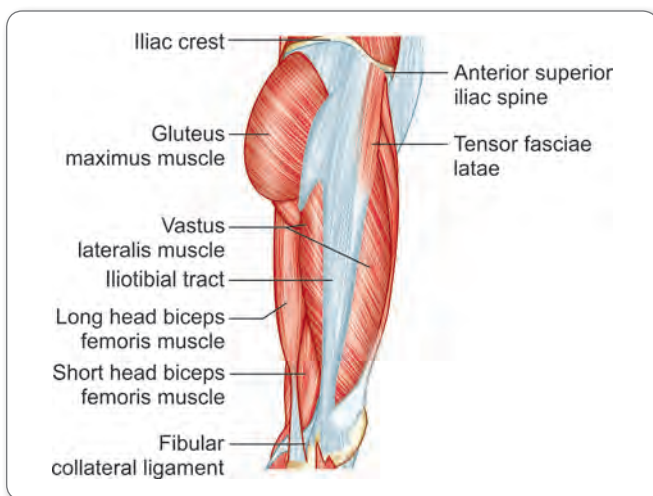


Fig. 37: Tensor fasciae latae



Clinical Aspect

Trendelenburg's Sign

On standing, the glutei medius and minimus muscles pull the corresponding pelvis downward by rotating the head of the femur. As a result, the opposite side pelvis raised. In this way, the muscles of one side prevent the opposite side of the pelvis from sinking downward. In paralysis of **gluteus medius and minimus** (superior gluteal nerve palsy involving gluteus medius, minimus and tensor fascia lata), when the individual stands on the limb of affected side, pelvis sink on the unsupported side. This is called as Trendelenburg sign.

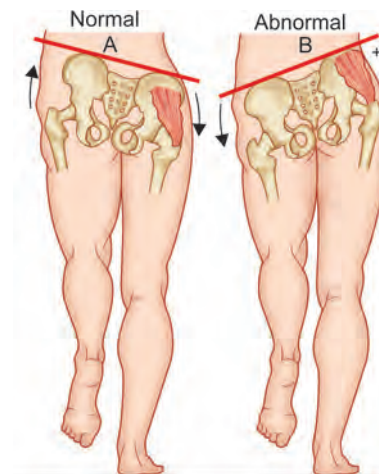


Fig. 38: Trendelenburg's sign



Trendelenburg Test

- Purpose: To detect the weakness in hip abductors
- Test position: Standing

Performing the test

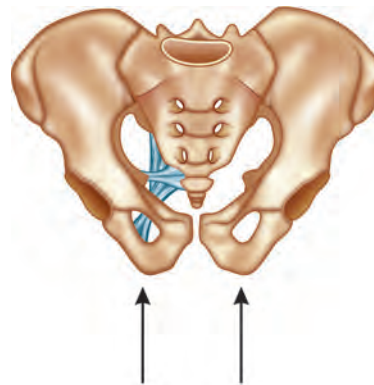
- Patient stands on one leg
- There are two types of positive tests
- If muscle is weak or innervation is poor, we often see the result as an individual walking with their opposite hip dropping or their trunk leaning to the ipsilateral side to make up for the weakness
- Compensated Trendelenburg: Occurs when the patient's trunk leans ipsilateral to the side of stance leg
- Uncompensated Trendelenburg: Occurs when the examiner observes contralateral pelvic drop
- Normal test: When the patient is able to maintain a level pelvis without either of these substitutions.
- The examiner should also watch for any deviations in transverse plane, which could signify mobility impairments.

Key muscle in the gluteal region – piriformis

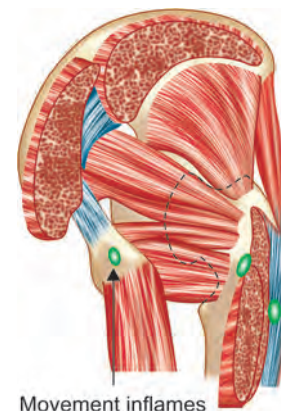
Weaver's bottom



Weaver on treadle



Sit on ischial tuberosities

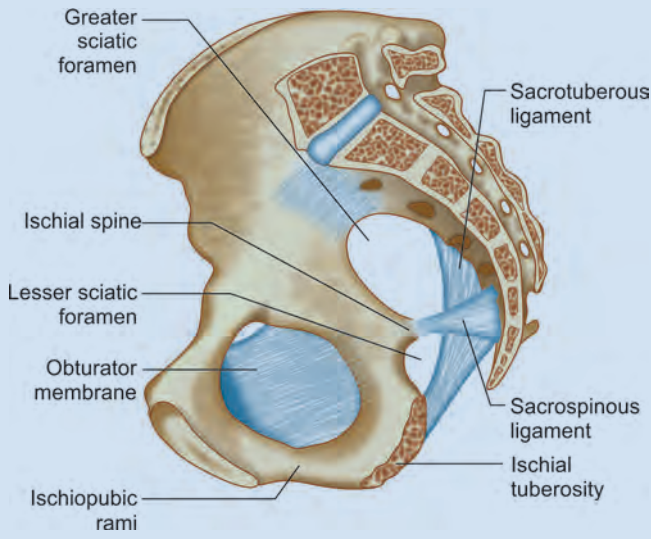


Movement inflames ischial bursa

Ischial Bursitis Called Weaver's Bottom

Due to inflammation of ischial bursa (synovial bursa between ischial tuberosity and gluteus maximus) due to prolonged sitting.

REMEMBER



Structures through Greater sciatic foramen

Piriformis

Above piriformis:

- Superior gluteal vessels and superior gluteal nerve

Below piriformis:

- Inferior gluteal nerve, inferior gluteal vessels and
- **Sciatic nerve**
- PIN structures: Pudendal nerve, Internal pudendal vessels and Nerve to obturator internus
- Posterior cutaneous nerve of thigh
- Nerve to quadratus femoris

Structures through lesser sciatic foramen

Pudendal nerve, Internal pudendal vessels, Nerve to obturator internus and Tendon of obturator internus (**Mn-PINT**)

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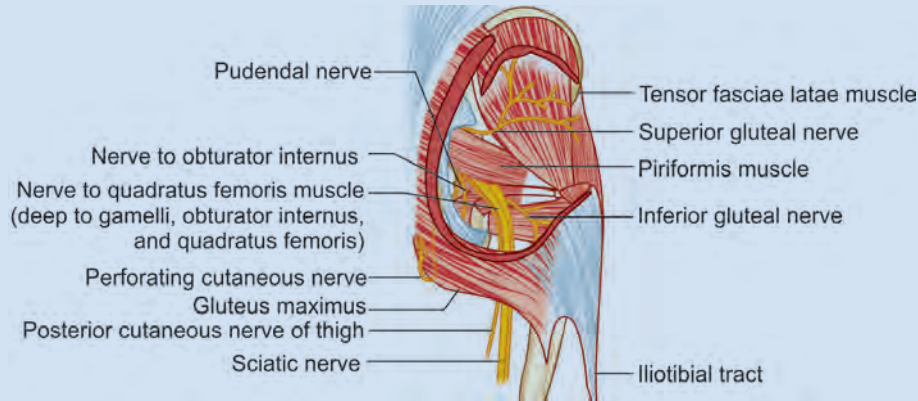


Fig. 39: Gluteal region

SCIATIC NERVE

- The widest and the thickest nerve of the body
- Largest branch of sacral plexus
- **Tibial component is medial and is derived from ventral branch of the ventral rami of L4, 5, S1, 2, 3. Common peroneal component arises from dorsal branch of ventral rami of L4, 5, S1, 2**
- **Sciatic nerve emerges below the piriformis**
- **Emerges beneath the gluteus maximus and midway between ischial tuberosity and greater trochanter**
- Sciatic nerve bifurcates at the upper angle of popliteal fossa into tibial nerve and common peroneal nerve
- Tibial component supplies **hamstring** muscles
- Nerve to short head of biceps femoris from common peroneal component
- Provides articular branches to hip joint and knee joint
- Only one cutaneous branch arises in popliteal fossa, called the **sural nerve**, which is frequently used for nerve grafting.



Clinical Aspect

Sciatic nerve injury – due to hip dislocation

Features of sciatic nerve palsy

- Loss of extension of hip
- Loss of flexion of knee joint
- Paralysis of all muscles of sole
- Loss of dorsiflexion and plantar flexion of ankle joint
- Loss of Inversion and eversion of subtalar joint
- Loss of sensation over the dorsum of foot and sole of foot.

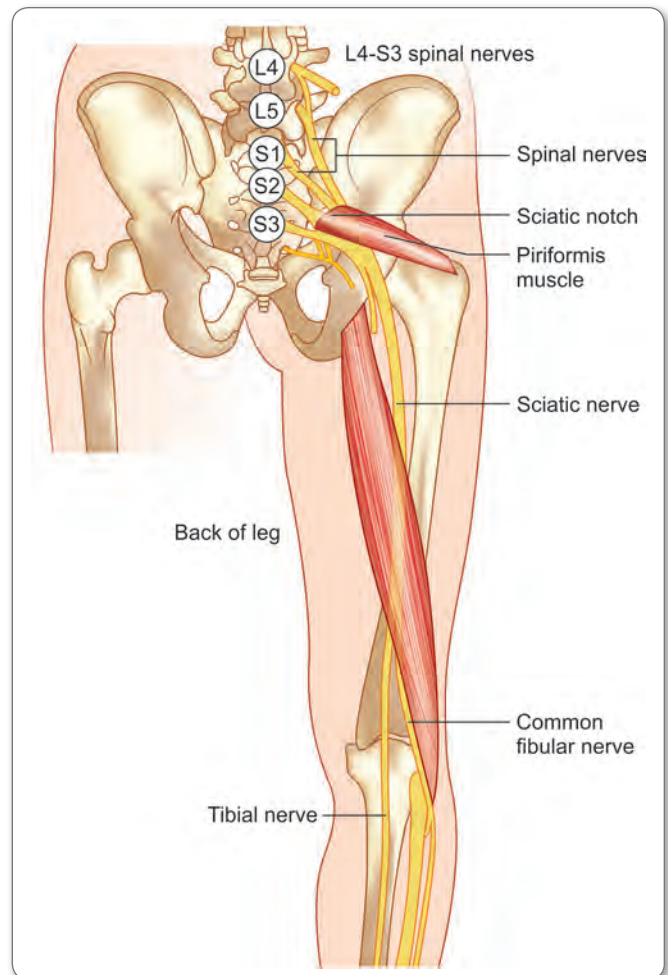


Fig. 40: Course of sciatic nerve



Superior Gluteal Nerve–Root Value – L4-S1

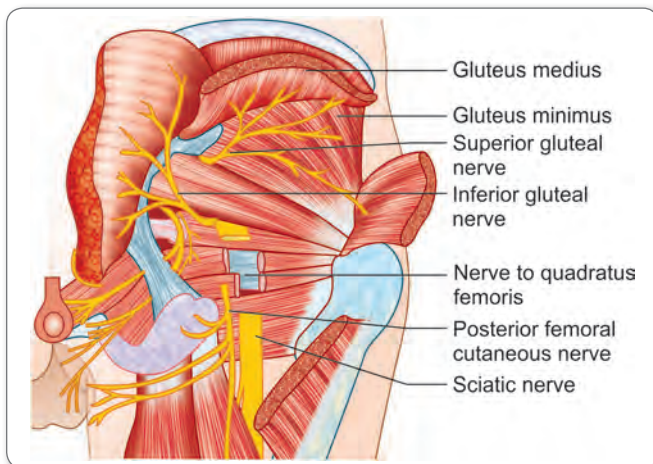


Fig. 41: Superior gluteal nerve

- Branch from sacral plexus
- Enters the gluteal region above the piriformis
- Pass between gluteus medius and minimus and innervates those two muscles
- Also supplies tensor fascia lata and hip joint.

Inferior Gluteal Nerve–Root Value – L5 – S2

- Branch from sacral plexus
- Enters the gluteal region below the piriformis
- Supplies gluteus maximus.

Superior gluteal nerve supplies	Gluteus medius Gluteus minimus Tensor fascia lata
Inferior gluteal nerve supplies	Gluteus maximus

Posterior Femoral Cutaneous Nerve

- Branch from sacral plexus
- Enters the gluteal region below the piriformis
- Innervates skin of gluteal region, scrotum, labia majora, thigh and calf.

Superior Gluteal Artery

- Branch of posterior branch of internal iliac artery
- Passes between lumbosacral trunk and first sacral nerve

- Enters the gluteal region through greater sciatic foramen above the piriformis
- Divides into superficial and deep branch and supplies gluteal muscles and contribute trochanteric anastomosis.

Inferior Gluteal Artery

- Branch of anterior branch of internal iliac artery
- Enters the gluteal region through greater sciatic foramen below the piriformis
- Contributes to trochanteric anastomosis and cruciate anastomosis.

Note: Sciatic artery: Artery to sciatic nerve arising from inferior gluteal artery

CRUCIATE ANASTOMOSIS

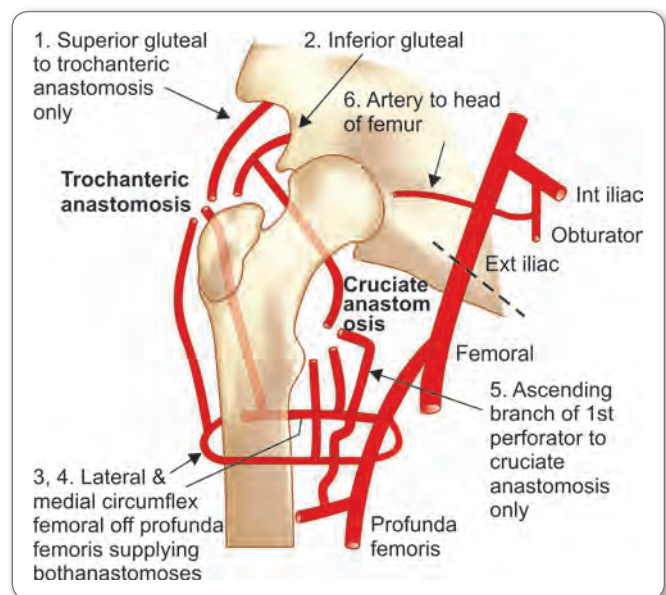


Fig. 42: Hip arterial anastomoses

- Close to root of greater trochanter, cruciate anastomosis is formed. It is formed by:
 - Transverse branch of medial circumflex femoral
 - Transverse branch of lateral circumflex femoral
 - Ascending branch of first perforating
 - Descending branch of inferior gluteal.

Note: Superior gluteal artery not take part in cruciate anastomosis



Trochanteric Anastomosis

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LOWER LIMB

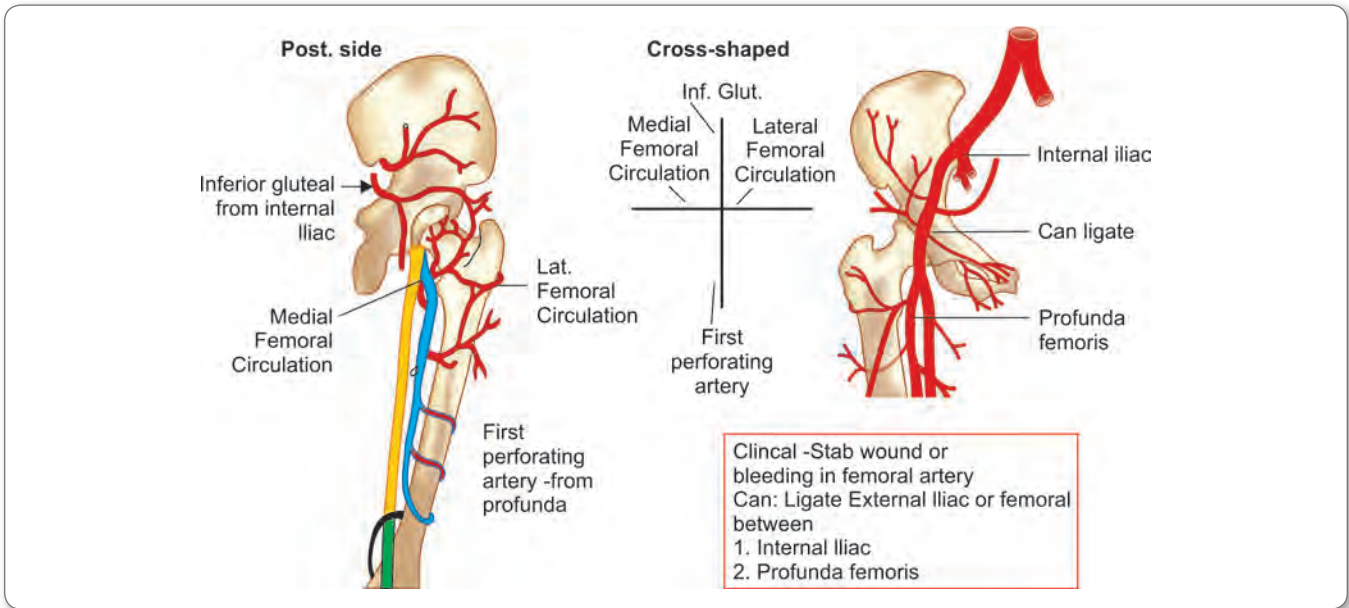


Fig. 43: Cruciate anastomosis

- In trochanteric fossa, an anastomosis is formed by
 - Descending branch of superior gluteal artery
 - Ascending branch of lateral and medial circumflex femoral
 - Branch from inferior gluteal artery.
- Action – extension of hip and flexion of knee
- Nerve supply – tibial component of sciatic nerve.
- Hamstring muscles–
 - Semitendinosus
 - Semimembranosus
 - Long head of biceps femoris
 - Hamstring part of adductor magnus.

Hamstring Muscles

- Origin from ischial tuberosity
- Inserted to bones of leg

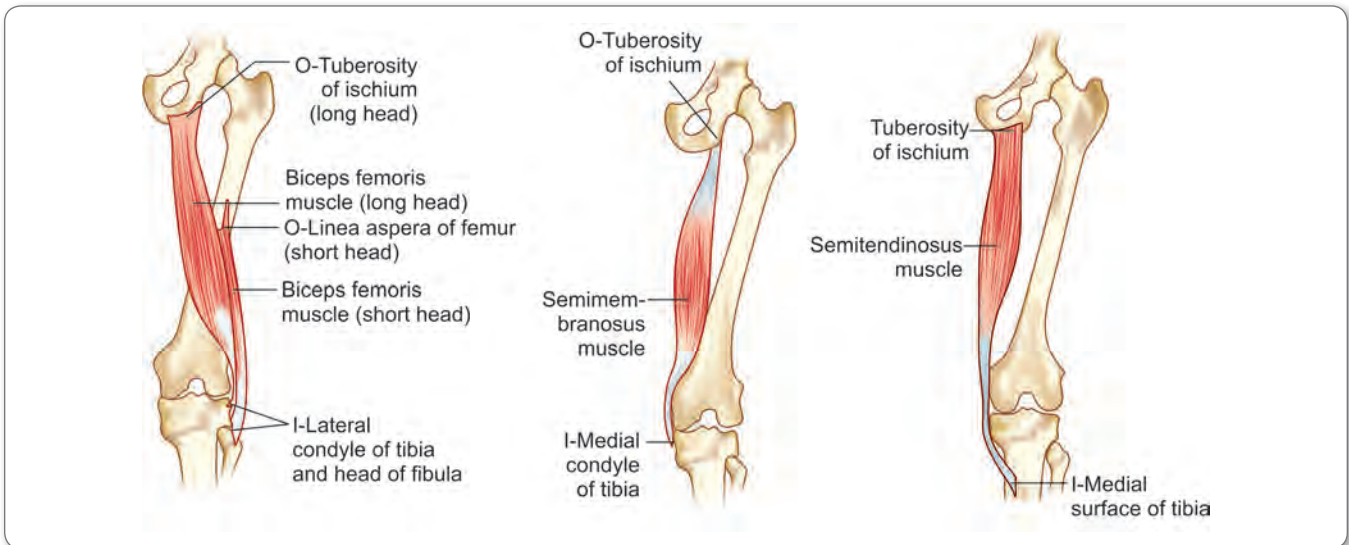


Fig. 44: Hamstring muscles

New SARP Series Anatomy



Table 10: Hamstring group of thigh muscles

Muscle	Origin	Insertion	Nerve supply	Action
Semitendinosus	Ischial tuberosity	Upper part of medial surface of tibia	Tibial component of sciatic nerve	Extension of hip and flexion of knee
Semimembranosus	Ischial tuberosity	Groove on the posterior surface of medial condyle of tibia	Tibial component of sciatic nerve	Extension of hip and flexion of knee
Biceps femoris	Long head – ischial tuberosity Short head – linea aspera	Head of fibula	Long head - tibial component of sciatic nerve	Extension of hip and flexion of knee

- Short head of biceps femoris not true hamstring – origin from femur, nerve supply by common peroneal component
- Sacrotuberous ligament: Degenerated remnant of long head of biceps and pierced by perforating cutaneous nerve, S5 and coccygeal nerve, branches of coccygeal plexus and coccygeal branch of inferior gluteal artery.

Note:

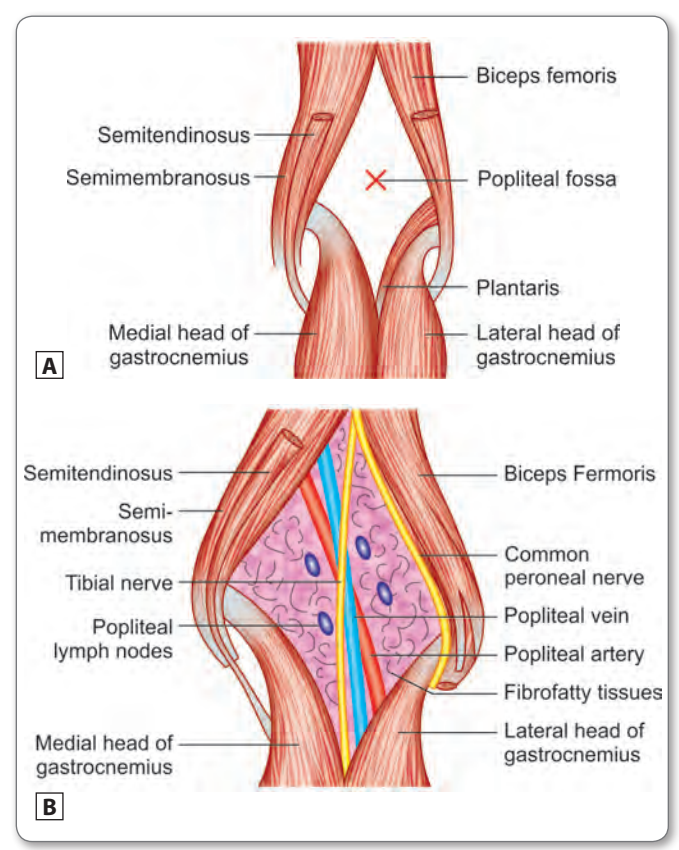
Semitendinosus – proximal fleshy, distal – tendon
 Semimembranosus – proximal – membrane, distal – fleshy
 MN – Tendon – T – disTal – T is there, so **semitendinosus distal – tendon**, proximal – fleshy
 Membrane – M – proxiMal – M is there, so **semimembranosus – proximal membrane distal fleshy**

Two Joint Muscles

- Hip joint and knee joint interlinked. The muscles cross hip joint and knee joint are called two joint muscles. It includes:
- Rectus femoris
- Gracilis
- Semimembranosus
- Semitendinosus
- Biceps femoris.

POPLITEAL FOSSA – DIAMOND SHAPED FOSSA IN BACK OF KNEE JOINT

Above medially	Semimembranosus and semitendinosus
Above laterally	Long head of biceps femoris
Below medially	Medial head of gastrocnemius
Below laterally	Lateral head of gastrocnemius and plantaris
Roof	Skin, superficial fascia, popliteal fascia
Floor	Popliteal surface of femur, popliteus muscle, fascia over popliteus, oblique popliteal ligament
Contents	<ul style="list-style-type: none"> • Popliteal artery • Popliteal vein • Common peroneal nerve • Tibial nerve • Termination of small saphenous vein • Posterior femoral cutaneous nerve before it becomes cutaneous • Genicular branch of obturator nerve • Popliteal group of nodes



Figs 45A and B: Popliteal fossa

POPLITEAL ARTERY

- Continuation of femoral artery at the adductor hiatus and runs through popliteal fossa
- Terminates at the lower border of popliteus muscle by dividing into anterior and posterior tibial arteries
- Deeply located in the popliteal fossa.

Branches of Popliteal Artery

- Muscular branches
- Superior medial genicular
- Superior lateral genicular
- Inferior medial genicular
- Inferior lateral genicular
- Middle genicular genicular–pierces the oblique popliteal ligament and enters the knee joint.



Clinical Aspect

- Pain in the popliteal fossa is mostly due to popliteal aneurysm
- Necessary to ligate the femoral artery for surgical repair, blood can bypass the occlusion through genicular anastomosis and reach the popliteal artery distal to ligation.

Anastomosis Around Knee Joint

It is anastomosis between:

- Popliteal artery – 5 genicular branches
- Femoral artery – descending genicular branch
- Descending branch from lateral circumflex femoral artery
- Anterior tibial artery – recurrent branches
- Posterior tibial artery – circumflex fibular artery.

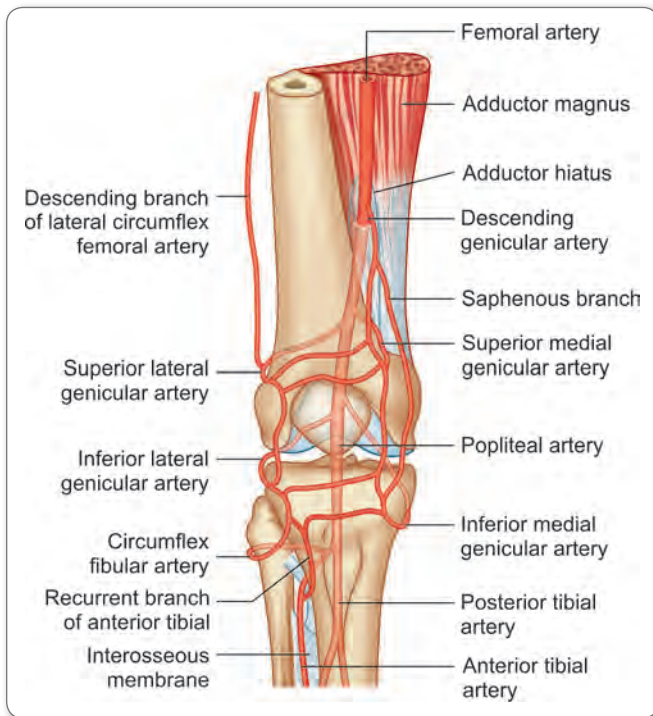


Fig. 46: Anastomosis of popliteal artery

- Superior medial genicular artery anastomosis with descending genicular branch of femoral artery and inferior medial genicular artery
- Inferior medial genicular anastomose with superior medial genicular and saphenous branch of descending genicular artery

- Superior lateral genicular anastomose with descending branch of lateral circumflex femoral and inferior lateral genicular artery
- Inferior lateral genicular anastomose with superior lateral genicular artery, anterior & posterior recurrent branch of anterior tibial and circumflex branch of posterior tibial artery.

ANTERIOR COMPARTMENT MUSCLES OF LEG

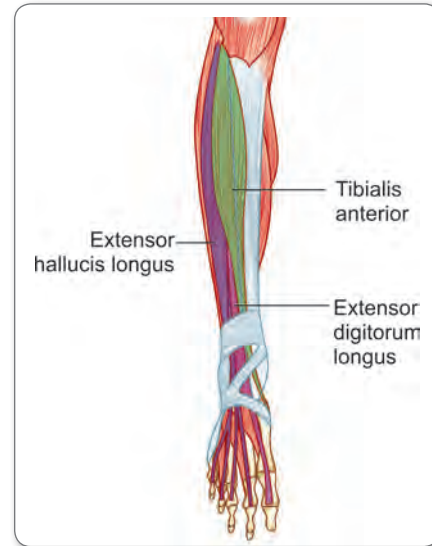


Fig. 47: Muscles of anterior compartment of leg

Table 11: Muscles of anterior compartment of leg

Muscle	Attachment	Action
Tibialis anterior	Inserted to first metatarsal bone and adjacent first cuneiform	Invertor Maintains medial longitudinal arch Dorsiflexor of ankle joint
Extensor digitorum longus	Forms dorsal digital expansion	Dorsiflexor of ankle joint Dorsiflexes lateral four toes
Extensor hallucis longus	Attach to terminal phalanx of great toe without forming dorsal digital expansion	Dorsiflexes the great toe
Peroneus tertius	Inserted to dorsal surface of base of 5 th metatarsal bone	Dorsiflexor of ankle joint Weak evertor of foot



ANTERIOR TIBIAL ARTERY (Refer The Chart, Artery)

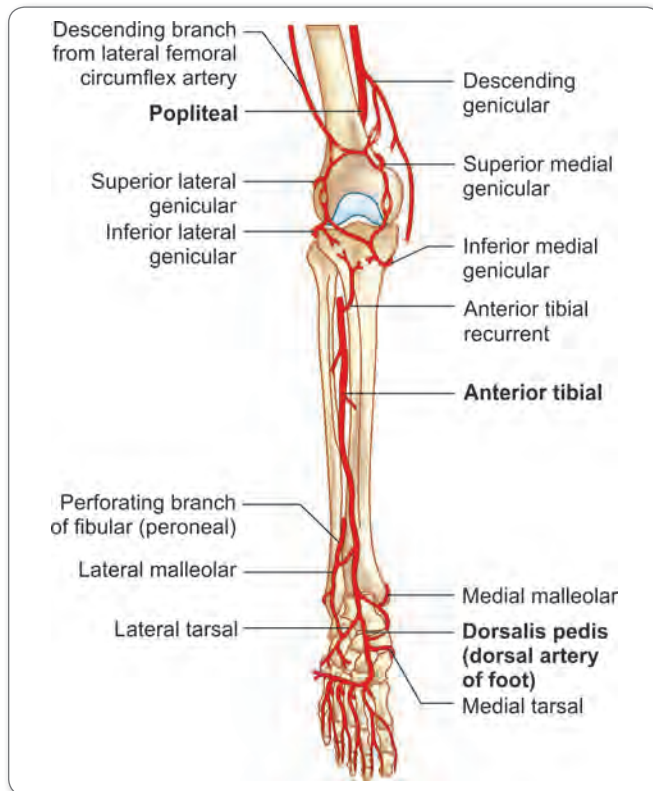


Fig. 48: Course of anterior tibial artery

- One of terminal branch of popliteal artery
- Enters the anterior compartment by passing through gap between tibia and fibula at upper end of interosseous membrane
- Descend in front of interosseous membrane along with deep peroneal nerve
- In the lower part of leg artery rests on the tibia between medial and lateral malleoli
- At front of ankle, continues as dorsalis pedis artery.

Branches of Tibial Artery

- Anterior tibial recurrent
- Posterior tibial recurrent
- Muscular branches
- Medial malleolar artery and
- Lateral malleolar artery.



Clinical Aspect

Anterior Tibial Compartment Syndrome

Compression of anterior tibial artery results in ischemic necrosis of muscles of anterior compartment of leg. Characterized by extreme tenderness and pain on the anterolateral aspect of leg. It's mild form is Shin splint.

Shin Splint

Painful condition caused by swollen muscles (tibialis anterior) in the anterior compartment of leg along the shin bone – tibia following athletic overexertion.

Dorsalis Pedis Artery

- Continuation of anterior tibial artery
- Terminates as deep plantar artery which enters sole by passing between two heads of first dorsal interosseous and joins with lateral plantar artery and forms plantar arch.

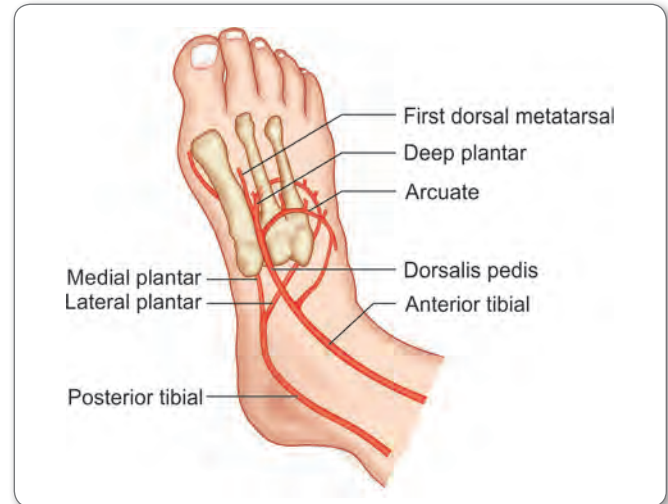


Fig. 49: Course of dorsalis pedis artery

Branches of Pedis Artery

- Medial tarsal artery
- Lateral tarsal artery
- Arcuate artery and
- First dorsal metatarsal artery.

SUPERIOR EXTENSOR RETINACULUM

- In front of ankle joint
- Attachments – from lower part of anterior border of tibia to anterior border of fibula.

Mnemonic

Arrangement of structures beneath superior extensor retinaculum – Mn **T – HAND – P** (MEDIAL TO LATERAL)

- Tibialis anterior
- Extensor hallucis longus
- Anterior tibial artery
- Deep peroneal nerve
- Extensor digitorum longus
- Peroneus tertius.

INFERIOR EXTENSOR RETINACULUM

- Y shaped band of deep fascia
- Stem attaches to upper surface of calcaneum
- Upper band attaches to–medial malleolus, lower band attach to plantar aponeurosis.



LATERAL COMPARTMENT OF LEG

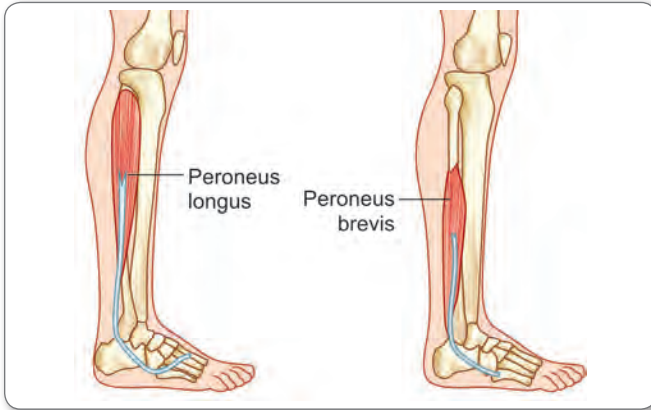


Fig. 50: Peronei muscles

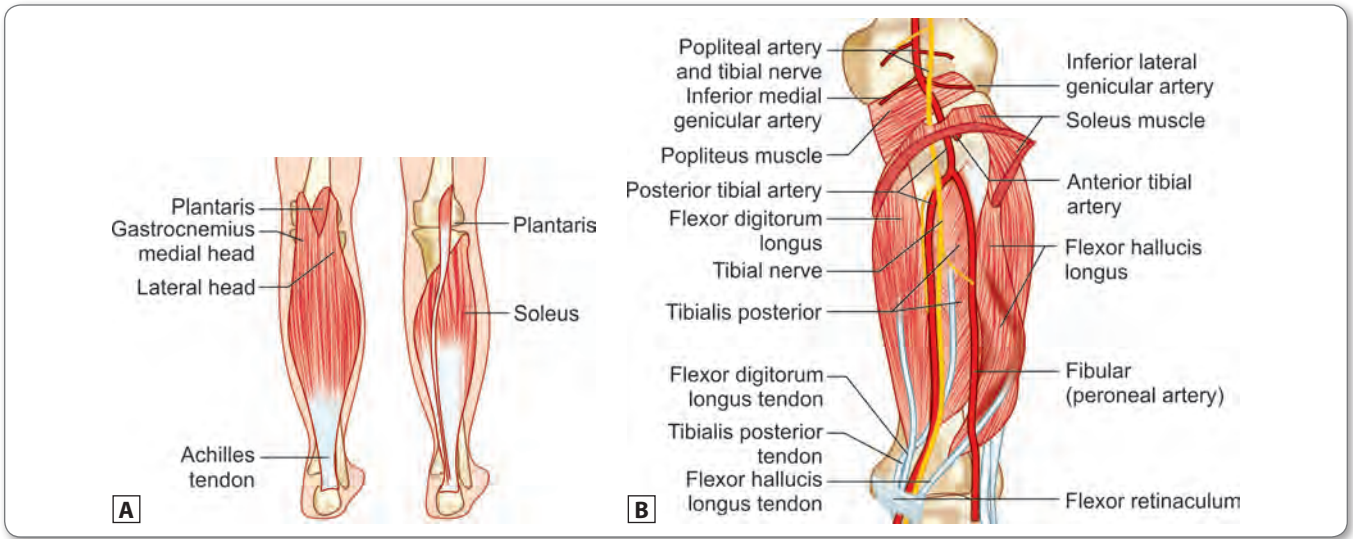
Table 12: Peronei muscles

Muscles	Attachment	Action
Peroneus longus	Attached to plantar surface of 1 st metatarsal bone and medial cuneiform bone	Evertor of foot Maintains lateral longitudinal arch Maintains transverse arch of foot
Peroneus brevis	Inserted to 5 th metatarsal bone	Evertor of foot Maintains lateral longitudinal arch

PERONEAL RETINACULUM

- **Superior peroneal retinaculum**
 - Attachments: From fibular malleolus to lateral surface of calcaneum
 - Peroneus longus and brevis pass below this.
- **Inferior peroneal retinaculum**
 - Continues anteriorly as inferior extensor retinaculum
 - Septum splits, so that peroneus longus and brevis pass through separate compartments.

POSTERIOR COMPARTMENT OF LEG



Figs 51A and B: Muscles of posterior compartment

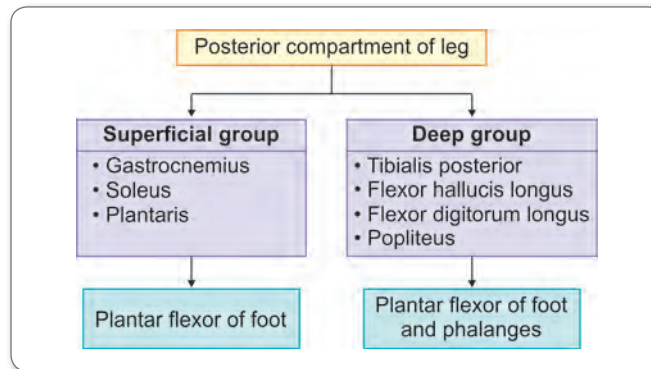




Table 13: Muscles of posterior compartment of leg

Muscle	Origin	Insertion	Nerve supply	Action
Gastrocnemius	Lateral head Lateral supracondylar line Medial head Medial condyle	Forms Achilles tendon and inserts to calcaneum	Tibial nerve	Plantar flexion of foot, flex the knee
Soleus	Soleal line	Forms Achilles tendon and inserts to calcaneum	Tibial nerve	Plantar flexion of foot
Plantaris	Lateral supracondylar line	Joins with Achilles tendon	Tibial nerve	Plantar flexion of foot
Popliteus	Lateral surface of lateral condyle of femur	Posterior surface of tibia above soleal line	Tibial nerve	Unlocks the knee joint
Flexor hallucis longus	Lower two-thirds of posterior surface of tibia	Distal phalanx of great toe	Tibial nerve	Plantar flexion of foot and phalanges
Flexor digitorum longus	Posterior surface of tibia below the soleal line	Distal phalanx of lateral 4 toes	Tibial nerve	Plantar flexion of foot and phalanges
Tibialis posterior	Posterior surface of tibia and fibula	Tuberosity of navicular bone and then to all tarsal and metatarsal bones except talus and 1 st and 5 th metatarsal bone	Tibial nerve	Plantar flexion of foot and phalanges

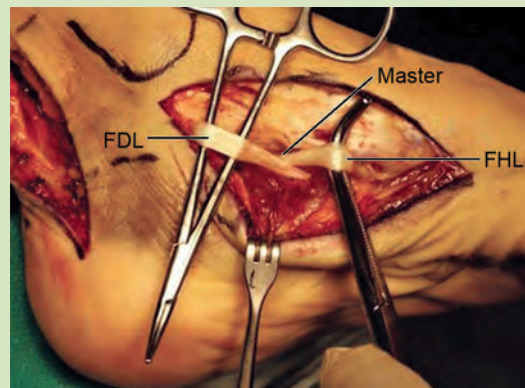
HIGH YIELD POINTS

- Gastrocnemius - cross knee joint and ankle joint posteriorly. So action – flexion of knee and plantar flexion of ankle joint.
- Gastrocnemius and soleus are called as triceps surae.
- Fabella - sesamoid bone in lateral head of gastrocnemius



B. Squeezing calf produces no motion of foot in injured leg. On squeezing the calf muscle ankle moves into plantar flexion. In Achilles tendon rupture, there is no plantar flexion.

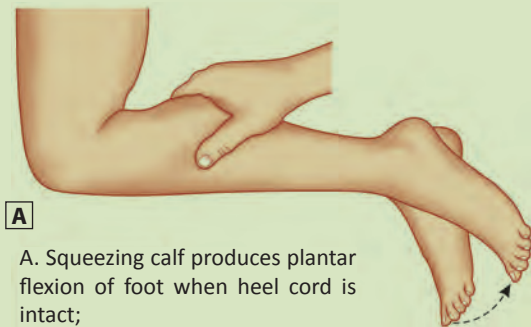
Master knot of Henry



Thickening of sheaths of flexor digitorum longus and flexor hallucis longus while they cross at navicular bone.

- Soleus—peripheral heart.
- Rupture of Achilles tendon—disables the triceps surae—patient not able to plantar flex the foot
- Muscle to act on knee joint and ankle joint – gastrocnemius (flex the knee and plantar flexion of ankle joint)

Thompson's calf muscle squeeze test – Simmond's test



A. Squeezing calf produces plantar flexion of foot when heel cord is intact;

Contd...



FLEXOR RETINACULUM

Modification of Deep Fascia

- Extent: from medial malleolus to medial surface of calcaneum
- Forms tarsal tunnel (similar to carpal tunnel) with tarsal bones
- Provides pathway for long flexor tendons, tibial nerve and posterior tibial artery.



Clinical Aspect

Tarsal Tunnel Syndrome

Due to compression of tibial nerve or its terminal division medial and lateral plantar nerve in the tarsal tunnel. Patient presents with pain, numbness, tingling sensation on the ankle, heel and sole.

Mnemonic

Arrangement of structures in flexor retinaculum medial to lateral

Mnemonic – Tom Dick AND Harry

- Tibialis posterior
- Flexor **D**igitorum longus
- Posterior tibial **A**rtery
- Tibial **N**erve
- Flexor **H**allucis longus

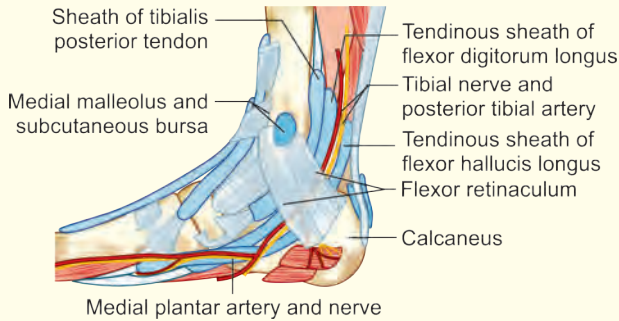


Fig. 52: Attachment of flexor retinaculum – from medial malleolus to calcaneum and plantar aponeurosis

POSTERIOR TIBIAL ARTERY

- One of terminal branch of popliteal artery
- Accompanied by tibial nerve on the posterior surface of tibialis posterior
- Gives peroneal artery, which descends between tibialis posterior and flexor hallucis longus and supply the peroneal compartment muscles

Note: Peroneal artery gives nutrient branch to fibula.

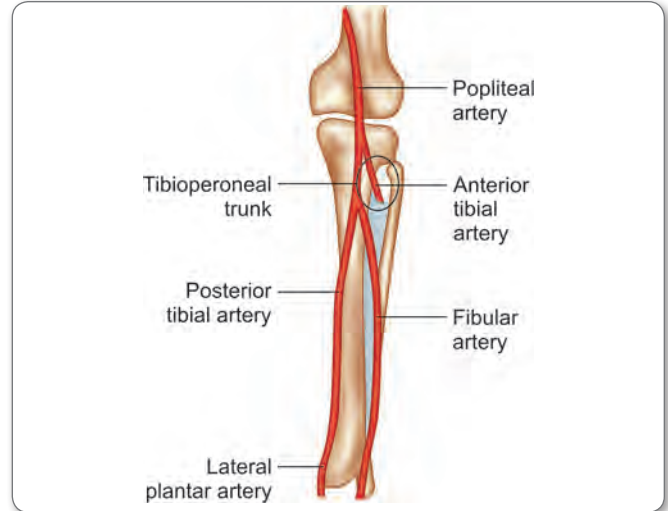


Fig. 53: Course of posterior tibial artery

Branches of Posterior Tibial Artery

- Circumflex fibular artery
- Peroneal artery
- Nutrient branch to tibia – nutrient branch to tibia (largest nutrient branch)
- Medial malleolar branch
- Muscular branch.

Table 14: Terminal branches of tibial artery

Medial plantar artery	Lateral plantar artery
<ul style="list-style-type: none"> • Smaller terminal branch of posterior tibial artery • Gives superficial branch (supplies the big toe) and deep branch, which forms three superficial digital branch 	<ul style="list-style-type: none"> • Larger terminal branch of posterior tibial artery • Forms plantar branch by joining deep plantar branch of dorsalis pedis artery

TIBIAL NERVE

- It is nerve of posterior compartment of leg
- Descends through popliteal fossa then lies on the popliteal fossa
- Terminates beneath the flexor retinaculum and divides into medial and lateral plantar nerve.

Branches

- Give rise to three articular branches which accompany the medial superior genicular, middle genicular, medial inferior genicular branches to knee joint and also gives articular branch to ankle joint
- Muscular branch to posterior compartment of leg
- Cutaneous branch: Sural nerve which supplies lateral side of little toe and accompanies short saphenous nerve behind the lateral malleolus.

Medial Plantar Nerve

Larger terminal branch of tibial nerve passes between abductor hallucis and flexor digitorum brevis and innervates them gives common digital nerves that divides into proper digital branch which



supply the abductor hallucis, flexor digitorum brevis, flexor hallucis brevis and 1st lumbrical and skin of medial three and half toes.

Lateral Plantar Nerve

Smaller terminal branch **supplies lateral 1 ½ of sole and supplies rest of the sole muscles.**



Clinical Aspect

Morton's Neuroma

Perineural fibrosis of common plantar digital nerve

COMMON PERONEAL NERVE

- Small terminal branch of sciatic nerve
- Descends through fossa and superficially cross the lateral head of gastrocnemius
- Pass behind the head of fibula, then winds laterally around the neck of fibula and pierces the peroneus longus and divides into deep and superficial peroneal nerve.



Clinical Aspect

- Fracture of neck of fibula – results in injury of common peroneal nerve
- Features of common peroneal nerve injury
 - Loss of dorsiflexion of ankle joint
 - Complete loss of eversion
 - No loss of complete inversion (because of tibialis posterior supplied by tibial nerve is intact)
 - Loss of extension of great toe
 - Loss of extension of lateral four toes
 - Complete loss of sensation on dorsum of foot except lateral part of dorsum of foot

Features of Nerve Injuries

Injury of Tibial Nerve	Injury of Superficial Peroneal Nerve	Injury of Deep Peroneal Nerve
Loss of Plantar flexion	Eversion completely affected	Loss of dorsiflexion – foot drop
No loss of complete inversion (because of tibialis anterior supplied by deep peroneal nerve is intact)	Sensory loss on major part of dorsum except medial side of foot and lateral side of foot and lateral side of little finger	Inversion not completely affected because tibialis posterior functional
Loss of flexion of great toe		Loss of extension of great toe
Loss of flexion of lateral four toes		Loss of extension of lateral four toes
Paralysis of all muscles of sole		Sensory loss on the area between great and second toe
Loss of sensory supply over sole		

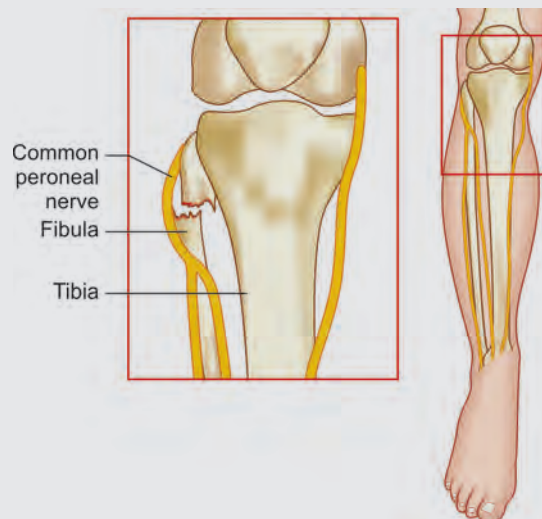


Fig. 54: Broken fibula causes damage to peroneal nerve



LAYERS OF SOLE

- **First layer:** Abductor hallucis, flexor digitorum brevis, abductor digiti minimi
- **Second layer:** Tendon of flexor digitorum longus, tendon of flexor hallucis longus, flexor digitorum accessorius, four lumbricals
- **Third layer:** Flexor hallucis brevis, adductor hallucis, flexor digiti minimi brevis
- **Fourth layer:** 4 dorsal interossei and 3 palmar interossei, medial plantar nerves –supply flexor digitorum brevis, abductor hallucis, flexor hallucis brevis and 1st lumbrical lateral plantar nerve –supplies rest of the sole muscles.

Table 15: Muscles of foot

Muscle	Origin	Insertion	Nerve supply	Action
Dorsum of foot				
Extensor digitorum brevis	Dorsal surface of calcaneum	Tendon of extensor digitorum longus	Deep peroneal nerve	Extend toes
Extensor hallucis brevis	Dorsal surface of calcaneum	Proximal phalanx of big toe	Deep peroneal nerve	Extend big toes
Sole of foot				
First layer				
Abductor hallucis	Medial tubercle of calcaneum	Proximal phalanx of big toe	Medial plantar nerve	Abducts the big toe
Flexor digitorum brevis	Medial tubercle of calcaneum	Middle phalanx of lateral four toes	Medial plantar nerve	Flex the middle phalanges of lateral four toes
Abductor digiti minimi	Medial and lateral tubercle of calcaneum	Proximal phalanx of little toe	Lateral plantar nerve	Abducts the little toe
Second layer				
Quadratus plantae	Medial and lateral tubercle of calcaneum	Tendon of flexor digitorum longus	Lateral plantar nerve	Helps in flexing toes
Lumbricals	Tendon of flexor digitorum longus	Proximal phalanx and extensor expansion	1 st lumbrical – medial plantar nerve. Rest by lateral plantar nerve	Flex the metatarsophalangeal joint and extend the interphalangeal joint
Third layer				
Flexor hallucis brevis	Cuboid and third cuneiform	Proximal phalanx of big toe	Medial plantar nerve	Flex the big toe
Adductor hallucis				
Oblique head	Base of metatarsal 2–4	Proximal phalanx of big toe	Lateral plantar nerve	Adducts the big toe
Transverse head	Capsule of lateral four Metatarsophalangeal joints			
Flexor digitorum minimi brevis	Base of metatarsal 5	Proximal phalanx of little toe	Lateral plantar nerve	Flex the little toe
Fourth layer				
Plantar interossei	Medial side of metatarsal 3–5	Medial side of base of proximal phalanges 3–5	Lateral plantar nerve	Adducts toes, flex proximal and extend distal phalanges
Dorsal interossei	Adjacent shaft of metatarsal	Proximal phalanx of second toe (medial and lateral side) and third and fourth toe lateral side	Lateral plantar nerve	Abduct the toes, flex proximal and extend distal phalanges



REMEMBER

Bones and Joint

The longest and the strongest bone in body	Femur
The largest sesamoid bone in body	Patella
The largest nutrient artery in body	Tibia- posterior tibial artery
The largest tarsal bone in the body	Calcaneum
The longest metatarsal in the body	Second
The shortest, thickest, stoutest metatarsal in the body	First
The largest cuneiform	Medial cuneiform
The largest and complex joint in body	Knee joint
The march fracture is due to fracture of	2 nd metatarsal

Nutrient Artery for Long Bones

Femur	Profunda femoris artery
Tibia	Posterior tibial artery (largest single nutrient artery)
Fibula	Peroneal artery

Sesamoid Bone in the Lower Limb

Tendon	Sesamoid bone
Quadriceps femoris	Patella
Adductor longus	Rider's bone
Lateral head of gastrocnemius	Fabella
Peroneous longus	Os peronium
Peroneus brevis	Os vesalis

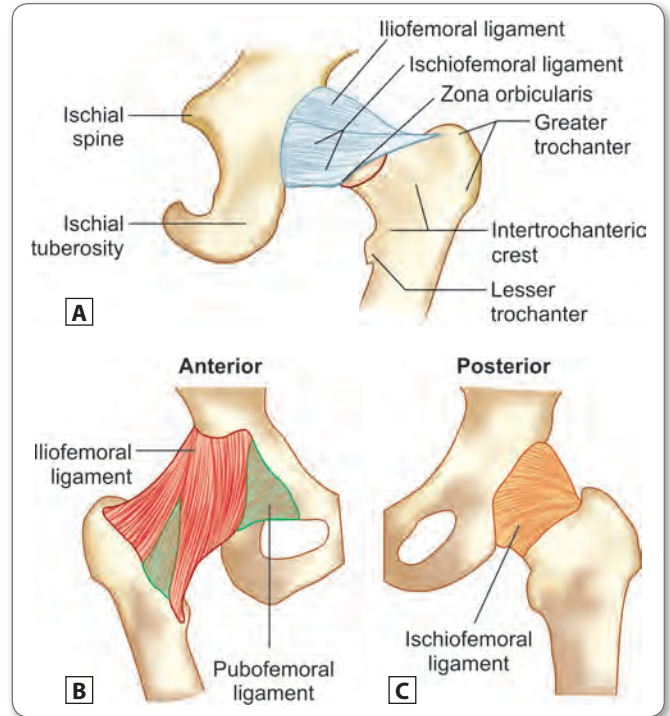
JOINTS OF LOWER LIMB

HIP JOINT (BALL AND SOCKET JOINT)

The hip joint is formed by the **head of the femur** and the **acetabulum**.

Ligaments

- Fibrous capsule: Medially to acetabulum, laterally – intertrochanteric line on anterior aspect and 2 cm medial to intertrochanteric crest on posterior aspect
- Iliofemoral ligament (Ligamentum Bigelow) inverted V shaped: Prevents hyperextension of hip joint – from anterior inferior iliac spine to intertrochanteric line
- Ischiofemoral ligament: Covers the joint capsule posteriorly and assist iliofemoral ligament
- Pubofemoral ligament: Prevents over abduction of hip joint
- Ligament of head of femur: Conveys blood vessel to head of femur.



Figs 55A to C: Ligaments of hip joint

Table 16: Ligaments of hip joint

Ligament	Nature
Ligament of Bigelow	The strongest ligament of hip
Ischiofemoral ligament	The weakest ligament of hip
Ligament of head of femur	Ligamentum teres (contains obturator artery)

Blood Supply of Hip Joint

Blood supply to head and neck of femur

- From medial and lateral circumflex femoral artery (branch of profunda femoris artery)
- From artery to head of femur (branch of obturator artery)

Note: Medial circumflex femoral artery (lateral epiphyseal artery) is the main vessel which supply the femoral head



Clinical Aspect

Intra capsular fracture – damage the blood supply to the head. Results in avascular necrosis or non-union.

Nerve Supply of Hip Joint

Femoral nerve:

- Anterior division of obturator nerve
- Nerve to quadratus femoris
- Superior gluteal nerve
- Twig from sciatic nerve.



Muscle Compartments of Hip Joint

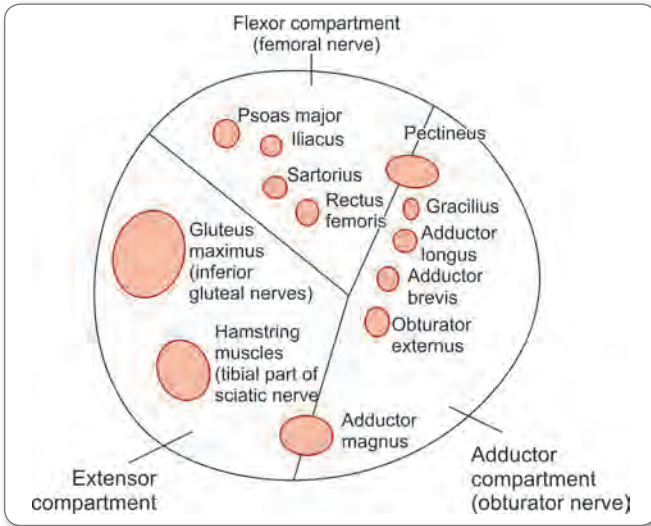


Fig. 56: Muscle compartment of hip joint

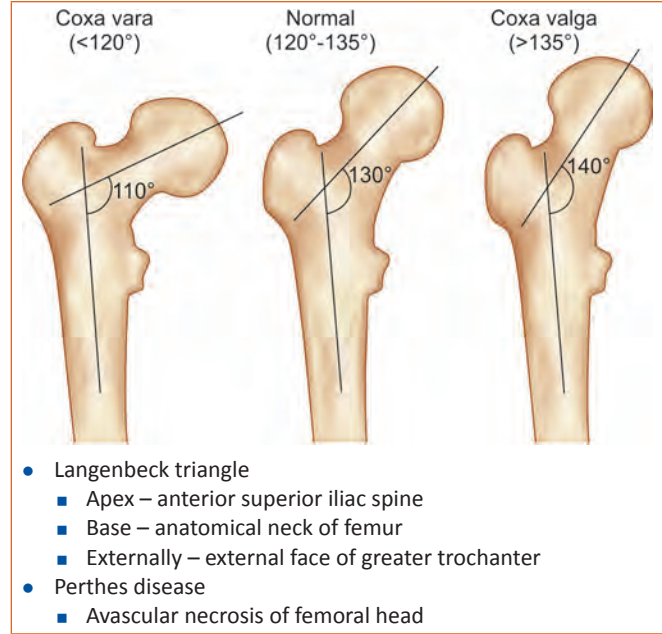


Table 17: Muscles responsible for various movements of the hip joint

Adductors	Abductors	Medial Rotators	Lateral Rotators
<ul style="list-style-type: none"> • Pectineus: Flexor and adductor muscles • Adductor magnus: Extensor and adductor muscle • Gracilius, adductor longus adductor brevis, obturator externus and internus 	<ul style="list-style-type: none"> • Gluteus medius • Gluteus minimus • Tensor fasciae latae • Sartorius 	<ul style="list-style-type: none"> • Gluteus medius • Gluteus minimus • Tensor fasciae latae 	<ul style="list-style-type: none"> • Gluteus maximus (chief lateral rotator), Piriformis • Superior and Inferior gemelli • Obturator internus • Quadratus femoris • Obturator externus

Mnemonic

Lateral rotators → Lateral rotation of thigh is quality performance of girls



Clinical Aspect

- Coxa valga: Angle made by femoral neck to shaft exceeds 135°
- Coxa vara: Angle made by femoral neck to shaft less than 135°
- Posterior tearing of joint capsule results in posterior dislocation of hip joint. (Most common type of hip dislocation – accounts for 90%). The fractured femoral head lies posterior to acetabulum or ischium. Results in affected lower limb being shortened, flexed, adducted and medially rotated
- Anterior tearing of joint capsule results in anterior dislocation of hip joint. The fractured femoral head lies anterior to acetabulum or ischium. Results in affected lower limb being shortened, flexed, abducted and laterally rotated

KNEE JOINT – COMPOUND SYNOVIAL JOINT

- The largest synovial joint in the body
- The knee joint is formed by the articulations of the medial and lateral femoral condyles, the medial and lateral tibial condyles, and the patella
- bi condylar > Modified hinge joint: Flexion coupled with lateral rotation and extension coupled with medial rotation.



Fig. 57: Bursae of knee joint



Ligaments

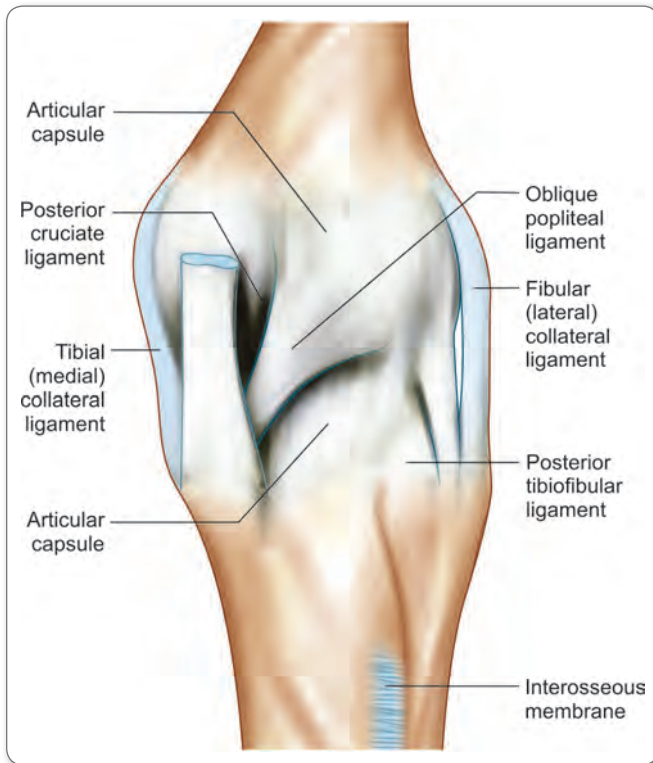
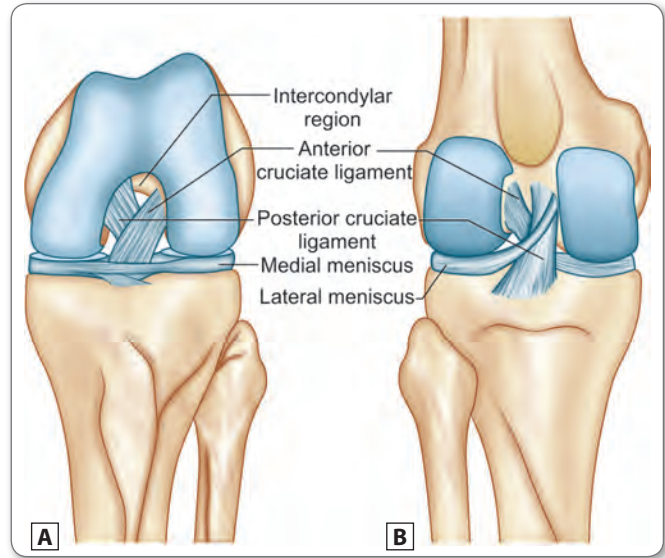


Fig. 58: Ligaments of knee joint

- **Fibrous capsule-deficient anteriorly**, replaced anteriorly by quadriceps femoris tendon and patella. Through the defect in the capsule, popliteus tendon exits
- Synovial membrane lines inner surface of capsule except in front and behind. Posteriorly reflected by cruciate ligaments. Superiorly synovial membrane extends as suprapatellar bursa through defect in the capsule
- Ligamentum patella: From patella to tibial tuberosity
- Medially and laterally, the knee joint capsule is strengthened by the medial and lateral collateral ligaments. These ligaments resist abduction and adduction, respectively
- Medial collateral ligament: Degenerated remnant of adductor magnus
- Lateral collateral ligament: Degenerated remnant of peroneus longus.

Anterior and Posterior Cruciate Ligaments

- They are pain sensitive
- Intracapsular and extrasynovial ligaments
- These are named according to the site of inferior attachment of the ligament on the tibia
- These ligaments prevent anterior and posterior displacement of the tibia on the femur, respectively.



Figs 59A and B: Intracapsular ligament

Table 18: Differences between anterior and posterior cruciate ligament

Anterior cruciate ligament	Posterior cruciate ligament
Attached to anterior part of the intercondylar area of tibia	Posterior part of intercondylar area of tibia
Direction: Upward, backward and laterally and attached to posterior aspect of medial surface of lateral condyle	Upward, forward and medially and attached to the anterior aspect of the lateral surface of the medial condyle
Prevents posterior dislocation of femur on tibia and forward dislocation of tibia on femur	Prevents anterior dislocation of femur on tibia and posterior dislocation of tibia on femur
Limits hyperextension of knee joint (taut during extension)	Limits hyper flexion of knee joint (taut during flexion)
Weaker	Stronger

Clinical Aspect

- The tests for the integrity of the cruciate ligaments are the anterior and posterior drawer signs (anterior drawer sign indicates damage to the anterior cruciate ligament).

Anterior and posterior drawer tests



Anterior drawer test
Lower leg pulled up to check knee joint laxity



Posterior drawer test
Lower leg pushed down to check knee joint laxity



- *Oblique popliteal ligament*: Expansion of **semimembranosus** tendon and pierced by middle genicular vessels
- The medial and lateral menisci are fibrocartilaginous structures between the femoral condyles and the tibial plateaus.

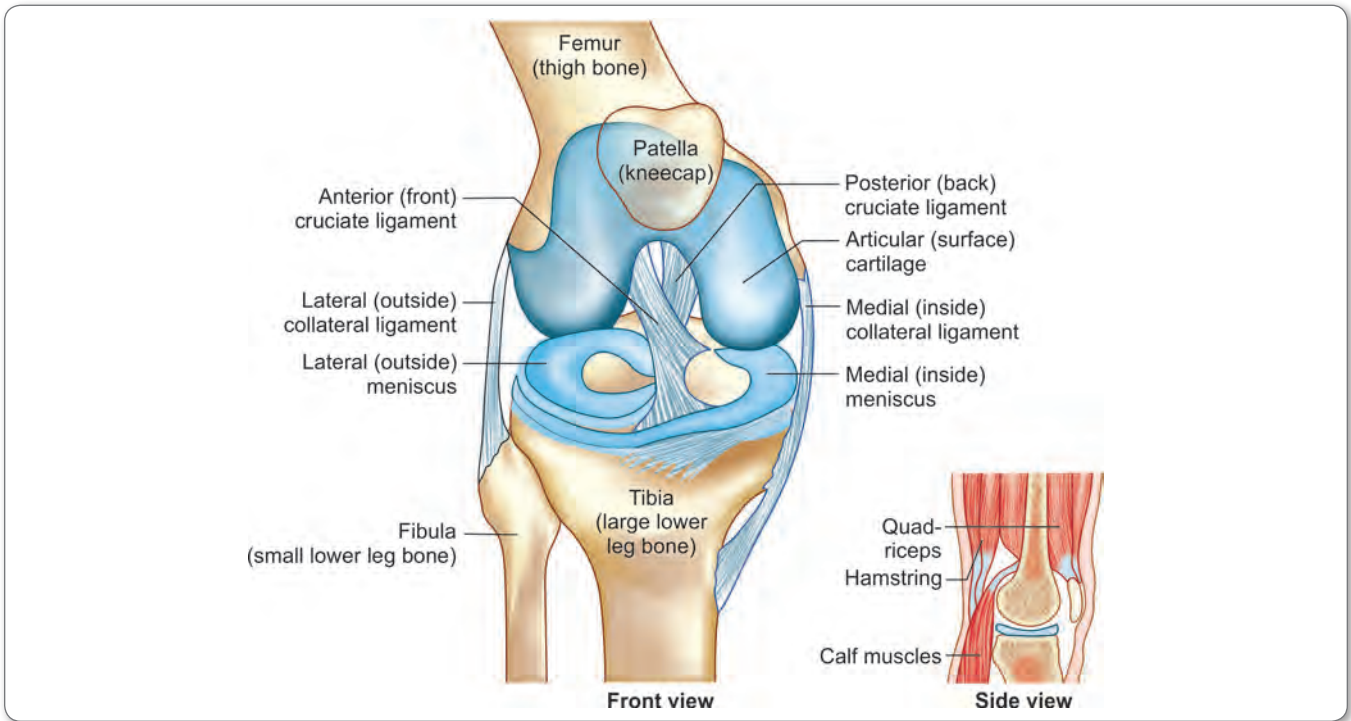


Fig. 60: Menisci of knee joint

- Periphery of the meniscus is vascular, inner part is avascular
- Coronary ligaments attach both menisci to tibial condyle. So coronary ligament is otherwise known as tibiomeniscal ligament.

Table 19: Menisci of knee joint

Lateral meniscus	Medial meniscus
<ul style="list-style-type: none"> • Lateral meniscus is circle shape. O shape • Anterior horn is smaller than posterior horn • Not attached to the lateral collateral ligament • Attach to popliteus tendon • Less firmly anchored to the tibia • More mobile and less prone to injury 	<ul style="list-style-type: none"> • Medial meniscus is semicircle shape. C shape • Anterior and posterior horn are equal size • Attached to the medial collateral ligament • More firmly anchored to the tibia • Less mobile and prone to injury

Table 20: Locking and unlocking

Locking	Unlocking
Locking: Full extension Femur internally (medial) rotated on fixed tibia Caused by quadriceps femoris Ligaments – taut	Unlocking start by initiation of flexion from full extended position External (lateral)rotation of femur on fixed tibia Initiated by popliteus Ligaments - relaxed

REMEMBER

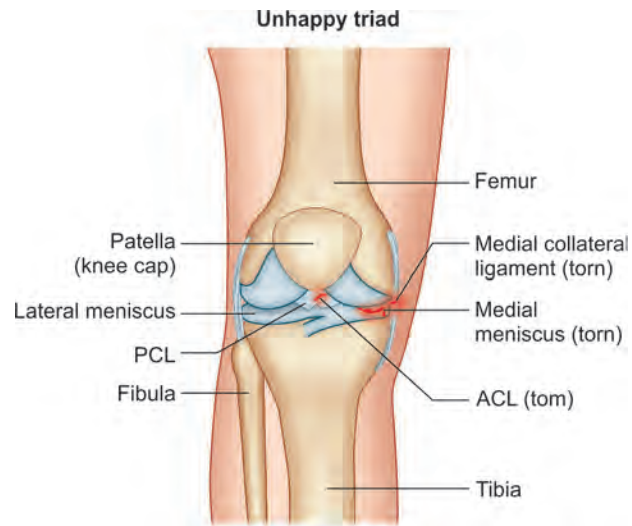
Bursa Around Knee

- Suprapatellar bursa: Deep to quadriceps femoris. Communicates with knee joint
- Prepatellar bursa: Lies over the superficial surface of patella
- Housemaid’s knee – pre patellar bursitis
- Infrapatellar bursa: Lies over patellar ligament
- Clergyman’s knee – infrapatellar bursitis
- Anserine bursa: Lies between tibial collateral ligament and tendons of sartorius, gracilis and semitendinosus.



Clinical Aspect

Unhappy Triad – Donoghue's Triad



- Due to severe blow on the lateral aspect of knee joint when he planted his shoe firmly on the ground
- Involves the involvement of three ligament
 - Medial collateral ligament
 - Medial meniscus (medial collateral ligament is closely attached to medial meniscus)
 - ACL

Infrapatellar Bursitis

- Clergyman's knee



House Maid's Knee - Prepatellar Bursitis



Table 21: Movements at knee joint muscles

Movements	Primary muscle	Accessory muscle
Extension	Quadriceps femoris	Tensor fasciae latae
Flexion	Biceps femoris Semimembranosus Semitendinosus	Gracilis Sartorius Popliteus
Medial rotation of flexed leg	Semimembranosus Semitendinosus Popliteus	Gracilis Sartorius
Lateral rotation of flexed leg	Biceps femoris	

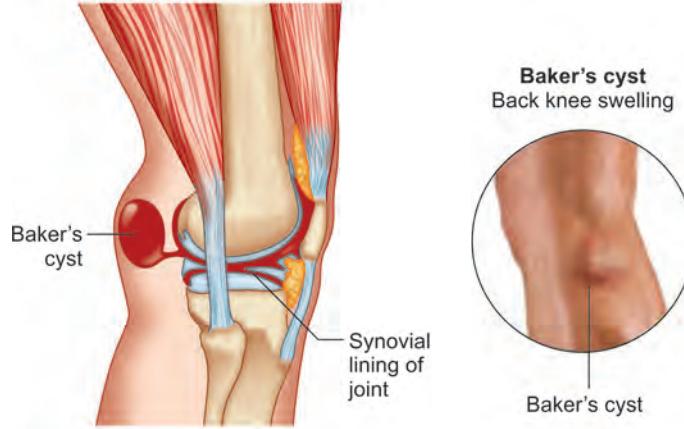


Patellar Tendon Reflex

- Tap on the patellar tendon – elicits extension of the knee joint
- Afferent and efferent – femoral nerve.

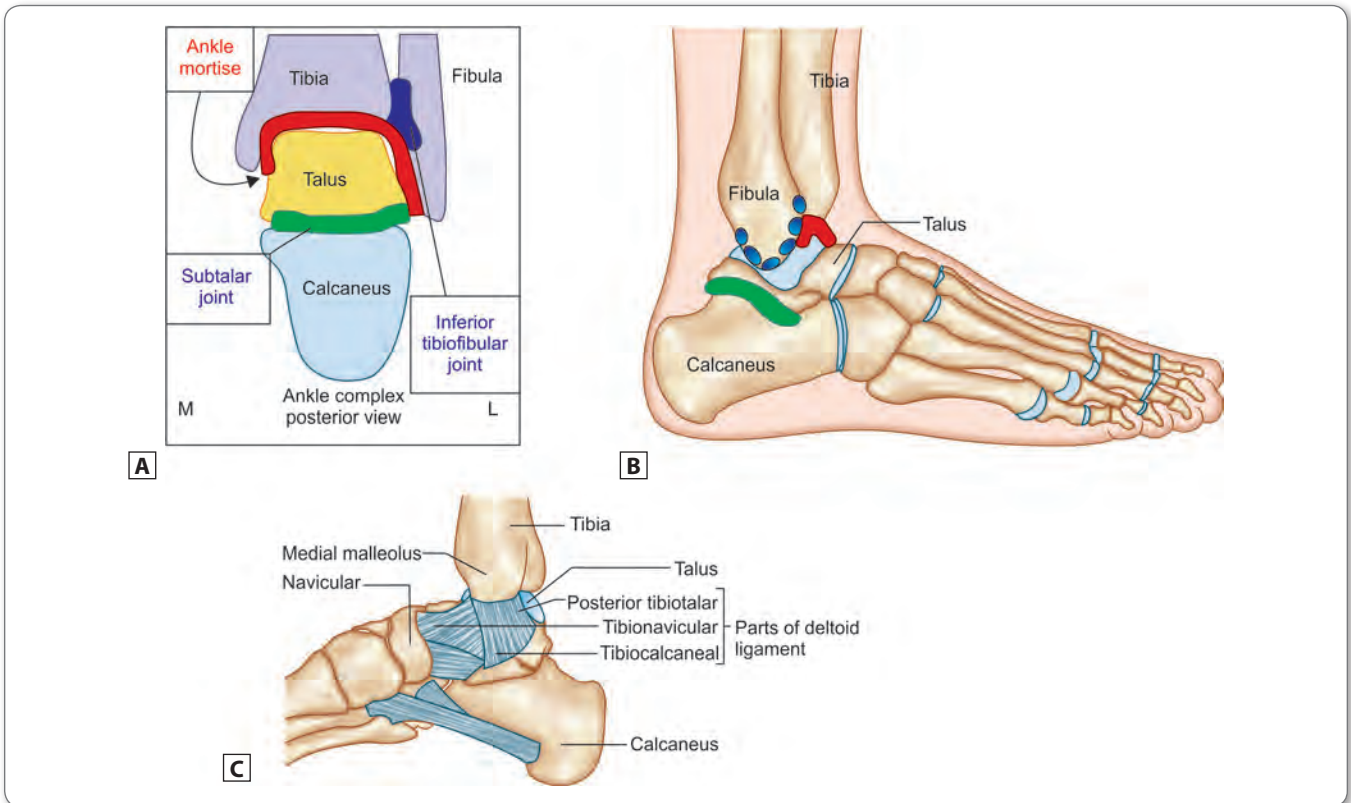
Clinical Aspect

Bakers Cyst – Popliteal Cyst



Herniation of synovium through weakening of posterior knee capsule. Presents as popliteal cyst.

ANKLE JOINT



Figs 61A to C: Ankle joint



- Synovial type of hinge joint
- Stability of joint is by:
 - Closed interlocking of articular surface
 - Tendons that cross the joint 4 in front and 5 behind
 - Strong collateral ligaments
- **Movements:** Dorsiflexion (joint is more stable in this position) and plantar flexion
- **Ligaments:** Capsule is strengthened by medial and lateral collateral ligament.

Medial Collateral Ligament or Deltoid Ligament

Attachment

- Superficial fibers
- **Proximally:** Apical portion of medial malleolus
- **Distally:** Anterior fibers—tuberosity of navicular bone (tibionavicular ligament)
- **Middle fibers:** Sustentaculum tali (tibiocalcaneal ligament)
- In between the above the fibers blends the spring ligament.
- **Posterior fibers:** Posterior part of medial side of the talus (Posterior tibiotalar lig)
- **Deep fibers:** Attached more anteriorly on the talus form anterior tibiotalar ligament.
- **Forced eversion:** Avulses the medial malleolus or ruptures deltoid ligament.

Lateral Collateral Ligament

- Talofibular ligament
- Calcaneofibular ligament
- **Forced inversion:** Avulse the lateral malleolus and ruptures lateral collateral ligament (talofibular and calcaneofibular ligament).

Table 22: Muscles acting at ankle joint and subtalar joint

Movement	Main muscle	Accessory muscle
Plantar flexion	Gastrocnemius, soleus	Plantaris, tibialis posterior, flexor hallucis longus, flexor digitorum longus
Dorsiflexion	Tibialis anterior	Peroneus tertius, extensor hallucis longus, flexor digitorum longus

JOINTS OF FOOT

Table 23: Different foot joints

Joints	Types
Interphalangeal joint	Hinge
Metatarsophalangeal joint	Ellipsoidal type
Tarsometatarsal joint	Plane
Talocalcaneonavicular joint	Ball and socket
Calcaneocuboid	Saddle
Posteriortalocalcaneal joint	Plane

Inversion and eversion mainly occurs at

- Subtalar (talo calcaneal) joint and talocalcaneonavicular joint.
- Accessory joint: Calcaneocuboid and talonavicular.

Table 24: Inversion and eversion at foot

Inversion	Eversion
Medial margin of foot raised above the ground	Lateral margin of foot raised above the ground
Sole is directed downwards and medially	Sole is directed downward and laterally
Associated with plantar flexion	Associated with dorsiflexion
Main muscles: tibialis anterior and tibialis posterior	Main muscle: peroneus longus and brevis

ARCHES OF FOOT

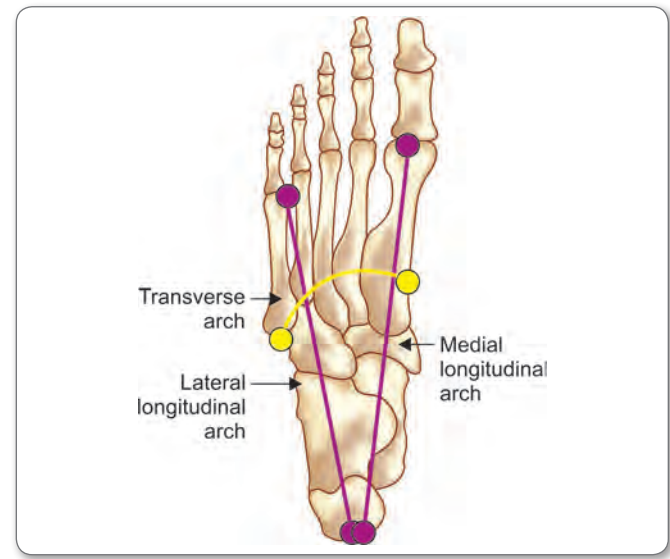
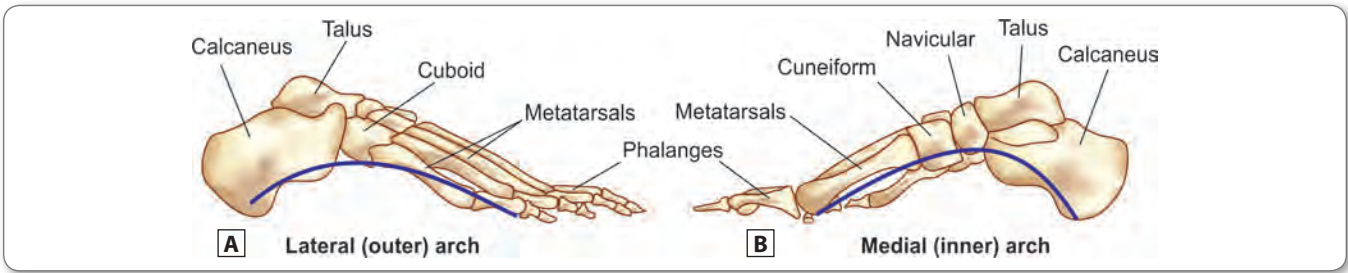


Fig. 62: Arches of foot



Medial Longitudinal Arch



Figs 63A and B: Medial and lateral arch

- Bones contributing to this arch – talus, calcaneum, navicular, cuneiform and three medial metatarsal bones
- Summit of the joint is formed by head of the talus
- Supported by spring ligament and tendon of flexor hallucis longus.

Long Plantar Ligament

- Otherwise known as plantar calcaneocuboid ligament
- Extent – from plantar aspect of calcaneum to tuberosity of cuboid and base of metatarsal bone
- Supports lateral longitudinal arch.

Lateral Longitudinal Arch

- Formed by calcaneum, cuboid and two lateral metatarsal bones
- Keystone: Cuboid bone
- Plantar ligaments and peroneus longus tendon support this arch.

Short Plantar Ligament

- Otherwise known as plantar calcaneocuboid ligament
- Extent – plantar aspect of calcaneum to cuboid
- Supports lateral longitudinal arch.

Transverse Arch

- Complete arch formed by when both medial borders are approximated
- Each foot forms half doom
- Proximal arch: Formed by navicular bone, three cuneiform, cuboid and base of the five metatarsal. Supported by peroneus longus
- Distal arch: Formed by heads of five metatarsal bones. Supported by transverse head of adductor hallucis.

Spring Ligament

- Otherwise known as plantar calcaneonavicular ligament
- Extent – sustentaculum tali(calcaneum) to navicular bone
- Supports head of talus
- Maintains medial longitudinal arch
- Supported by tendon of the tibialis posterior.

Table 25: Medial and lateral longitudinal arches

Medial longitudinal arch	Lateral longitudinal arch
Summit is at the higher level	Summit is at lower level
Bones contributing: Calcaneum, talus, navicular, three cuneiform, medial 3 metatarsal bones.	Calcaneum, cuboid, 4 th and 5 th meta tarsal bone
Summit of the arch: talus	Summit: calcaneum
Posterior pillar: Medial tubercle of calcaneum	Posterior pillar: Lateral tubercle of calcaneum
Anterior pillar: Head of medial three metatarsal bones	Anterior pillar: Head of 4 th and 5 th metatarsal head
Main joint: Talocalcaneonavicular joint	Main joint: Calcaneocuboid joint
Intersegmental ties: Spring ligament	Intersegmental ties: Long and short plantar ligament
Tie beams: Plantar aponeurosis, abductor hallucis, flexor digitorum brevis	Tie beams: Plantar aponeurosis, abductor digiti minimi, flexor digitorum brevis
Slings: Tibialis posterior, tibialis anterior, flexor hallucis longus, flexor digitorum longus	Slings: Peroneus longus and brevis

Ligaments

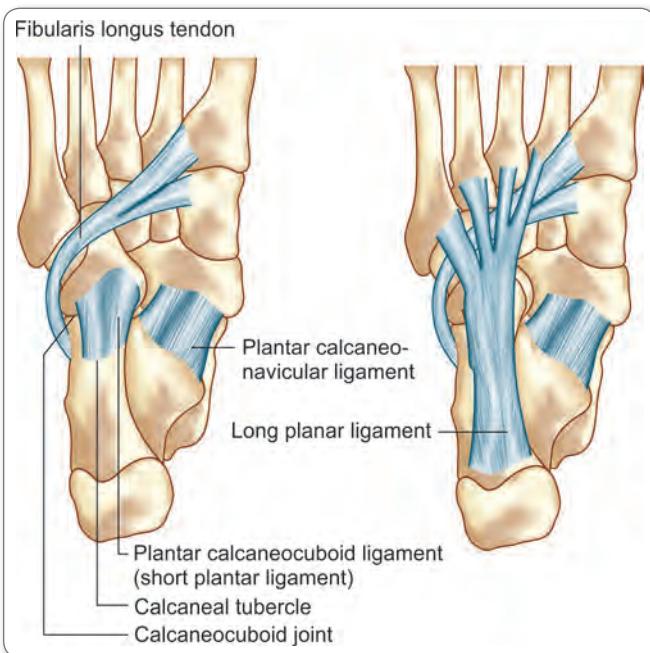


Fig. 64: Ligaments of foot joint



RADIOLOGICAL ANATOMY OF JOINTS OF LOWER LIMB

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THEORY

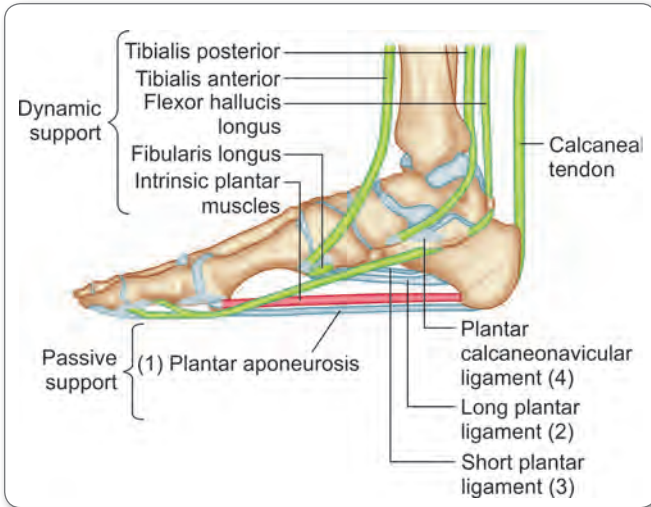
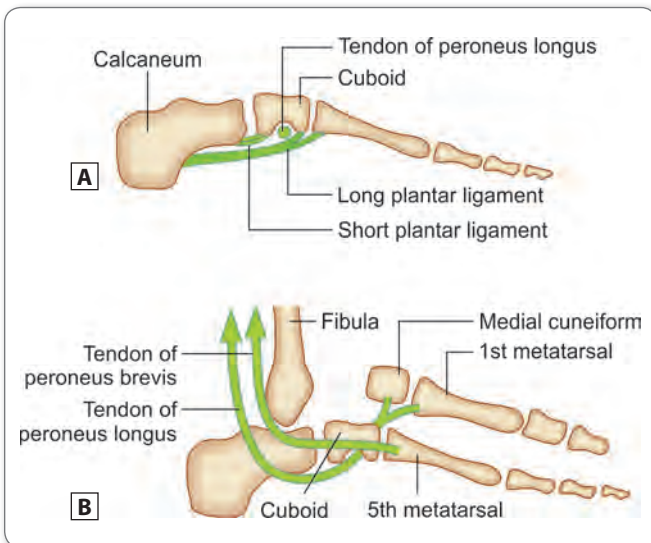


Fig. 65: Medial longitudinal arch (Medial view)

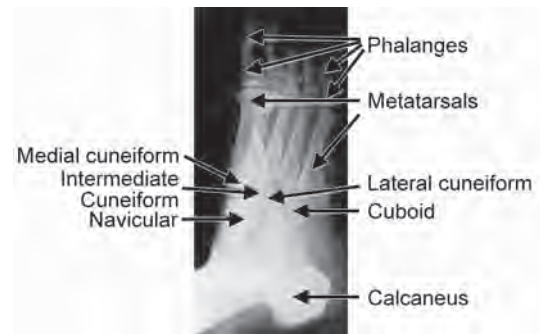
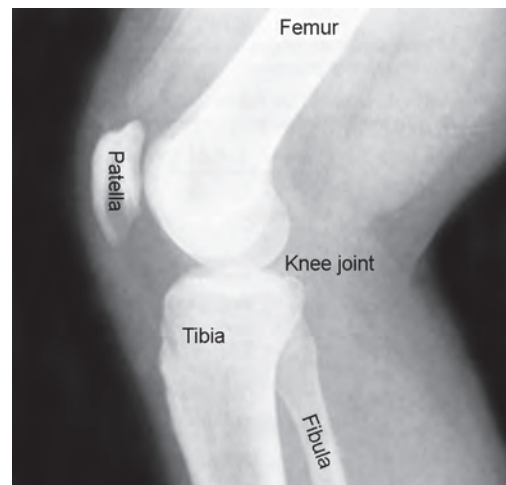
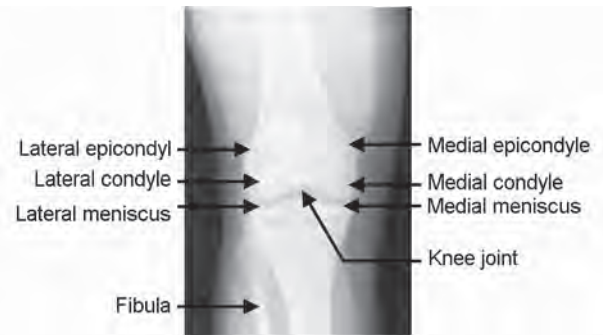
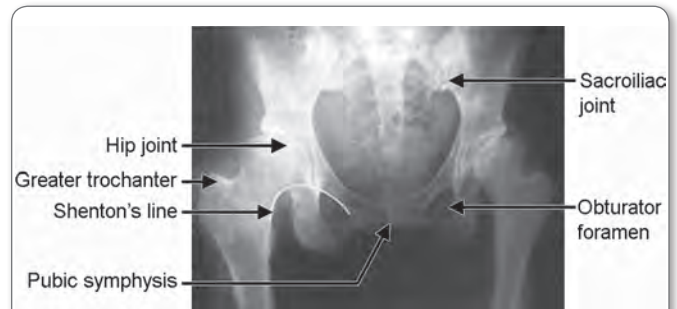


Figs 66A and B: Lateral longitudinal arch



Clinical Aspect

- Flat foot – pes planus – talipes planus: Due to involvement of spring ligament
- Pes cavus: Exhibits an exaggerated height of the medial longitudinal arch
- Club foot: Congenital deformity – foot is plantar flexed, inverted and adducted. Heal is elevated and turns medially (equinovarus) or laterally (equinvalgus)
- Commonest foot deformity – talipes equinovarus.



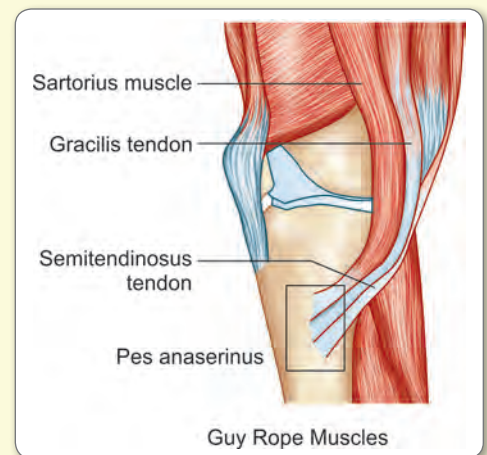


Chapter at a Glance

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LOWER LIMB

- Anterior compartment of thigh is supplied by : Femoral nerve
- Adductor compartment of thigh is supplied by : Obturator nerve
- Posterior compartment of thigh (Except short head of biceps supplied by common peroneal nerve) : Tibial part of sciatic nerve
- Gluteus medius, minimus and tensor fascia lata are supplied by : Superior gluteal nerve
- Gluteus maximus supplied by : Inferior gluteal nerve
- Adductor magnus is supplied by : Tibial part of sciatic nerve + obturator nerve
- Flexor compartment of leg is supplied by short head of biceps supplied by common peroneal nerve : Tibial nerve
- Intrinsic muscles of foot is supplied by : Plantar branch - Tibial nerve
- Peroneal or lateral compartment is supplied by : Superficial - peroneal nerve
- Extensor or anterior compartment supplied by : Deep peroneal nerve
- Thickest nerve in body : Sciatic nerve
- Longest cutaneous nerve : Saphenous nerve
- Guy rope muscles : Sartorius, gracilis and semitendinosus. Stabilizes pelvis on femur
- Anserine bursa: Separates tendons of Sartorius, Gracilis and Semitendinosus
- Brodie's bursa: Medial head of gastrocnemius
- Spring ligament: Plantar calcaneonavicular ligament – maintains medial arch of foot
- Sacrotuberous ligament is pierced by inferior gluteal artery
- Oblique popliteal ligament is pierced by middle genicular vessels
- Deltoid ligament of ankle joint is attached to tibia, talus, calcaneus, spring ligament
- Inversion and eversion takes place at subtalar joint
- Talus bone does not have any muscular attachment
- Fibula bone violates the law of ossification
- Nutrient branch to tibia from posterior tibial artery is the largest nutrient branch in body
- Longest muscle: Sartorius
- Soleus muscle: Peripheral heart
- Hamstring muscles originate from ischial tuberosity and is inserted to bones of leg
- Adductor magnus attach to adductor tubercle in femur not to bones of leg
- Short head of biceps is not true hamstring
- Hamstring muscle: Flexion of knee joint and extension of hip joint
- Rectus femoris: Flexion of hip joint and extension of knee joint
- Piriformis is key muscle in gluteal region
- Action of Sartorius: Flexion of hip joint, abduction of hip joint, lateral rotator of hip joint, knee joint flexion and medial rotation
- Tibialis posterior muscle attach to all tarsal and metatarsal bones except talus and 1st and 5th metatarsal bones
- Trendelenburg sign: Gluteus medius and minimus – superior gluteal nerve – lurching gait
- Sural nerve: Cutaneous branch of tibial nerve, accompanies short saphenous vein
- In lower limb, Popliteal artery is difficult to palpate
- Structures attached to anterior superior iliac spine: Inguinal ligament and Sartorius
- Structures attached to anterior inferior iliac spine: Iliofemoral ligament and straight head of rectus femoris
- Structures passing through lesser sciatic foramen: Pudendal nerve, internal pudendal artery, nerve to obturator internus and tendon of obturator internus.





Multiple Choice Questions

- Posterior superior iliac spine is at the level of:** (Recent Question 2014)
 - L5
 - S1
 - S2
 - S3
- Outer border of pubic ramus forms which structure:**
 - Public tubercle
 - Pectin pubis
 - Anterior superior iliac spine
 - Linea terminalis
- Angle formed by the shaft and the neck of the femur is:** (AI 2007)
 - 115
 - 125
 - 135
 - 145
- Third trochanter of femur provides attachment to?** (Recent Question 2015)
 - Gluteus maximus
 - Gluteus medius
 - Gluteus minimus
 - Piriformis
- True for linea aspera is:** (Recent Question 2015)
 - Forms lateral border of femur
 - Forms medial border of femur
 - Continue as guteal tuberosity
 - Present on posterior surface of femur
- Structure which passes through both greater and lesser sciatic foramen:**
 - Nerve to quadratus femoris
 - Superior gluteal nerve
 - Nerve to obturator internus
 - Piriformis muscle
- The blood supply of femoral head is mostly by:** (AI 2011)
 - Lateral epiphyseal artery
 - Medial epiphyseal artery
 - Ligamentous teres artery
 - Profunda femoris
- Lower end of femur ossify by how many ossification centers:** (AI 2013)
 - 1
 - 2
 - 3
 - 4
- Nutrient artery to tibia arises from which of the following arteries:** (AIIMS 2008)
 - Popliteal artery
 - Anterior tibial artery
 - Peroneal artery
 - Posterior tibial artery
- Neck of fibula is grooved by:** (AIIMS Nov. 2006)
 - Tibial nerve
 - Common peroneal nerve
 - Deep peroneal nerve
 - Sural nerve
- Ligament supporting the head of talus:**
 - Talonavicular ligament
 - Cervical ligament
 - Plantar calcaneonavicular ligament
 - Deltoid ligament
- Spring ligament consists of:**
 - Plantar calcaneocuboid ligament
 - Plantar calcaneonavicular ligament
 - Medial talocalcaneal ligament
 - Lateral calcaneocuboid ligament
- Which of the following bone has no muscle attachment?**
 - Navicular
 - Calcaneum
 - Talus
 - Cuboid
- Lymphatic drainage of glans penis is:** (DNB 2004, AI 1995)
 - Superficial inguinal lymph nodes
 - Deep inguinal lymph nodes
 - Para aortic lymph nodes
 - Internal iliac lymph nodes
- Infection/inflammation of all of the following causes enlarged superficial inguinal lymph nodes except:** (AI 2004)
 - Isthmus of uterine tube
 - Inferior part of anal canal
 - Big toe
 - Penile urethra
- Short saphenous vein is a tributary of:** (AIIMS 1991)
 - Lateral marginal vein
 - Posterior tibial vein
 - Medial marginal vein
 - Dorsal venous arch
- True about great saphenous vein:** (PGI June 2005)
 - Continuation of medial marginal vein
 - Ends at femoral vein 2.5 cm below the inguinal ligament
 - There are 2-5 valves below the knee
 - Ascends 2.5 - 3 cm behind the medial malleolus
 - In the thigh it is relation with medial cutaneous nerve of thigh
- Venous return to heart during quiet standing is facilitated by all of the following factors, except:** (AI 2010)
 - Calf muscle contraction during standing
 - Valves in perforators
 - Sleeves of deep fascia
 - Gravitational increase in arterial pressure
- Knowledge of segmental cutaneous innervations of skin of lower limb is important in determining the level of intervertebral disc disease. Thus S1 nerve root irritation will result in pain located along:** (AIIMS Nov. 2004)
 - Anterior aspect of thigh
 - Medial aspect of thigh
 - Antero medial aspect of leg
 - Lateral side of foot
- All of the following are true about lateral cutaneous nerve, except:**
 - Supplies skin over the lateral skin of thigh
 - Supplies skin over the medial aspect of thigh
 - Arises from L2 and L3
 - It is purely sensory nerve
- Skin over femoral triangle supplied by:**
 - Iliohypogastric nerve
 - Ilioinguinal nerve
 - Genitofemoral nerve
 - Lateral femoral cutaneous nerve
- All are branches of femoral artery, except:**
 - Superficial epigastric artery
 - Superficial circumflex artery
 - Inferior epigastric artery
 - Descending Genicular Artery



23. Which structure is midway between the ASIP and pubic symphysis? (DNB 1999)
- Femoral artery
 - Deep inguinal ring
 - Superior epigastric artery
 - Inguinal ligament
24. Medial compartment of femoral sheath contains: (DNB 2010)
- Lymphatics
 - Femoral artery
 - Femoral vein
 - Femoral nerve
25. In Femoral triangle most medial structure is: (AIIMS Nov. 2009)
- Lymphatics
 - Artery
 - Vein
 - Nerve
26. Femoral ring is bounded by the following structures, except: (DNB 2007, AI 2005)
- Femoral vein
 - Inguinal ligament
 - Femoral artery
 - Lacunar ligament
27. The contents of adductor canal are all, except: (DNB 2010, 2009)
- Femoral artery
 - Popliteal artery
 - Nerve to vastus medialis
 - Saphenous nerve
28. Chief extensor of knee joint in hip flexion: (DNB 2002, AIIMS 1999)
- Rectus femoris
 - Vastus medialis
 - Vastus lateralis
 - Hamstrings
29. Lateral dislocation of patella is prevented by: (Recent Question 2015)
- Rectus femoris
 - Vastus intermedius
 - Vastus lateralis
 - Vastus medialis
30. Main extensor of knee: (DNB 2003, AIIMS 1991)
- Biceps femoris
 - Quadriceps femoris
 - Semitendinosus
 - Semimembranosus
31. Muscle supplied by lumbar plexus is?
- Obturator externus
 - Obturator internus
 - Piriformis
 - Gastrocnemius
32. Action of Sartorius are all, except: (AI 2014)
- Flexion of thigh
 - Flexion of leg
 - Extension of leg
 - Lateral rotation of thigh
33. True regarding the hip joint is: (DNB 2004)
- Medial rotation and abduction is caused by Gluteus medius and Gluteus minimus
 - Medial rotation and adduction is caused by Gluteus medius and Gluteus minimus
 - Lateral rotators of thigh are supplied by femoral nerve
 - Hyperextension of hip is prevented by capsular thickening
34. All are true about gluteus maximus, except:
- Supplied by superior gluteal nerve
 - Causes extension at hip
 - Insertion is at gluteal tuberosity
 - It is lateral rotator of thigh
35. Following are the lateral rotators, except: (DNB 2002, AI 1995)
- Piriformis
 - Quadratus femoris
 - Gluteus medius
 - Obturator internus
36. Gluteus medius is supplied by: (AI 2010)
- Superior gluteal nerve
 - Inferior gluteal nerve
 - Nerve to obturator internus
 - Nerve to quadratus femoris
37. All are matched correctly, except: (DNB 2004)
- Gluteus maximus – inferior gluteal nerve
 - Gluteus minimus – superior gluteal nerve
 - Gluteus medius – inferior gluteal nerve
 - Tensor fascia lata – superior gluteal nerve
38. True regarding semitendinosus:
- Supplied by common peroneal part of sciatic nerve
 - Proximal fleshy distal thin
 - Distal fleshy proximal thin
 - Proximal and distal thin middle fleshy
39. Which nerve does not supply the gluteal region: (AIIMS Nov. 2012)
- Superior gluteal nerve
 - Sciatic nerve
 - Nerve to quadratus femoris
 - Nerve to obturator internus
40. Trendelenburg sign is positive in paralysis of all, except: (AI 2000)
- Gluteus medius
 - Gluteus minimus
 - Gluteus maximus
 - Tensor fascia lata
41. Lurching gait is due to paralysis of: (DNB 2010)
- Gluteus maximus
 - Gluteus medius
 - Piriformis
 - Cremaster
42. In post-polio case, iliotibial tract contracture is likely to result: (AI 2001)
- Extension of hip and knee
 - Extension of hip
 - Flexion of hip and knee
 - Extension of knee
43. True regarding origin and insertion of piriformis:
- Origin from sacrum and ilium and insertion on LT
 - Origin from sacrum and ilium and insertion on GT
 - Origin from ischial tuberosity and insertion on LT
 - Origin from ischial tuberosity and insertion on GT
44. The following are part of hamstrings: (PGI Dec. 2007)
- Semitendinosus
 - Semimembranosus
 - Gracilis
 - Short head of biceps femoris
 - Sartorius
45. True about femoral nerve are all, except:
- Lies outside femoral sheath
 - Saphenous is largest cutaneous branch
 - Supplies femoral artery
 - Root value L2-L5
46. Anterior division of femoral nerve supplies:
- Sartorius
 - Rectus femoris
 - Vastus medialis
 - Vastus lateralis
47. Which of the following dorsiflexes the foot?
- Tibialis posterior
 - Tibialis anterior
 - Peroneus brevis
 - Flexor digitorum longus
48. Which of the following causes foot inversion?
- Soleus
 - Plantaris
 - Peroneus longus
 - Tibialis posterior



49. **Action of tibialis anterior:**
a. Plantar flexion of foot b. Adduction of foot
c. Inversion of foot d. None of the above
50. **Which of the following muscle has intra capsular origin:** (PGI Nov. 2012)
a. Anconeus b. Short head of biceps
c. Long head of biceps d. Popliteus
e. Gastrocnemius
51. **All are true about popliteus, except:**
a. Flexes the knee
b. Unlocks the knee
c. Intracapsular
d. Inserted to medial meniscus
52. **Violent inversion of foot will lead to avulsion of tendon of which the following muscle attached to tuberosity of 5th metatarsal bone:** (AIIMS Nov. 2007)
a. Peroneus brevis
b. Peroneus longus
c. Tibialis posterior
d. Extensor digitorum brevis
53. **Common peroneal nerve is related to which of the following:** (AIIMS Nov. 2006)
a. Shaft of tibia
b. Neck of fibula
c. Lower tibiofibular joint
d. Shaft of fibula
54. **Boundaries of popliteal fossa:** (PGI 2004)
a. Soleus b. Both heads gastrocnemius
c. Biceps femoris d. Semi tendinous
e. Adductor longus
55. **Muscles acting both at knee joint and ankle joint is/are:** (PGI Dec. 2005)
a. Gastrocnemius b. Soleus
c. Plantaris d. Tibialis posterior
e. Flexor hallucis longus
56. **Structure passing deep to flexor retinaculum:** (AIIMS 1997)
a. Posterior tibial artery
b. Long saphenous vein
c. Tibialis anterior tendon
d. Peroneus tertius
57. **Muscles causing dorsiflexion of foot is/are:** (PGI June 2009)
a. Extensor digitorum longus
b. Extensor hallucis longus
c. Flexor digitorum longus
d. Flexor hallucis longus
e. Thailis anterior
58. **Which passive movement causes pain in deep posterior compartment syndrome?** (AIIMS Nov. 2008)
a. Foot abduction b. Dorsiflexion of foot
c. Plantar flexion of foot d. Foot abduction
59. **Which of the following is the muscle of first layer of the sole?**
a. Lumbricals b. Abductor hallucis
c. Flexor hallucis brevis d. Peroneus longus
60. **3rd and 4th lumbrical (lateral two lumbricals) of foot are supplied by:**
a. Medial plantar nerve b. Lateral plantar nerve
c. Peroneal nerve d. None of the above
61. **Muscle that originates from tibia and fibula bone and interosseous membrane is:**
a. Peroneus longus b. Peroneus brevis
c. Tibialis anterior d. Tibialis posterior
62. **A man is stuck with lathi on the lateral aspect of head of fibula, which of the following can occur as a result of nerve injury:** (PGI Dec. 2008)
a. Loss of sensation of lateral foot
b. Loss of sensation of adjacent sides of first and second toe
c. Inversion inability
d. Dorsi flexion not possible
e. Plantar flexion not possible
63. **Injury to the common peroneal nerve at the lateral aspect of head of fibula results in all of the following, except:** (AIIMS Nov. 2004)
a. Weakness of ankle dorsi flexion
b. Foot drop
c. Loss of ankle reflex
d. Sensory impairment on lateral aspect of leg extending to dorsum of foot
64. **Injury to head of fibula may involve the following, except:** (AIIMS Nov. 2009)
a. Anterior tibial nerve
b. Common peroneal nerve
c. Tibial nerve
d. Superficial peroneal nerve
65. **All are seen in injury of common peroneal nerve injury, except:**
a. Loss of sensation over sole
b. Foot drop
c. Injury to neck of fibula
d. Loss of dorsiflexion of toe
66. **Tibial nerve palsy causes:** (PGI May 2012)
a. Dorsiflexion of foot at ankle joint
b. Plantar flexion of foot at ankle joint
c. Loss of sensation of dorsum of foot
d. Paralysis of muscles of anterior compartment of leg
e. Loss of sensation over medial border of foot
67. **Posterior cutaneous nerve of thigh supplies skin:** (PGI May 2012)
a. Medial side of thigh
b. Postero inferior aspect of buttock
c. Scrotum
d. Back of thigh
e. Popliteal fossa
68. **Which of the following ligaments prevent hyperextension of hip?** (DNB 2008, AI 1997)
a. Iliofemoral ligament b. Ischiofemoral lig
c. Pubofemoral ligament d. Pubo-ischial lig
69. **Bigelow's ligament is at:** (DNB 2001)
a. Knee joint b. Shoulder joint
c. Hip joint d. Ankle joint
70. **Iliofemoral ligament arises from:** (PGI Nov. 2014)
a. Ischial tuberosity
b. Anterior superior iliac spine
c. Lio pubic rami
d. Anterior inferior iliac spine
e. Iliac crest



- 71. True regarding hip joint:** (Recent Question 2014)
 a. Retinaculum attaches to femur to hip
 b. Inferior gluteal nerve supplies abductors of hip
 c. Capsule is attached to inter trochanteric line
 d. Iliopsoas abduction of hip
- 72. Posterior dislocation of tibia on femur is prevented by:**
 a. Posterior cruciate ligament (PGI Nov. 2011)
 b. Anterior cruciate ligament
 c. Medial meniscus
 d. Lateral meniscus
 e. Medial collateral ligament
- 73. Which of the following arteries gives arterial supply to ACL?** (DNB 2009, AI 2008)
 a. Fibular head artery
 b. Descending genicular artery
 c. Superior genicular artery
 d. Middle genicular artery
- 74. Which of the following is true about the posterior cruciate ligament?** (AI 2007, AIIMS Nov. 2006)
 a. Attached to lateral condyle
 b. Intrasynovial
 c. Prevents posterior dislocation of tibia
 d. Relaxed in full flexion
- 75. Physiological locking is:** (AI 2008)
 a. Internal rotation of femur over stabilized tibia
 b. Internal rotation of tibia over femur
 c. External rotation of tibia over stabilized femur.
 d. External rotation of femur over stabilized tibia
- 76. When patient gets up from sitting position which of the following events takes place in his knee joint:** (AI 2008)
 a. Medial rotation of femur over stabilized tibia
 b. Lateral rotation of femur over stabilized femur
 c. Medial rotation of tibia over stabilized femur
 d. Lateral rotation of tibia over stabilized femur
- 77. Coronary ligament is present between:** (AI 2008)
 a. Menisci and tibial condyle
 b. Posterior horns of two menisci
 c. Tibia to meniscus
 d. Femur to meniscus
- 78. Popliteal artery is difficult to palpate because:** (AI 2009)
 a. It is not superficial
 b. Does not pass over bony prominence
 c. Superficial but does not pass over prominent bony structure
 d. Not superficial and does not pass over prominent bony structure.
- 79. Which of the following tendons has attachments on sustentaculum tali?** (AI 2010)
 a. Tibialis anterior
 b. Tibialis posterior
 c. Flexor digitorum longus
 d. Flexor hallucis longus
- 80. Muscles used in normal walk during stance and swing:** (DNB 2007)
 a. Popliteus
 b. Gastrocnemius
 c. Tibialis anterior
 d. Iliopsoas
- 81. Deltoid ligament is attached to all, except:** (DNB 2009)
 a. Medial malleolus
 b. Medial cuneiform
 c. Spring ligament
 d. Sustentaculum tali
- 82. Stability of ankle joint is maintained by following, except:** (AIIMS Nov. 2009)
 a. Cruciate ligament
 b. Collateral ligaments
 c. Tendons of muscle attached
 d. Close approximation of articular surface
- 83. True about ankle joint is/are:** (PGI Dec. 2004)
 a. Strengthened by deltoid ligament
 b. More stable at dorsi flexion
 c. More stable at plantar flexion
 d. Allows supination and pronation movement
 e. Hinge joint

Hip and Thigh

General

- 84. Function of tensor fascia lata:** (Recent Question 2016-17)
 a. Knee flexion
 b. Medial rotation at hip
 c. Hip lateral rotation
 d. Adduction of hip
- 85. True statement about oblique popliteal ligament is:** (Recent Question 2016-17)
 a. It is not pierced by middle genicular vessel
 b. Tendon of semimembraneous
 c. Tendon of semitendinosus
 d. Runs upward and medially

Knee

- 86. Vastus medialis insertion is over:** (Recent Question 2016-17)
 a. Quadriceps tendon and medial side of patella
 b. Lateral side of patella
 c. On the tibia
 d. On the femur
- 87. True statement about lateral menisci is:** (Recent Question 2016-17)
 a. Semicircular in shape
 b. More firm attachment to tibia than medial meniscus
 c. Nearly circular in shape
 d. It is attached to tibial collateral ligament
- 88. Anterior cruciate ligament attach to:** (Recent Question 2016-17)
 a. Anterior intercondylar area of tibia to medial surface of lateral condyle of femur
 b. Posterior intercondylar area of tibia to medial surface of lateral condyle of femur
 c. Anterior intercondylar area of tibia to lateral surface of lateral condyle of femur
 d. Anterior intercondylar area of tibia to lateral surface of medial condyle of femur



Leg, Ankle and Foot

89. Identify the disorder depicted below:

(Recent Question 2016-17)



- a. Pes planus b. Claw foot (Pes clavus)
c. Hallux valgus d. Foot drop
90. Which of the following nerve loops around neck of fibula:
(Recent Question 2016-17)
- a. Deep Peroneal nerve b. Common peroneal nerve
c. Tibial nerve d. Sciatic nerve
91. Action of tibialis anterior: (Recent Question 2016-17)
- a. Inversion of ankle joint b. Dorsiflexion of foot
c. Plantarflexion of foot d. Eversion of ankle joint
92. Which structure lies midway between the anterior superior iliac spine and public symphysis:
(Recent Question 2012)
- a. Femoral artery
b. Deep inguinal ring
c. Superior epigastric artery
d. Inguinal ligament
93. Line from midinguinal point to adductor tubercle represents:
(Recent Question 2013)
- a. Inferior epigastric artery
b. Femoral artery
c. Superior epigastric artery
d. Obturator artery
94. The ischial tuberosity provides attachment to:
(Recent Question 2015)
- a. Obturator internus b. Quadratus femoris
c. Gluteus naximum d. Adductor magnus
95. All of the following structures pass through lesser sciatic foramen except:
(Recent Question 2013)
- a. Pudendal nerve
b. Obturator internus muscle
c. Internal pudendal vessels
d. Nerve to obturator internus
96. TRUE about attachment at ischial tuberosity:
(Recent Question 2015)
- a. Origin of semitendinous from superolateral area
b. Origin of semimembranosus from superolateral area
c. Origin of long head of biceps from inferolateral area
d. Origin of adductor magnus from inferolateral area
97. Muscle attached to medial lip of linea aspera of femur:
(Recent Question 2015)
- a. Short lead of biceps femoris
b. Vastus lateralis
c. Vastus intermedius
d. Vastus medialis

98. All of the following are true about upper end of tibia, except:
(AI 2000)

- a. Ossification centre for the upper end fuses by 18 years
b. Meniscal cartilage is attached to the intercondylar area
c. Gives attachment to semimembranosus
d. Posterior aspect of patella articulates with upper end of tibia laterally

99. FALSE about tibia and fibula is: (Recent Question 2015)

- a. Nutrient artery of tibia is from posterior tibial artery
b. Nutrient artery of fibula is from peroneal artery
c. Proximal end of tibia is related to common peroneal nerve
d. Tibia is the most common site of osteomyelitis

100. Gluteofemoral bursa is in between gluteus maximus and:
(Recent Question 2014)

- a. Greater trochanter b. Lesser trochanter
c. Ischial tuberosity d. Vastus lateralis

101. Pes anserinus includes following three muscle, except:

(Recent Question 2015)

- a. Semitendinosus b. Semimembranosus
c. Gracilis d. Sartorius

102. Clergyman's knee is an inflammation of:

- a. Anserine bursa b. Pre-patellar bursa
c. Suprapatellar burs d. Infrapatellar bursa

103. A healthy young athlete sitting at table with knee at 90-degree flexion. What will happen when he fully extends the knee?
(AIIMS 2010)

- a. Movement of tibial tuberosity toward medial border of patella
b. Movement of tibial tuberosity towards lateral border of patella
c. Movement of tibial tuberosity towards centre of patella
d. No change in relationship

104. Medial rotation of tibia in flexed leg is brought about by:

(JIPMER 2000)

- a. Popliteus b. Vastus medialis
c. Quadriceps femoris d. Adductor magnus

105. All of the following movements are possible due to contraction of tensor fascia lata, except:
(AIPG)

- a. Medial rotation of hip joint
b. Abduction of hip joint
c. Flexion of hip joint
d. Extension of hip joint

106. All are branches of lumbar plexus, except:

(Recent Question 2015)

- a. Iliohypogastric nerve b. Ilioinguinal nerve
c. Obturator nerve d. Subcostal nerve

107. What is the root value of sciatic nerve:

(Recent Question 2012)

- a. S1,S2,S3 b. L4,L5;S1,S2,S3
c. L1,L2,L3 d. L2,L3,L4

108. Root value of the posterior cutaneous nerve of the right:

(Recent Question 2012)

- a. S1,S2 b. S2,S3
c. S1,S2,S3 d. S2,S3,S4



- 132. In L5 root involvement, which among the following is NOT affected?** (AIPG 2011)
a. Thigh abduction b. Knee flexion
c. Knee extension d. Toe extension
- 133. Which of the following structure(s) pass through adductor magnus?** (PGIC 2015)
a. Femoral vessels b. Femoral nerve
c. Femoral sheath d. Saphenous nerve
e. Tibial nerve
- 134. Neurovascular bundle of anterior compartment of leg passes between the tendons of:** (Recent Question 2013)
a. Tibialis anterior and extensor hallucis longus
b. Extensor hallucis longus and extensor digitorum longus
c. Extensor hallucis longus and peroneus tertius
d. Extensor digitorum longus and peroneus tertius
- 135. Abduction and adduction of foot occurs at which joints?** (Recent Question 2016)
a. Ankle b. Subtalar
c. Tarso-metatarsal d. Transverse tarsal
- 136. Which tendon passes below Sustentaculum tali:** (AIPG 2010)
a. Tibialis anterior
b. Tibialis posterior
c. Flexor hallucis longus
d. Flexor digitorum longus
- 137. Muscle(s) of anterior compartment of leg is/are:** (PGI Nov 2017)
a. Peroneus tertius b. Peroneus brevis
c. Peroneus longus d. Flexor digitorum longus
e. Extensor hallucis longus
- 138. All are true regarding Langenbuck triangle except** (JIPMER Nov 2015)
a. Apex is formed by anterior superior spine of the ilium
b. Base lies over the anatomical neck of the femur
c. External side is formed by the external face of the greater trochanter of the femur
d. Area spared during penetrating wounds
- 139. Which is attached most anteriorly on the intercondylar area of tibia (area b/w medial and lateral tibial plateau):** (PGI May 2017)
a. Anterior cruciate ligament
b. Posterior cruciate ligament
c. Anterior horn of the lateral meniscus
d. Anterior horn of the medial meniscus
e. Ligamentum patellae
- 140. True about medial meniscus:** (PGI Nov 2014)
a. Made up of hyaline cartilage
b. Injury of lateral meniscus is more frequent than medial meniscus
c. C shaped
d. Fixed to medial collateral ligament
e. Inner part is more avascular
- 141. Compartment of leg without neurovascular bundle?** (AIIMS May 2018)
a. Anterior b. Lateral
c. Deep posterior d. Superficial posterior
- 142. All of the following muscles help in inversion of foot; except:** (AIIMS Nov 2019)
a. Tibialis posterior
b. Tibialis anterior
c. Peroneus longus
d. Extensor hallucis longus
- 143. Gamelli muscle related to which joint?** (JIPMER May 2018)
a. Hip b. Shoulder
c. Knee d. Elbow
- 144. If want to operate lower medial side of leg what nerve to be blocked?** (JIPMER May 2018)
a. Femoral nerve b. Common peroneal nerve
c. Sciatic nerve d. Deep peroneal nerve
- 145. Which of the is medial rotators of thigh?** (Recent Question June 2018)
a. Piriformis b. Obturator internus
c. Gluteus medius d. Quadratus femoris
- 146. Tensor fascia latae supplied by** (Recent Question June 2018)
a. Superior gluteal nerve
b. Inferior gluteal nerve
c. Nerve to obturator internus
d. Nerve to quadratus femoris
- 147. Sacrotuberous ligament pierced by** (Recent Question June 2018)
a. Superior gluteal artery b. Internal pudendal artery
c. Inferior gluteal artery d. Pudendal nerve
- 148. Joint involved in forefoot eversion and inversion** (Recent Question June 2018)
a. Talocrural joint b. Calcaneocuboid joint
c. Cuneo cuboid joint d. Inferior tibiofibular joint
- 149. Foot drop is due to** (Recent Question 2019)
a. Deep Peroneal nerve b. Tibial nerve
c. Sural nerve d. Superficial peroneal nerve



Answers with Explanations

1. Ans. c. S2

[Ref: Gray's Anatomy 39th ed./ 1425]

ASIS – L2
Iliac tubercle – L5
Highest point of iliac crest – L4
PSIS – S2
PIIS – S3

2. Ans. a. Public tubercle

[Ref: Gray's Anatomy 40th ed. ch. 111]

3. Ans. b. 125

[Ref: Gray's Anatomy 40th ed., pg 1349]

Normal neck shaft angle – 125
Neck shaft angle in children – 160

4. Ans. a. Gluteus maximus

[Ref: Gray's Anatomy 39th ed. /1433]

5. Ans. c. Continue as gluteal tuberosity

[Ref: Gray's Anatomy 40/e, chapter 80, Keith L. Moore 4/e, pg 540, Cunningham's Textbook of Anatomy pg 242]

Linea aspera – posterior border not surface.

6. Ans. c. Nerve to obturator internus

[Ref: Gray's Anatomy 40/e., chapter 80]

PIN structures pass through greater and lesser sciatic foramen

7. Ans. d. Profunda femoris

[Ref: Textbook of anatomy by Vishram Singh volume II, 2nd ed. pg 341, 342]

Blood Supply of Femoral Head

Mostly through medial circumflex femoral artery branch of profunda femoris artery
Later circumflex femoral artery branch of profunda femoris artery
Artery of ligamentum teres branch of obturator artery

8. Ans. a. 1

One primary ossification center and three secondary ossification center for upper end and one for lower end

9. Ans. d. Posterior tibial artery

[Ref: Gray's Anatomy 40th ed., 2008, pg 1493]

Posterior Tibial Artery

Nutrient artery to tibia – posterior tibial artery - largest nutrient artery in the body

10. Ans. b. Common peroneal nerve

11. Ans. c. Plantar calcaneonavicular ligament

[Ref: Textbook of Clinical Anatomy pg 786]

Head of talus supported by spring ligament (plantar calcaneonavicular ligament) which is not attached to talus.
Talus articulates with tibia, fibula, calcaneum and navicular
So ligaments tibio talur, talo fibular, talocalcaneal and talo navicular

12. Ans. b. Plantar calcaneonavicular ligament

[Ref: Clinical Anatomy 9th/ed. pg 786]

13. Ans. c. Talus

[Ref: BDC 6th ed. vol. II/30]

Talus and incus no muscle attachment.

Efferents to External Iliac Nodes

14. Ans. b. Deep inguinal lymph nodes

15. Ans. d. Penile urethra

[Ref: Gray's 40th ed. pg 1597]

16. Ans. b. Posterior tibial vein

Small saphenous vein is tributary of popliteal vein (formed by anterior tibial vein and posterior tibial vein)
So here posterior tibial vein is the best option

17. Ans. a. Continuation of medial marginal vein

Ends at femoral vein 4cm below and lateral to pubic tubercle
10–20 valves present more in leg
Ascends in front of medial malleolus

- Structures accompanying great saphenous vein
- In thigh – medial branch of anterior cutaneous branch of femoral nerve

18. Ans. d. Gravitational increase in arterial pressure

Gravitational increase in arterial pressure does not influence the venous return

19. Ans. d. Lateral side of foot

[Ref: Last Anatomy 12th edition pg. 162]

20. Ans. b. Supplies skin over the medial aspect of thigh

[Ref: Clinical Anatomy 11th ed. /251]

Not supply the skin over medial side of thigh

21. Ans. c. Genitofemoral nerve

[Ref: Gray's anatomy 40/e, p 1080]

Skin over femoral triangle supplied by genito femoral nerve



22. Ans. c. Inferior epigastric artery

[Ref: BDC 6th ed. vol. II / 49-50]

Obturator Artery

Branch of anterior division of internal iliac (supplies head of femur)

Abnormal Obturator Artery

An enlarged pubic branch of the inferior epigastric artery either takes the place of the obturator artery (replaced obturator artery) or joins it as an accessory obturator artery in approximately 20% of people. Closely related to the neck of a femoral hernia. Consequently, this artery could be involved in a strangulated femoral hernia.

23. Ans. a. Femoral artery

[Ref: BDC 6th ed 2nd volume pg no 50]

The structure stretches between the ASIP and pubic tubercle is Inguinal ligament.

The femoral artery can be felt pulsating at the mid-inguinal point, half-way between the anterior superior iliac spine and the pubic symphysis. (Mid-inguinal point)

24. Ans. a. Lymphatics

[Ref: I. B. Singh Text book of Anatomy 6th ed pg no 309]

Medial compartment – femoral canal – contain deep inguinal node of cloquet

25. Ans. a. Lymphatics

[Ref: I.B. Singh Text book of Anatomy 6th ed pg no 309]

Femoral ring is the medial most compartment of femoral sheath, which contains deep inguinal nodes of cloquet

26. Ans. c. Femoral artery

[Ref: I.B. Singh Text book of Anatomy 6th ed pg no 309]

Femoral artery do not form boundary to femoral ring

27. Ans. b. Popliteal artery

[Ref: Gray's Anatomy 40th ed]

Femoral artery content of adductor canal

28. Ans. a. Rectus femoris

[Ref: Last Anatomy 12th edition pg120]

29. Ans. d. Vastus medialis

[Ref: Last Anatomy 12th edition pg120]

Vastus medialis stabilizes patella and prevent from lateral dislocation.

30. Ans. b. Quadriceps femoris

[Ref: BDC vol II/155]

Quadriceps femoris – extensor of knee joint

Rectus femoris – flexor of hip joint and extensor of knee joint
Hamstrings – flexor of knee joint and extensor of hip joint

31. Ans. a. Obturator externus

[Ref: Gray's Anatomy 40/e Chapter 62]

Obturator externus supplied by obturator nerve branch of lumbar plexus
Rest of the muscles supplied by sacral plexus branch

32. Ans. c. Extension of leg

[Ref: Last Anatomy 12th ed. pg117]

Action of Sartorius – flexion, abduction and lateral rotation of thigh
Flexion and medial rotation of thigh of leg

33. Ans. a. Medial rotation and abduction is caused by Gluteus medius and Gluteus minimus.

[Ref: Last Anatomy 12th ed. pg 124 to 126]

Abduction is produced by gluteus medius and minimus
Medial rotation is produced by tensor fasciae latae and the anterior fibers of gluteus minimus and medius.
Hyper extension is prevented by iliofemoral ligament
Lateral rotators supplied by branches from sacral plexus

34. Ans. a. Supplied by superior gluteal nerve

[Ref: Gray's Anatomy 40/ed., Chapter 80]

Gluteus maximus supplied by inferior gluteal nerve

35. Ans. c. Gluteus medius

[Ref: Gray's Anatomy 40th ed]

Lateral rotation is produced by the obturator muscles, the gemelli and quadratus femoris, assisted by piriformis, gluteus maximus.

36. Ans. a. Superior gluteal nerve

[Ref: I.B. Singh 6th ed. pg 315]

Name of the nerve	Name of the muscles supplied
Inferior gluteal nerve (dorsal branch of ventral rami L5, S1 and S2)	Gluteus maximus
Superior gluteal nerve (dorsal branch of ventral rami L4, L5, S1)	Gluteus medius and minimus
Nerve to obturator internus (ventral branch of ventral rami L5, S1, S2)	Obturator internus, Superior and Inferior gemellus
Nerve to quadrates femoris (ventral branch of ventral rami L4, L5, S1)	Quadratus femoris and Obturator externus

37. Ans. c. Gluteus medius – inferior gluteal nerve

**38. Ans. b Proximal fleshy distal thin**

Semitendinosus – proximal fleshy, distal thin

39. Ans. b. Sciatic nerve**Nerve Supplying Gluteal Region**

Superior gluteal nerve supplies gluteus medius and minimus

Inferior gluteal nerve supplies gluteus maximus

Nerve to obturator internus supplies superior gemelli and obturator internus

Nerve to quadratus femoris supplies inferior gemelli and quadratus femoris

40. Ans. c. Gluteus maximus

[Ref: I.B.Singh 6th ed. pg 335]

Gluteus maximus not involved in trendlenberg sign

41. Ans. b. Gluteus medius

[Ref: I.B.Singh Textbook of Anatomy 6th ed. pg 335]

Trendelenburg's sign – Unilateral palsy of Gluteus medius and minimus.-Lurching gait

Waddling gait – Bilateral palsy of Gluteus medius and minimus

42. Ans. c. Flexion of hip and knee

[Ref: I.B.Singh 6th ed.]

43. Ans. b. Origin from sacrum and ilium and insertion on GT

[Ref: BDC Vol-II 5th/e p. 74]

Origin from sacrum and ilium and insertion to greater tubercle.

44. Ans. a. Semitendinosus, b. Semimembranosus

[Ref: Last Anatomy 12th ed. pg130-132]

45. Ans. d. Root value L2-L5

[Ref: Gray's Anatomy 40/ed., chapter 80]

Root value – dorsal branch of the ventral rami of L2, 3, 4

46. Ans. a. Sartorius

[Ref: Essentials of Human Anatomy by AK Datta 5th ed. volume 3 pg 174]

Quadriceps femoris supplied by posterior division branch

Sartorius supplied by anterior division of femoral nerve

47. Ans. b. Tibialis anterior

[Ref: BDC 5th/ed. Vol. II p. 158]

Tibialis posterior – plantar flexion of foot, invertor

Tibialis anterior – dorsiflexor of foot

Peroneus brevis – evertor

48. Ans. d. Tibialis posterior

[Ref: Gray's Anatomy 40/ed., chapter 84]

Inversion and eversion are movements of sub talar joints

Invertors – tibialis anterior, tibialis posterior

Evertors – peroneus longus, peroneus brevis

49. Ans. c. Inversion of foot

[Ref: BDC 6th/ed. Vol. 2 p. 95]

Tibialis anterior and posterior – invertors of foot

50. Ans. c. Long head of biceps, d. Popliteus

In shoulder joint – long head of biceps intra capsular origin

In knee joint – popliteus is intra capsular origin

In hip joint, ankle joint, elbow joint, wrist joint – no intracapsular origin of muscles

51. Ans. d. Inserted to medial meniscus

[Ref: Last Anatomy 12th ed. pg 134]

Popliteus muscle – intracapsular in origin

Origin from lateral femoral condyle

Course – pass downwards from fibular collateral ligament and lateral meniscus, then come out of capsule and become fleshy

Action – initiate the flexion by unlocking the locked knee

Pull the lateral meniscus prevent it being trapped at the starting of flexion

52. Ans. a. Peroneus brevis

[Ref: Last Anatomy 12th ed pg 146]

Peroneus brevis inserted to 5th metatarsal bone

Peroneus longus inserted to plantar surface of 1st meta tarsal bone and adjacent **medial cuneiform**

Tibialis anterior inserted to dorsal surface to 1st meta tarsal bone and adjacent **medial cuneiform**

Tibialis posterior inserted to **all tarsal and meta tarsal bones except talus and 1st and 5th meta tarsal bone** –

Extensor digitorum brevis – inserted to joins with dorsal digital expansion

53. Ans. b. Neck of fibula

[Ref: Last Anatomy 12th ed. pg 164]

Common peroneal nerve wind around the neck of fibula

So fracture of neck of fibula leads to injury of common peroneal nerve (superficial and deep)

54. Ans. b. Both heads gastrocnemius, c. Biceps femoris, d. Semi tendinious

Refer theory

[Ref: Last Anatomy 12th ed. pg 132 soleus and adductor magnus not boundary]

55. Ans. a. Gastrocnemius, c. Plantaris

[Ref: Last anatomy 12th ed. pg 132]

Gastrocnemius and plantaris – have origin above the knee joint, i.e from lower end of femur, they cross the knee joint so minimal action on knee joint too apart from main action on the ankle joint.

So Gastrocnemius and plantaris plantar flexion of ankle joint and flexion of knee joint



Rest of muscles take origin from the bones of leg
 Rectus femoris act at both hip and knee
 Sartorius – hip and knee
 Hamstring – hip and knee
 Tensor fascia lata – hip and knee
 EHL, EDL, FHL, FDL – ankle and toes

56. Ans. a. Posterior tibial artery

Refer theory

[Ref: Last Anatomy 12th ed. pg 150]

57. Ans. a. Extensor digitorum longus, b. Extensor hallucis longus, c. Tibialis anterior

[Ref: Last Anatomy 12th ed. pg 143 - 145]

Anterior compartment muscles of leg–dorsi flexors of ankle joint

Tibialis anterior – main muscle
 Extensor digitorum longus – accessory muscle
 Extensor hallucis longus - accessory muscle
 Peroneus tertius - accessory muscle

Posterior compartment muscles of leg - plantar flexors of ankle of joint

Gastrocnemius – main muscle
 Soleus – main muscle
 Plantaris – accessory muscle
 Tibialis posterior – accessory muscle
 Flexor hallucis longus – accessory muscle
 Flexor digitorum longus – accessory muscle

58. Ans. b. Dorsi flexion of foot

Passive stretching of muscles in opposite compartment produces pain in compartment syndrome

In deep posterior compartment syndrome – dorsiflexion of foot and toe extension

In superficial compartment syndrome – dorsiflexion of foot

Lateral compartment syndrome – inversion of foot

Anterior compartment syndrome – Plantar flexion of foot and toe flexion

59. Ans. b. Abductor hallucis

[Ref: Last Anatomy 12th ed. pg 151-154]

First layer – abductor hallucis, flexor digitorum brevis, abductor digiti minimi

60. Ans. b. Lateral plantar nerve

[Ref: Last Anatomy 12th ed. pg 151-154]

Medial plantar nerve supplies 1st lumbrical and rest supplied by lateral plantar nerve

61. Ans. d. Tibialis posterior

[Ref: Gray's Anatomy 40th ed. ch. 83, Snell's 8th ed. ch.10]

Origin-Posterior surface of tibia and fibula and interosseous membrane

Insertion-Tuberosity of navicular bone and then to all tarsal and meta tarsal bone except talus and 1st and 5th meta tarsal bone.

62. Ans. b. Loss of sensation of adjacent sides of first and second toe, d. Dorsi flexion not possible

[Ref: Last Anatomy 12th ed. pg 164]

63. Ans. c. Loss of ankle reflex

64. Ans. c. Tibial nerve

65. Ans. a. Loss of sensation over sole

Common Peroneal Nerve Injury

Seen in fracture of neck of fibula

Nerves injured common peroneal nerve, superficial peroneal nerve (musculo cutaneous nerve of lower limb), deep peroneal nerve (anterior tibial nerve)

Deformity–foot drop–dorsi flexion not possible

Muscles paralysed–tibialis anterior, extensor digitorum longus, extensor hallucis longus, peronius longus, peroneus brevis and peroneus tertius

Sensory loss along dorsum of foot except medial side of foot up to ball of great toe (saphenous nerve), lateral side of foot and lateral side of little toe (sural nerve).

Sensory supply to sole is by medial and lateral plantar nerve branch of tibial nerve (which is not affected in neck of fibula) fracture in common peroneal nerve injury

66. Ans. a. Dorsiflexion of foot at ankle joint

Tibial nerve injury causes dorsiflexion of foot – paralysis of posterior compartment of leg

Loss of sensation in sole

67. Ans. a,b,c,d,e

[Ref: Last Anatomy 12th ed. pg 162-163]

Posterior cutaneous nerve of thigh S1, 2, 3 supplies skin of posterior part of scrotum, infero medial quadrant of buttock, back of thigh, popliteal fossa, proximal part of back of leg.

68. Ans. a. Iliofemoral ligament

[Ref: Last Anatomy 12th ed. pg 127-130]

Ilio-femoral ligament–prevents hyper extension of hip joint

Pubofemoral ligament and adductor muscles – prevents over abduction of hip joint

69. Ans. c. Hip joint

Bigelow ligament – iliofemoral ligament

70. Ans. d. Anterior inferior iliac spine

Anterior inferior iliac spine – iliofemoral ligament, straight head of rectus femoris

71. Ans. c. Capsule is attached to inter trochanteric line

Inferior gluteal nerve supplies gluteus medius and minimus which are abductors and medial rotators

Ilio psoas – flexor

**72. Ans. a. Posterior cruciate ligament**

[Ref: I.B.Singh 6th ed. pg 402] ref theory]

Posterior cruciate ligament prevents posterior dislocation of tibia and anterior dislocation of femur on tibia

73. Ans. d. Middle genicular artery

[Ref: I.B.Singh 6th ed. pg 347]

Middle genicular artery branch of popliteal artery pierces the oblique popliteal ligament and supply the intra articular structures of knee joint.

74. Ans. c. Prevents posterior dislocation of tibia

Posterior cruciate ligament is intra capsular and extra synovial Taut in full flexion Attached to medial condyle

75. Ans. a. Internal rotation of femur over stabilized tibia

[Ref: I.B.Singh 6th ed. pg 407]

Locking of Knee or Screw-Home Movement

When the foot is on the ground (with stabilized tibia), medial or internal rotation of femur occur at extreme extension.

When the foot is off the ground (not stabilized with tibia), lateral rotation or external rotation of tibia occur at extreme extension.

76. Ans. a. Medial rotation of femur over stabilized tibia

Standing extension – locking mechanism – medial rotation of femur over stabilized tibia

77. Ans. a. Menisci and tibial condyle

[Ref: I.B.Singh 6th ed. pg 403]

Coronary Ligament

Connect the peripheral margins of medial and lateral menisci to the medial and lateral tibial condyles respectively.

Provide anchorage to the menisci.

Lateral coronary ligament is weak whereas medial coronary ligament strong.

78. Ans. d. Not superficial and does not pass over prominent bony structure

[Ref: I.B.Singh 6th ed. pg 347]

Popliteal artery is the continuation of femoral artery through the opening of adductor magnus at

Lies deep in the popliteal fossa on the back of knee joint and lies over the popliteal surface of the femur.

79. Ans. b. Tibialis posterior

[Ref: Last Anatomy 12th ed. pg 176]

Tendon of flexor hallucis longus pass below the sustentaculum tali

Tendon of tibialis posterior lies immediately above the sustentaculum tali and pass some slips of attachment to it

80. Ans. c. Tibialis anterior

[Ref: Last Anatomy 12th ed. pg 161-162]

Tibialis anterior is the most muscle used in both stance and swing phase in normal walking

81. Ans. b. Medial cuneiform

[Ref: I.B.Singh Textbook of Anatomy 6th ed. pg 412]

Deltoid ligament is attached to tibia (medial malleolus), talus, calcaneum(sustentaculum tali), navicular and spring ligament

82. Ans. a. Cruciate ligament

[Ref: Last Anatomy 12th ed. pg 156-157]

Cruciate ligaments are present in knee joint not in ankle joint

83. Ans. a. Strengthened by deltoid ligament, b. More stable at dorsi flexion, e. Hinge joint

[Ref: Last Anatomy 12th ed. pg 151-154]

Ankle joint is more stable in dorsi flexion

It allows dorsi flexion and plantar flexion

84. Ans. b. Medial rotation of hip

[Ref: BDC-II 6th/e pg. 45]

Tensor fascia late assists gluteus medius and minimus in abduction and medial rotation of hip joint

It also stabilizes the knee joint in standing position and helps in extension of knee joint through iliotibial tract

85. Ans. b. Tendon of semimembranosus

[Ref: BDC-II 6th/e pg. 143]

Oblique popliteal ligament is derived from semimembranosus tendon

Pierced by middle genicular vessels

86. Ans. a. Quadriceps tendon and medial side of patella

[Ref: BDC vol 2, 6th/e pg. 54]

Rectus femoris and vastus intermedius are inserted to base

Vastus lateralis to lateral margin

Vastus medialis to medial margin

Ligamentum patellae into apex

87. Ans. c. Nearly circular in shape

[Ref: BDC-II, 6th/e pg. 143]

Lateral meniscus is nearly circular shape

Medial meniscus is c shape

88. Ans. a. Anterior intercondylar area of tibia to medial surface of lateral condyle of femur

[Ref: BDC-II 6th/e pg. 143]

Anterior cruciate ligament attachment - anterior intercondylar area of tibia to medial surface of lateral condyle of femur

Posterior cruciate ligament – posterior intercondylar area of tibia to lateral surface of medial condyle

**89. Ans. a. Pes planus – flat foot**

[Ref: BDC-II 6th/e pg. 163]

Flat foot – lesion in spring ligament

90. Ans. b. Common peroneal nerve

[Ref: BDC-II 6th/e pg. 80]

Common peroneal nerve loop around the neck of fibula.

91. Ans. b. Dorsiflexor of foot

[Ref: BDC-II, 6th/e pg. 95]

Actions of tibialis anterior – inversion of subtalar joint and dorsi flexion of foot.

92. Ans. a. Femoral artery

- Halfway between the anterior superior iliac spine and the pubic symphysis lies the midinguinal point. Femoral artery lies in it

93. Ans. b. Femoral artery

- A line drawn from the midinguinal point to the adductor tubercle represents the femoral artery

94. Ans. d. Adductor magnus

- Posterior (hamstring) part of adductor magnus takes origin from the ischial tuberosity

95. Ans. b. Obturator internus muscle

- It is the tendon of obturator internus, which passes through lesser sciatic notch not muscle

96. Ans. b. Origin of semimembranosus from superolateral area

- Divided into upper quadrilateral and lower triangular area by transverse ridge.
- **Oblique ridge:** Quadrilateral area into upper and lateral area (semimembranosus origin) and lower and medial (semitendinosus and long head of biceps origin)
- Lower triangular part divided by vertical ridge into medial with transmits body weight and lateral part (origin to hamstring part of adductor magnus).

97. Ans. d. Vastus medialis

- From the medial lip of the linea aspera vastus medialis originates

98. Ans. d. Posterior aspect of patella articulates with upper end of tibia laterally

- Patella has no articulation with tibia;

99. Ans. c. Proximal end of tibia is related to common peroneal nerve

- Common peroneal nerve wind around neck of fibula

100. Ans. d. Vastus lateralis

- Gluteofemoral bursa is present between gluteus maximus and vastus lateralis

101. Ans. b. Semimembranosus

- Sartorius, gracilis, and semitendinosus form pes anserinus

102. Ans. d. Infrapatellar bursa

- Clergymans knee – infrapatellar bursitis
- Housemaid knee – supra patellar bursitis

103. Ans. b. Movement of tibial tuberosity towards lateral border of patella

- Since foot is off the ground, In full extension the knee – locking of knee joint - lateral rotation of tibia so tibial tuberosity moves laterally towards the lateral border of patella

104. Ans. a. Popliteus

- Medial rotation of the flexed leg is produced by popliteus, semimembranosus and semitendinosus, assisted by Sartorius and gracilis

105. Ans. d. Extension of hip joint

Actions of tensor fascia latae

- Its actions are varied
- Abduction, flexion and medial rotation at hip
- Weak extension of knee joint

106. Ans. d. Subcostal nerve

- Subcostal nerve arises from the anterior division of the twelfth nerve

107. Ans. b. L4, L5; S1, S2, S3

- Sciatic nerve arises from the ventral divisions of L-4, 5 and S-1, 2, 3

108. Ans. c. S1, S2, S3

- Posterior cutaneous nerve of thigh arises from the sacral plexus with root value S-1, 2,3

109. Ans. d. S4

- Perianal skin is supplied by S4 root value of the pudendal nerve

110. Ans. a. Lateral cutaneous nerve of thigh

- In meralgia paresthesia nerve involved is lateral cutaneous nerve of thigh there is constant pain and abnormal perception in the outer side of the thigh

111. Ans. c. Iliopsoas

- Iliopsoas is the chief flexor at hip joint, assisted by sartorius and pectineus as the accessory muscles

112. Ans. d. Adductor magnus is the largest muscle > b profunda femoris is the main blood supply.

- Adductor magnus is the largest muscle
- Ischial head of adductor magnus – hamstring component - takes origin from ischial tuberosity and is hamstring part – extensor of hip
- Adductor part of adductor magnus arise from pubic bone. Insertion to adductor tubercle.
- Profunda femoris artery provides major supply to all the three compartments of thigh

**113. Ans. c. Maintains arches of foot**

- Peroneus longus causes eversion
- Maintains longitudinal and transverse arches of foot are maintained by peroneus longus
- Origin from fibula and
- Supplied by superficial peroneal nerve

114. Ans. d. Plantaris

- Plantaris is a muscle of calf region, which gets stretched in dorsiflexion, and might get ruptured

115. Ans. d. Talus

- Talus bone and incus do not have no muscle attachment

116. Ans. c. Inserted on tibial tuberosity

- Iliotibial tract is inserted on the Gerdy's tubercle not to tibial tuberosity

117. Ans. a. Gluteus maximus

- Gluteus maximus works as an extensor of trunk on high antigravity muscle helps the movement from sitting to standing

118. Ans. a. Popliteus

- Popliteus muscle causes unlocking of knee joint, when foot is in the air, by rotating medially

119. Ans. b. It runs anterior to medial malleolus

- Begins from medial end of arch
- Accompanied by saphenous nerve
- Terminates into femoral vein

120. Ans. b. Below inguinal ligament

- There is no perforator veins below the inguinal ligament

121. Ans. a. Vertical group of superficial inguinal lymph nodes

- Lymphatics from lower limb terminate into vertical group of inguinal nodes except lymphatics along small saphenous vein which terminate into popliteal vein

122. Ans. d. Talo-navicular and calcaneo-cuboid

- In pronation, soles move outwards and is accompanied by eversion Talo Navicular and Calcaneo Cuboid joint become parallel

123. Ans. a. Peroneus longus

- Peroneus longus and brevis support the lateral longitudinal arch

124. Ans. b. Genicular + Anterior and posterior tibial artery

Popliteal artery gives 5 genicular arteries and two terminal branches anterior and posterior tibial artery

125. Ans. c. Primary action is to prevent the internal rotation of knee joint

PCL – intracapsular extrasynovial, main action – prevent posterior dislocation of tibia on femur & prevent anterior

displacement of femur on tibia. Attach to anterolateral aspect of medial condyle

126. Ans. c. Coccygeal nerve

- The sacrotuberous ligament is pierced by the coccygeal branches of the inferior gluteal artery, the perforating cutaneous nerve (S2,3) and filaments of the coccygeal plexus (formed by S4,5 & coccygeal nerve)

127. Ans. a. Internal pudendal vessels

- Internal pudendal vessels pass through greater and lesser sciatic foramina (not through obturator foramen)

128. Ans. d. Middle genicular branch of popliteal artery

- It is pierced by: Middle genicular nerve, middle genicular vessels and posterior division of the obturator nerve

129. Ans. a. Anterior cruciate ligament tear; c. Medial meniscus; e. Medial collateral ligament**130. Ans. a. L4,5**

Lumbosacral trunk arises from the anterior rami of the L4 and L5 nerve roots in lumbar plexus. It contributes to the sacral plexus

131. Ans. d. S-2

Posterior calf and thigh region has S2 dermatome

132. Ans. c. Knee extension

Knee extension L3, L4.. L5 Not involved in knee extension.

133. Ans. a. Femoral vessels

Adductor magnus has a hiatus through which pass the femoral artery and vein from the adductor canal to enter the popliteal fossa

134. Ans. b. Extensor hallucis longus and extensor digitorum longus

Arrangement of structures (medial to lateral) in front of ankle joint: Tibialis anterior, extensor hallucis longus, anterior tibial artery, deep peroneal nerve, extensor digitorum longus, peroneus tertius

135. Ans. d. Transverse tarsal

Adduction is movement of the foot towards the middle in the transverse plane; abduction is movement away from the midline.

This movement occurs at the transverse tarsal joints (a compound joint made up of calcaneocuboid and talonavicular joints) and also by the first tarsometatarsal and metatarsophalangeal joints

136. Ans. c. Flexor hallucis longus

The tendon of flexor hallucis longus passes in a groove between the two tubercles of the posterior talus and then lower surface of the sustentaculum.



137. Ans. a. Peroneus tertius, e. Extensor hallucis longus

138. Ans. d. Area spared during penetrating wounds

Ref: *Lexicon of Orthopaedic Etymology, Mohammad Diab, 1st edition, 1999, page 157*

Langenbeck triangle or trigonum iliofemorale: Boundaries

- Apex-anterior superior iliac spine
- Base-anatomical neck and greater trochanter of femur
- Both sides-Lines connecting from apex to base
- Exploration of hip joint to be approached through this triangle following a penetrating injury

139. Ans. d. Anterior horn of the medial meniscus

140. Ans. c. C shaped; d. Fixed to medial collateral ligament; e. Inner part is more avascular

- Made up of fibrous cartilage
- Medial meniscus injury more common

141. Ans. d. Superficial posterior

(Ref: *Gray's Anatomy, 41st ed. Pg. 1406-1412 and Last anatomy 12th ed. Pg. 142*)

- Anterior compartment have deep peroneal nerve and anterior tibial artery
- Lateral compartment have superficial peroneal nerve and peroneal artery
- In the posterior compartment of leg - Tibial nerve and posterior tibial artery pass deep to soleus that is deep posterior compartment of leg
- Superficial posterior leg contains - gastrocnemius, soleus and plantaris

142. Ans. c. Peroneus longus

Peroneus longus - eversion muscle NOT INVOLVED IN INVERSION

143. Ans. a. Hip

Muscles acting at hip joint

Adductors	Abductors	Medial Rotators	Lateral Rotators
Pectineus	Gluteus medius	Gluteus medius	Gluteus maximus
Adductor longus	Gluteus minimus	Gluteus minimus	piriformis
Adductor brevis	Tensor fasciae latae	Tensor fasciae latae	Superior and Inferior gamelli
Gracilius	Sartorius		Obturator internus
Adductor magnus			Quadratus femoris
Obturator externus			Obturator externus

144. Ans. a. Femoral nerve

Saphenous branch - Branch from posterior division of femoral nerve - Longest cutaneous branch

Extend downward along lateral side of femoral artery in femoral triangle and in adductor canal

Nerve leaves the canal by piercing fascial roof and accompanied by saphenous branch of descending genicular artery

The nerve may be subject to an entrapment neuropathy as it leaves the adductor canal

Contributes peripatellar plexus and sub sartorial plexus

It descends along the medial side of leg along medial tibial border with the long saphenous vein provide sensory supply on the medial side of dorsum of the foot up to ball of the great toe

So saphenous nerve can be damaged in venesection of great saphenous vein

145. Ans. c. Gluteus medius

- Gluteus medius and minimus - medial rotators and abductors of hip joint
- Lateral rotation of hip joint
 - Gluteus maximus
 - Piriformis
 - Obturator internus and externus
 - Superior and inferior gameli
 - Quadratus femoris

146. Ans. a. Superior gluteal nerve

Superior gluteal nerve supplies

- Gluteus medius
- Gluteus minimus
- Tensor fascia lata
 - Inferior gluteal nerve supplies gluteus maximus

147. Ans. c. Inferior gluteal artery

Sacrotuberous ligament pierced by

- Coccygeal branches of inferior gluteal artery
- Perforating cutaneous nerve
- Filaments of coccygeal plexus

148. Ans. b. Calcaneo cuboid joint

Inversion and eversion occurs at

- Sub talar joint - talocalcaneal joint
- Talocalcaneo navicular joint
- Talo navicular
- Calcaneo cuboid joint

149. Ans. a. Deep peroneal

Foot drop is due to involvement of deep peroneal nerve

Deep peroneal nerve supplies anterior compartment of leg

Anterior compartment of leg - dorsiflexion of ankle joint

So injury of deep peroneal nerve causes foot drop

NOTES

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6



THORAX



SURFACE LANDMARKS OF THORAX

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THORAX

BONY LANDMARKS

- **Suprasternal or jugular notch:** It is felt just above the superior border of the manubrium between the sternal ends of the clavicles. It lies at the level of the lower border of the body of the second thoracic vertebra (T2). The **trachea** can be palpated in this notch.
- **Sternal angle/angle of Louis:** It is felt as a transverse ridge about 5 cm below the suprasternal notch. It marks the manubriosternal joint, and lies at the level of the **second costal cartilage** anteriorly, and the disc between the fourth and fifth thoracic vertebrae posteriorly (T4-T5).
- **Ribs:** The scapula overlies the second to seventh ribs on the posterolateral aspect of the chest wall. The tenth rib is the lowest point, lies at the level of the third lumbar vertebra. Though the 11th rib is longer than the 12th, both of them are confined to the back and are not seen from the front.
- **Thoracic vertebral spines:** The first prominent spine felt at the lower part of the back of the neck is that of the *seventh cervical vertebra or vertebra prominens*. Below this spine, all the thoracic spines can be palpated along the posterior median line. The third thoracic spine lies at the level of the roots of the spines of the scapulae. The **seventh thoracic spine** lies at the level of the **inferior angles** of the scapulae.

SOFT TISSUE LANDMARKS

- **The nipple:** The position of the nipple varies considerably in females, but in males it usually lies in the fourth intercostal space (4th ICS) about 10 cm from the midsternal line.
- **Apex beat:** It is a visible and palpable cardiac impulse in the left fifth intercostal space (5th ICS) 9 cm from the midsternal line, or medial to the midclavicular line.
- **Trachea:** It is palpable in the suprasternal notch midway between the two clavicles.

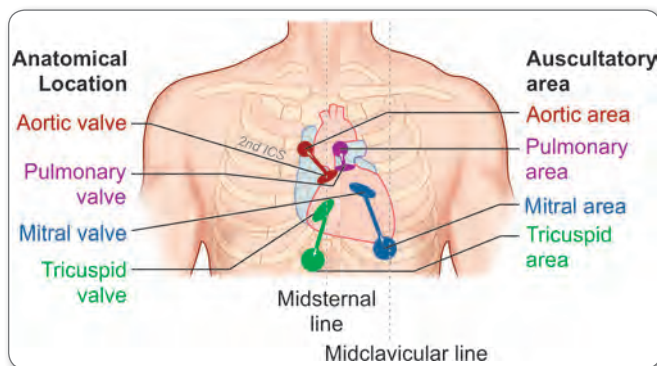


Fig. 1: Surface anatomy of heart valves/anatomical location and auscultatory areas

DEVELOPMENT OF HEART

- Heart develops in **splanchnopleuric lateral plate mesoderm**
- Cardiovascular system is the first system that becomes functional.

- First sign is the appearance of angioblastic cord cells by 3rd week
- Heart beat begins at **22nd day** at fourth week^Q
- Two heart tubes fuse at the cranial end and fail to fuse at the caudal end.
 - Mesoderm around endocardium forms the myocardium (secretes extracellular matrix protein— *cardiac jelly*)
 - Mesoderm migrate from coelomic wall near the liver into cardiac region and forms the epicardium.

PRIMITIVE HEART TUBE DILATATIONS

- Five dilatations appear along the length of the tube. They are truncus arteriosus, bulbous cordis, primitive ventricle, primitive atrium and sinus venosus
- These dilatations undergo dextral looping and develop into adult structures of heart

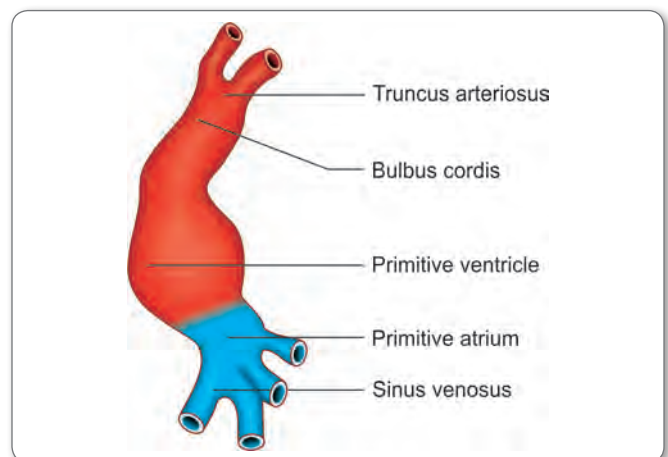
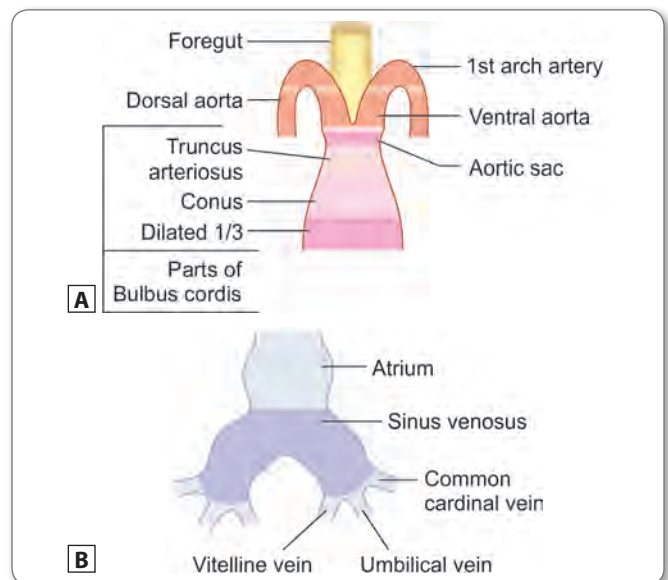


Fig. 2: Primitive heart tube dilatation

ARTERIAL END



Figs 3A and B: (A) Arterial end; (B) Venous end of heart tube



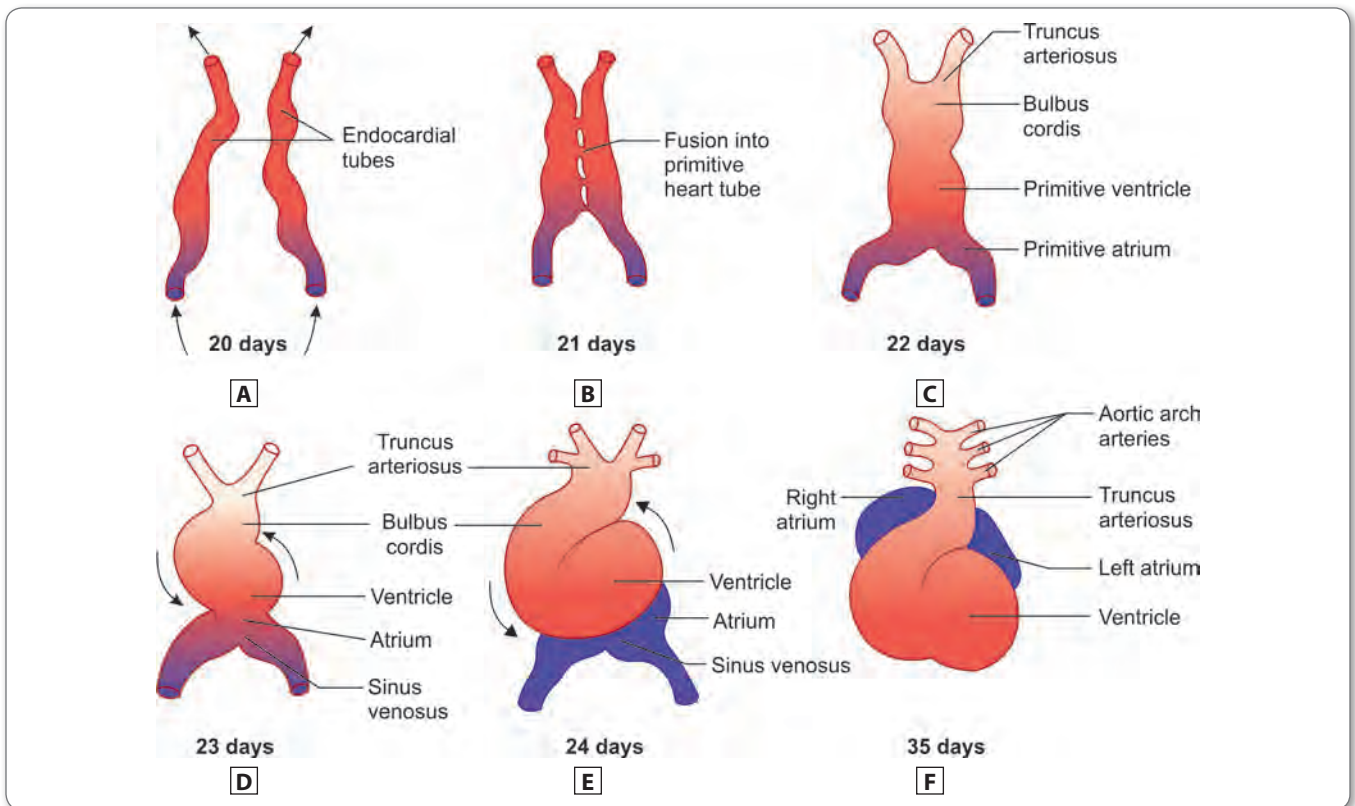
- Truncus arteriosus represents the arterial end of the heart
- Cranially truncus arteriosus is continuous with aortic sac having right and left horn
- Then each horn is connected to dorsal aorta through pharyngeal arch arteries.

Table 1: Primitive heart tube dilatations at embryonic and adult stage

Embryonic dilation	Adult structure
Truncus arteriosus	Ascending aorta and pulmonary artery
Bulbus cordis	Smooth part of right and left ventricle
Primitive ventricle	Trabeculated part of right and left ventricle
Primitive atrium	Rough part of right and left atrium
Body of sinus venosus	Smooth part of right atrium
Left horn of sinus venosus	Coronary sinus and oblique vein of left atrium

VENOUS END

- Sinus venosus represents venous end
- Each horn of sinus venosus receives three primitive veins—vitelline vein from yolk sac, umbilical vein from placenta, common cardinal vein from body wall.

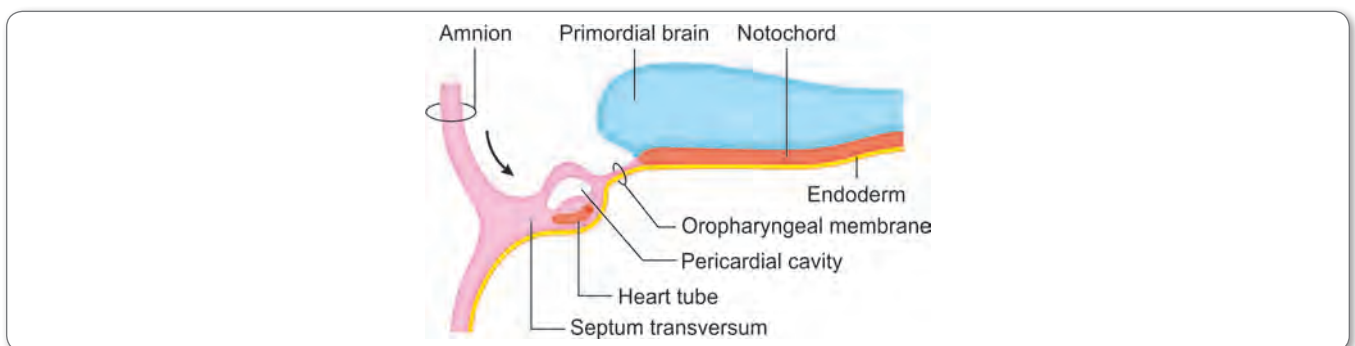


Figs 4A to F: Development of heart tube into adult derivatives

Note:

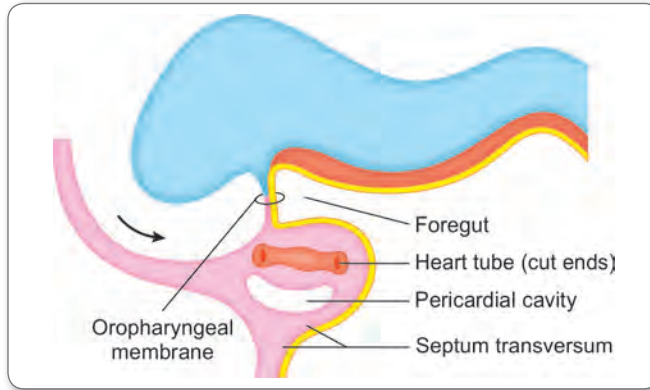
- **Smooth part of left atrium** is formed by incorporation of **pulmonary veins** into atrial wall
- **Crista terminalis** – junction of rough and smooth part of right atrium.

POSITION OF HEART TUBE IN RELATION TO PERICARDIAL CAVITY





- Before the formation of head fold, heart tube lies in the floor of pericardial cavity caudal to septum transversum



- After the formation of head fold, pericardial cavity and heart tube comes to lie ventral to foregut and cranial to septum transversum
Note: Now the heart tube lying in the roof of pericardial cavity

CARDIAC JELLY

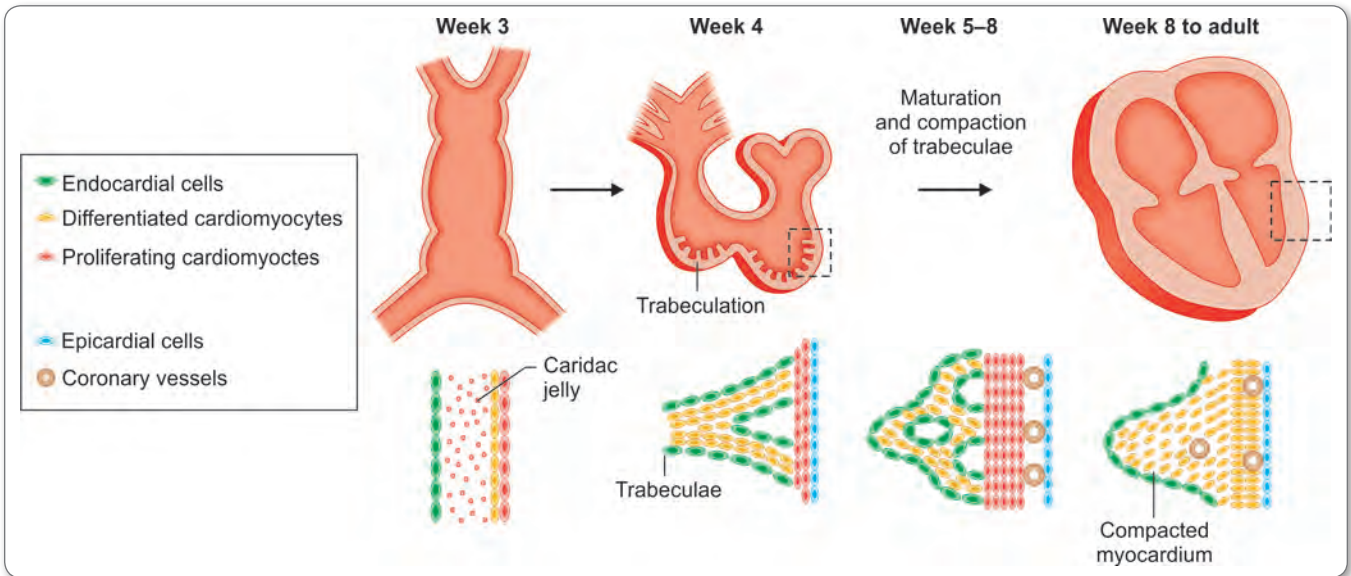


Fig. 5: Compacting the heart with notch

- Cardiac jelly (gelatino retinaculum) is the extracellular matrix which is rich in hyaluronic acid, fibronectin, laminin and collagen
- This extracellular matrix are secreted by myocardial cells
- Cardiac jelly present between endothelium and myocardium which transforms into connective tissue of endocardium
- Cardiac jelly accumulates within endocardial cushions which are precursors of cardiac valves.

Table 2: Structures derived from the different layers of the heart

Structures derived from Epicardium	Structures derived from Myocardium	Structures derived from Endocardium
Visceral pericardium Coronary blood vessels	Cardiac muscles Conducting system of heart	Endothelial lining and valves

- Somatopleuric mesoderm—forms parietal layer of pericardium.



FORMATION OF AORTICOPULMONARY SEPTUM

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THEORY

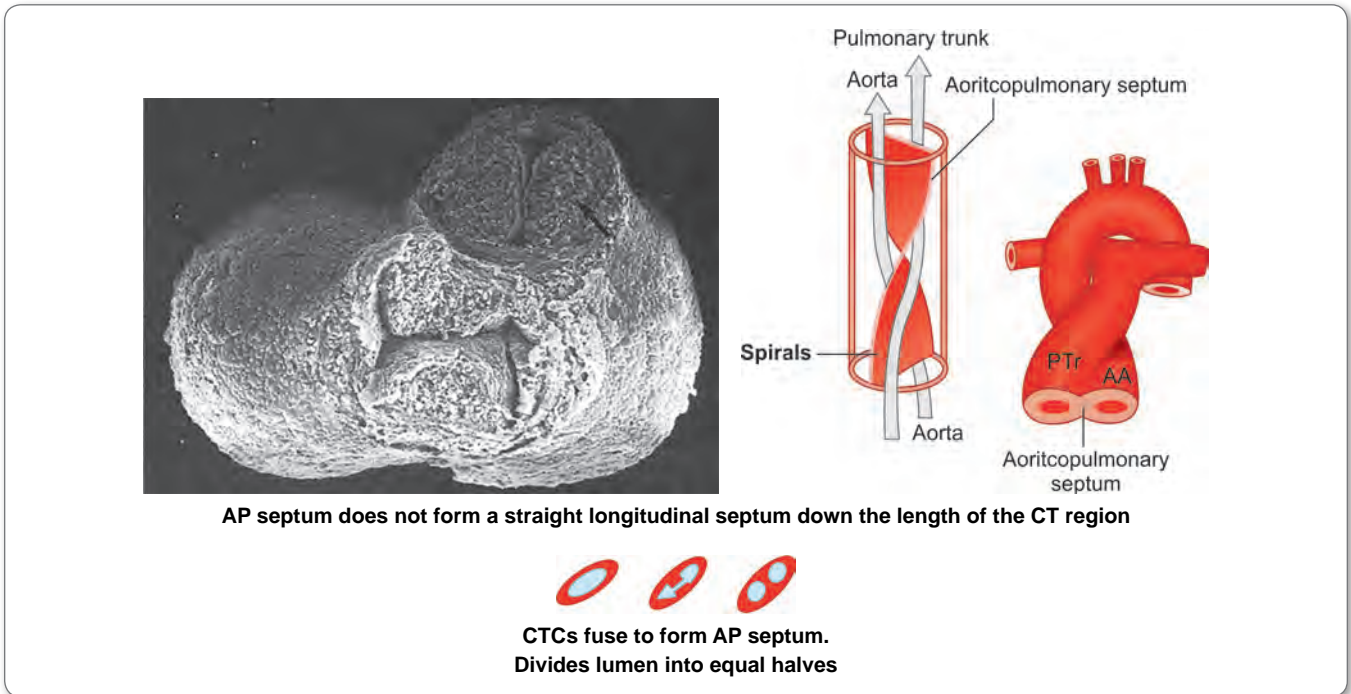


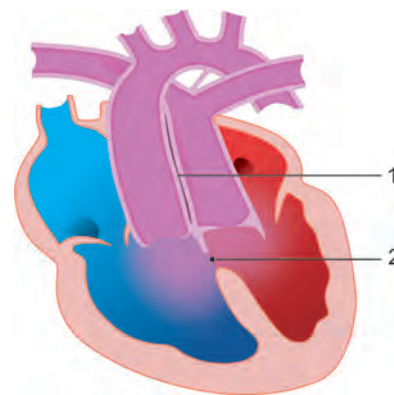
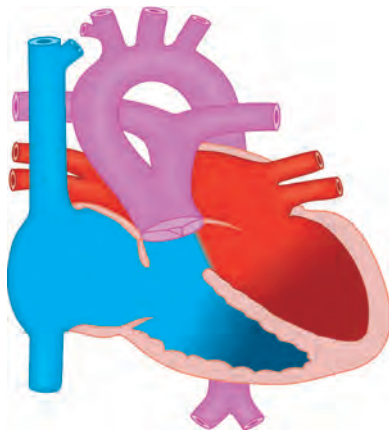
Fig. 6: Development of aorticopulmonary septum

- Neural crest cells invade truncal and bulbar ridges
- These truncal and bulbar ridges grow and twist around each other in spiral manner and fuse to form Aorticopulmonary septum
- Aorticopulmonary septum divides the truncus arteriosus into aorta and pulmonary trunk



Clinical Aspect

- **Persistent truncus arteriosus:** Abnormal neural crest migration therefore partial development of AP septum occurs. Truncus arteriosus persists and receives blood from right and left ventricle. PTA accompanied by VSD and associated with cyanosis (right to left shunting)
- **Transposition of great vessels:** Nonspiral development of aorticopulmonary septum occurs. So pulmonary trunk receives blood from left ventricle. Aorta receives blood from right ventricle.



Contd...

New SARP Series Anatomy



- **Tetralogy of Fallot:** Anterior displacement of aorticopulmonary septum results in tetralogy of Fallot. Components of TOF are: 1. Pulmonary valve stenosis/narrowing, 2. Overriding of aorta, 3. VSD, 4. Right ventricular hypertrophy (RVH)

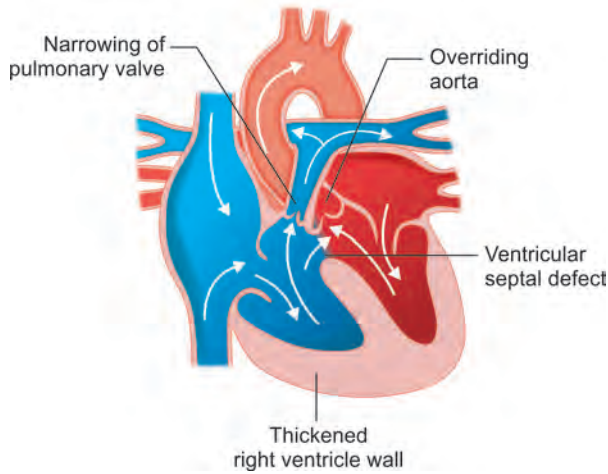


Table 3: Embryological defects in cardiac anomalies

Anomaly	Cause	Components
TOF	Unequal division of conus due to anterior displacement of conotruncal septum	PS +RVH + VSD + Overriding of aorta
Persistent truncus arteriosus	Conotruncal ridge fails to fuse and to descend toward ventricle	Persistent truncus arteriosus arises from undivided truncus + VSD + Common truncus receives blood from both the ventricles
TGA	Conotruncal septum fails to follow its normal spiral course & runs straight down	Aorta arises from RV + Pulmonary artery arises from LV + PDA

FORMATION OF PERICARDIUM AND SINUSES

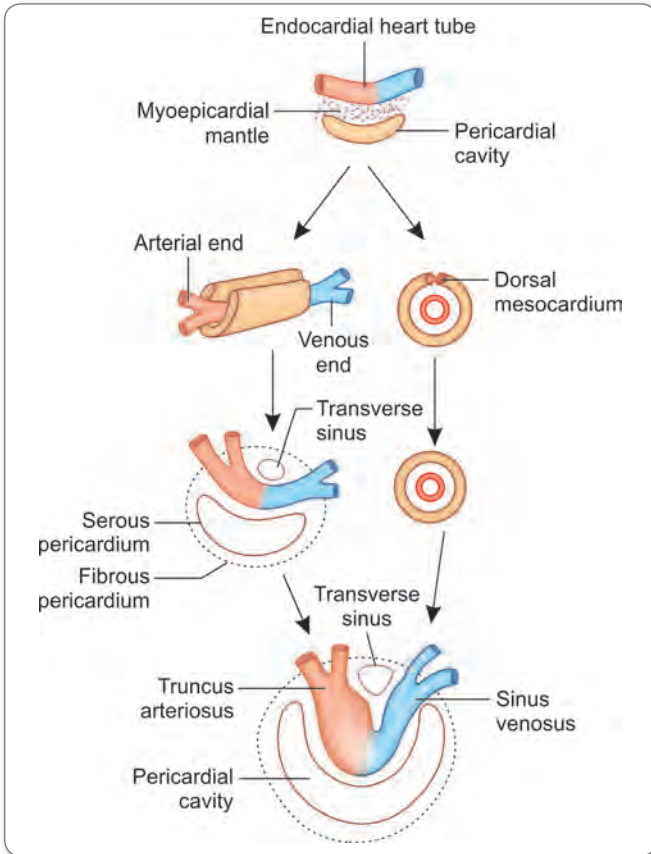


Fig. 7: Formation of serous and fibrous pericardium

- Consists of two components serous and fibrous layer
- Serous pericardium consists of two layers visceral layer and parietal layer

- Visceral layer derived from splanchnopleuric layer of lateral mesoderm & parietal layer and fibrous pericardium derived from somatopleuric layer of mesoderm.

Mode of Formation

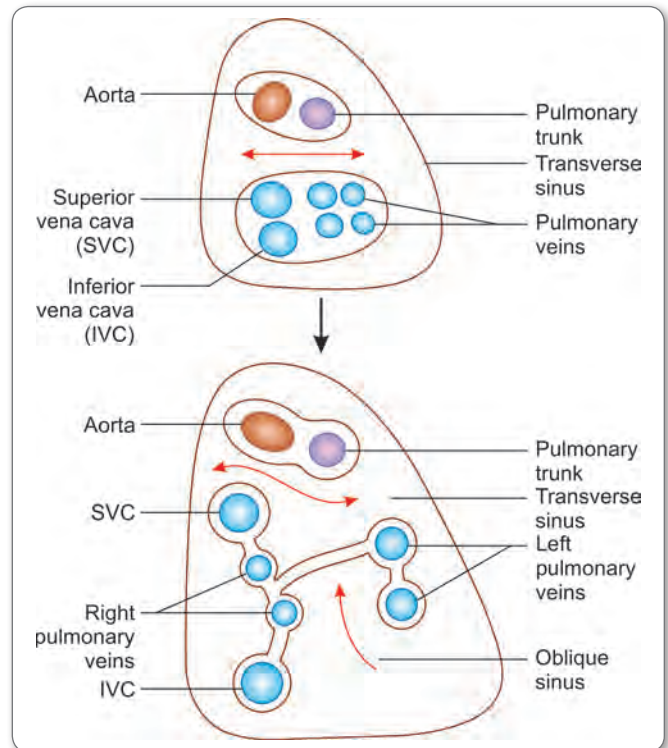
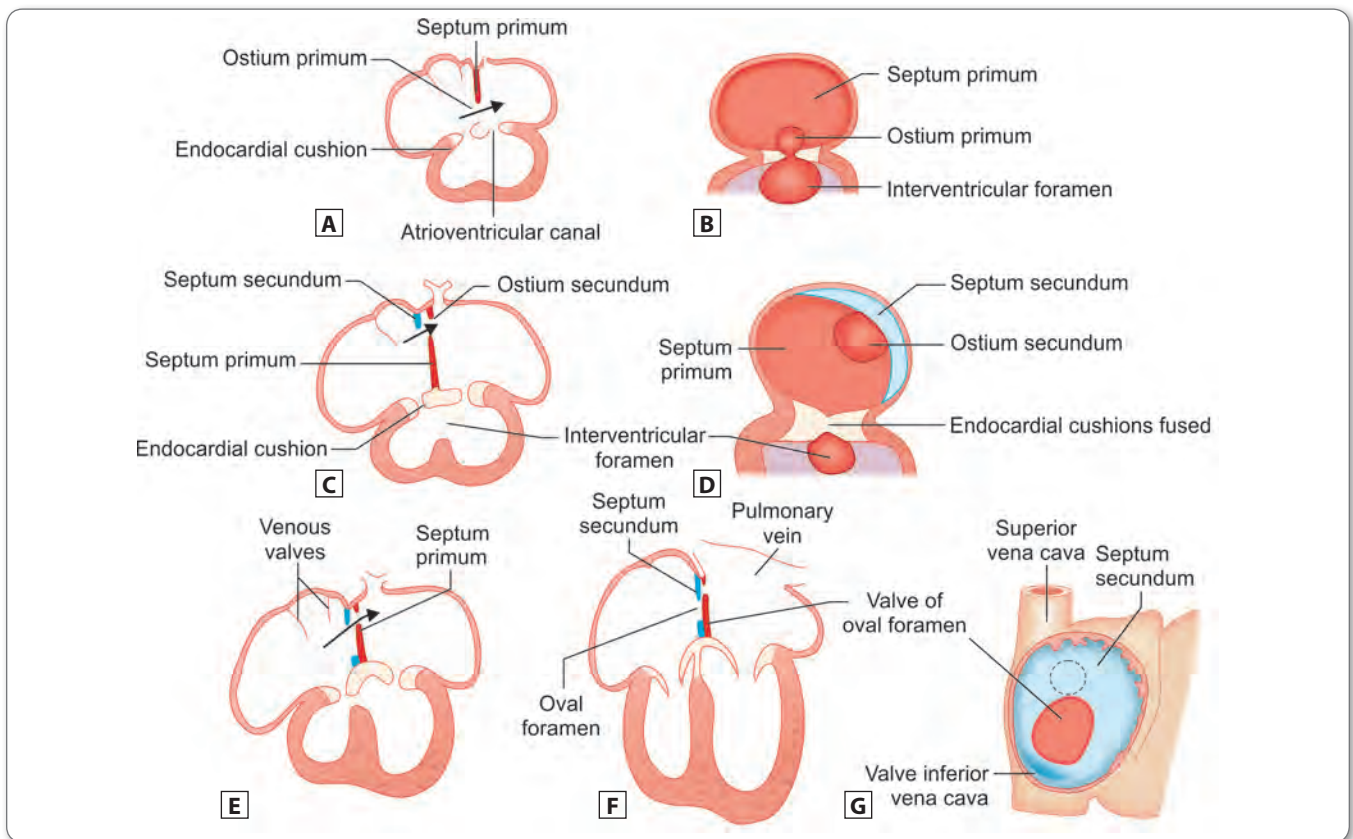


Fig. 8: Formation of transverse and oblique sinuses of the pericardium



- Pericardial cavity – derived from part of intraembryonic celom
- Splanchnopleuric mesoderm on the dorsal aspect of pericardial cavity forms myoepicardial mantle
- Heart tube invaginates pericardial cavity from dorsal aspect so the heart tube is covered by myoepicardial mantle and pericardial cavity.
- Heart is suspended in the pericardial cavity by dorsal mesocardium
- Due to folding of heart tube, arterial and venous end comes close and dorsal mesocardium forms transverse sinus
- Now the parietal and visceral layer continuous with each other at arterial end and venous end
- So the serous pericardium gets arranged into two tubes – one enclosing aorta and pulmonary trunk (arterial end) and the other enclosing superior vena cava, inferior vena cava & four pulmonary veins(venous end). These two tubes are separated by transverse sinus of pericardium
- Oblique sinus of pericardium derived from definitive reflections of pericardium in accordance with rearrangement of SVC, IVC and pulmonary veins at the venous end.

FORMATION OF ATRIAL SEPTUM



Figs 9A to G: Different stages in the formation of atrial septum

- Crescent shaped septum primum forms the roof of primitive atrium and grow towards AV cushions in the AV canal
- *Foramen primum* formed between free edges of septum and AV cushion
- *Septum primum* fuses with AV cushions, therefore break appears in center of septum primum, which results in the formation of foramen secundum
- *Septum secundum* forms right to septum primum
- *Foramen ovale* is formed between septum secundum and primum
- During embryonic life, blood is shunted right atrium to left atrium through foramen ovale
- Immediately after birth functional closure of foramen ovale occurs due to increase of pressure in left atrium (lungs starts to function)
- Later anatomical closure occurs
- **Probe patency of foramen ovale:**
 - This is of no clinical importance
 - Incomplete anatomic closure of septum primum and septum secundum.



Clinical Aspect

Premature closure of foramen ovale

- Closure of foramen ovale during fetal life results in hypertrophy of right side of the heart and underdevelopment of left side of heart

Foramen Secundum Defect

- Excessive resorption of septum primum, septum secundum or both
- Results in opening between right atrium and left atrium
- This defect can be tolerated so usually symptoms manifest by late 30.
- Right atrium and right ventricle enlarge, enlargement of pulmonary artery and increased pulmonary vascularity
- Enlarged pulmonary artery prevent aorta forming normal left border of the heart (aortic knob is small)

FORMATION OF ATRIOVENTRICULAR SEPTUM

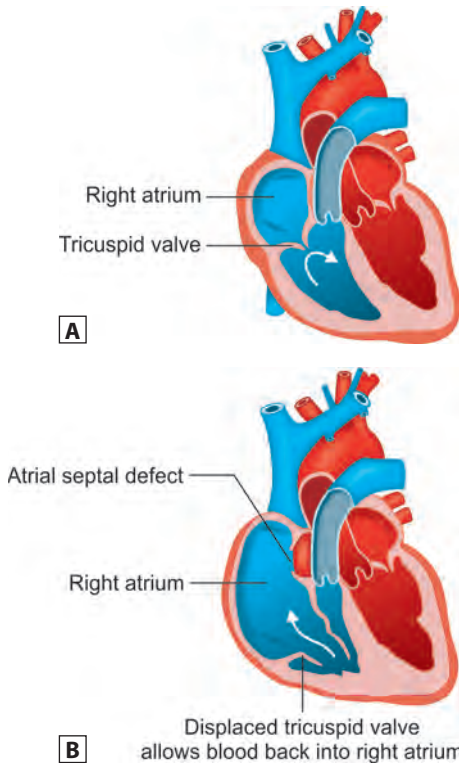
- Dorsal and ventral part of AV cushion approach each other and fuse to form AV septum
- AV septum separate AV canal into right and left AV canal



Clinical Aspect

- AV canal fails to partition into right and left AV canal so large opening appears in the center of the heart
- Tricuspid valve and bicuspid valve represented by one valve

Ebstein's Anomaly

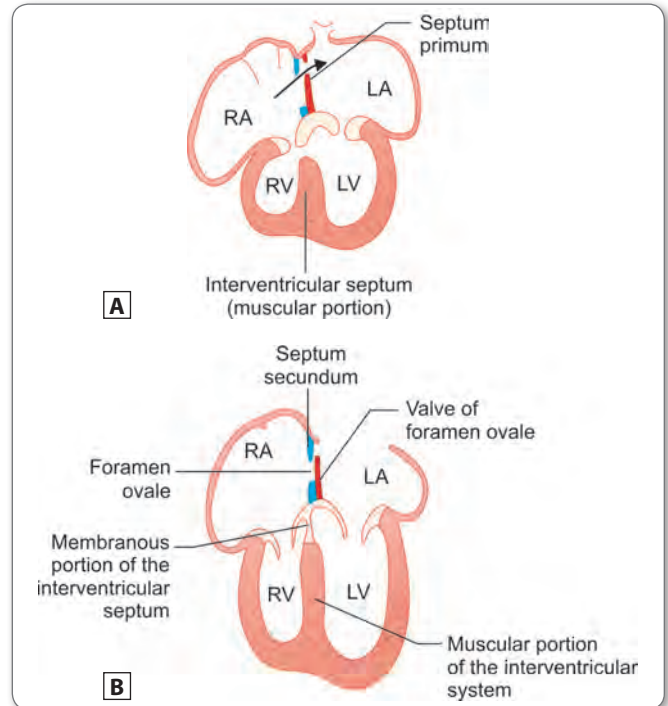


Figs 10A and B: (A) Normal heart; (B) Ebstein's anomaly

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- Failure of posterior and septal leaflets of the **tricuspid valve** to attach normally to annulus and displaced inferiorly into right ventricle
- Results in division of right ventricle into upper, larger atrial portion and smaller lower functional part (so very low amount of blood available for pulmonary trunk).
- Usually associated with **ASD**.

FORMATION OF INTERVENTRICULAR SEPTUM



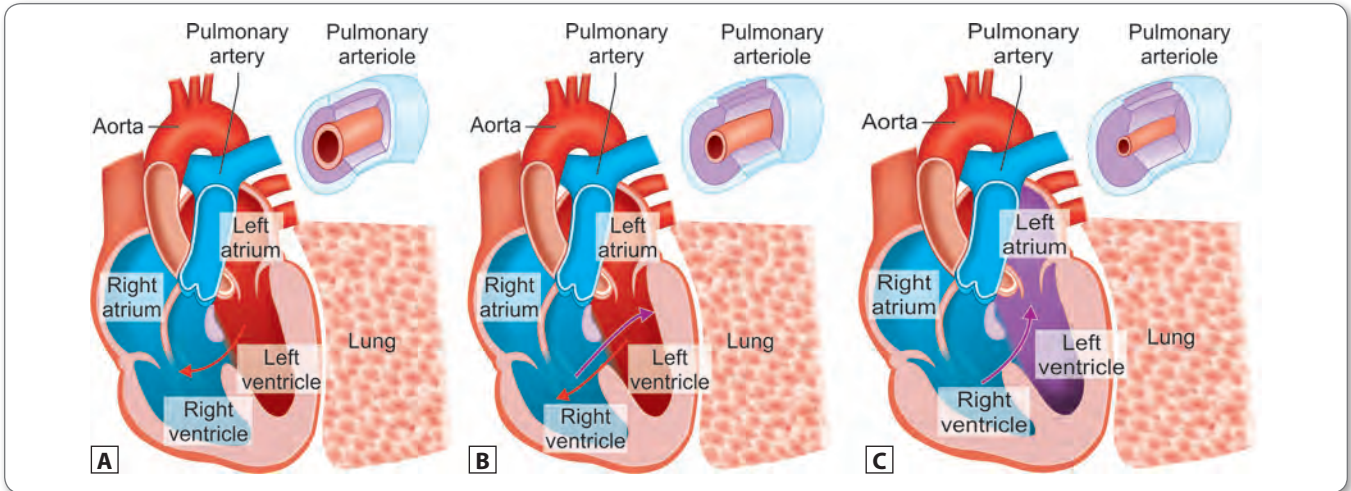
Figs 11A and B: Septum formation in the ventricle

- Muscular part of interventricular septum develops in midline on the floor of the primitive ventricle and grow toward the AV cushion
- So foramen formed between free edges of muscular part of IV septum and fused AV cushions
- Membranous part is formed by proliferation of tissues from three sources—right bulbar ridge, left bulbar ridge and AV cushions.



Clinical Aspect

- Muscular VSD – perforations in muscular part of IV septum
- Membranous VSD –
 - Faulty fusion of right bulbar ridge, left bulbar ridge and AV cushions.
 - Results in opening between right and left ventricle
 - Large VSD initially associated with left to right shunt, so increased pulmonary blood flow and increased pulmonary hypertension
 - Pulmonary resistance becomes higher than systemic
 - This results in right to left shunt and cyanosis. Patients exhibits **EISENMENGER COMPLEX**
 - This exhibits difference between blue baby (cyanotic baby) and blue kid (late onset of cyanosis)



Figs 12A to C: (A) Evolution of Eisenmenger syndrome ASD, VSD or complex defect increases pulmonary blood flow via left-to-right-shunt; (B) Pulmonary resistance rises and results in bi-directional flow; (C) Reversal of shunt right-to-left, Eisenmenger syndrome

FORMATION OF PHARYNGEAL ARCH ARTERIES

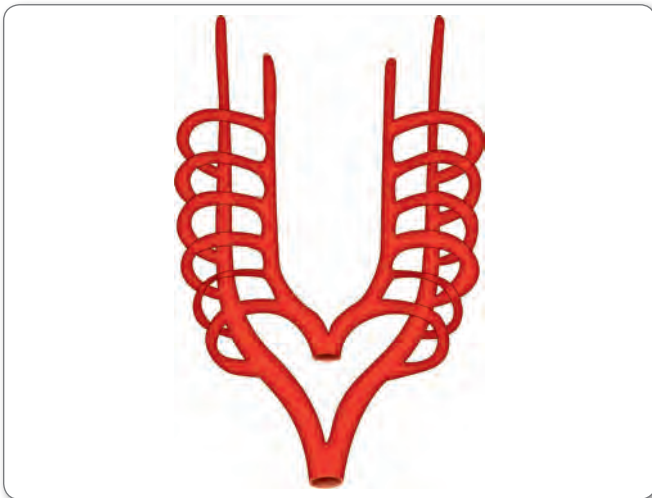


Fig. 13: Pharyngeal arch arteries

- 3rd, 4th and 6th persist
- Fate of 3rd arch artery
 - Proximal part of 3rd arch artery forms common carotid artery
 - Distal part of 3rd arch artery and cranial part of dorsal aorta forms **internal carotid**
 - Bud arising from 3rd arch artery forms external carotid artery
- Fate of 6th arch artery
 - Proximal part of 6th arch of artery forms pulmonary artery
 - Distal part of 6th arch artery on the left side forms ductus arteriosus (right side – disappears)
- Arch of aorta developed from
 - Ventral part of aortic sac, left horn of the aortic sac, left 4th arch artery and caudal part of left dorsal aorta
- Brachiocephalic trunk developed from right horn of the aortic sac
- Right subclavian artery developed from three source
 - Right 4th arch artery
 - Part of dorsal aorta cranial to right 7th cervical intersegmental artery
 - And right 7th cervical intersegmental artery
- Left subclavian artery developed from left 7th cervical intersegmental artery.

Table 4: Aortic arch and their derivatives

Aortic arch	Derivatives
1 st arch	Transitory maxillary artery
2 nd arch	Transitory hyoid & stapedia artery
3 rd arch	Common carotid artery and 1 st part (proximal part) of internal carotid artery
4 th arch	Left – arch of aorta Right + 7 th intersegmental artery → right subclavian artery
6 th arch	Left → left pulmonary artery and ductus arteriosus Right → right pulmonary artery

- Cranial part of the heart tube connected to dorsal aorta by 6 arch arteries
- 1st, 2nd and 5th arch artery disappear

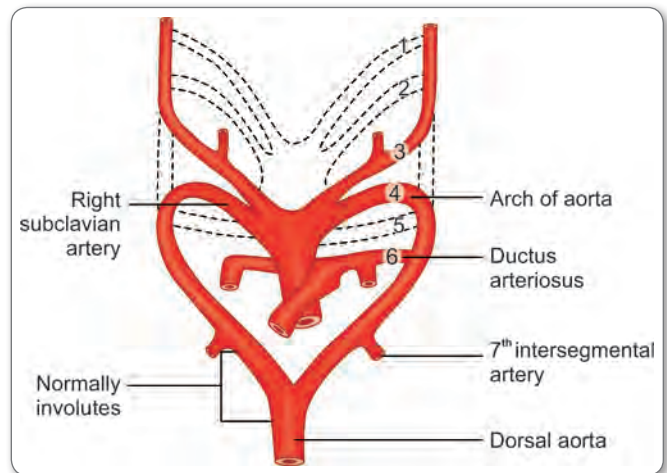
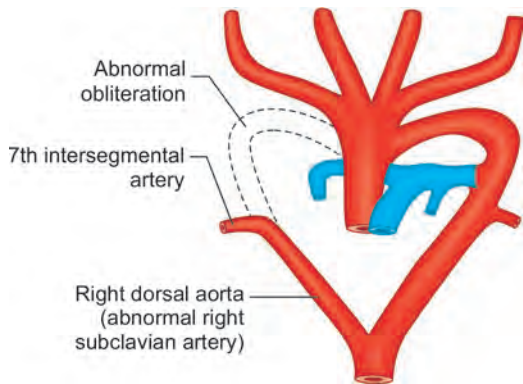


Fig. 14: Fate of arch arteries

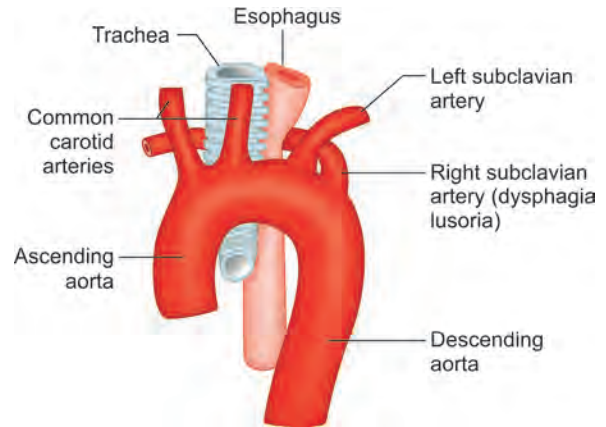


Clinical Aspect

Anomalies of Aortic Arch



A. Right dorsal aorta



B. Abnormal origin of right subclavian artery

Double aortic arch	Due to presence of right dorsal aorta distal to 7 th intersegmental artery (which usually disappears)
Right aortic arch	Left dorsal aorta distal to 7 th intersegmental artery disappears Right dorsal aorta persists entirely as right aortic arch
Abnormal origin of right subclavian artery	Right fourth arch artery and right dorsal aorta cranial to 7 th intersegmental artery disappears Right dorsal aorta caudal to 7 th intersegmental artery and 7 th intersegmental artery persists forms abnormal origin of right subclavian artery.
Patent ductus arteriosus	Ductus arteriosus fails to close. So oxygenated blood from aorta passes to pulmonary trunk – left to right shunt – no cyanosis .
Post ductal coarctation	Constriction of aorta distal to origin of left subclavian artery and inferior to ductus arteriosus. Associated with increased BP in the upper extremity and lack of pulse in femoral artery.
Pre ductal coarctation of aorta	Constriction located superior to ductus arteriosus. But very rare

Note:

- Ductus arteriosus closes shortly after birth to form ligamentum arteriosum
- But anatomical closure takes place 1 to 3 months.

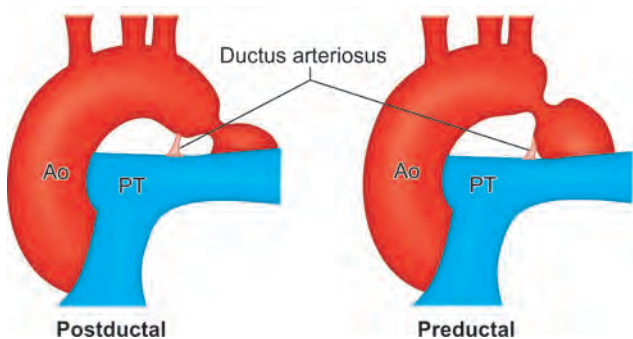


Fig. 15: Coarctation of the aorta

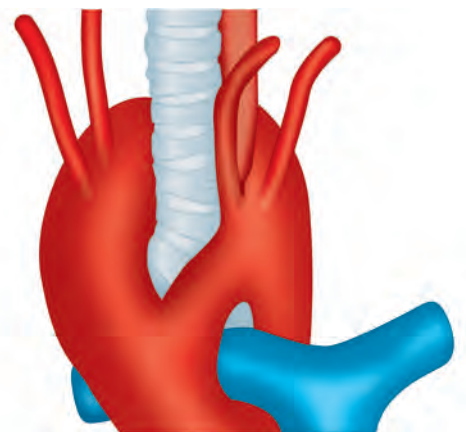


Fig. 16: Double aortic arch



DERIVATIVES OF VEINS

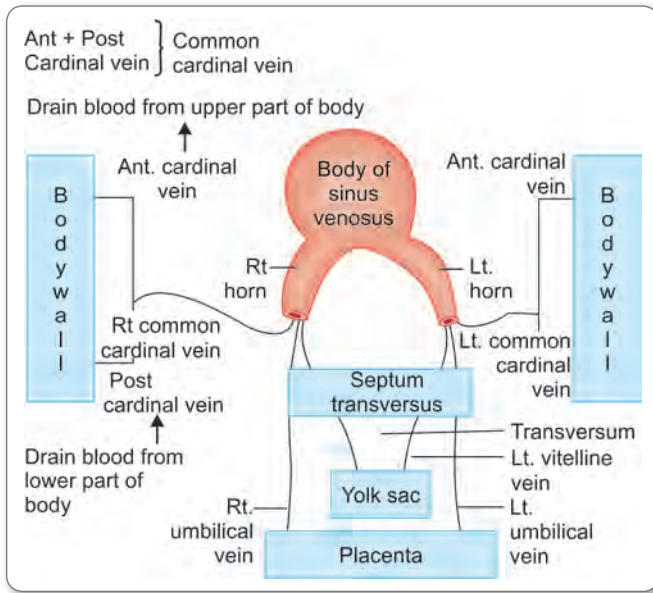


Fig. 17: Derivatives of veins

Three Types of Vein

Vitelline vein	Carries poorly oxygenated blood from Yolk sac to corresponding horn of sinus venosus
Right vitelline vein forms	Hepatic veins & sinusoids, ductus venosus, portal vein, superior mesenteric vein, inferior mesenteric vein, splenic vein and part of IVC
Left vitelline vein	Hepatic vein & sinusoids & ductus venosus
Umbilical vein	Carries oxygenated blood from Placenta to corresponding horn of sinus venosus
Right umbilical vein	Degenerates
Left umbilical vein	Forms ligamentum teres hepatis
Common cardinal vein	Carries poorly oxygenated blood from body to corresponding horn of sinus venosus

Note: Vitelline vein and umbilical vein: Pass through septum transversum

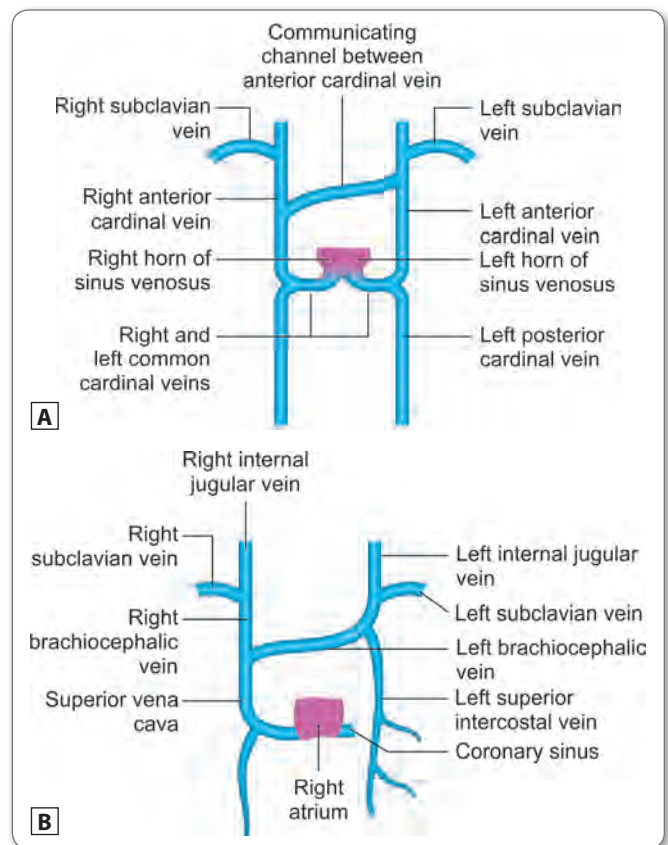
Table 5: Embryonic veins and their adult derivative

Embryonic veins	Adult derivative
Vitelline vein (right and left)	Superior mesenteric vein Hepatic vein and sinusoids IVC Portal vein (Mn – SHIP)
Right umbilical vein	Regress and from the site of regression gastroschisis may arise
Left umbilical vein	Ligamentum teres

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Embryonic veins	Adult derivative
Anterior cardinal vein (Drains upper part of body)	Superior vena cava and internal jugular vein
Posterior cardinal vein (Drains lower part of body)	Inferior vena cava and common iliac veins
Subcardinal vein	Inferior vena cava, gonadal veins and renal veins
Supracardinal vein	Inferior vena cava, azygos system of veins and intercostal veins.

DEVELOPMENT OF VEINS IN THE UPPER PART OF THE BODY



Figs 18A and B: Development of major veins of the upper part of the body.

- Internal jugular vein – from anterior cardinal vein cranial to opening of subclavian vein
- Subclavian veins – derived from intersegmental veins which develop in the region of upper limb bud
- Right brachiocephalic vein – from right anterior cardinal vein above the opening of oblique communicating channel and below the opening of right subclavian vein
- Left brachiocephalic vein – develops from oblique channel connecting left and right anterior cardinal veins and left anterior cardinal vein between the opening of communicating channel and left subclavian vein



- Superior vena cava – developed in two parts:
 - First part – develops from right anterior cardinal vein caudal to oblique transverse anastomosis
 - Second part – right common cardinal vein

Note

- SVC first opens into right horn of sinus venosus (right common cardinal vein opens into right horn of sinus venosus)

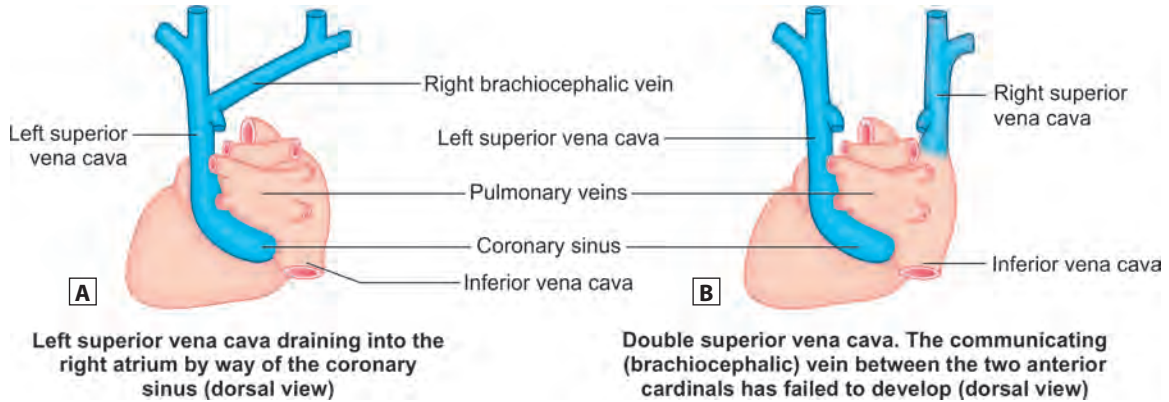
- Lateral right horn of sinus venosus forms the smooth wall of right atrium so SVC finally opens into right atrium.

Mnemonic

- **SVC is derived from:** CAR
- Common cardinal + Anterior cardinal veins, both from **Right** side

Clinical Aspect

Anomalies



Double Superior Vena Cava

- Anastomosis between two anterior cardinal veins fails to form and left anterior cardinal vein persists
- Anterior cardinal vein of both sides develop into superior vena cava.
- Note:** Left superior vena cava opens into coronary sinus

Left Superior Vena Cava

- Anastomosis between two anterior cardinal veins develop like the normal cases
- But the blood is shunted from right to left side through brachiocephalic veins
- So the right anterior cardinal vein below the oblique transverse anastomosis regresses and left anterior cardinal develops into superior vena cava
- Left superior vena cava opens into coronary sinus

DEVELOPMENT OF PORTAL VEIN

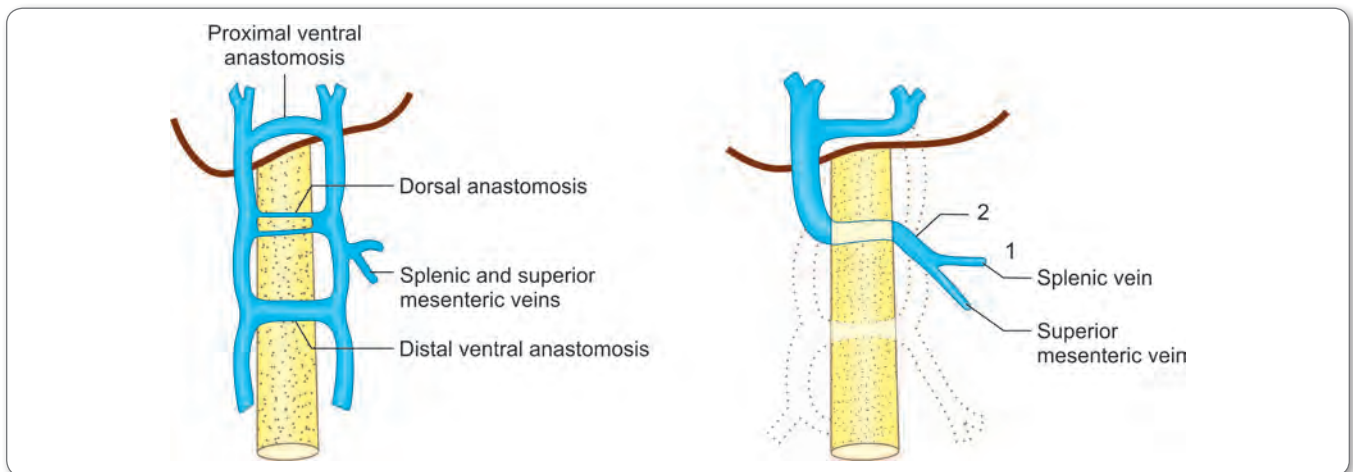
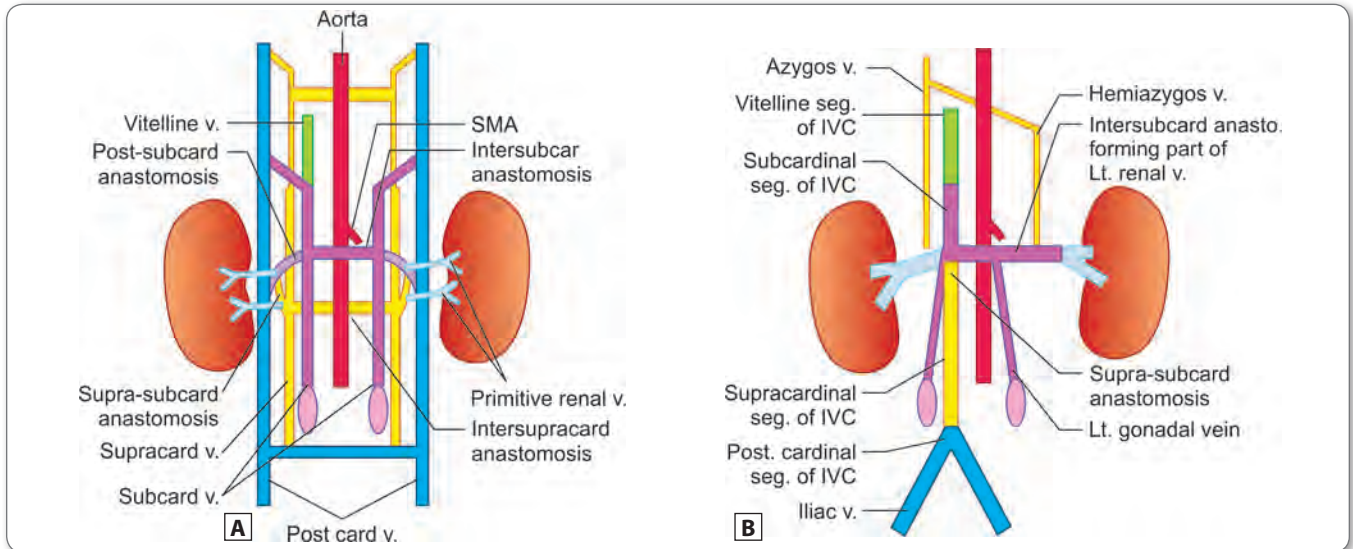


Fig. 19: Portal vein development



- From three components:
 - Caudal part of left vitelline vein between point at which superior mesenteric and splenic vein open and point where the dorsal anastomosis joins the left vitelline vein
 - Middle dorsal anastomosis
 - Part of right vitelline vein between dorsal and proximal ventral anastomosis.

DEVELOPMENT OF IVC

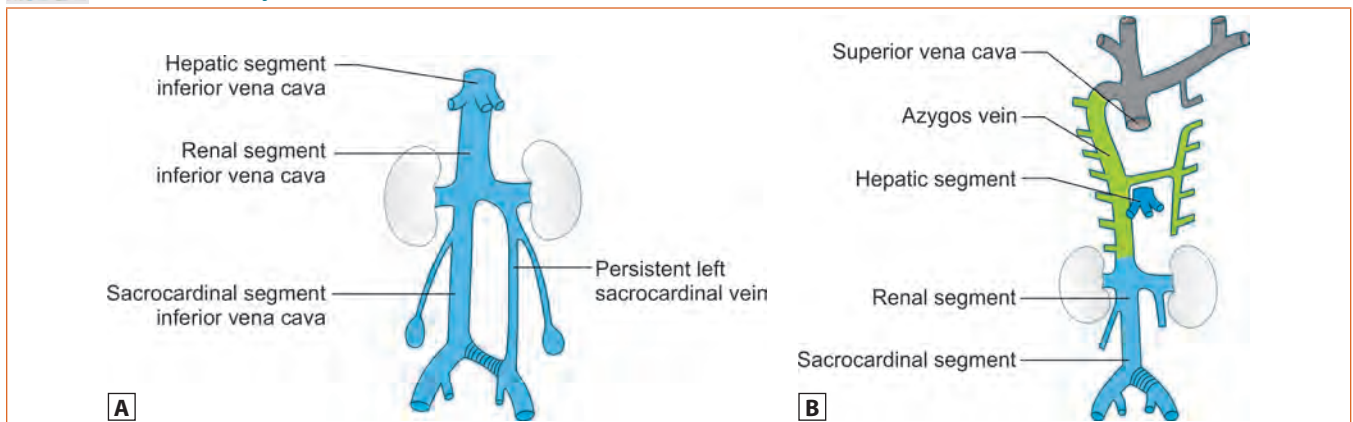


Figs 20A and B: Development of IVC

Following sources (from caudal to cranial):

- Right posterior cardinal vein. It is termed as sacrocardinal segment of IVC
- Caudal part of right supra cardinal vein
- Supracardinal – subcardinal anastomosis
- Right subcardinal vein – renal segment of IVC
- Anastomosing channel that connects right subcardinal vein to right hepatocardiac channel
- Right hepatocardiac channel forms hepatic segment of IVC.

Clinical Aspect



Figs 21A and B: (A) Double Inferior cava; (B) Absent inferior vena cava

Double inferior vena cava	Left sacrocardinal vein persists forming additional inferior vena cava below the level of kidneys Due to persistence of left Sacro cardinal vein – according to <i>Langman's Embryology</i> Due to persistence of left supra cardinal vein – according to majority of clinical books/ <i>Moore's Embryology</i> So double IVC due to persistence of left supra cardinal vein > left sacro cardinal vein
Left superior vena cava	Left anterior cardinal vein persists forming SVC on left side. Right side – regresses
Double superior vena cava	Left anterior cardinal vein persists forming SVC on left side. Right anterior cardinal vein also forms SVC on right side. So double SVC



DEVELOPMENT OF RESPIRATORY SYSTEM

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THORAX

- Larynx, trachea, bronchi and lungs developed from respiratory diverticulum in the ventral wall of primitive foregut during 4th week
- Distal end of the diverticulum enlarges to form lung bud
- Lung bud divides into 2 bronchial buds that branch into main, lobar (secondary) and segmental (tertiary) and subsequent bronchi
- Respiratory diverticulum initially in communication with foregut but later they become separated by trachea esophageal fold
- Trachea esophageal fold fuse to form tracheoesophageal septum
- Foregut is divided into trachea ventrally and esophagus dorsally.

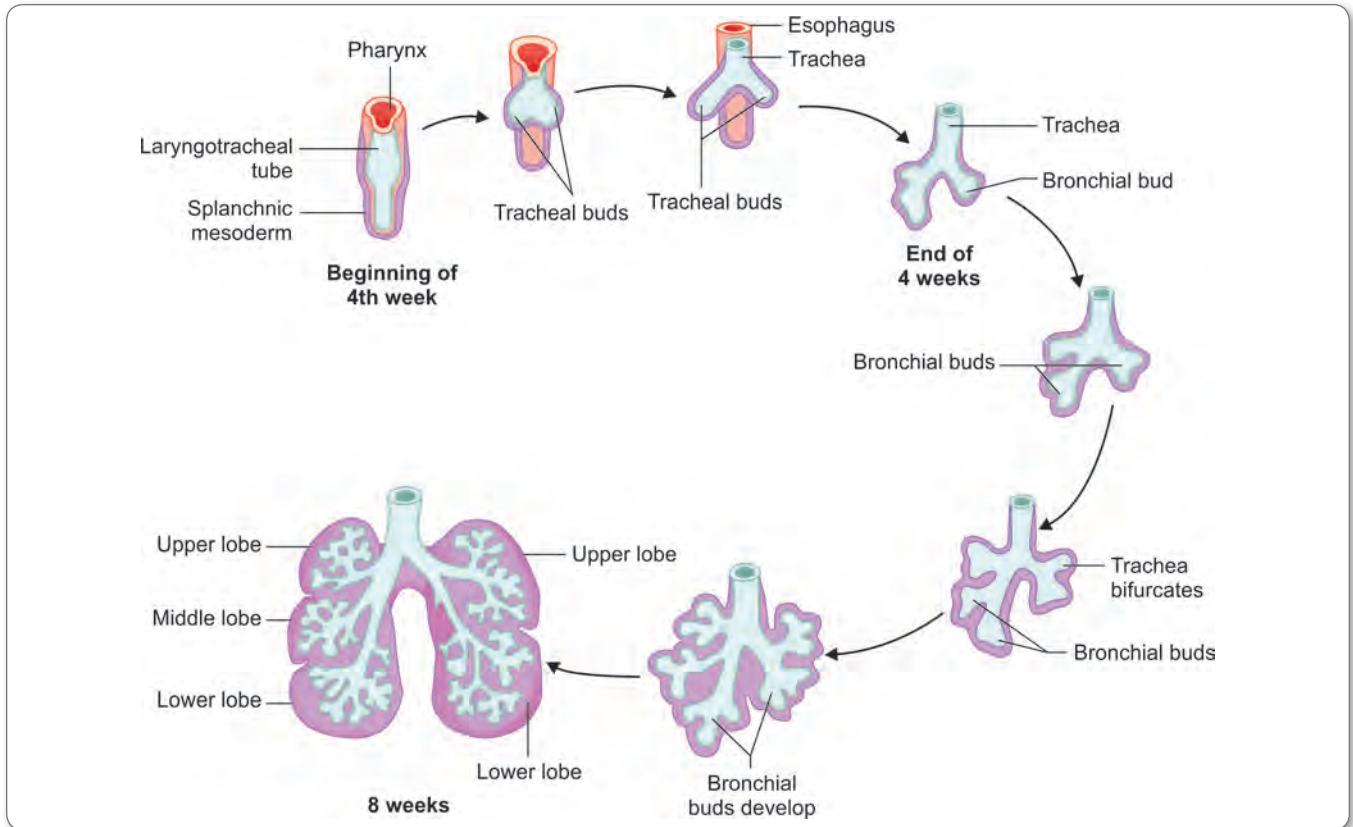


Fig. 22: Development of respiratory system



Clinical Aspect

- Tracheoesophageal fistula is the abnormal communication between trachea and esophagus results from improper division of trachea esophageal septum.
 - H type tracheoesophageal fistula only – occurs at 4% of cases
 - Esophageal atresia with tracheoesophageal fistula at proximal end – occurs in 2% of cases
 - Esophageal atresia with tracheoesophageal fistula at both proximal and distal end – occurs in 1% of cases.
 - Esophageal atresia only – this malformation occurs in around 9% of cases only.
- Types**
- Esophageal atresia with tracheoesophageal fistula at distal one third of trachea – most common type. Occurring in 85% of cases



Esophageal atresia with distal TEF (85%)



Esophageal atresia with no TEF (8%)



H-type TEF (4%)



Esophageal atresia with proximal TEF (2%)



Esophageal atresia with proximal and distal TEF (1%)

- Usually associated with esophageal atresia, which results in polyhydramnios
- **Clinical features:** Excessive accumulation of saliva or mucus in the nose and mouth, episodes of gagging and cyanosis after swallowing milk, reflux of gastric contents into lungs causing pneumonitis
- **Diagnostic features:** Inability to pass catheter into stomach and radiograph demonstrating air in the infant's stomach.

DEVELOPMENT OF LUNGS

- Lungs mature in proximal – distal direction, beginning with largest bronchi and proceed outward
- Proximal tissue is more advanced period of development than distal tissue
- Periods of development

Table 6: Development of lungs at different periods

Periods	Development of lungs
Pseudo-glandular period (Weeks 7–16)	<ul style="list-style-type: none"> • Developing lung resembles an exocrine gland • Numerous endodermal tubules lined by simple columnar epithelium and surrounded by capillary network • Each endodermal tubule branches into 15–25 terminal bronchiole • Respiration not possible, premature infant cannot survive
Canalicular period (Weeks 16–24)	<ul style="list-style-type: none"> • Terminal bronchiole branch into three or more respiratory bronchiole • Respiratory bronchiole branch into six alveolar ducts • These are lined by simple cuboidal epithelium and surrounded by capillary network • Premature infant before 20 weeks rarely survive
Terminal sac period (24 week to birth)	<ul style="list-style-type: none"> • Terminal sacs bud off alveolar ducts and then dilate and expand into surrounding mesoderm • Simple cuboidal epithelium within the terminal sac differentiate into type 1 pneumocytes (flat cells form the blood air barrier) and type 2 pneumocytes (which produce surfactant) • Premature infant 25–28 weeks survive with intensive care
Alveolar period (Week 32 – 8 years)	<ul style="list-style-type: none"> • Terminal sac portioned to form adult alveoli • 20–70 million alveoli are present at birth • About 300–400 million alveoli present at 8 years

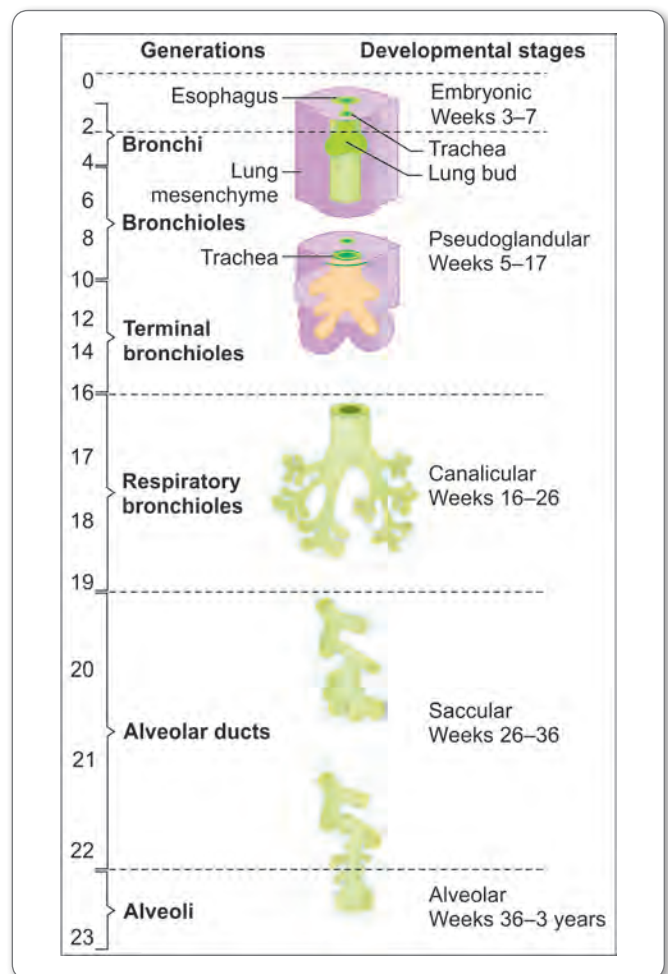


Fig. 23: Developmental stages of respiratory system



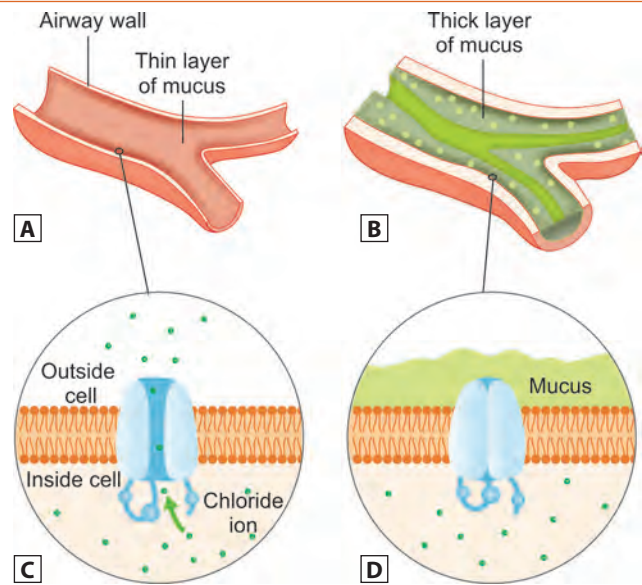
Clinical Aspect

Hyaline Membrane Disease

- Deficiency or absence of surfactant that is produced by type 2 pneumocytes
- Surfactant is the surface-acting agents that coats inside the alveoli to maintain alveolar patency
- Prevalent in premature infants, infants of diabetic mother, infants who experienced fetal asphyxia and multiple birth infants
- **Clinical features:** Dyspnea, tachypnea, cyanosis, nasal flaring and expiratory grunting.

Cystic fibrosis

- Autosomal recessive genetic disorder caused by mutations in cystic fibrosis transmembrane conductance (CFTR) gene
- Cystic fibrosis is due to three base pair deletion that code for phenylalanine
- Clinical features: Production of abnormally thick mucus by epithelial cells lining respiratory tract, resulting in obstruction of pulmonary airway, recurrent bacterial respiratory infections, pancreatic insufficiency with malabsorption, acute salt depletion, chronic metabolic alkalosis, males are sterile due to obstruction of vas deferens.



Figs 24A to D: (A) Cross section of normal airway; (B) Cross section of airway with cystic fibrosis; (C) Normal CFTR channel; (D) Mutant CFTR channel

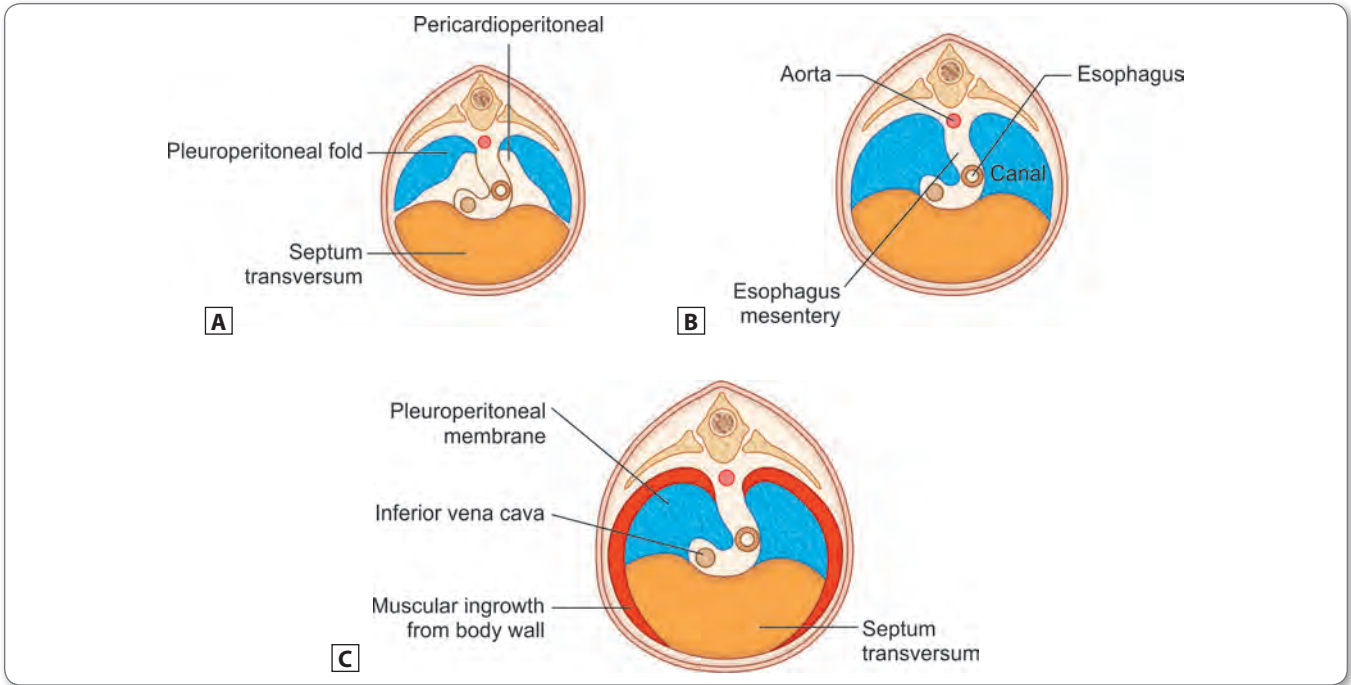
REMEMBER

Embryological structure	Adult derivative
Ductus arteriosus (connects pulmonary trunk and aorta)	Ligamentum arteriosum Ductus arteriosus closes immediately after birth Complete anatomical closure by 1–3 months
Ductus venosus (connects left branch of portal vein with left hepatic vein or inferior vena cava)	Ligamentum venosus
Left umbilical vein	Ligamentum teres of liver
Right umbilical vein	Disappears Gastroschisis develop at the site of regression of right umbilical vein
Proximal part of umbilical artery	Superior vesical artery
Distal part of umbilical artery	Medial umbilical ligament
Septum primum	Fossa ovalis
Septum secundum	Limbus fossa ovalis

DIAPHRAGM

It develops from four sources:

- **Septum transversum** forms central tendon. Septum transversum also contributes to liver formation
- **Pleuroperitoneal membrane:** Defective formation of this membrane results in the Bochdalek's hernia
- **Dorsal mesentery of esophagus** forms the crus
- **Body wall:** Cervical somites contribution.



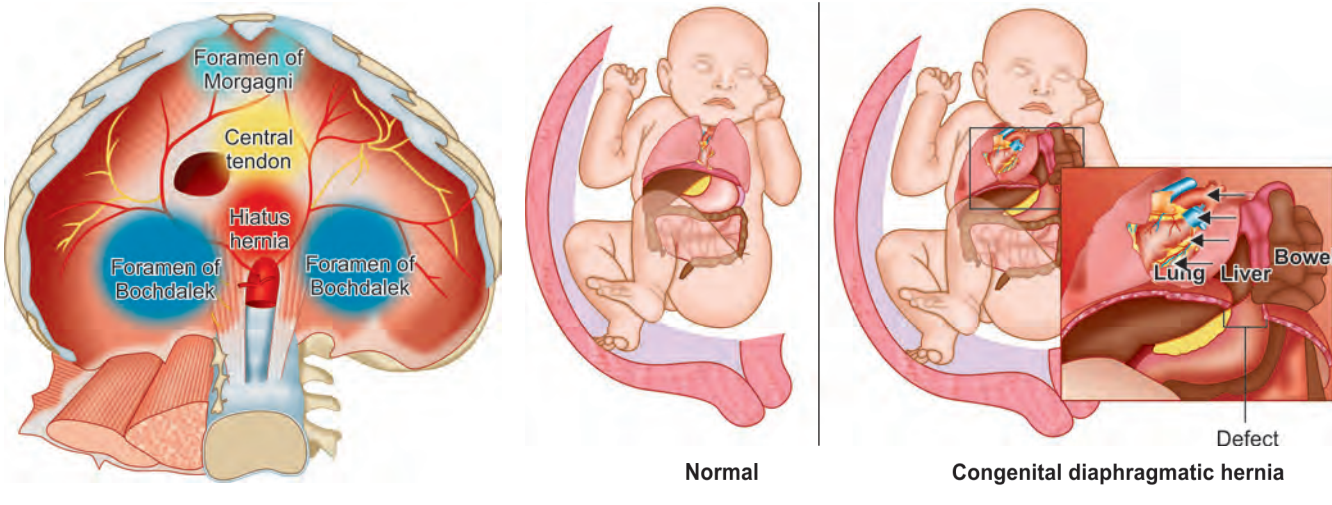
Figs 25A to C: Development of diaphragm



Clinical Aspect

Congenital Diaphragmatic Hernia

Bochdalek hernia	Morgagnian hernia
Most common congenital hernia	Not most common hernia
Due to defect in pleuroperitoneal membrane	Hernia through space of Morgagni (enlarged space of Larry)
Most common in Posterolateral position, left side	Most common in Retrosternal (anteromedial), right side
Symptomatic, requires immediate intervention Abdominal viscera herniate into thoracic cavity Shift the mediastinum to opposite side and cause collapse of lung on the same side	Asymptomatic Viscera enters the anterior mediastinum (space between sternum and pericardium)





OSTEOLOGY OF THORAX

- Consists of 12 pairs of bones that form the part of thoracic cage
- Increase the transverse and anteroposterior diameter of thorax

Structure

Ribs have head, neck, tubercle and body

- Head: Articulate with corresponding vertebral bodies and supra adjacent vertebral bodies
- Body: Thin and flat and turns sharply at the angle and has costal groove that lodges the intercostal vessels and nerves
- Tubercle articulates with transverse process of corresponding vertebra with exception of 11 and 12.

Classification

- True ribs: Joins with sternum 1 to 7
- False ribs: Joins with ribs not with sternum 8 to 12
- Typical: Share common feature 3 to 9
- Atypical ribs: 1, 2, 11 and 12
- 1st Rib: Atypical, shortest, widest and scalene tubercle present for the insertion of scalenus anterior muscle and two grooves for subclavian artery and vein.
- 7th Rib: The longest rib
- 9th rib: Most oblique
- Floating ribs: 11 and 12

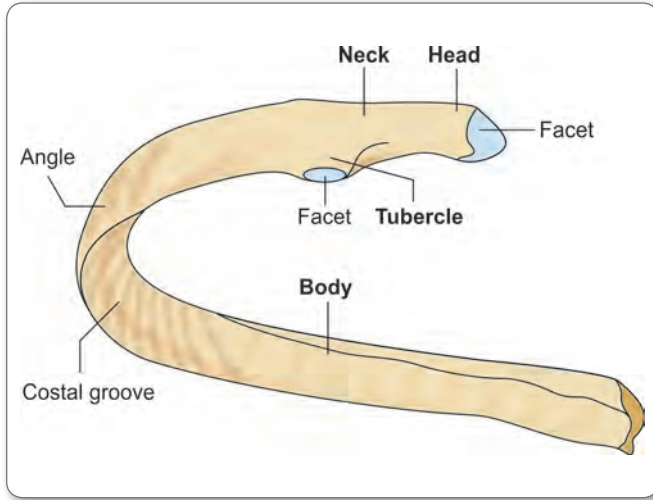


Fig. 26: Structure of rib

The under surface of the 1st rib is smoother. When the rib is laid on a flat surface, the head touches the flat surface when the rib is the correct way up

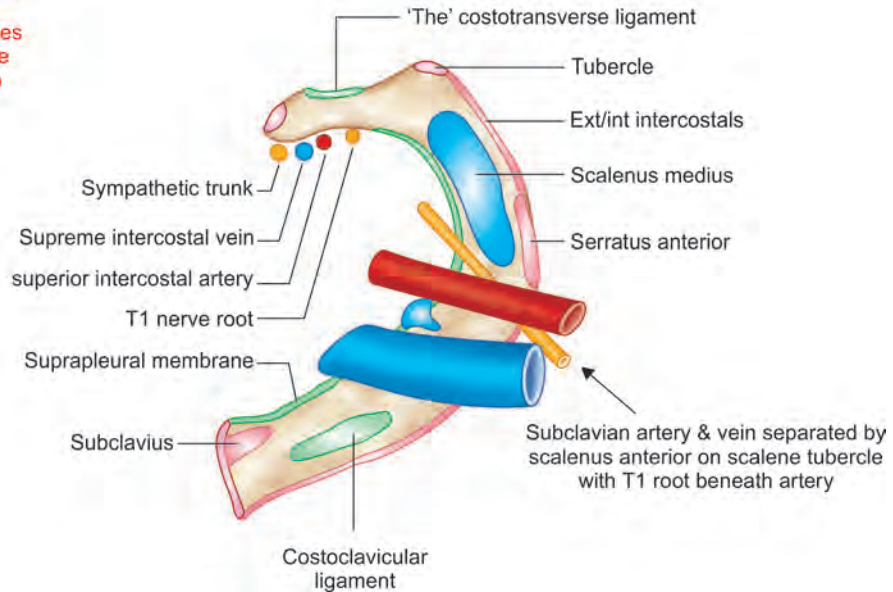


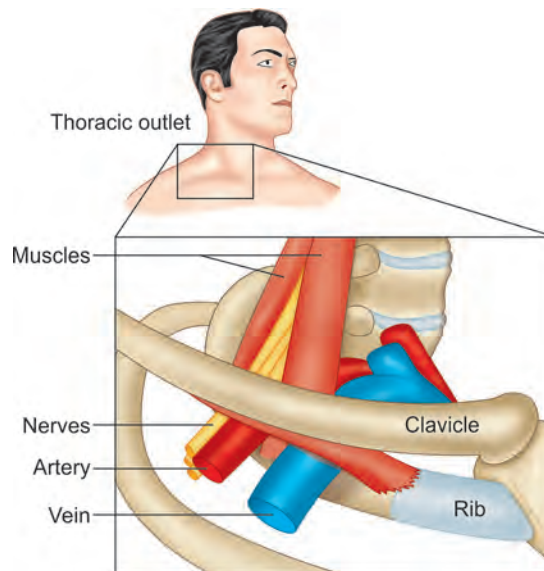
Fig. 27: First rib

- First rib – strongest, flat, most curved
- Between the neck of the rib and apex of the lung the following structures present from medial to lateral . sympathetic trunk, supreme intercostal vein, superior intercostal artery, T1 nerve – mn SVAN
- The arrangement of neurovascular structures from above downwards is intercostal nerve, intercostal artery and intercostal vein.



Clinical Aspect

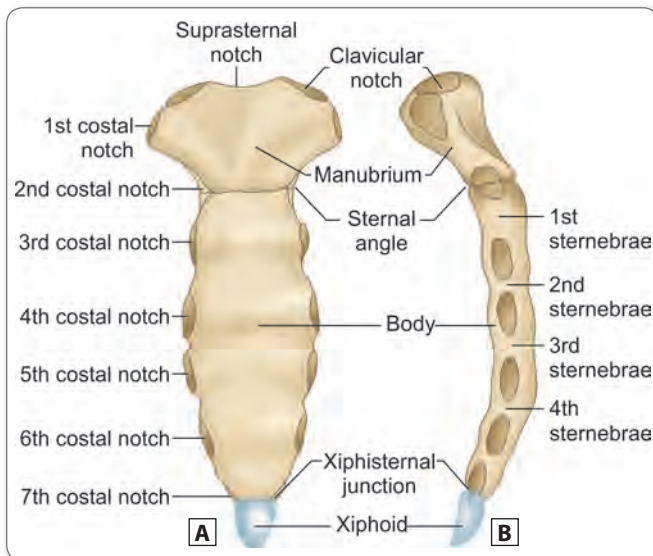
Thoracic Outlet Syndrome



- In the space between clavicle and first rib (thoracic outlet), neurovascular structures are compressed
- Cause pain, numbness in the upper limb due to compression of brachial plexus
- Ischemic muscle pain due to compression of subclavian artery
- **Cervical rib:** Cartilaginous elongation of transverse process of C7
- Cervical rib or abnormal insertion of anterior/middle scalene muscles are the common cause of thoracic outlet syndrome.

STERNUM

It has three parts—manubrium, body and xiphoid process



Figs 28A and B: Sternum. (A) Anterior view; (B) Lateral view

Manubrium

- Superior margin has jugular notch
- Clavicular notch for articulation of clavicle – sternoclavicular saddle, a type of synovial

- Articulate with first rib—primary cartilaginous joint
- Articulates with upper part of second rib—synovial variety
- Lower end articulates with body – manubriosternal joint – second cartilaginous joint—angle of Louis (vertebral level T4) which corresponds with 2nd costal cartilage.

Body

- Upper end articulates with manubrium—angle of Louis
- Lower end articulates with xiphoid process—second cartilaginous joint
- Lateral border with 2nd (lower half), 3, 4, 5, 6, 7th (upper half) ribs—synovial joint.

Xiphoid Process

- Tapering end of sternum.

REMEMBER

Features of Sternal Angle (Angle of Louis) – Vertebral Level T4

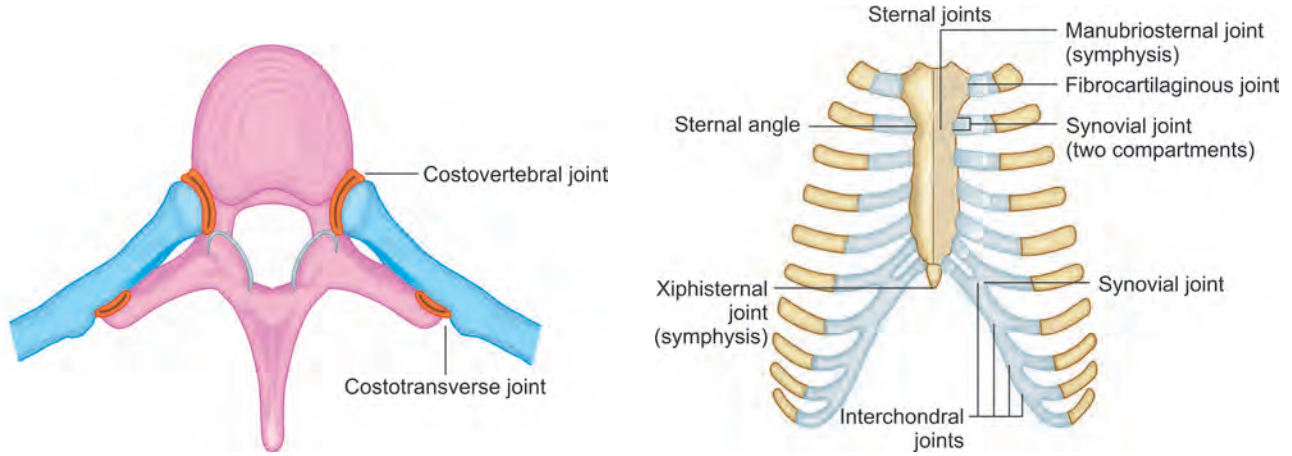
- Helps in counting ribs: Sternum articulates with 2nd costal cartilage
- Line of demarcation between the dermatomes C4 and T2
- Junction between superior and inferior mediastinum
- Beginning and ending of arch of aorta
- Thoracic duct deviates from right to left close to this level
- Superior vena cava pierces the fibrous pericardium
- Arch of azygos vein terminates
- Trachea bifurcation in cadaver at T4, but in living at T6



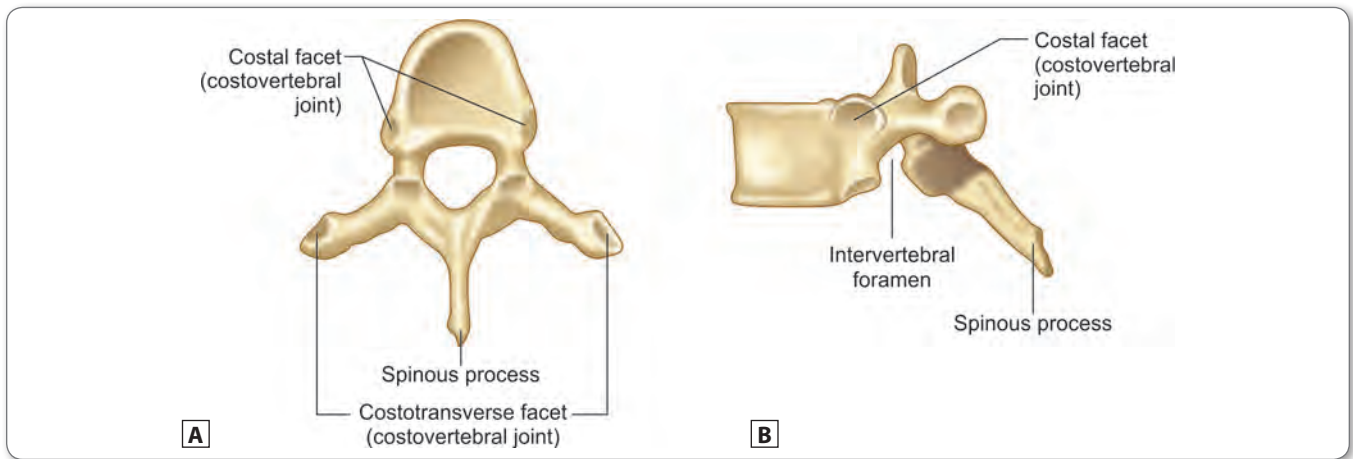
Joints in Thorax

- Manubrio sternal joint: Secondary cartilaginous
- Xiphisternal joint: Secondary cartilaginous
- Sternoclavicular: Saddle type of synovial
- 1st sternocostal joint: synarthrosis > primary cartilaginous joint
- Remaining sternocostal: Synovial joint
- Costochondral joints: Synchondrosis
- Inter chondral joint: Synovial type
- Head of the rib articulate with facet on the body of vertebra – costovertebral joint
- Tubercle of rib articulates with facet on the transverse process – costo transverse joint

Costovertebral joint and costotransverse joint: Plane type of synovial joint



THORACIC VERTEBRA



Figs 29A and B: Thoracic vertebra. (A) Axial (overhead view); (B) Lateral (side) view

- Main features: Costal demi facet
- Vertebral foramen: Small, circular and heart-shaped body
- No foramen transversarium
- Typical vertebrae: 2 to 8, share common features
- Atypical: 1, 9, 10, 11 and 12
- T3: Body small and T4 body typically heart-shaped
- T2: Corresponds with superior angle, T7 – inferior angle of scapula
- 5th to 8th thoracic spine are the longest and the most oblique
- Superior articular facet articulate with inferior articular facet – facet joint or zygapophyseal joint – synovial joint.

INTERCOSTAL SPACES

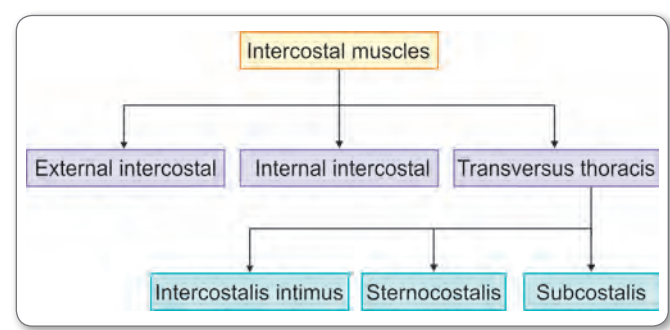
- 11 in number
- Typical – 3rd, 4th, 5th and 6th



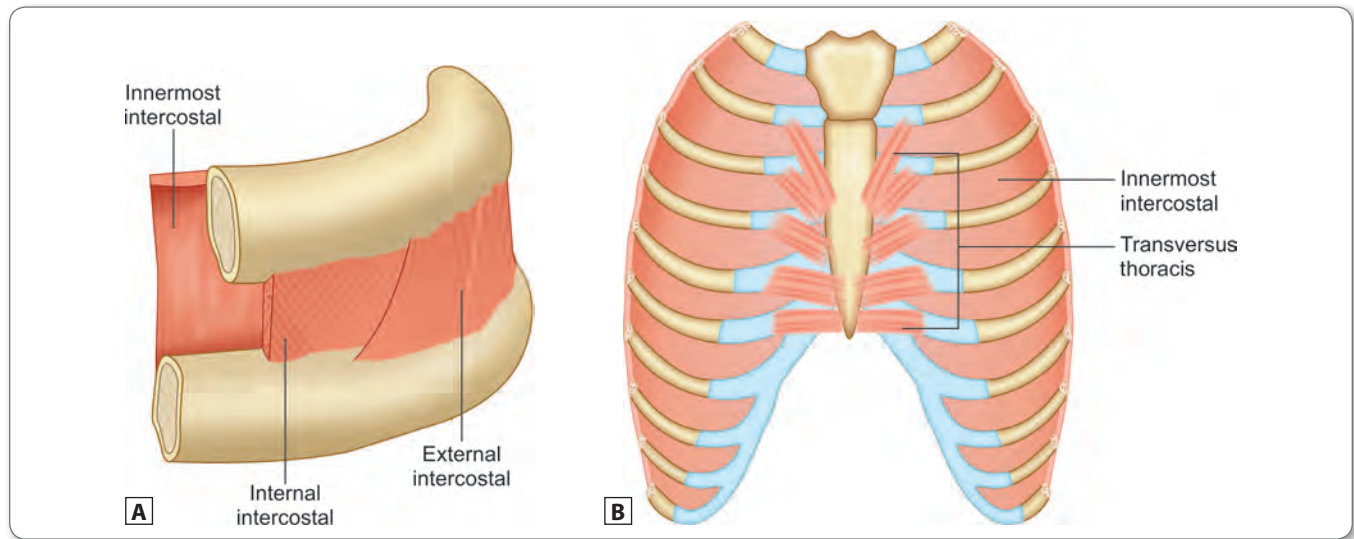
Boundaries

- Above-Sharp lower margin of rib; Below-Blunt upper margin of rib; In front – Lateral border of sternum; Behind-Bodies of thoracic vertebrae
- Contents: Intercostal muscles, nerves and vessels.
- Lower border of upper rib contains neurovascular structures and it is arranged in order—vein, artery and nerve from above downward.

INTERCOSTAL MUSCLES



- Arise from lower border of upper rib and inserted to upper border of lower rib
- Supplied by intercostal nerve.



Figs 30A and B: Intercostal muscles

Table 7: Intercostal muscles, their origin, insertion, nerve supply and action

Muscle	Origin	Insertion	Nerve supply	Action
External intercostal	Lower border of ribs	Upper border of lower rib	Intercostal nerve	Elevate the ribs in inspiration
Internal intercostal	Lower border of ribs	Upper border of lower rib	Intercostal nerve	Depress the rib and help in expiration
Innermost intercostal	Lower border of ribs	Upper border of lower rib	Intercostal nerve	Elevate the ribs
Transversus thoracis	Posterior surface of lower sternum And xiphoid	Inner surface of costal cartilage 2 or 3 below	Intercostal nerve	Depress the rib
Subcostalis	Inner surface of lower ribs near their angles	Upper border of ribs 2 or 3 below	Intercostal nerve	Elevate the ribs



RESPIRATORY MUSCLES

- Inspiration is active process and expiration is passive process.
- All the diameters of thoracic cavity increase during inspiration
- Vertical diameter increases by diaphragm
- Transverse and anteroposterior diameter increase by intercostal muscle
 - Transverse expansion: Bucket handle movement
 - Anteroposterior expansion: Pump handle movement

Inspiratory Muscles

Table 8: Inspiratory muscles, during quiet and forced breathing

During quiet breathing	(Accessory muscles) Forced breathing
Diaphragm External Intercostal muscles	Sternocleidomastoid Serratus anterior and posterior Scaleni Erector spinae Pectoralis major and minor (Mn – S3 EP)

Expiratory Muscles

Table 9: Structures involved during quiet and forced expiration

Quiet expiration	Forced expiration
Elastic recoiling of alveoli and thoracic wall	Abdominal muscles Latissimus dorsi Internal intercostal muscles (Mn – LIA)

Respiratory Movements

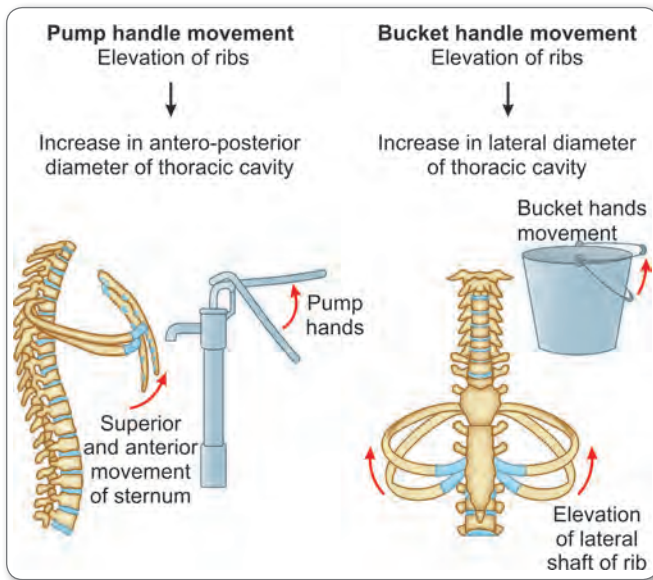


Fig. 31: B-movements of Ribs.

- Bucket handle movement – change the transverse diameter of thorax
- Pump handle movement – changes the AP diameter of thorax.

ARTERIAL AND VENOUS SUPPLY IN THORAX

Intercostal Arteries

Table 10: Intercostal arteries

Anterior	Posterior
Two in number	One in number
Arise from	Arise from
<ul style="list-style-type: none"> • 1 to 6 – Internal mammary artery • 7 to 9 – Musculophrenic artery 	<ul style="list-style-type: none"> • 1 and 2 – superior intercostal artery • 3 to 11 – descending thoracic aorta
Superior intercostal artery-branch of Costocervical branch of Costocervical trunk	

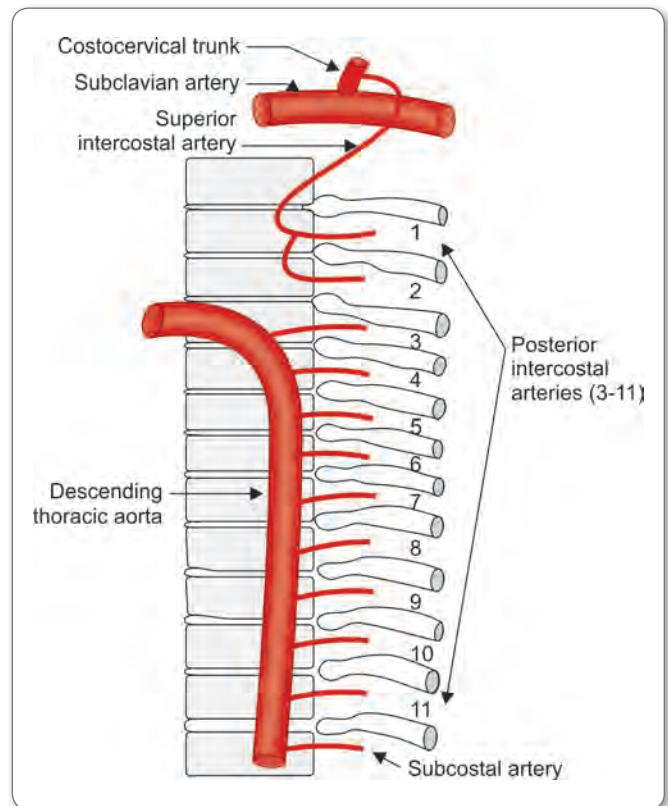


Fig. 32: Intercostal arteries

- Anterior intercostal arteries are absent in with 11th space.



Internal Thoracic Artery

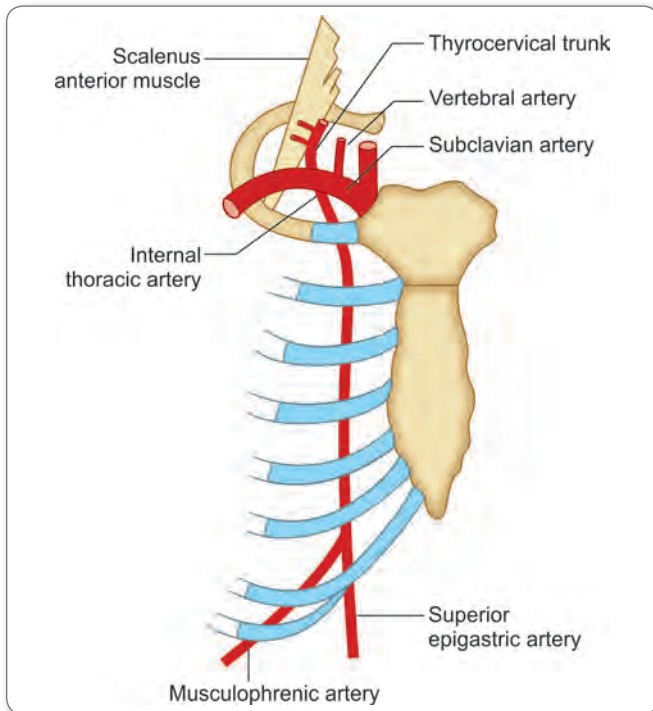


Fig. 33: Internal thoracic artery

- Branch of 1st part of subclavian artery 2 cm below the sternal end of clavicle
- Enters thorax, crossed by phrenic nerve from lateral to medial side.

Branches

- Gives anterior intercostal artery to upper 6 spaces
- Perforating arteries 2–4, supply blood to the mammary gland
- Pericardiophrenic artery – accompanies phrenic nerve between pleura and pericardium. Supplies blood to pleura, pericardium and diaphragm
- At the 6th intercostal space, it divides into musculophrenic artery and superior epigastric artery
- (☛Refer the Chart, Arterial tree) for further information on branches

Intercostal Veins

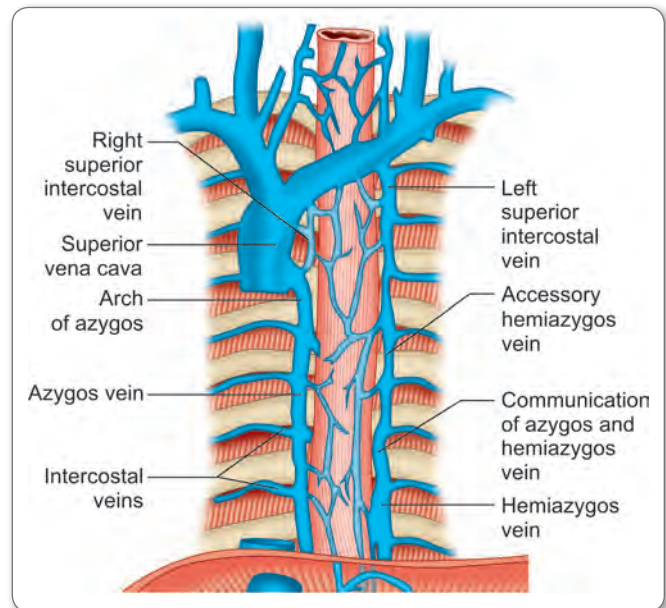


Fig. 34: Intercostal veins

Table 11: Intercostal veins

Anterior	Posterior	
Follow the arteries and drain into internal thoracic vein and musculophrenic vein	Right	Left
	<ul style="list-style-type: none"> • 1st highest right intercostal vein - drain to right brachiocephalic vein • 2, 3, 4– joins to form right superior intercostal vein which drains into arch of azygos • 5 to 11 – Azygos vein • Right subcostal vein drains into azygos 	<ul style="list-style-type: none"> • 1st – highest left intercostal vein drain to left brachiocephalic vein • 2, 3, 4 joins to form left superior intercostal vein which drains into to left brachiocephalic vein • 5 – 8 drain into – Superior hemiazygos • 9, 10,11 – Inferior hemiazygos vein • Left subcostal vein drain into inferior hemiazygos vein

COLLATERAL PATHWAY IN SVC AND IVC OBSTRUCTION

The SVC may be obstructed at two sites:

- Above the opening of azygos vein or
- Below the opening of azygos vein



In case of SVC obstruction above the opening of azygos vein

- The venous blood from the upper half of the body is shunted to right atrium through azygos vein
- The collateral channel is from subclavian vein to internal thoracic vein to anterior intercostal vein to posterior intercostal vein to azygos vein to SVC

In case SVC obstruction is below the opening of the azygos vein

- The venous blood from the upper half of the body is returned to the right atrium through collateral pathways, formed between the tributaries of superior and inferior vena cava
- The patient develops prominent subcutaneous anastomotic venous communications due to dilation of various anastomotic venous channels between upper and lower body. Few of them are shown below:
 - SVC → Azygos vein → lumbar azygos/ascending lumbar vein → IVC
 - SVC → Subclavian vein → internal thoracic vein → superior epigastric vein → iliac vein → IVC
 - SVC → Subclavian vein → axillary vein → lateral thoracic vein → thoracoepigastric vein → superficial epigastric vein → femoral vein → IVC
- In IVC obstruction also, the same anastomosing channels are dilated between IVC and SVC so that the blood could be returned to the right atrium

THORACIC SPINAL NERVE

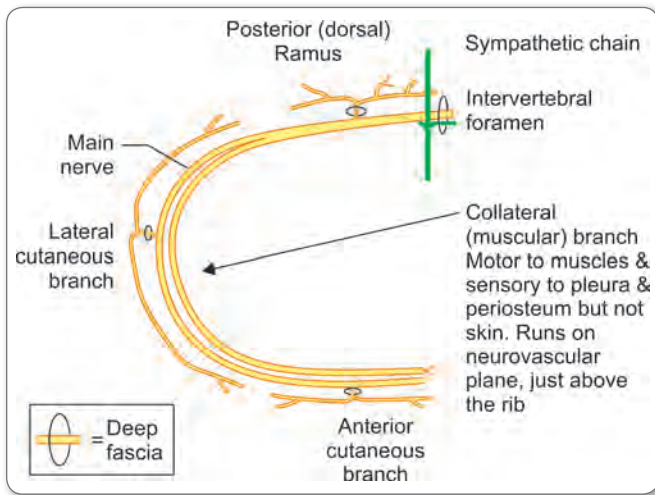


Fig. 35: Spinal nerve and Typical intercostal nerve

- There are 12 pairs of thoracic spinal nerve
- Ventral rami of first 11 thoracic spinal nerve is the intercostal nerve
- Ventral rami of T12 is the subcostal nerve.
- Intercostal nerve Lodged in costal groove and runs between internal and innermost costal muscles along with intercostal vessels
- Arrangements of the neurovascular structures in the costal groove from the above downwards—vein, artery and nerve

- Typical intercostal nerve – should supply only thoracic wall. T3 to T6 are typical intercostal nerve
- A typical intercostal nerve – T₁ contributes to brachial plexus, T₂ form Intercostobrachial nerve (which supply the skin of the floor of axilla and upper part of medial aspect of arm – source of referred cardiac pain), T₇ to T₁₁ supply anterior abdominal wall.

Clinical Aspect

Thoracotomy

Fig. 36: Pleural tapping

Thoracotomy the surgical procedure for getting pleural fluid. Needle is inserted in the upper border of lower rib, because of **neurovascular structures** present in the lower border of upper rib posterior to mid axillary line in the 7th or 8th or 9th intercostal spaces (not below the 9th intercostal space)

- While doing anterolateral thoracotomy following structures pierced:
 - Skin
 - Superficial fascia
 - Pectoralis major
 - Pectoralis minor
 - Serratus anterior
 - Intercostal muscle
 - Endothoracic fascia
 - Parietal pleura
- While doing posterolateral thoracotomy following structures are cut:
 - Skin
 - Superficial fascia
 - Latissimus dorsi
 - Serratus anterior
 - Rhomboids major
 - Intercostal muscle

Contd...



- Endothoracic fascia
- Parietal pleura
- Muscles pierced during pleural tapping in midaxillary line:
 - Skin
 - Superficial fascia
 - Serratus anterior
 - External intercostal muscle
 - Internal intercostal muscle
 - Innermost intercostal muscle
 - Endothoracic fascia
 - Parietal pleura

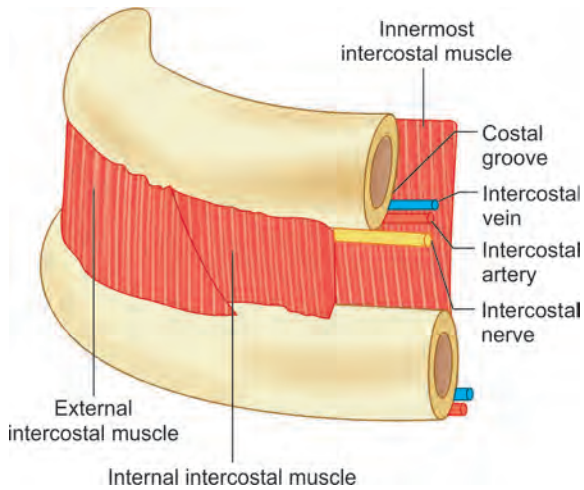


Fig. 37: Muscles pierced during pleural tapping

MEDIASTINUM

- Mobile septum present between right and left pleural sac
- Bounded laterally by pleural cavity, anteriorly sternum and posteriorly vertebral column
- Consists of superior mediastinum (situated above the pericardium) and inferior mediastinum (situated below the pericardium) which has three lower sub-divisions— anterior, middle and posterior.

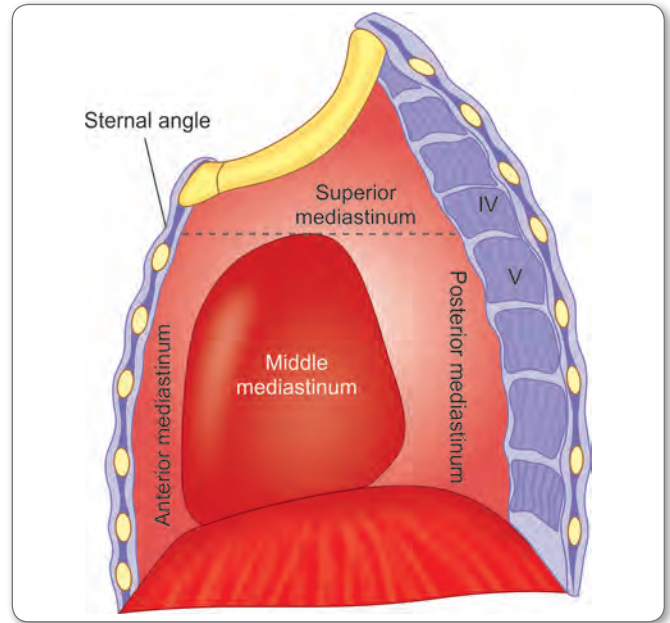
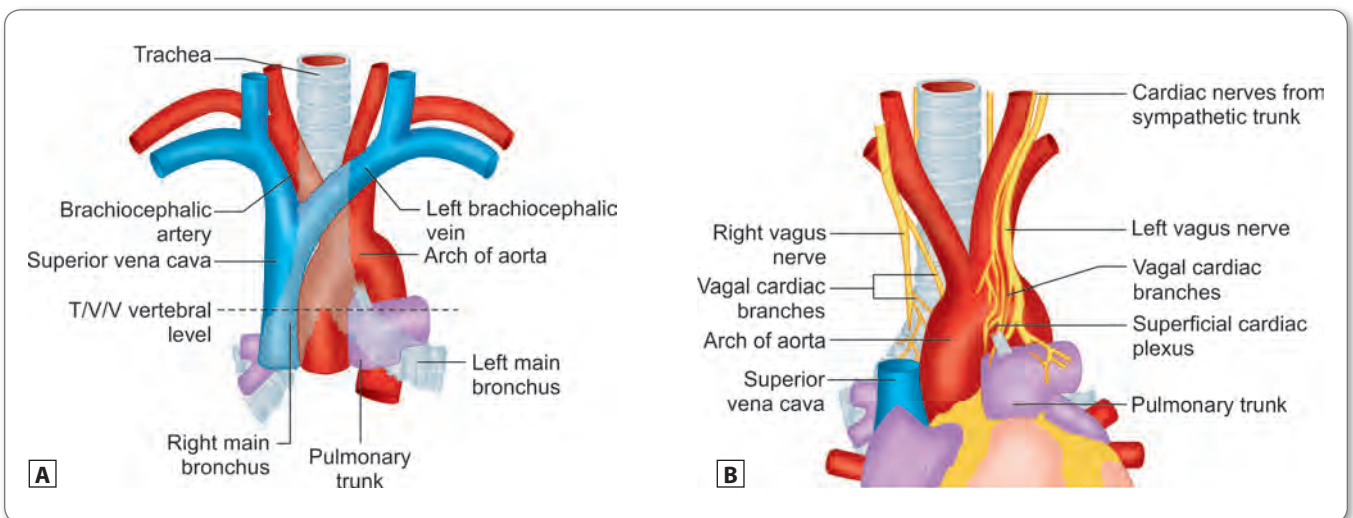


Fig. 38: Boundaries of mediastinum



Figs 39A and B: Contents of superior mediastinum

SUPERIOR MEDIASTINUM

Boundaries

- Above: Oblique plane of first rib
- Below: Imaginary line from sternal angle to T4
- Details are given in Table 12.

ANTERIOR MEDIASTINUM

Lies behind sternum and in front of pericardium.

MIDDLE MEDIASTINUM

Lies between the right and left pleural cavities.



POSTERIOR MEDIASTINUM

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THORAX

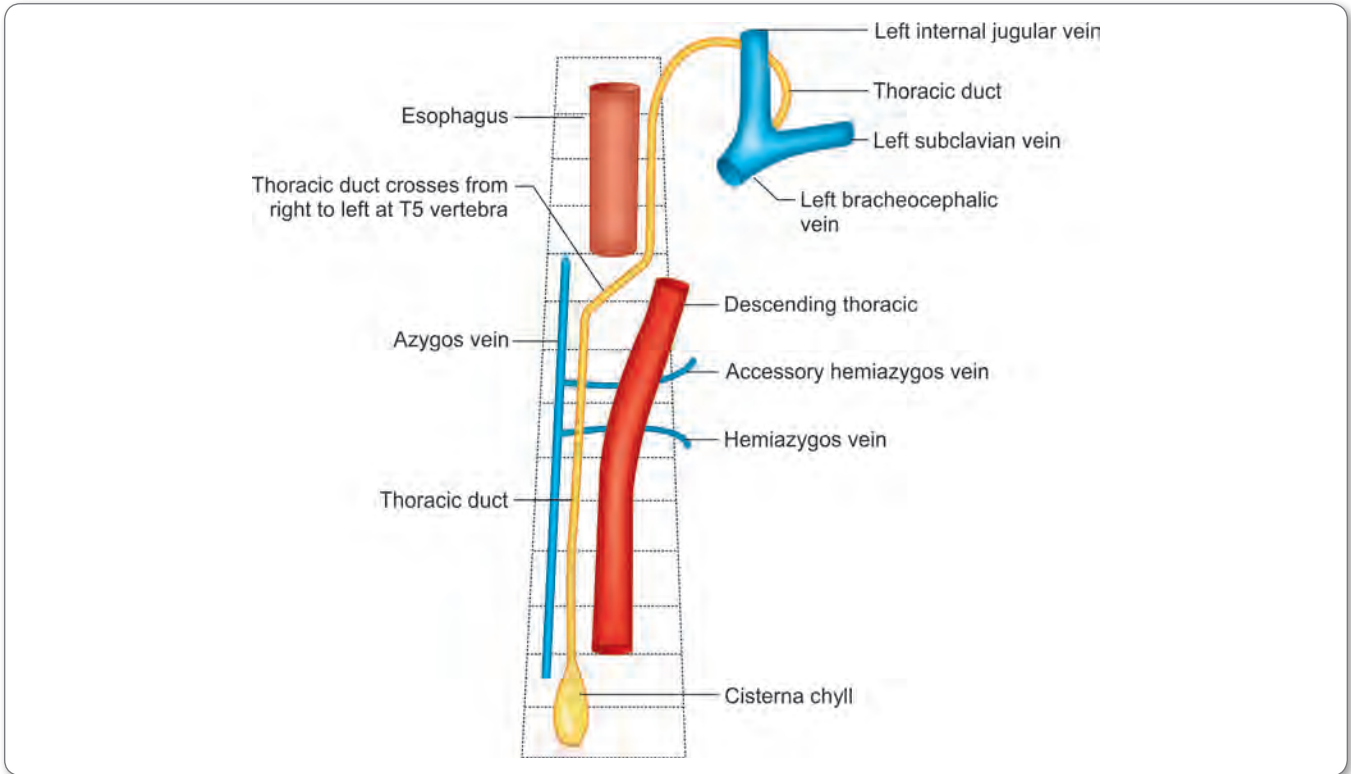


Fig. 40: Posterior mediastinum

- Lies posterior to pericardium.

Table 12: Contents of mediastinum

Superior mediastinum	Inferior mediastinum		
	Anterior mediastinum	Middle mediastinum	Posterior mediastinum
<ul style="list-style-type: none"> • Retrosternal • Sternohyoid, Sternothyroid • Thymus • Brachiocephalic veins and superior vena cava • Intermediate • Arch of aorta and its branches <ul style="list-style-type: none"> ▪ Brachiocephalic trunk ▪ Left common carotid ▪ Left subclavian • Vagus, phrenic • Prevertebral • Trachea • Esophagus • Left recurrent laryngeal nerve • Thoracic duct 	<ul style="list-style-type: none"> • Sternopericardial ligaments • Retrosternal lymph nodes 	<ul style="list-style-type: none"> • Pericardium and heart • Ascending aorta and pulmonary trunk • Four pulmonary veins • Lower half of SVC and arch of azygos • Bifurcation of trachea and deep cardiac plexus • Phrenic nerve and Pericardiophrenic vessels 	<ul style="list-style-type: none"> • (Mn DATES - vp) • Descending aorta • Azygos vein and hemiazygos vein • Thoracic duct • Esophagus • Splanchnic nerves • Vagus nerve • Posterior intercostal vessels, Termination of Sup and inferior hemiazygos vein



PLEURA AND LUNGS

PLEURA

- Pleura: Closed serous sac invaginates lung from medial side and consists of parietal and visceral pleura
- Visceral pleura (developed from splanchnopleuric mesoderm) intimately covers lung and parietal pleura (developed from somatopleuric mesoderm)
- Parietal pleura: Lines the inner surface of the thoracic wall (named according to structures it lines):
 - Costal pleura
 - Diaphragmatic pleura
 - Cervical pleura
 - Mediastinal pleura

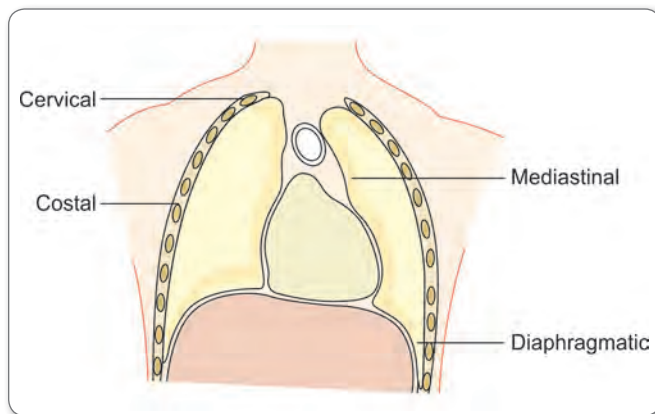


Fig. 41: Pleura

- Cervical pleura: Dome of the pleura. It is projecting into the neck above the neck of the first rib
- It is reinforced by Sibson's fascia, which is thickening portion of endothoracic fascia.

SIBSON'S FASCIA – SUPRAPLEURAL MEMBRANE

- Dome shaped musculofascial expansion, which protects the apex of lung and cervical pleura
- Muscular part is derived from scalenus minimus and fascial part is derived from endothoracic fascia
- **Attachments: In front**-Internal border of first rib and its costal cartilage behind transverse process of C 7. Continuous medially with pretracheal fascia by side of trachea.

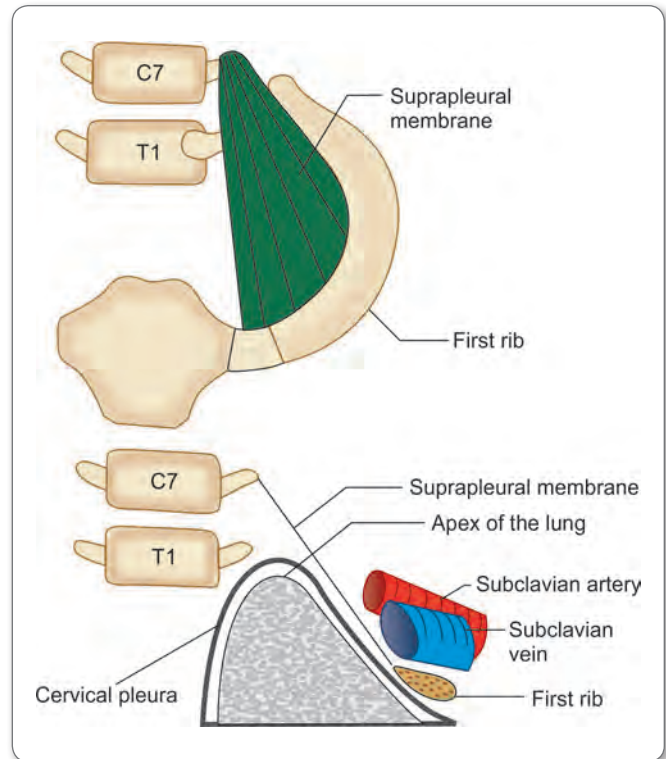


Fig. 42: Relations of suprapleural membrane

Note:

- Pulmonary ligament: Bilaminar fold of mediastinal pleura extends along the mediastinal surface of lung from hilum to base.

Table 13: Differences between the parietal and visceral pleurae

Parietal pleura	Visceral pleura
Lines the thoracic wall and mediastinum	Lines the surface of the lung
Develops from the somatopleuric mesoderm	Develops from the splanchnopleuric
Innervated by the somatic nerves. Sensitive to pain	Innervated by the autonomic nerves. Insensitive to pain
Blood supply and lymphatic drainage is same as that of thoracic wall	Blood supply and lymphatic drainage is same as that of the lung



Pleural Reflections

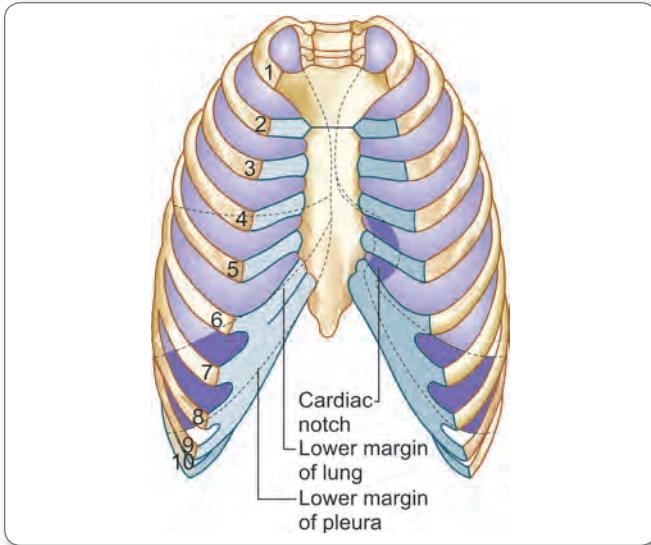


Fig. 43: Pleural reflections

Table 14: Costodiaphragmatic line of pleural reflection

	Midclavicular line	Midaxillary line	Lateral to T12
Lungs	6 th rib	8 th rib	10 th rib
Costodiaphragmatic Pleural line	8 th rib	10 th rib	12 th rib

Table 15: Costomediastinal Line of Reflection

Right side	Left side
From	From
Sternoclavicular joint	Sternoclavicular joint
Line of reflection Up to xiphisternal joint	Line of reflection Up to 4 th rib then deviates 2 to 1.5 cm laterally and reach 6 th sternochondral joint

- Potential space between parietal and visceral pleura
- Contains fluid that lubricates the surface of pleura and facilitates the movement of lungs
- Two recess are found – Costodiaphragmatic and Costomediastinal recess
 - Costodiaphragmatic recess
 - Pleural recesses formed by reflections of costal and diaphragmatic pleura
 - Allow the lungs to expand in downward
 - Costomediastinal recess
 - Pleural cavity where the costal and mediastinal pleura meet.

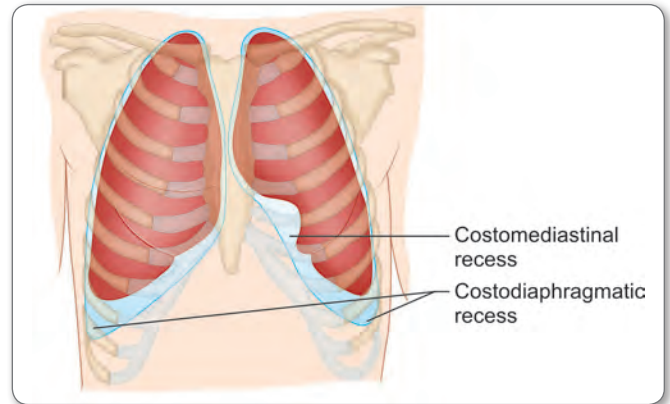


Fig. 45: Costodiaphragmatic and Costomediastinal recess

Table 16: Comparative study of Costodiaphragmatic and Costomediastinal recess

Costodiaphragmatic recess	Costomediastinal recess
<ul style="list-style-type: none"> • Situated inferiorly • Situated between costal and diaphragmatic pleura • It is the most dependent recess, if there is pleural effusion, it is the first part to get filled 	<ul style="list-style-type: none"> • Situated anteriorly • Situated between costal and mediastinal pleura • During inspiration, anterior border of both lungs expand and enter the left and right Costomediastinal recess

Pleural Cavity

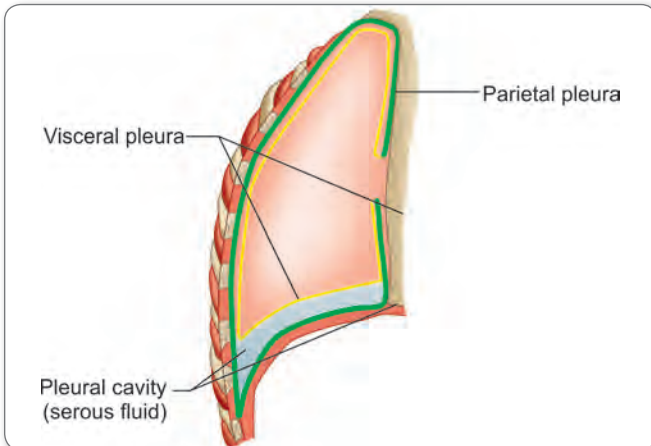


Fig. 44: Pleural membranes

NERVE SUPPLY

Table 17: Nerve supply of parietal and pulmonary pleura

Parietal pleura	Pulmonary pleura
<ul style="list-style-type: none"> • Sensitive to pain • Costal pleura and peripheral margins of diaphragmatic pleura supplied by intercostal nerve and mediastinal and central part of diaphragmatic pleura supplied by phrenic nerve 	<ul style="list-style-type: none"> • Insensitive to pain • Supplied by autonomic system Sympathetic: T2 – T5 • Parasympathetic – vagus



SURFACE MARKING OF PLEURA

The reflection of parietal pleura can be marked on the surface by the following lines:

Cervical Pleura

- It is marked by a curved line (with convexity directed upwards) drawn from sternoclavicular joint to the junction of medial third and middle third of the clavicle.
- The summit of dome of pleura lies 1 inch (2.5) above the medial one-third of the clavicle.

Anterior (Costomediastinal) Line of Pleural Reflection

On the right side, it extends downwards and medially from the right sternoclavicular joint descends vertically up to the midpoint of the xiphisternal joint.

On the left side, it extends downwards and medially from the left sternoclavicular joint descends vertically only up to the level of the 4th costal cartilage.

It then arches outwards **2 to 1.5 cm laterally and reach 6th sternochondral joint**

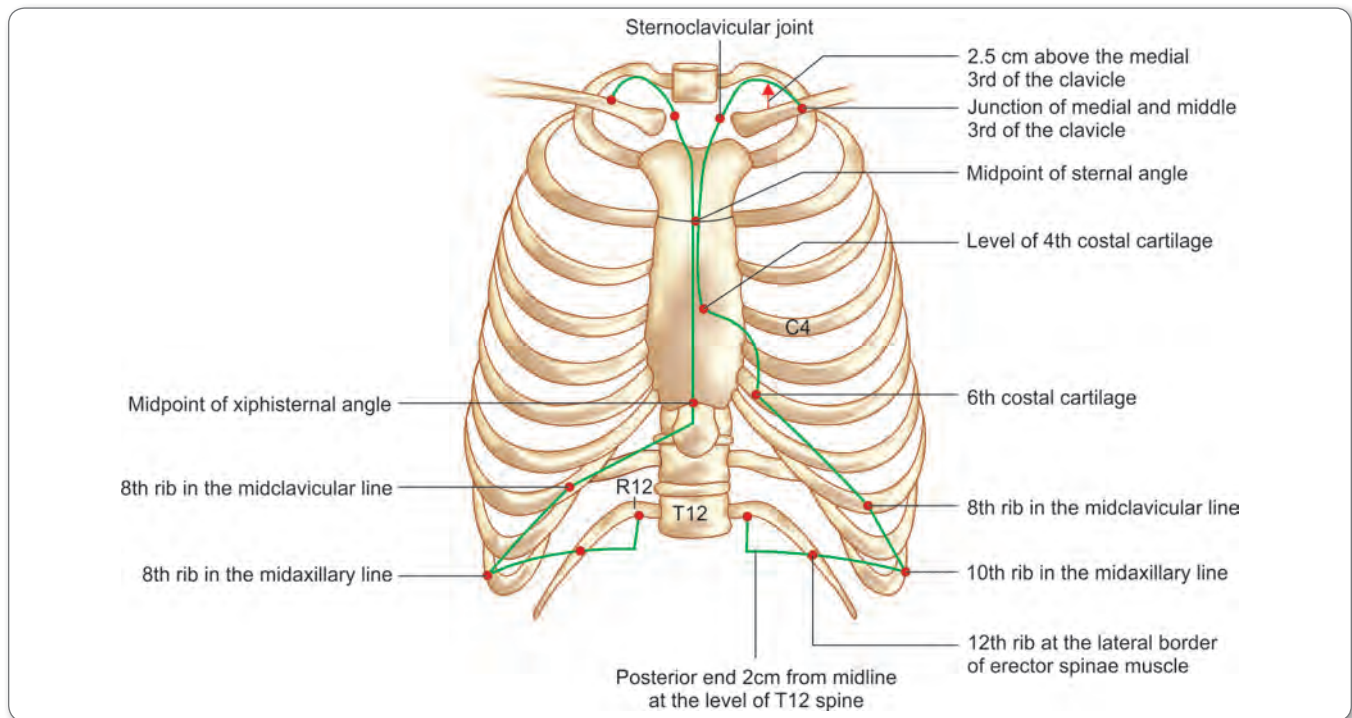


Fig. 46: Schematic diagram showing lines of pleural reflection

Inferior (Costodiaphragmatic) Line of Pleural Reflection

- On the right side, the line of reflection starts from the xiphisternal joint crosses the 8th rib in the midclavicular line, 10th rib in the midaxillary line, and 12th rib at the scapular line
- On the left side, the line of reflection starts at the level of the 6th costal cartilage thereafter it follows the same course as on the right side.

Posterior (Costovertebral) Line of Pleural Reflection

It ascends from the end of the inferior line, 2 cm lateral to the T12 spine along the vertebral column to the point 2 cm lateral to the spine of C7 vertebra. The costal pleura becomes mediastinal pleura along this line.

Note

The ribs crossed by inferior margin of the lung and pleura in midclavicular line, midaxillary line, and scapular line:

- Inferior margin of lung: 6th rib, 8th rib, and 10th rib
- Inferior margin of pleura: 8th rib, 10th rib, and 12th rib

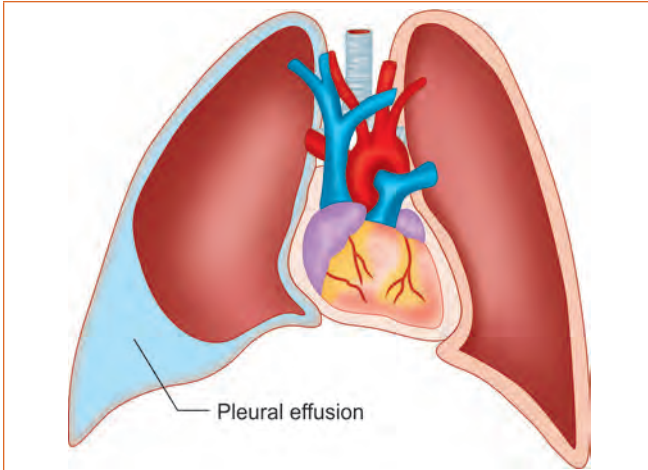


Clinical Aspect

Some clinical conditions associated with the pleura are as follows:

- **Pleurisy:** This is inflammation of the pleura. It may be dry, but often it is accompanied by collection of fluid in the pleural cavity. The condition is called pleural effusion. Dry pleurisy is more painful because during inspiration both layers come in contact and there is friction. This roughening produces friction and pleural rub can be heard with stethoscope
- **Pneumothorax:** Presence of air in the pleural cavity.
- **Hemothorax:** Presence of blood in the pleural cavity.
- **Hydropneumothorax:** Presence of both fluid and air in the pleural cavity.
- **Empyema:** Presence of pus in pleural cavity.
- **Pleural effusion:** Abnormal accumulation of excess fluid in the pleural space. There are two types of effusion transudate and exudate.

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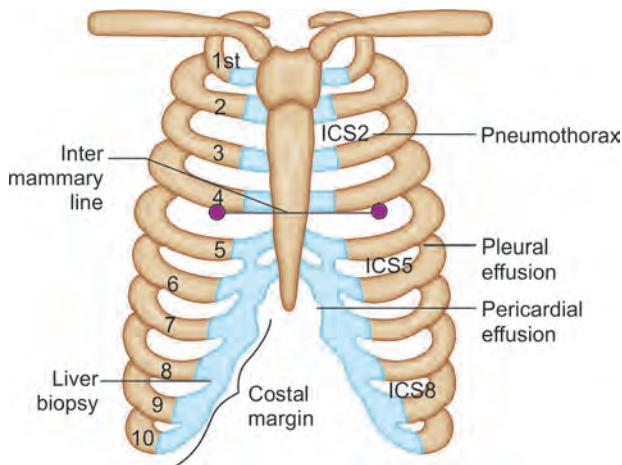


Pleural effusion

Transudate: Clear water fluid and caused by congestive heart failure, less commonly seen in kidney or liver disease.

Exudate: Viscous fluid – caused by inflammation, pneumonia, TB, etc.

- Pleural tap: Surgical puncture of thoracic wall into pleural cavity for aspiration of fluid.
 - Performed at or posterior to midaxillary line.
 - Ideal site is 7th, 8th or 9th intercostal space
 - Needle is inserted immediately above the superior margin of rib to avoid injury to intercostal neurovascular structures.



Ideal sites of intercostal spaces for different procedures

LUNGS

Essential organ of respiration attach to trachea and heart by lung root.

Table 18: Differences between right and left lungs

Right lung	Left lung
Shorter and wider	Long and narrower
Three lobes separated by two fissures	Two lobes separated by one fissure
Base more concave	Base shallow
Absence of cardiac notch	Presence of cardiac notch
Arrangement at hilum from above downward	Arrangement at hilum from above downwards
Eparterial bronchus	Pulmonary artery
Pulmonary artery	Main bronchus
Main bronchus	Lower pulmonary vein
Lower pulmonary vein	
Cardiac impression shallow	Cardiac impression deep
Absence of lingula	Presence of lingula
Supplied by one bronchial artery	Supplied by two bronchial arteries
Presence of ten bronchopulmonary segments	Presence of ten segments, but medial basal segment is suppressed.

HIGH YIELD POINTS

Bronchial artery arises from descending thoracic aorta. Sometimes right bronchial artery arises from third right posterior intercostal artery.

Apex of the Lung

- Part of lung 2.5 cm above the clavicle
- Relations
 - Anterior: Subclavian vessels
 - Posterior: Sympathetic trunk, first posterior intercostal vein, superior intercostals artery and neck of first rib.

Base

Rest on diaphragm, on right side related to right lobe of liver, left side with left lobe of liver, fundus of stomach and spleen.

Borders

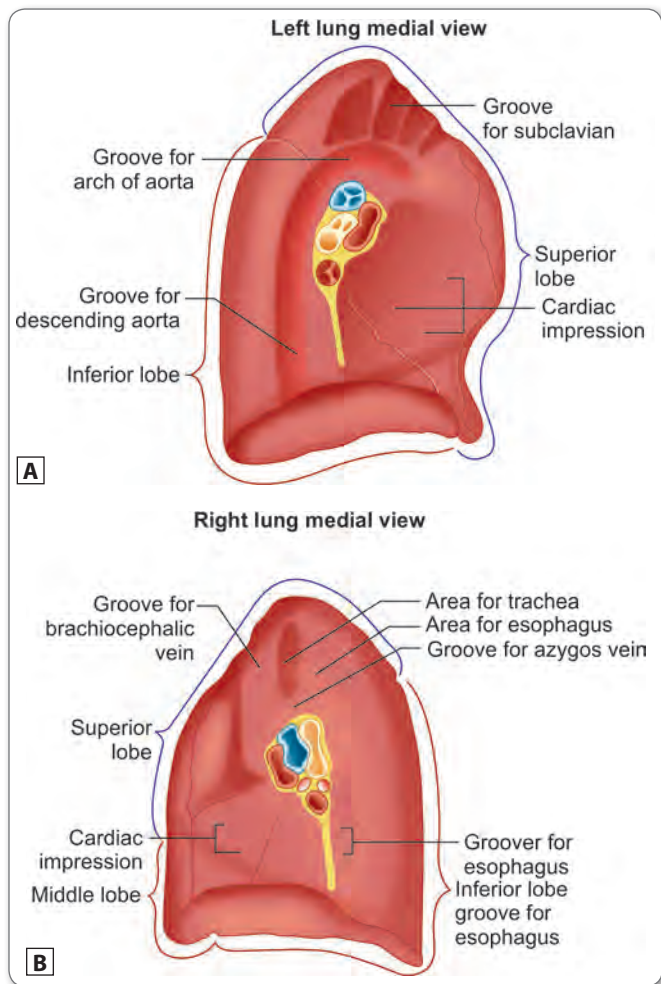
- Anterior border: Sharp (on left side it shows cardiac notch)
- Posterior border is thick and ill defined
- Inferior border: Separates diaphragmatic surface from costal surface and mediastinal surface.

Surface

- Costal surface: Convex and related to ribs.



Structures Related to Mediastinal Surface of Right and Left Lungs



Figs 47A and B: Structures related to mediastinal surface of right and left lungs

Table 19: Structures related to medial surfaces of right and left lung

Right lung	Left lung
<ul style="list-style-type: none"> • Cardiac impressions • Right atrium, right auricle and right ventricle • Superior and inferior vena cava, brachiocephalic vein • Hilum is arched by azygos vein • Trachea and esophagus • Phrenic and vagus nerve 	<ul style="list-style-type: none"> • Cardiac impressions • Left atrium, left auricle, left ventricle and right ventricle • Descending thoracic aorta, pulmonary artery, brachiocephalic vein, left subclavian artery • Hilum is arched by arch of aorta • Esophagus • Phrenic and vagus nerve, thoracic duct and recurrent laryngeal nerve

Fissures

- In right lung, oblique and horizontal fissures present, by which right lung divided into three lobes
- In left lung only one oblique fissure and divided into two lobes
- Oblique fissure from mediastinal surface above and behind the hilum and cuts posterior border of lung 2.5 cm lateral to T4 and then cuts inferior border 7.5 cm lateral to midline at 6th costochondral junction
- Surface marking 2 cm lateral to T3, another point on 5th rib in midaxillary line, last point on 6th costal cartilage 7.5 cm lateral to median line
- Horizontal fissure: **Only in right lung.** Extends horizontally from oblique fissure at midaxillary line up to 4th costal cartilage.
- Point on the fourth costal cartilage on the anterior border of right lung and 2nd point on 5th rib in midaxillary line.

Azygos Lobes of the Lung

- Upper azygos: Situated above the hilum
- Lower azygos: Situated below the hilum
- Lobe of azygos vein: Apex of right lung split into medial and lateral part. The medial part of split apex forms the lobe of azygos vein.

Blood Supply of Lung

Pulmonary Trunk

- Carries deoxygenated blood from right ventricle to lungs for oxygenation
- Pressure inside lungs is less than that of aorta and it is present in the fibrous pericardium
- Left pulmonary artery
 - Carries deoxygenated blood to left lung
 - Shorter and narrower than right pulmonary artery
 - Connected to arch of aorta by ligamentum arteriosum (remnant of ductus arteriosus)
- Right pulmonary artery
 - Runs horizontally toward right lung under arch of aorta behind ascending aorta
- Bronchial arteries
 - Arise from thoracic aorta
 - Sometimes right bronchial artery arises from third right posterior intercostal artery.
 - One for right lung and two for left lung
 - Conducting part up to the beginning of respiratory bronchioles is supplied by bronchial artery
 - Respiratory part distal to respiratory bronchioles (alveolar duct, air sacs, atrium) supplied by pulmonary artery.

Venous Drainage

Pulmonary Veins

- Pulmonary veins not accompanying bronchi and segmental artery within the parenchyma of lung
- Leaves the lung as five pulmonary vein one from each lobe. Right upper and middle join together and form four pulmonary vein enter left atrium.



Bronchial Vein

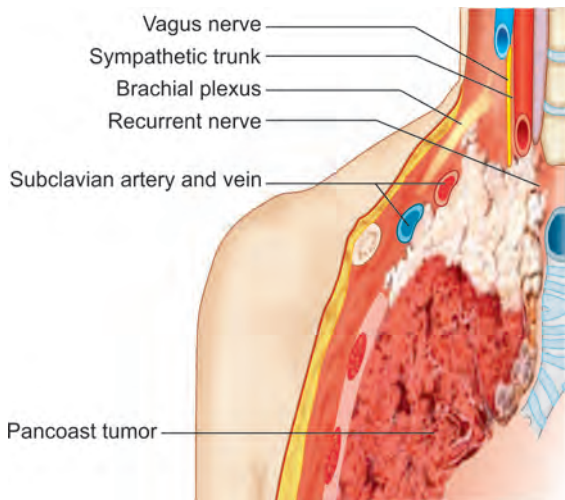
- Consists of superficial vein and deep vein

Table 20: Blood drain through superficial and deep veins

Superficial bronchial vein	Deep bronchial vein
<ul style="list-style-type: none"> • Drain pulmonary pleura and extra pulmonary bronchus 	<ul style="list-style-type: none"> • Drain intrapulmonary bronchial tree and parenchyma of lung
<ul style="list-style-type: none"> • Right side drain into arch of azygos vein Left side drain into left superior intercostal vein of superior hemiazygos vein 	<ul style="list-style-type: none"> • Drain into pulmonary vein

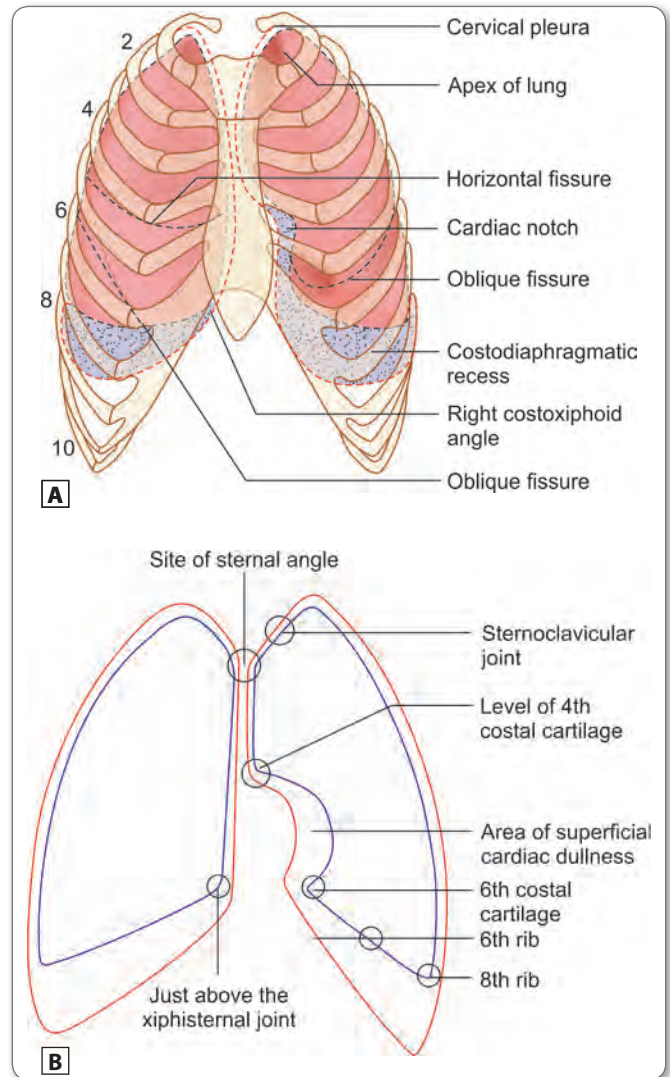
Clinical Aspect

- Tuberculosis of lung is one of the most common diseases. A complete course of treatment must be taken under the guidance of a physician.
- *Bronchial asthma* is a common disease of respiratory system. It occurs due to bronchospasm of smooth muscles in the wall of bronchioles. Patient has difficulty especially during expiration. It is accompanied by wheezing. Epinephrine, a sympathomimetic drug, relieves the symptoms.
- *Pulmonary embolism*
 - Obstruction of **pulmonary artery** or one of its branches by embolus which arise from deep veins of lower limb or pelvic veins or occurs after surgery
 - *Symptoms: Sudden onset of dyspnoea, anxiety and substernal chest pain*
- *Pancoast tumor*



- Malignant neoplasm of lung apex
- Lower trunk brachial plexus injury and lesion of cervical sympathetic chain (Horner's syndrome)

SURFACE MARKINGS OF LUNG



Figs 48A and B: Surface markings of Lung

- **Margins:** The lung margins approximately coincide with those of the pleura (see page 241), except at the following points:
 - **Lower border:** The lower border of each lung (i) 6th rib in the midclavicular line, (ii) 8th rib in the midaxillary line, and (iii) 10th rib at the scapular line
 - **Anterior border:** The anterior border of the left lung has a distinct notch (the cardiac notch), which passes laterally behind the 4th and 5th intercostal spaces.
 - **Posterior border:** Its lower end ends at the level of spine of T10 vertebra.
- **Fissures**
 - The oblique fissure is marked by a line drawn obliquely downwards and outwards from 1 inch (2.5 cm) lateral to the T5 spine to the 6th costal cartilage about 1½ inches (4 cm) from the midline.
 - The transverse fissure is marked by a line drawn horizontally along the 4th costal cartilage, and meets the oblique fissure where the latter crosses the 5th rib.



Trachea

- Trachea bifurcates at T4 in the cadaver
- Trachea bifurcates at T6 in the living, and descends further on inspiration.

Measurements

- Length: 10–15 cm
- Diameter: 2 cm in male, 1.5 cm in female
- 15–20 rings in trachea, first is the broadest and last ring is called carina and situated at tracheal bifurcation
- Compressed by aortic arch aneurysm, goiter or thyroid tumors causing dyspnea

Blood Supply

- Arterial supply: Inferior thyroid artery
- Drained by left brachiocephalic vein
- Nerve supply: Sensory and motor supply by parasympathetic system through vagus and recurrent laryngeal nerve.

Clinical Aspect

Carina (Latin *keel*) of the trachea is a sensitive area. When patient is made to lie on her/his left side, secretions from right bronchial tree flow toward the carina due to effect of gravity. This stimulates the cough reflex, and sputum is brought out. This is called *postural drainage*.

Bronchus

Table 21: Right and left bronchi

Right bronchus	Left bronchus
<ul style="list-style-type: none"> • Shorter and wider • Right bronchus is more vertical line with trachea. So the foreign material lodged in right lung mostly • Divides into 3 secondary (lobar) bronchus 	<ul style="list-style-type: none"> • Narrower and longer • Left bronchus makes 45° with median plane. It crosses in front of esophagus producing a slight constriction. • Divides into 2 secondary (lobar) bronchus

Clinical Aspect

COPD
Group of lung diseases associated with chronic obstruction of airflow through the airways and lungs—chronic obstructive pulmonary disease (OPD)

Chronic Bronchitis

- Inflammation of airways results in excessive mucus production that obstruct the airway

Emphysema

- Accumulation of air in the terminal bronchiole and alveolar sac due to destruction of the alveolar walls

Contd...

Asthma

- Chronic inflammation of bronchi that cause swelling and narrowing of the airway

Bronchiectasis

- Chronic dilatations of bronchi and bronchioles resulting from destruction of bronchial elastic and muscular elements which may cause collapse of bronchioles.

Bronchial Tree

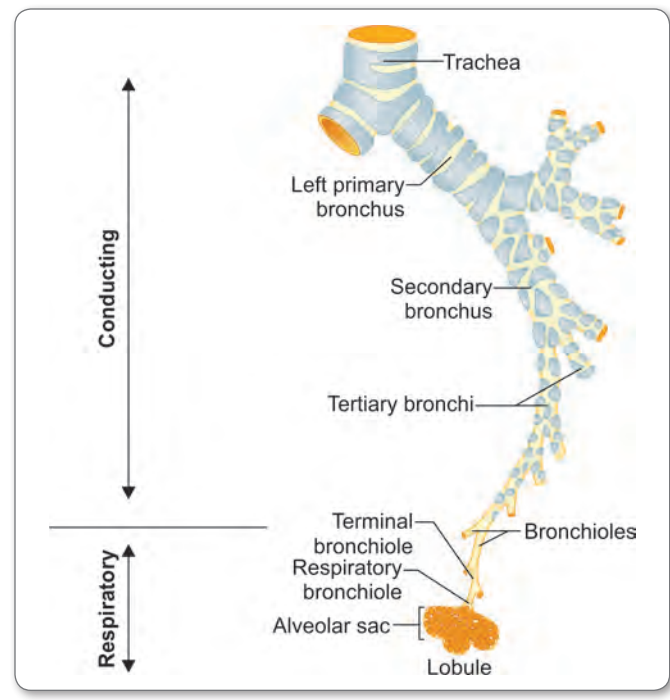


Fig. 49: Bronchial tree

- Trachea → Principle bronchi → Lobar bronchi → Segmental bronchi → Terminal bronchiole → Respiratory bronchiole → Alveolar duct → Atria → Alveolar sac

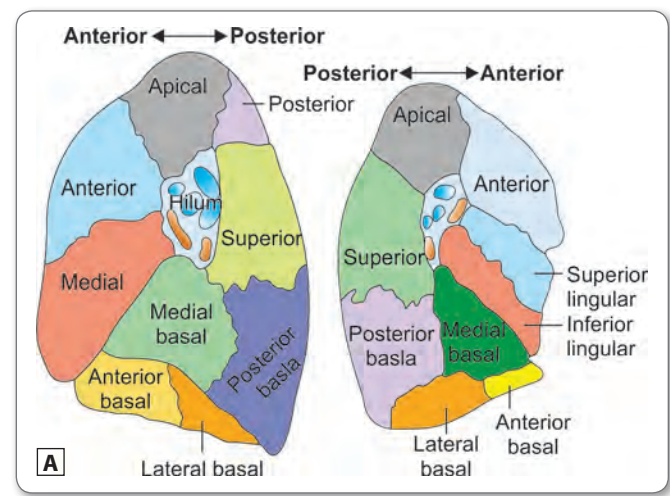
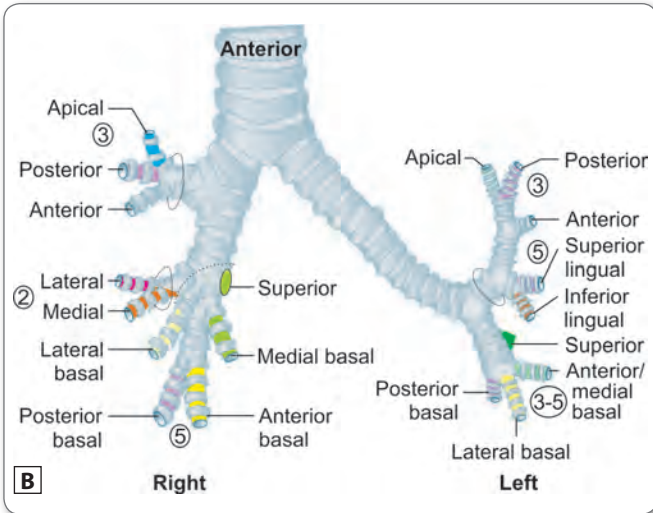


Fig. 50A:

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Figs 50A and B: Bronchopulmonary segment

Bronchopulmonary Segment

- Segment of lung aerated by tertiary bronchus called *bronchopulmonary segment*.
- Each segment is independent respiratory unit and wedge shape with base directed to surface of lung
- Separated from adjacent segment by intersegmental alveolar septum occupied by tributaries of pulmonary vein
- Interlobular septum limits the spread of infection from one segment to another
- Tertiary bronchus accompanied by branches of pulmonary artery
- Each segment contains segmental bronchi, pulmonary artery, bronchial vessels. But **the pulmonary vein is intersegmental**.

Right Lung Segments

- Upper lobe: Apical, anterior and posterior
- Middle lobe: Medial and lateral
- Lower lobe: Apical, anterior basal, posterior basal, medial basal and lateral basal.

Left Lung Segments

- Upper lobe: Apical, anterior, posterior, superior lingular and inferior lingular.
- Superior and inferior lingular corresponds with middle lobe of right lung
- Lower lobe: Apical, anterior basal, posterior basal, lateral basal (medial basal is suppressed in left lung)

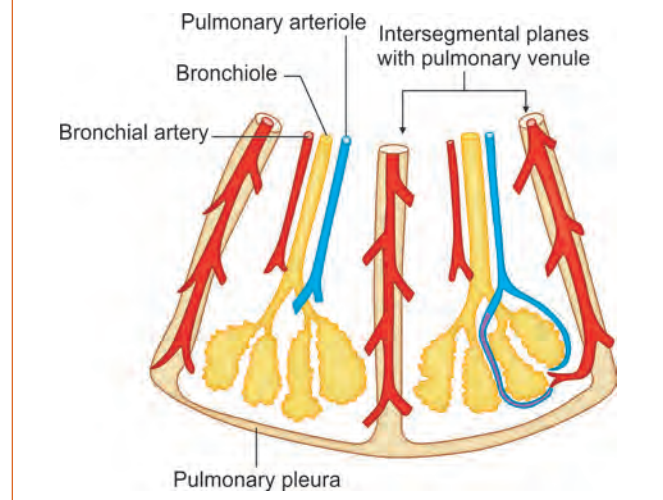
The posterior segment of upper lobe, and apical segment of lower lobe are common sites of lung abscess because they are in dependent position in recumbent position.

Note

- Apical and posterior of left upper lobe combine to form apico-posterior
- Anterior and medial basal of left lower lobe combine to form anteromedial segment basal segment.

Clinical Aspect

- Dependent bronchopulmonary segment in standing position – posterior basal segment of lower lobe of right lung
- Dependent bronchopulmonary segment in supine position – apical segment of lower lobe of right lung
- Medial basal segment of lower lobe of left lung is suppressed in left lung because presence of heart
- Posterior segment of right upper lobe is frequent site of tuberculosis.



PERICARDIUM AND HEART

PERICARDIUM

- Fibro serous sac which encloses heart and great vessels
- Situated in **middle** mediastinum
- Divided into outer fibrous pericardium and inner serous layer, which in turn divided into outer parietal layer and inner visceral layer
- Fibrous pericardium - Strong dense fibrous layer that blends with adventitia of root of great vessels
- Serous pericardium - Consists of parietal layer which line the inner surface of fibrous pericardium and visceral layer forms the outer layer of heart

Pericardial Cavity

- Potential space between visceral layer and parietal layer of serous pericardium.



Pericardial Sinuses

Transverse Sinus

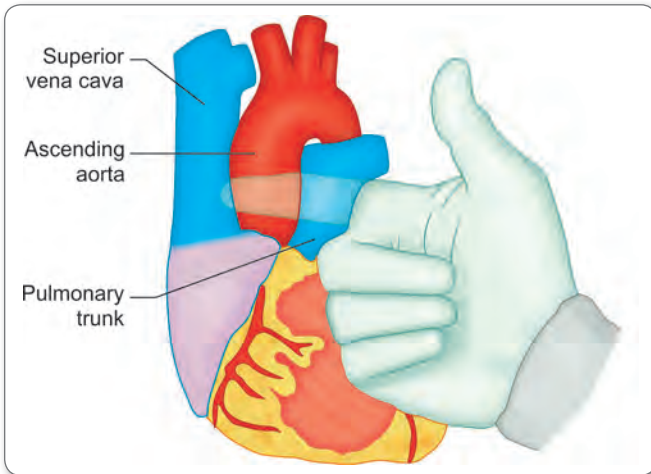


Fig. 51: Transverse sinus: Passage between two great vessels

Boundaries

- In front: Ascending aorta and pulmonary trunk
- Behind: Intrapericardial part of superior vena cava and upper margin of left atrium
- Above: Bifurcation of pulmonary trunk
- Below: Upper surface of left atrium

Oblique Sinus

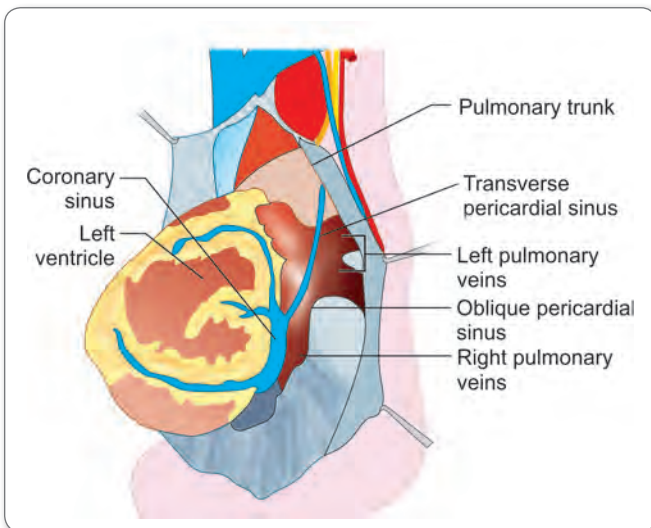


Fig. 52: Pericardial sac with heart drawn out

Cul-de-sac situated **behind the left atrium** and closed on all sides except below.

Boundaries

- In front: Left atrium
- Behind: Parietal layer covering posterior part of fibrous pericardium

- Right side: Right side pulmonary vein
- Left side: Left side pulmonary vein
- Above: Upper margin of left atrium.

HIGH YIELD POINTS

Oblique sinus situated behind the left atrium. Transverse sinus lies above and in front of left atrium.

Blood Supply

Pericardiophrenic vessels, bronchial vessels and esophageal vessels.

Nerve Supply

- Visceral pericardium supplied by autonomic system and is insensitive to pain
- Fibrous and parietal pericardium supplied by phrenic nerve and is sensitive to pain.

Clinical Aspect

Pericardial Effusion

- Accumulation of fluid in pericardial space due to inflammation of pericardium
- Accumulated fluid compress the heart
- Treated by pericardiocentesis

Pericardiocentesis

- Surgical puncture of pericardial cavity for the aspiration of fluid
- Needle is inserted into pericardial cavity through 5th intercostal space left to the sternum
- Due to cardiac notch, needle misses the pleura and lungs.

HEART

- Situated in middle mediastinum
- Extend from—2nd to 6th costal cartilage. 5th to 8th thoracic vertebra.

Table 22: External heart: Anterior view

Apex	Base (Posterior surface)	Surface	Borders
Left Ventricle	2/3 by left atrium and 1/3 by right atrium	Sternocostal – right atrium, ventricle, left ventricle and left auricle Diaphragmatic – 2/3 left ventricle and 1/3 right ventricle Left –left ventricle, auricle, atrium	Right – right atrium Inferior –right and left ventricles Extend from right 6 th costal cartilage to apex



- Coronary sulcus – atrioventricular sulcus – marks the division from atria and ventricle.
- Right side contents – right coronary artery, small cardiac vein
- Left side contents – left coronary artery, circumflex artery, great cardiac vein and coronary sinus
- Crux of heart – formed by the point at which interatrial and interventricular sulci meet the coronary sulcus
- Structures present in anterior interventricular groove— anterior interventricular artery and great cardiac vein

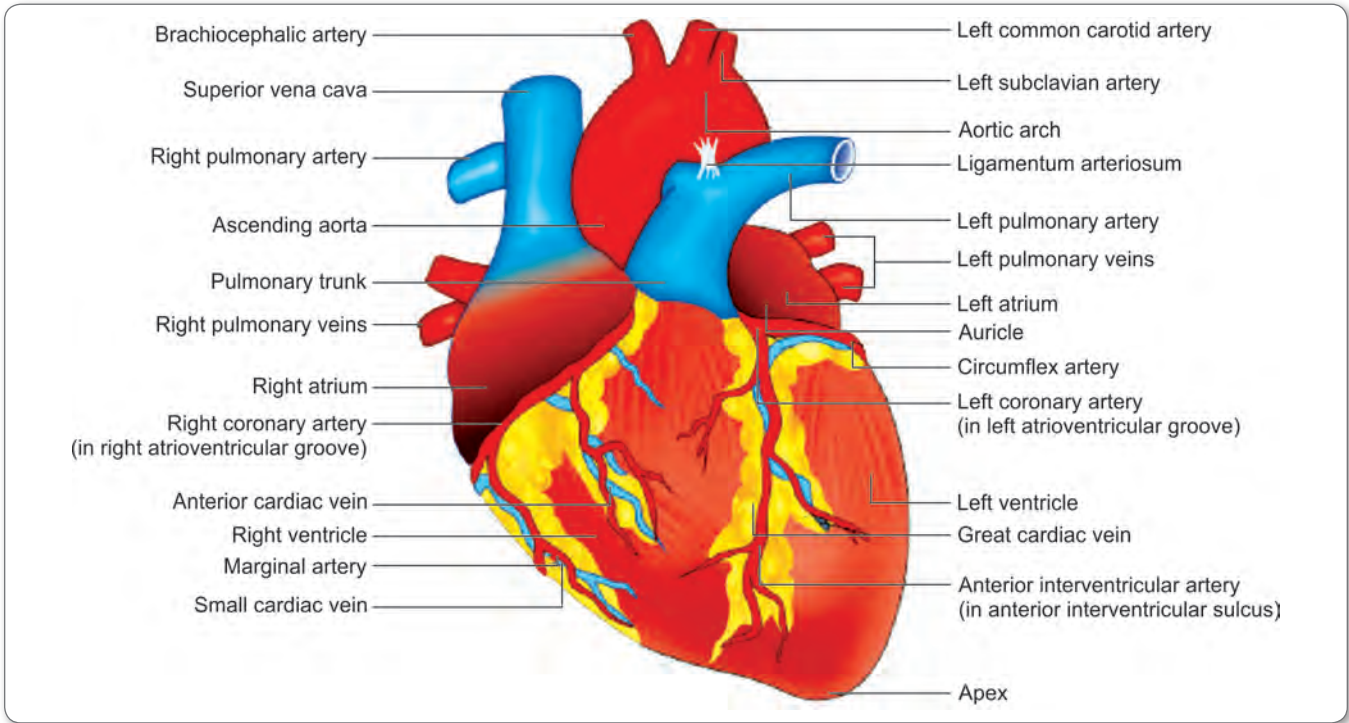


Fig. 53: Anatomy of heart

- Structures present in posterior interventricular groove—posterior interventricular artery and middle cardiac vein.

Note:

- Apex is formed only by left ventricle
- Base formed by only two atria (2/3 base by left atrium and 1/3 base by right atrium)
- Right border by only right atrium
- Diaphragmatic surface by only ventricles (2/3 left ventricle and 1/3 right ventricle).

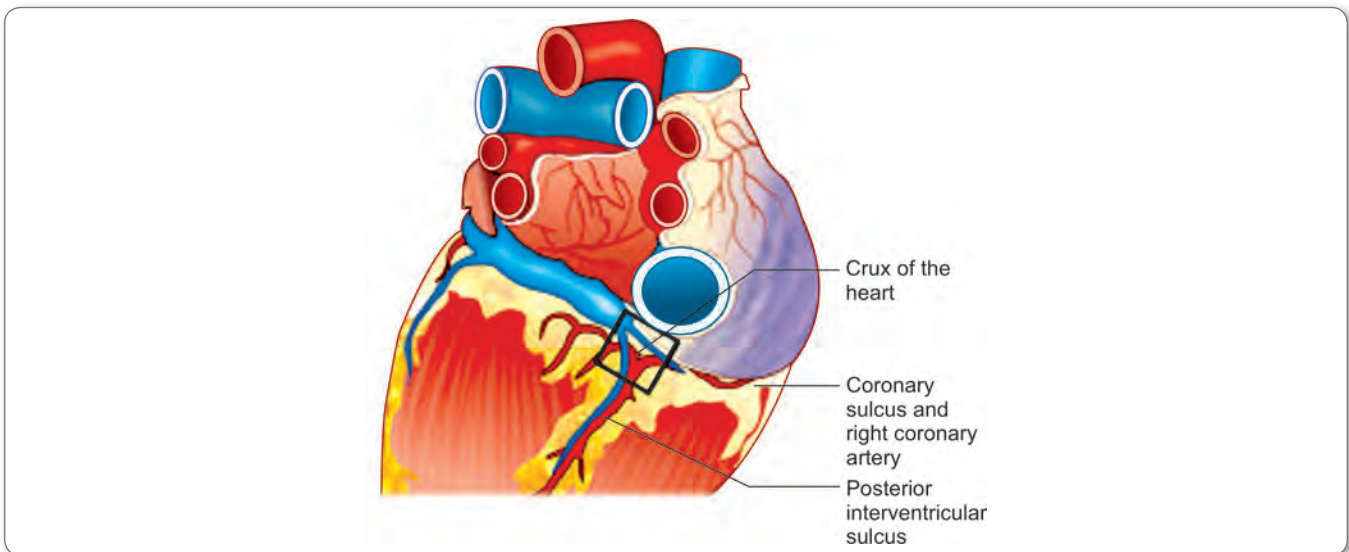


Fig. 54: Crux of the heart



Blood Supply of Heart

Arterial Supply of Heart

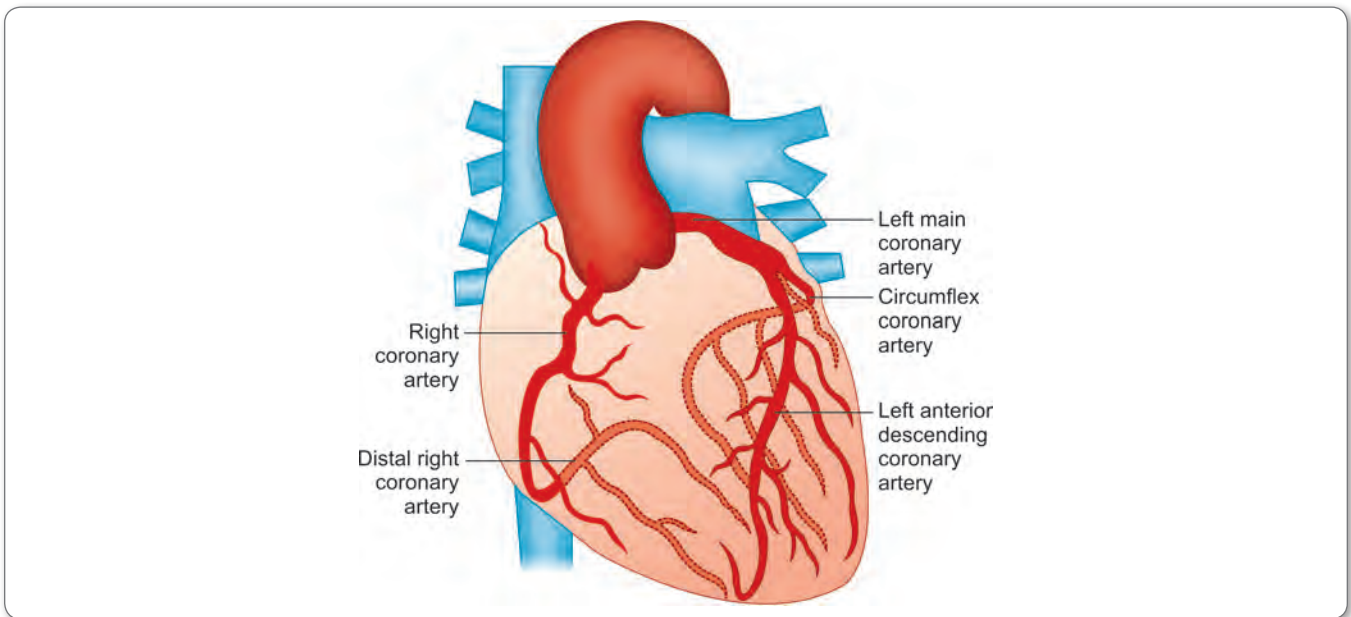


Fig. 55: Arterial supply of heart

Table 23: Arteries supplying blood to the heart

	Right coronary artery	Left coronary artery
Origin	Anterior aortic sinus of ascending aorta, diameter less than left coronary artery	Left posterior aortic sinus of ascending aorta. (Right posterior aortic sinus – noncoronary sinus)
Branches	<ul style="list-style-type: none"> • Right conus artery (third coronary artery) – supply the infundibulum of right ventricle • SA nodal artery • Right anterior ventricular artery – supplies sternocostal surface of right ventricle. • Acute marginal – pass from inferior margin of heart up to apex • Atrial rami – supplies right atrium. • Posterior interventricular artery – supplies diaphragmatic surface of right and left ventricle. <ul style="list-style-type: none"> ▪ Septal branch from posterior interventricular artery supply posterior 1/3 of ventricular septum and the AV node. • Right posterior atrial and ventricular rami 	<ul style="list-style-type: none"> • Anterior interventricular artery – supply the sternocostal surface of left and right ventricle. <ul style="list-style-type: none"> ▪ Septal rami from anterior interventricular artery - supplies anterior 2/3 of ventricular septum • Circumflex artery <ul style="list-style-type: none"> ▪ Gives SA nodal branch arise from this in 35% of subjects ▪ Supplies left atrium and left ventricle ▪ Single Left marginal (obtuse) artery – from the left border up to apex. ▪ Sometimes posterior interventricular artery arises from circumflex artery IN (33%) then Patient is said to have left cardiac dominance. • Left conus artery • AV nodal artery from left coronary in 20% of cases.
Areas of distribution	<ul style="list-style-type: none"> • Whole of right atrium • Most of right ventricle except a strip along anterior interventricular groove • Part left ventricle adjoining posterior interventricular groove <ul style="list-style-type: none"> ▪ SA node in 65% of cases ▪ AV node in 80% of cases ▪ AV bundle and left bundle branch partly. 	<ul style="list-style-type: none"> • Most of left atrium • Most of left ventricle except area adjoining posterior interventricular groove • Small part of right ventricle along anterior interventricular groove <ul style="list-style-type: none"> ▪ SA node in 35% of cases ▪ AV node in 20% cases ▪ AV bundle ▪ Right bundle branch ▪ Left bundle branch



Blood Supply to Ventricular Septum

- Septal branch from posterior interventricular artery—Postero-inferior one-third of ventricular septum
- Septal branch from anterior interventricular artery—Anterosuperior two-third of ventricular septum.

Cardiac Dominance

- **Dominance depends upon posterior interventricular artery**, if posterior interventricular artery arise from right coronary artery then right coronary dominance, if posterior interventricular artery arise from left coronary artery then left coronary dominance
- In balanced dominance, branches of right and left coronary artery run in posterior interventricular groove.

Blood Supply to Conducting System of Heart

- **SA node - Pacemaker** of the heart, which is situated in the upper part of crista terminalis at the junction of superior vena cava and right atrium. Atrial branch of right coronary artery supply the SA node 65% and circumflex branch of left coronary artery supply in 35% of cases
- **AV node:** lies in the **triangle of Koch**. Supplied by right coronary artery 80% cases. Left coronary artery in 20% cases.
 - **AV bundle** – mainly supplied by left coronary artery and partly supplied by right coronary artery
 - **Left bundle branch** - mainly supplied by left coronary artery and partly supplied by right coronary artery
 - **Right bundle branch** – supplied by left coronary artery.

Note:

- All parts of conducting system supplied by right coronary artery except **RIGHT BUNDLE BRANCH** which is supplied only by left coronary artery

Venous Drainage of Heart

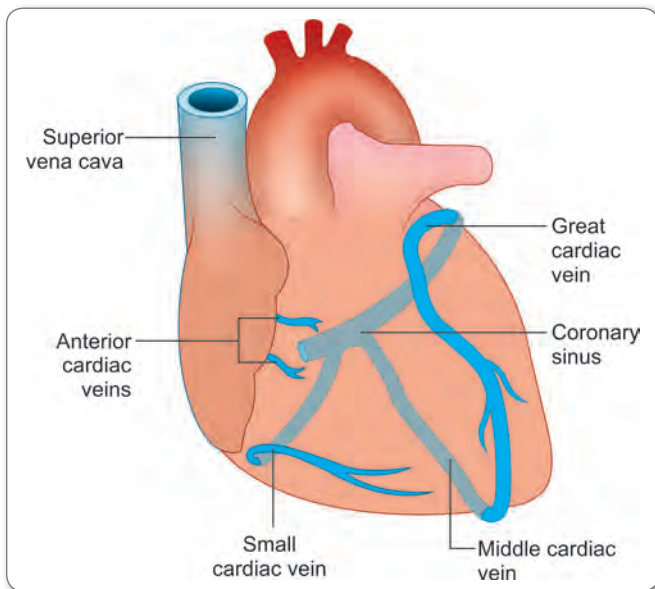


Fig. 56: Venous drainage of heart

Coronary Sinus Drains 60% of Blood

- Remaining 40% drain by anterior cardiac vein (drain infundibulum of right ventricle), which opens directly into right atrium guarded by thebesian vein and venae cordis minimi (opens in to different chambers by foramina minimarum)

Table 24: Coronary sinus tributaries

Coronary sinus	
Opening	<ul style="list-style-type: none"> • Opens into right atrium and opening is guarded by incomplete semilunar valve called the besian valve
Tributaries	<ul style="list-style-type: none"> • Great cardiac vein • Middle cardiac vein • Small cardiac vein • Posterior vein of left ventricle • Oblique vein of the left atrium



Clinical Aspect

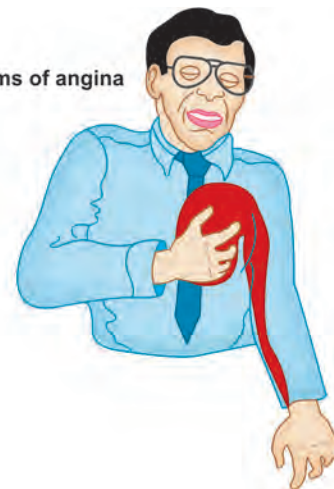
Myocardial infarction

- Necrosis of myocardium due to thrombus or embolus of coronary artery
- Symptoms – severe chest pain or pressure for prolonged period and murmur of mitral regurgitation

Angina Pectoris

Angina can spread anywhere between the belly button and the jaw, including to the shoulder, arm, elbow or hand-usually on the left side.

Symptoms of angina

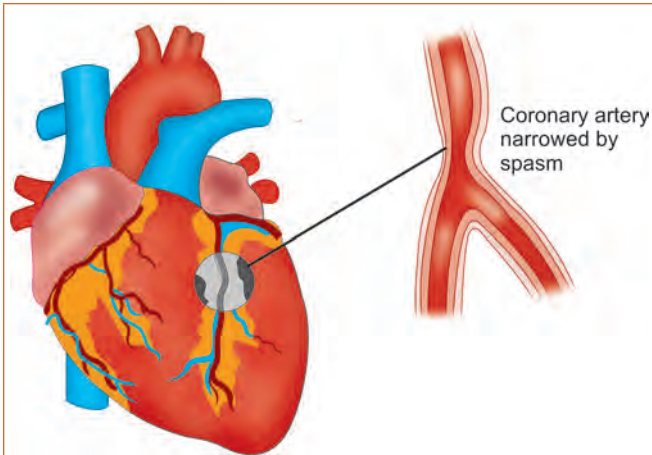


- Due to inadequate supply of oxygen to heart muscle
- Characterized by attacks of chest pain originating in heart and in many cases pain radiating to left shoulder and down the arm

Prinzmetal Angina

- It is a medical condition in which there is temporary spasm of the coronary arteries causing pain and discomfort.

Contd...



- Variant form of angina pectoris caused by transient coronary artery spasm
- Vasospasm typically occurs at rest and in many cases coronary arteries re-normal
- ECG exhibits ST segment elevation rather than depression during an attack
- Prolonged vasospasm may lead to myocardial infarction and sudden death.

Chambers of the Heart

Right Atrium

External Features

- Auricle: Muscular extension lies superomedially and covers initial part of right coronary artery
- Sulcus terminalis: Vertical groove corresponds with crista terminalis. Upper part of sulcus contains SA node.
- Larger than left atrium but has thinner wall
- Right atrial pressure is slightly lower than left atrial pressure.

Internal Features

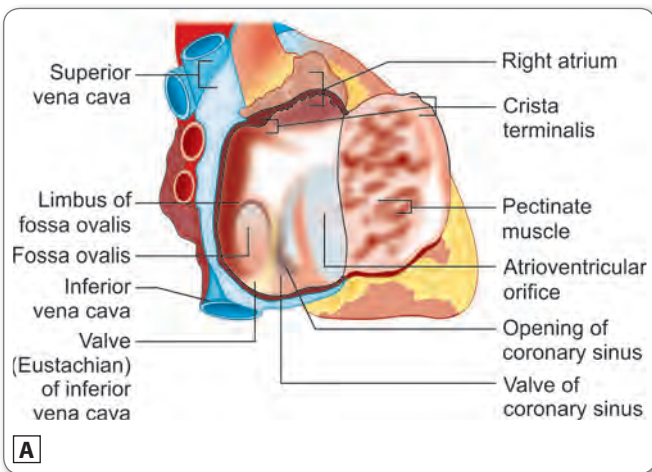
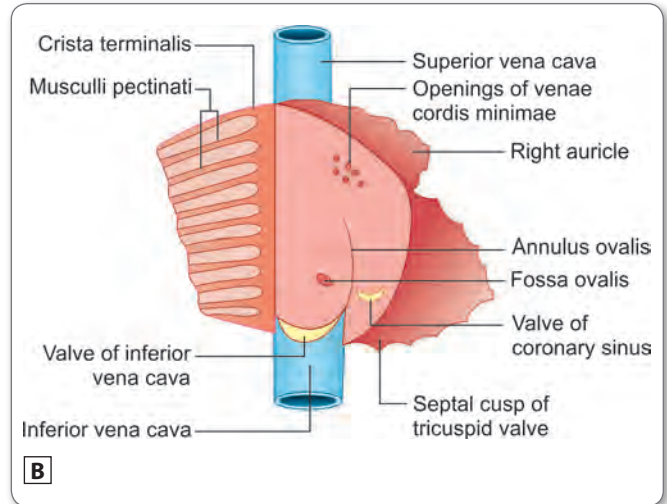


Fig. 57A:



Figs 57A and B: Interior of right atrium

Features of Posterior Smooth Part

- Developed by absorption of body of venous sinuses and right horn following veins open into smooth part.

Table 25: Valves in the major veins

Vein	Valve
Opening of superior vena cava	No valve
Opening of inferior vena cava	Guarded by Eustachian valve
Opening of coronary sinus	Guarded by Thebesian valve

Table 26: Features of anterior rough part (atrium proper) of right atrium developed from primitive atrium

Crista terminalis	Muscular ridge
Musculi pectinati	Parallel muscular fibers from crista terminalis
Fossa ovalis	Oval depression developed from septum primum
Limbus fossa ovalis	Sickle shaped margin surrounding the fossa ovalis. Developed from septum secundum
Triangle of Koch	In front by base of septal leaflet of tricuspid valve Behind by opening of coronary sinus Above by tendon of Todaro Contains – AV node
Torus aortic	Elevation due to noncoronary sinus (right posterior aortic sinus—noncoronary sinus)



Right Ventricle

Right ventricle is situated in front and to left of right atrium.

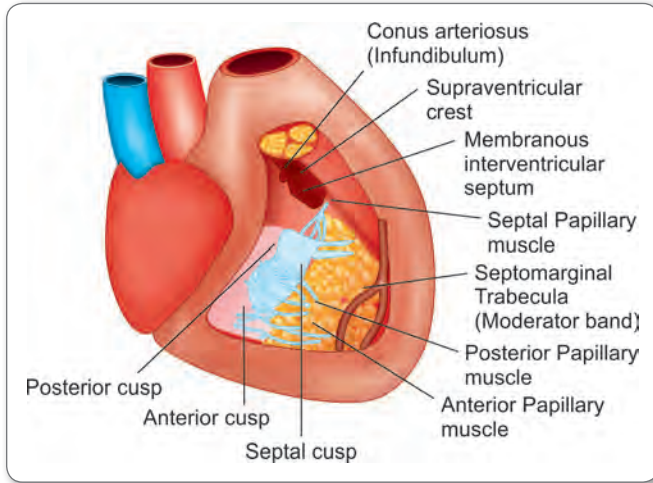


Fig. 58: Interior of right ventricle

Interior of Right Ventricle

- Inflow (rough part) or ventricle proper – coarsely trabeculated more in apical regions
- Outflow (smooth part) or conus arteriosus is the upper smooth walled portion of the right ventricle, which leads to pulmonary trunk.

Inflow consists of:

Tricuspid valvular complex

Trabeculae carneae consists of

- **Ridges:** Supraventricular crest intervenes between inflow and outflow tracts
- **Bridges:** Septomarginal trabecula or moderator band or septal band – prevents over distension of right ventricle
- **Papillary muscles:**
 - Cone shaped muscle enveloped by endocardium
 - Extend from anterior, posterior ventricular wall and septum and their apices are attached to chordae tendineae
- **Chordae tendineae:**
 - Extend from one papillary muscle to more than one cusp of the tricuspid valve

Left Atrium

- Rough part: Network of pectinate muscles, which is developed from left part of primitive atrium
- Smooth part: Receives 4 pulmonary veins, which is developed from absorption of pulmonary veins
- Smaller and thicker than right atrium
- Walls are smooth except for few pectinate muscle in the auricle
- Situated more posterior to four chambers and situated posterior to right atrium but anterior to esophagus.

Left Ventricle

- Thicker than right ventricle
- Lies at the back of the heart and apex is directed downward, forward and towards the left
- Contains two papillary muscles with chordae tendineae and meshwork of muscular ridges trabeculae carneae cordis

Consists of:

- In flowing part: Rough developed from left of primitive ventricle.
- Outflow part: Smooth developed from bulbus cordis.

Table 27: Differences between right and left ventricle

Right ventricle	Left ventricle
• Forms 2/3 of sternocostal surface	• Forms 1/3 of sternocostal surface
• Forms 1/3 of diaphragmatic surface	• Forms 2/3 of diaphragmatic surface
• Forms most of the inferior border	• Forms apex of heart
• Interior is semilunar	• Interior is circular
• Musculature is 3–5 mm thick (Ratio 1:3 with left ventricle)	• Musculature is 8–12 mm thick
• Normal mitral valve diameter—4–6 sq. cm	• Normal aortic valve—2.6–3.5 sq.cm

Valves of Heart

- Mitral valve situated in sternal end of **left 4th costal cartilage**.
- Aortic valve at sternal end of **left 3rd costal cartilage lower border**
- Pulmonary valve diameter—2.5 cm, sternal end of **left 3rd costal cartilage upper border**
- Tricuspid valve—4 cm in diameter, situated at right half of sternum along 4th and 5th space.

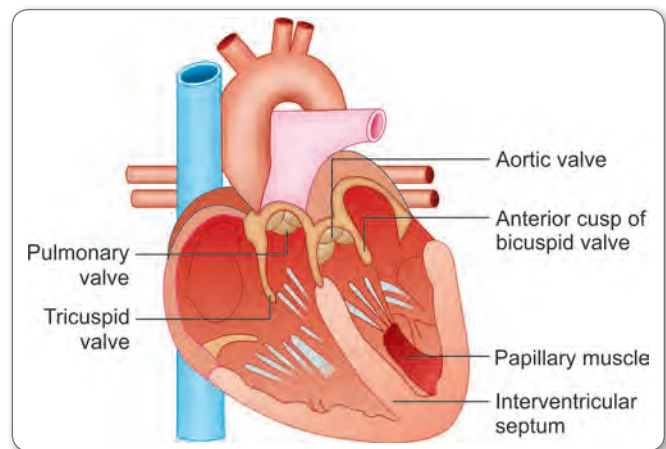


Fig. 59: Valves of the heart



Nerve Supply of Heart

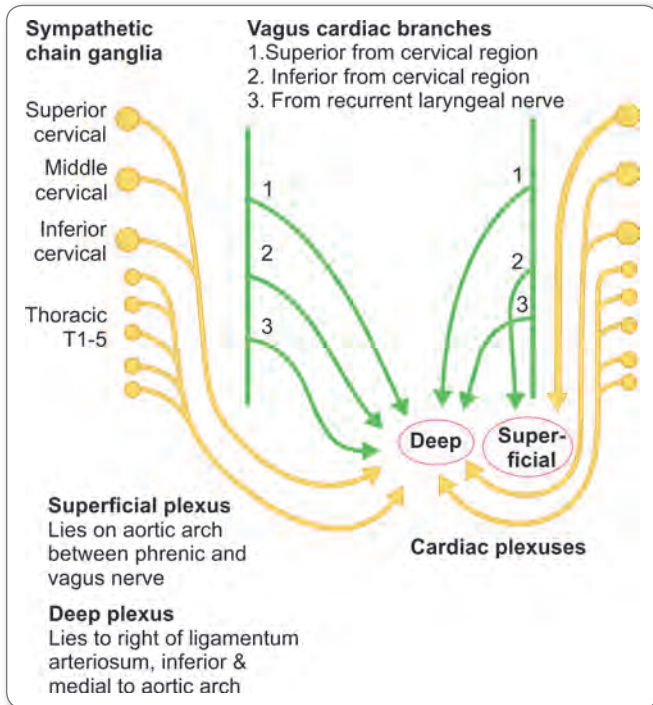


Fig. 60: Autonomic nerve supply to heart

Table 28: Cardiac plexuses

Cardiac plexus	Situation	Formation
Superficial cardiac plexus	Inferior to arch of aorta In front of right pulmonary artery	Cardiac branches from superior cervical ganglion of left sympathetic trunk Inferior cervical cardiac branches from left vagus
Deep cardiac plexus	In front of bifurcation of trachea Behind the arch of aorta	Cardiac branches from superior, middle and inferior cervical ganglia and upper 4 or 5 thoracic ganglion of sympathetic trunk Cardiac branches from vagus and recurrent laryngeal nerves

Table 29: Autonomic nerve supply of heart

Nervous system	Afferent	Efferent
Sympathetic	Afferent fibers reach dorsal root ganglia of upper 4 or 5 thoracic spinal nerves	Preganglionic fibers – arise from upper 4 or 5 thoracic spinal nerves and reach superior, middle and inferior cervical ganglion Postganglionic fibers from these ganglion reach heart via cardiac plexus

Contd...

Nervous system	Afferent	Efferent
	Function Convey pain sensation from the heart	Function Increases cardiac output and heart rate
Parasympathetic	Inferior ganglion (ganglion nodosum) of vagus nerve	Preganglionic fibers from nucleus ambiguus and dorsal nucleus of vagus Postganglionic fibers are situated in cardiac plexus
	Function Concerned with visceral reflexes depressing the cardiac activity	Function Diminish the heart rate and reduce the coronary blood flow

Fibrous Skeleton of the Heart

- Consists of four rings at base of mitral valve, tricuspid valve, aortic valve and pulmonary valve.
- Pulmonary ring and aortic ring connected by tendon of infundibulum
- Right and left atrioventricular rings united by trigonum fibrosum dextrum
- Left margin of trigonum connects aortic and left atrioventricular ring by trigonum fibrosum sinistrum.

Conduction System of Heart

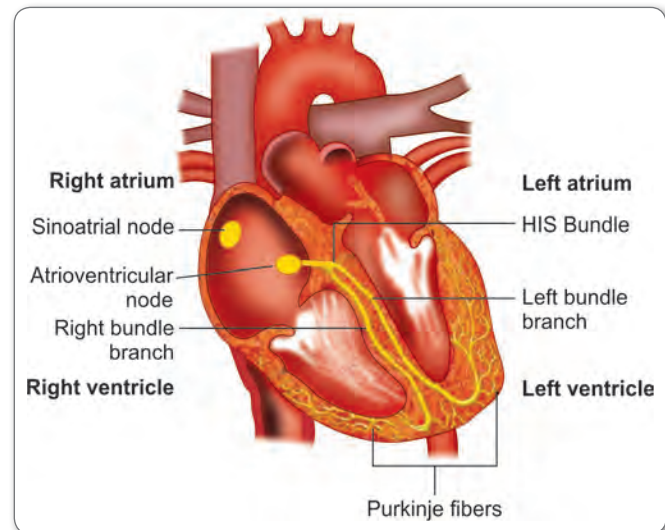


Fig. 61: Conduction system of heart

Sinoatrial Node or SA Node

- It is known as the “pacemaker” of the heart. Initiate heart beat which can be altered by autonomic stimulation.
- It generates impulses at the rate of about 70–100 beats/min and initiates the heart beat.



- It is horseshoe-shaped.
- It is situated at the atriocaval junction in the upper part of the sulcus terminalis.
- The impulse travels through the atrial wall to reach the AV node.

Supplied by sinus node artery, which is branch of right coronary artery

Atrioventricular Node or AV Node

- It is capable of generating impulses at a rate of about 40–60 beats/min.
- It is situated in the triangle of Koch.
 - Receives impulse from SA node and transmit to AV bundle
 - Supplied by AV nodal artery which is branch of right coronary artery
- **Atrioventricular bundle or AV bundle or bundle of His:** It is the only muscular connection between the atrial and ventricular musculatures. It begins as the atrioventricular (AV) node crosses AV ring and descends along the posteroinferior border of the membranous part of the ventricular septum. At the upper border of the muscular part of the septum, it divides into right and left branches.
- The **right branch** of the AV bundle passes down the right side of the interventricular septum. A large part enters the moderator band to reach the anterior wall of the right ventricle where it divides into Purkinje fibers.
- The **left branch** of the AV bundle descends on the left side of the interventricular septum and is distributed to the left ventricle after dividing into Purkinje fibers.
- The **Purkinje fibers** form a subendocardial plexus. They are large pale fibers striated only at their margins. They usually possess double nuclei. These generate impulses at the rate of 20–35 beats/min.
- Damage to conducting system causes heart block
- Delay or disruption of electric signal produces an irregular and slower heart beat
- Atrial or ventricular fibrillation is a cardiac arrhythmia resulting from rapid irregular uncoordinated contractions of atrial or ventricular muscles.

SURFACE MARKINGS OF THE CARDIAC VALVES

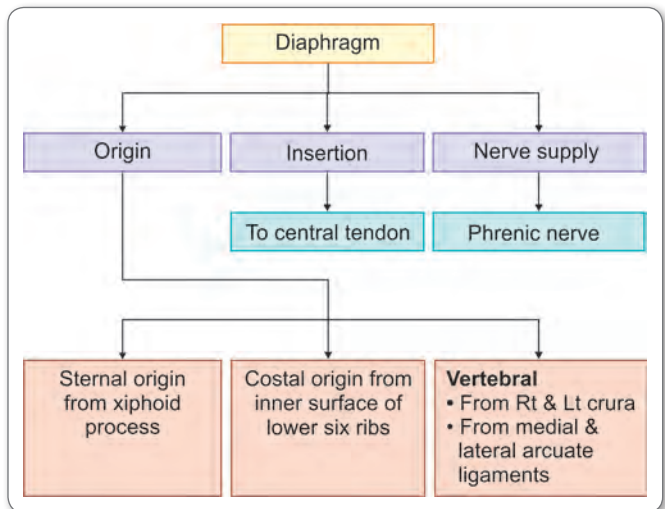
- Pulmonary valve – A horizontal line (2.5 cm long) behind the medial end left 3rd costal cartilage and adjoining part of the sternum
- Aortic valve – A lightly oblique line (2.5 cm long) behind the left half of the sternum opposite the 3rd intercostal space
- Mitral valve – An oblique line (3 cm long) behind the left half of the sternum opposite the left 4th costal cartilage
- Tricuspid valve – Nearly vertical oblique line (4 cm long) behind the right half of the sternum opposite the 4th and 5th intercostal spaces.

Clinical Aspect

Type of MI	M/c artery involved/blocked
Extensive anterior wall MI	Main Left coronary artery
Ant. wall MI	Left anterior descending artery
Septal MI	Left anterior descending artery septal branch
Posterior wall MI	Left circumflex artery or post. descending artery
Inferior wall MI	Right coronary artery (Posterior interventricular or posterior descending branch)
Anteroseptal MI	Right coronary artery
Lateral wall MI	Left circumflex artery

MI: Myocardial infarction

DIAPHRAGM



- Musculotendinous sheet forming the floor of the thoracic cavity and separates from abdominal cavity right dome of the diaphragm raised by the underlying liver

ORIGINS OF DIAPHRAGM

- Arises from xiphoid process (sternal part), lower 6 costal cartilage (costal part), right and left crus, medial and lateral arcuate ligaments (vertebral part).

Crura

- Right crus is longer arises from L1, 2, 3 and the intervening intervertebral disc
- Left crus arise from L1, 2 and the intervening intervertebral disc.



Arcuate Ligaments

- Medial arcuate ligament is thickening of psoas fascia. Extends from body of L2 to transverse process of L1
- Lateral arcuate ligament is thickening of anterior layer of thoracolumbar fascia. Extends from transverse process of L1 to 12th rib
- Median arcuate ligament is arched fibrous band connecting two crura
- Insertion of diaphragm
- Inserts into central tendon.

MAJOR OPENINGS IN DIAPHRAGM

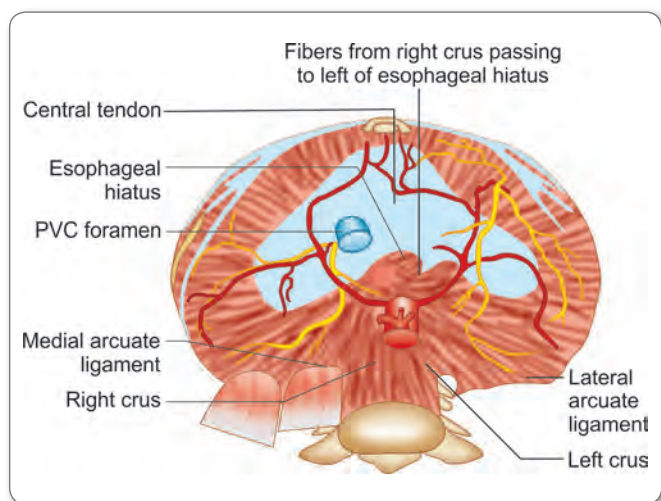


Fig. 62: Openings in diaphragm

Minor Orifices

Table 30: Structure passing through minor orifices

Structures passing	Minor orifices
Superior epigastric vessels	Gap between sternal origin and costal origin (space of Larry) When this opening is enlarged (foramen of Morgagni)
Lower 5 intercostal vessels and nerves	Between costal origin of diaphragm and transverses abdominus
Musculophrenic artery	Between 7 th and 8 th costal origins of diaphragm
Subcostal nerves and artery	Behind lateral arcuate ligament
Sympathetic trunk and lesser splanchnic nerve	Behind medial arcuate ligament
Greater, lesser, least splanchnic nerve	Piercing crus of diaphragm
Inferior hemiazygos vein	Pierce the left crus
Azygos vein	Pierce the right crus
Left phrenic nerve	Pierces left cupola

NERVE SUPPLY

- Motor supply: Phrenic nerve C3, 4, 5
- Right phrenic nerve supply the right part of the diaphragm up to right margin of esophageal opening
- Left phrenic nerve supply the left part of the diaphragm up to left margin of esophageal opening
- Therefore right crus is supplied by both right and left phrenic nerve
- Sensory part
- Central part by phrenic nerve
- Peripheral part by lower 6–7 intercostal nerve

REMEMBER

Openings	Vertebral level	Structures passing
Vena caval orifice – located in central tendon	T8	Inferior Vena Cava Right phrenic nerve MN – Video Cassette Recorder
Esophageal orifice – passing through right crus	T10	Esophagus Anterior and posterior vagal trunk Esophageal branch of left gastric artery Corresponding tributaries of left gastric vein, lymphatics
Aortic orifice Located posterior to median arcuate ligament	T12	Abdominal aorta Thoracic duct Azygos vein (sometimes)

Phrenic Nerve

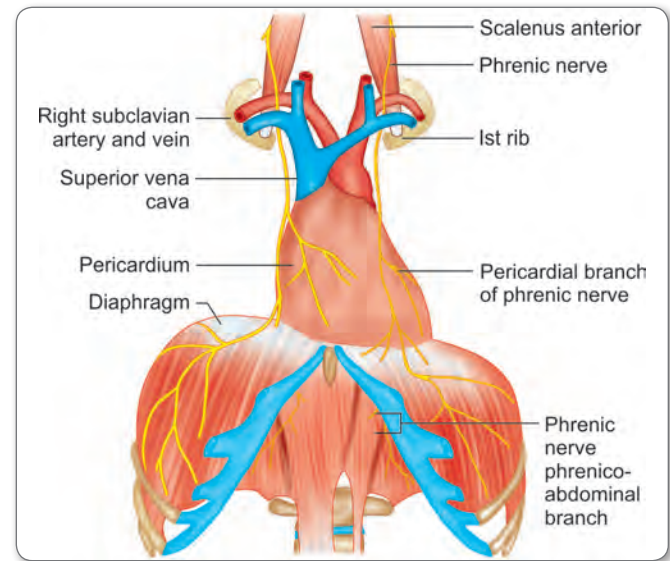


Fig. 63: Course of phrenic nerve



Root value - C3, 4, 5

- It is Mixed nerve
- Carries sensory, motor and sympathetic fibers
- Sole motor supply to diaphragm.

Sensory Supply

- Pleura diaphragmatic and mediastinal
- Fibrous pericardium
- Parietal layer of serous pericardium
- Parietal peritoneum.

Course

Neck anterior to scalenus anterior

Pass between subclavian artery and vein at the root of the neck and enters thorax – after crossing internal thoracic artery



Passes anterior to root of lung and between mediastinal pleura and fibrous pericardium to supply the sensory fibers to these structures.

Note:

Phrenic nerve pass in front of hilum of lung, vagus nerve pass behind the hilum of lung.

Right phrenic	Left phrenic
Crosses 2 nd part of right subclavian artery	Crosses 1 st part of left subclavian artery
Shorter vertical and most deeply placed	Longer oblique and not deeply placed
Pass right side of venous system	Pass left side of arterial system
Pass through venal caval opening of diaphragm	Pierce the left cupola of diaphragm

BLOOD SUPPLY

- Musculophrenic
- Pericardiophrenic
- Lower 5 or 6 posterior intercostal arteries
- Superior phrenic artery: Last branch of thoracic aorta
- Inferior phrenic artery: First branch of abdominal aorta.

ESOPHAGUS – 25 CM

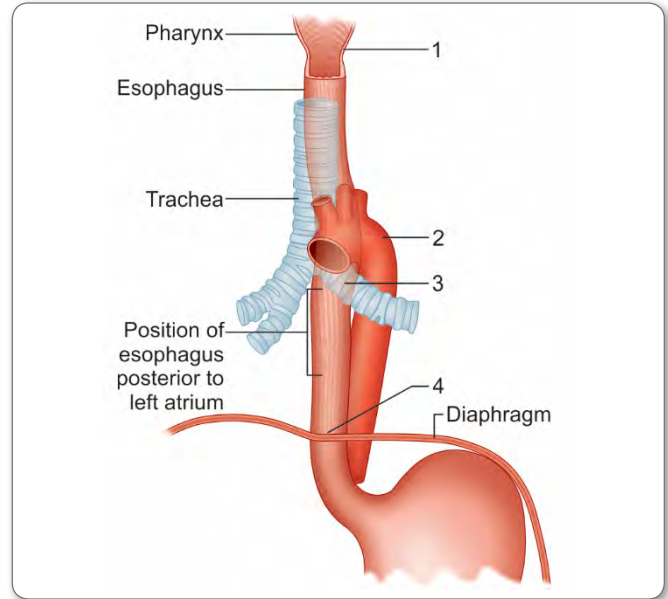


Fig. 64: Esophageal constrictions

- Muscular tube that extends from pharynx to stomach descending behind the trachea
- Has constrictions and details of these constrictions are tabulated below:

Constrictions	Vertebral level	Distance from incisor teeth
Due to crico pharyngeus part of Inferior constrictor (1)	C6	6''
Due to crossing of arch of aorta (2)	T4	9''
Due to crossing of left bronchus (3)	T6	11''
Due to esophageal opening of diaphragm (4)	T10	15''

**Refer the numbers from the figure above that shows the exact place of constrictions*

It has physiological sphincter, which is circular layer of smooth muscle at the gastroesophageal junction. This is called inferior esophageal sphincter by clinicians. Tonic contractions of this sphincter prevents stomach contents from regurgitating into the esophagus.

Abdominal part is half inch long extends from diaphragm to the cardiac orifice of the stomach through the opening in the crus of the diaphragm.



BLOOD SUPPLY OF ESOPHAGUS

- Inferior thyroid artery, a branch of thyrocervical trunk
- Descending thoracic aorta
- Bronchial artery, a branch of descending thoracic artery
- Left gastric artery, a branch of coeliac trunk
- Left inferior phrenic artery, a branch abdominal artery

Venous Drainage

- Cervical part drain into inferior thyroid vein
- Thoracic part drain into azygos and hemiazygos vein
- Abdominal part drain into left gastric vein of portal system and partly to inferior hemiazygos vein. (Left gastric vein joins with lower esophageal vein of azygos system of vein – portocaval anastomosis, forms esophageal varices in portal hypertension).

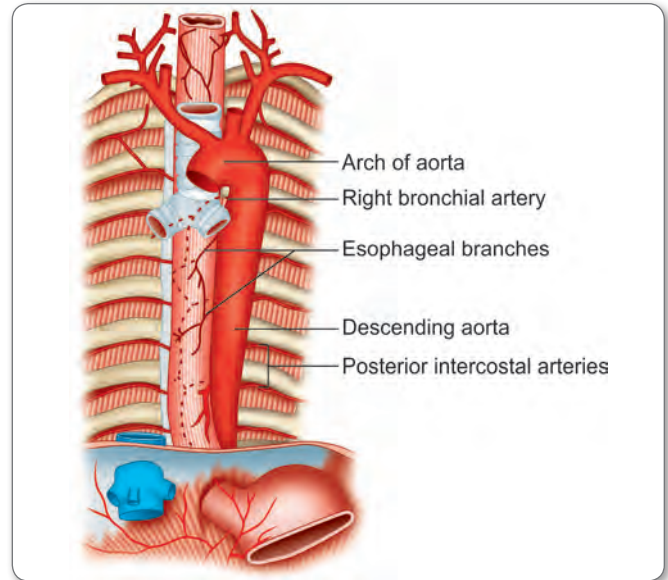
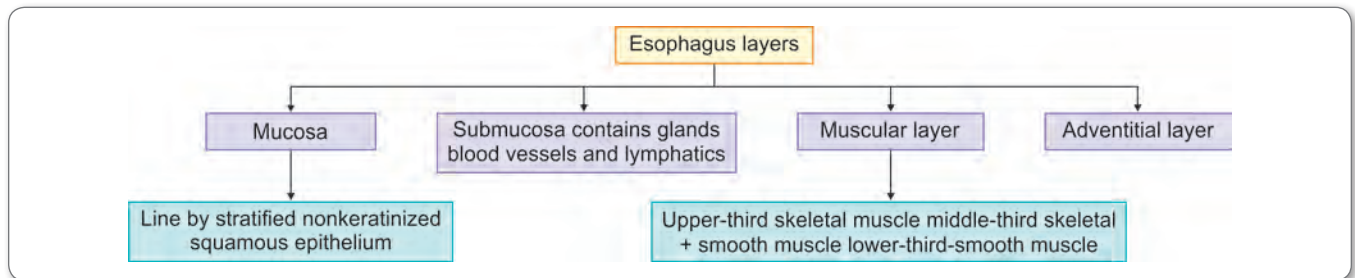


Fig. 65: Blood supply of esophagus

STRUCTURE OF ESOPHAGUS

- Like the other organs in the GIT, esophagus consists of four layers-mucosa, submucosa, muscular layer and adventitial layer



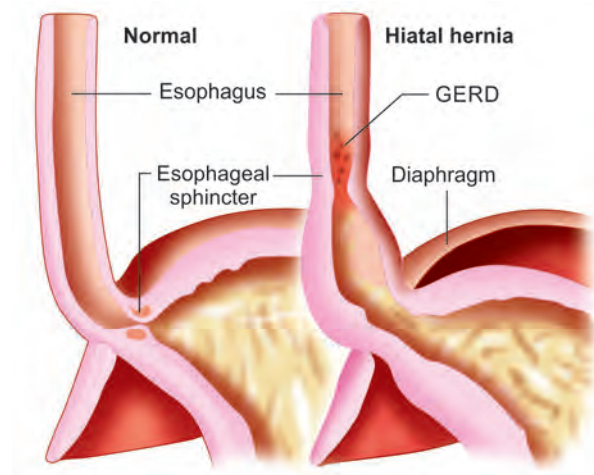
Clinical Aspect

Achalasia of Esophagus

- Impaired esophageal contractions because of failure of relaxation of inferior esophageal sphincter due to degeneration of Auerbach plexus
- Obstruction to passage of food in terminal esophagus with symptoms of dysphagia, loss of weight, nocturnal cough, chest pain and recurrent pneumonia or bronchitis
- Systemic sclerosis
- Systemic collagen vascular disease and has clinical feature of dysphagia for solid, liquids, severe heart burn and esophageal strictures

Hiatal hernia

- Herniation of part of stomach through esophageal hiatus into thoracic cavity
- Cause gastroesophageal reflux, strangulation of esophagus or stomach or vomiting after feeding in infant
- Surgery required to reduce its size

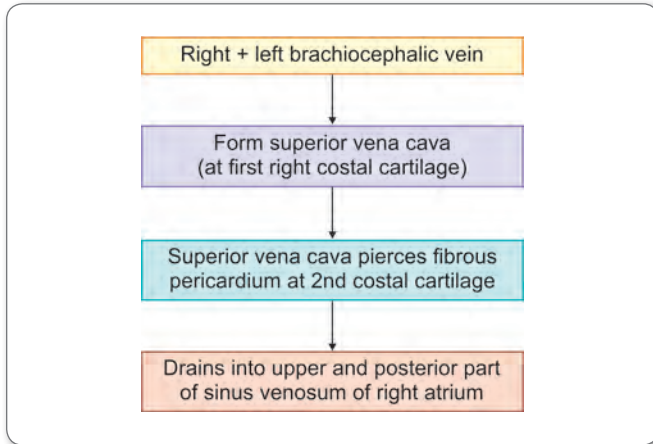




MAJOR BLOOD VESSELS OF THORAX

SUPERIOR VENA CAVA

Drains blood from all structures superior to diaphragm except lungs and heart.



Divided into Two Parts

Upper half	Lower half
Extra pericardial	Intra pericardial
Lies in superior mediastinum	Lies in middle mediastinum
Develop from caudal part of right anterior cardinal vein	Develop from right common cardinal vein

AORTA

Ascending Aorta

- Measurement: 5 cm
- Extension – from lower border of third costal cartilage to upper border of second costal cartilage
- Situated within the pericardium
- Three dilatations called aortic sinuses of Valsalva
 - Anterior aortic sinus: Right coronary sinus arises
 - Left posterior aortic sinus: Left coronary sinus
 - Right posterior aortic sinus: Noncoronary sinus – forms torus aorticus in right atrium.

Arch of Aorta

- Situated in superior mediastinum
- Extension – from right 2nd sternocostal junction to left 2nd sternocostal junction.

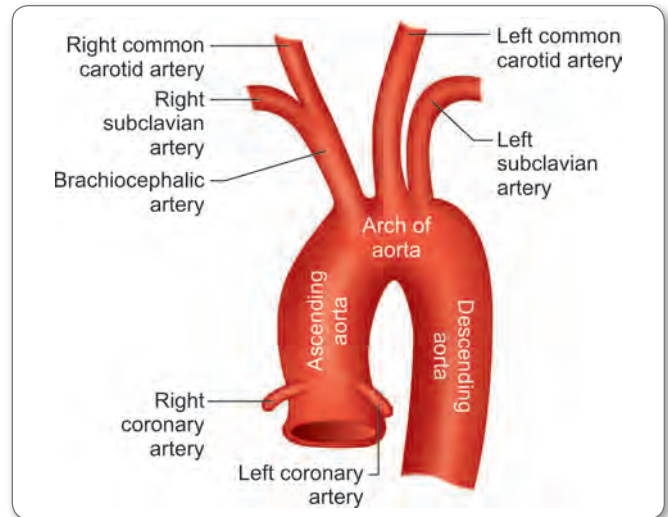


Fig. 66: Aorta

Branches

- Brachiocephalic trunk
- Left subclavian artery
- Left common carotid.

Crossed by Four Nerves and One Vein

- Left phrenic
- Inferior cervical cardiac branch of left vagus
- Superior cervical branch of left sympathetic trunk
- Left superior intercostal vein.

HIGH YIELD POINTS

Left recurrent laryngeal nerve winds around the arch of aorta.

Descending Thoracic Aorta

- Continuation of arch of aorta

Begins at the Level of T4

- Situated in posterior mediastinum
- Passes through aortic opening at T12

Branches

- Pericardial branches
- Mediastinal branches
- Esophageal branches
- Left bronchial artery
- Posterior intercostal artery except first two space
- Right and left superior phrenic arteries
- Right and left subcostal arteries.

HIGH YIELD POINTS

Right bronchial artery arise from 3rd right posterior intercostal artery.



Clinical Aspect

Coarctation of the aorta: Coarctation of the aorta is a localized narrowing of the aorta opposite to or just beyond the attachment of the ductus arteriosus. An extensive collateral circulation develops between the branches of the subclavian arteries and those of the descending aorta. These include the anastomoses between the anterior and posterior intercostal arteries. These arteries enlarge greatly and produce a characteristic notching on the ribs.

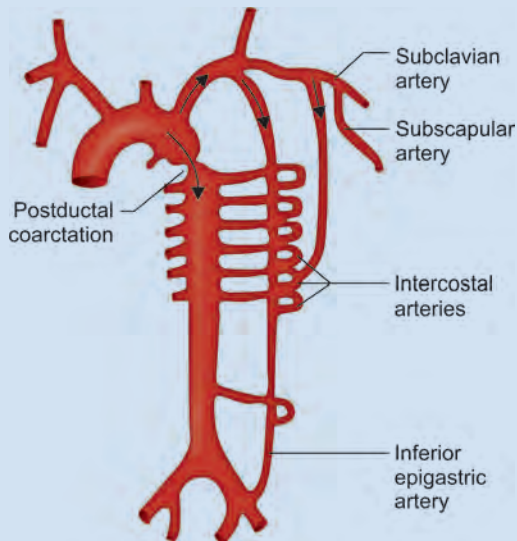
REMEMBER

Pre ductal coarctation - obliteration before ligamentum arteriosum. Prognosis very bad - since it involve entire subclavian artery and brachiocephalic trunk.

Post ductal coarctation- After the ligamentum arteriosum

Features are:

- Characteristic rib notching and high risk of cerebral hemorrhage
- Tortous and enlarged blood vessels especially internal thoracic, intercostal, epigastric and scapular arteries
- Elevated BP in radial artery and decreased pressure in femoral artery
- Femoral pulse to occur after radial pulse (normally femoral pulse occur before radial pulse)
- Some important collaterals



Postductal Coarctation Collateral Channels

- Anterior intercostal artery (internal thoracic artery)
Vs
- Posterior intercostal artery (costa cervical trunk, descending thoracic aorta)
- Superior epigastric artery (internal thoracic artery)
Vs
- Inferior epigastric artery (external iliac artery)

Contd...

- Superior intercostal artery (from costa cervical trunk)
Vs

3rd Posterior Intercostal Artery

- Suprascapular artery. Dorsal (through cervical trunk) scapular artery
Vs
- Subscapular artery, circumflex scapular + (axillary artery)
- **Aortic aneurysm:** Aortic aneurysm is a localized dilatation of the aorta which may press upon the surrounding structures and cause the mediastinal syndrome.

AZYGOS SYSTEM OF VEINS

- These veins are paravertebral in position
- Do not accompany corresponding arteries
- Consists of azygos vein, superior and inferior hemiazygos vein

Azygos Vein

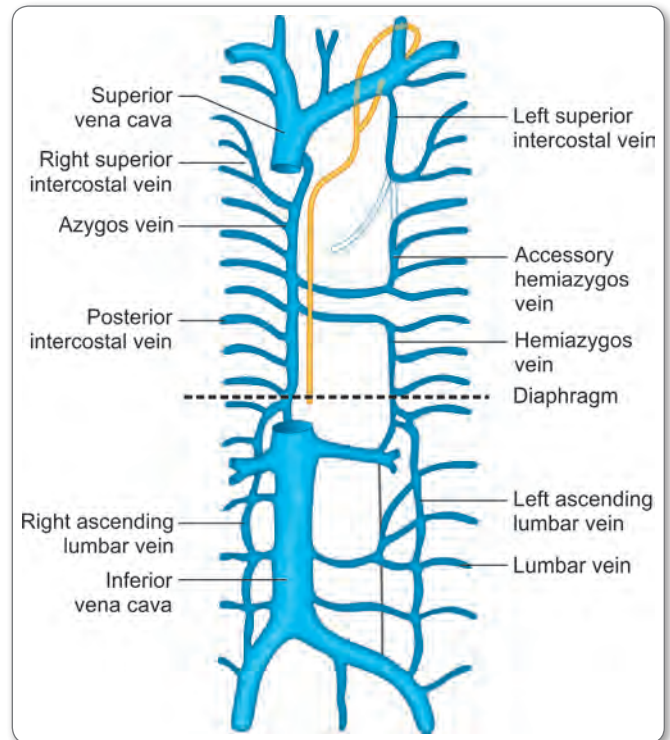


Fig. 67: Azygos system of veins

- Mode of formation is inconstant. But sometimes formed by lumbar azygos, right subcostal vein and right ascending lumbar vein
- **Enter thorax in aortic orifice of diaphragm and passes through posterior mediastinum and arch over the root of right lung and joins with superior vena cava**
- Tributaries (Refer the Chart, Venous System)
 - Posterior intercostal vein of the right side except first vein
 - 2nd, 3rd, 4th intercostal vein unite to form right superior intercostal vein which ends in arch of azygos



- Formation tributary- right subcostal vein and right ascending lumbar vein
- Terminal part of hemiazygos and accessory hemiazygos
- Right bronchial vein
- Esophageal, pericardial and mediastinal veins
- **Superior Hemiazygos Vein:** Accessory hemiazygos vein – present in the left side-equivalent to superior part of azygos vein
 - Begins at 4th or 5th intercostal space
 - Receives 5th to 8th left posterior intercostal vein
 - Finally terminates into azygos at the level of T7
- **Inferior Hemiazygos Vein:** Hemiazygos vein – present in the left side - equivalent to inferior part of azygos vein
 - Formed by left lumbar azygos, left subcostal vein and left ascending lumbar vein
 - Pierce the left crus of diaphragm and joins with azygos vein
 - Receives 9, 10, 11 left posterior intercostal vein and ends in azygos vein at the level of T8.

- Increase the heart rate, dilates bronchial lumen and coronary arteries.

Sympathetic Trunk

- Descends in front of neck of the ribs and posterior intercostal vessels
- Contains stellate ganglion which is formed by fusion of inferior cervical ganglion with first thoracic ganglion
- Enters the abdomen through crus of the diaphragm
- Gives cardiac branch, mediastinal branch, pulmonary and splanchnic branches
- Connected to thoracic spinal nerve by gray and white rami communicantes.



Clinical Aspect

Stellate Ganglion Block

- Injection of local anesthetic near the ganglion by placing the tip of the needle near the neck of first rib
- Produces temporary interruption of sympathetic function.

AUTONOMIC NERVOUS SYSTEM IN THORAX

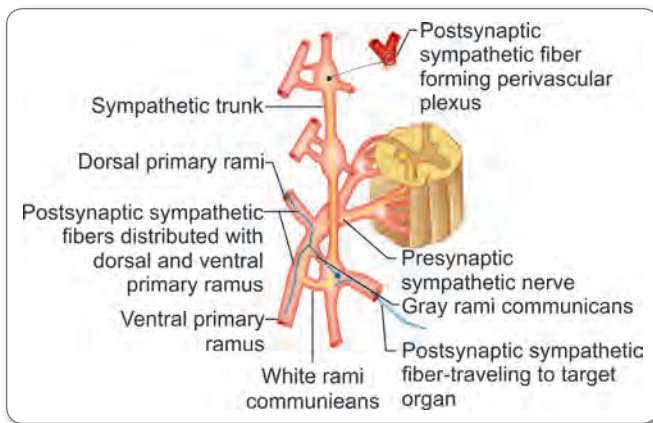


Fig. 68: Autonomic nervous system in thorax

- Consists of sympathetic and parasympathetic
- Involves preganglionic and post ganglionic neurons. And include general visceral afferent and these GVA fibers run along with general visceral efferent fibers
- Consists of cholinergic fibres (sympathetic preganglionic, parasympathetic preganglionic and post ganglionic) use acetylcholine as the neurotransmitter and adrenergic fibers (sympathetic post ganglionic) use norepinephrine as the neurotransmitter.

SYMPATHETIC NERVOUS SYSTEM

- Contains preganglionic cell bodies that are located in the lateral horn of the spinal cord segments T1 and T2
- Preganglionic fibers pass through white rami communicantes and enter the sympathetic ganglion and synapse
- Postganglionic fibers that join each spinal nerve by gray rami communicantes and supply the blood vessels, arrector pili muscles and sweat glands

Rami Communicantes White Rami Communicantes

- Contains preganglionic sympathetic GVE (myelinated) fibers with cell bodies located in lateral horn of the spinal cord and GVA fibers with cell bodies located in dorsal root ganglia
- Connected to spinal nerves.

Gray Rami Communicantes

- Post ganglionic sympathetic (unmyelinated) fibers that supply the blood vessels, sweat glands and arrector pili muscles
- Connected to spinal nerve and contain fibers with cell bodies located in sympathetic trunk.

Thoracic Splanchnic Nerves

- Greater splanchnic nerves – arises from T5–T9. Perforates crus of diaphragm and ends in the celiac ganglion
- Lesser splanchnic nerve – arises from T10, 11 pierces the crus of the diaphragm and end in aorticorenal ganglion
- Least splanchnic nerve – derived from T12 pierces the crus of the diaphragm and end in renal plexus.

PARASYMPATHETIC SYSTEM

- Has preganglionic fibers running in cranial nerve 3,7 and 9 that pass to cranial autonomic ganglia
- Has preganglionic fibers in vagus and in pelvic splanchnic nerve S2, 3, 4. That pass to terminal ganglion where they synapse
- Vagus nerve with the longest extra cranial course supply up to midgut
- Pelvis splanchnic nerve supply the hind gut and pelvic viscera
- Parasympathetic system decrease heart rate, constricts the bronchial lumen and causes vasoconstriction of coronary arteries.



Right Vagus

- Gives recurrent laryngeal nerve which hooks around the subclavian artery and ascends in the neck between trachea and esophagus
- Crosses anterior to right subclavian artery runs posterior to SVC and descends at the right surface of trachea and then posterior to right main bronchus
- Contributes to cardiac, pulmonary and esophageal plexus
- Pass through esophageal opening and continue as posterior vagal trunk.

Left Vagus

- Enters the thorax between left common carotid and subclavian artery and behind the brachiocephalic vein and descends on the arch of aorta

- Gives left recurrent laryngeal nerve which hook around the arch of aorta to the left of ligamentum arteriosum.
- It ascends through superior mediastinum and in neck in a groove between trachea and esophagus
- Gives cardiac branches, pulmonary branches and continue as anterior vagal trunk.



Clinical Aspect

- Injury to recurrent laryngeal nerve due to bronchogenic carcinoma, esophageal carcinoma, enlargement of mediastinal lymph nodes, aneurysm of aortic arch or thyroid surgeries.
- Effects—hoarseness of voice, inability to speak
- Vagotomy—transection of vagus at the lower end of esophagus to decrease the gastric secretion In the treatment of ulcer.



Chapter at a Glance

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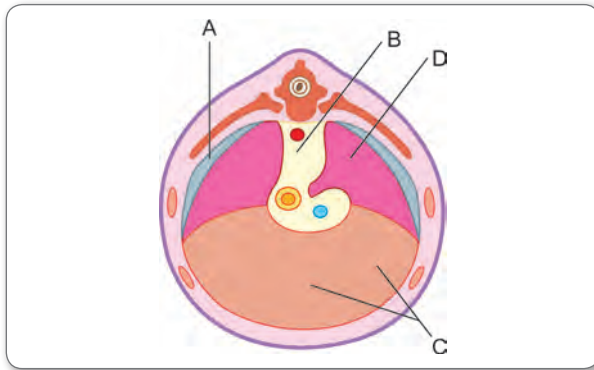
THORAX

- Medial arcuate ligament – thickening of psoas fascia
- Lateral arcuate ligament thickening of thoracolumbar fascia
- Typical intercostal space – 3 to 6
- First 6 anterior intercostal artery from internal thoracic artery, for 7 to 9 spaces from musculophrenic artery
- First right posterior intercostal vein opens into right brachiocephalic vein
- 2, 3, 4 right posterior intercostal vein opens into arch of azygos vein
- 5 to 11 right posterior intercostal vein opens into azygos vein
- 1st, 2nd, 3rd, 4th left posterior intercostal vein drain into left brachiocephalic vein
- 5 to 7 left posterior intercostal vein – superior hemiazygos
- 8 to 11 left posterior intercostal vein – inferior hemiazygos
- Suprapleural membrane (Sibson's fascia) – cervical diaphragm – scalenus minimus
- Attachment – behind – Transverse process of C7, in front – Inner border of 1st rib
- Trachea bifurcation in living – T6, cadaver – T4
- In erect posture – most dependent bronchopulmonary segment – right posterior basal segment (right lower lobe)
- In supine posture – most dependent bronchopulmonary segment – apical segment in right lower lobe
- Medial basal segment in left lung is suppressed
- Tetralogy of Fallot – pulmonary stenosis, right ventricular hypertrophy, ventricular septal defect, overriding of aorta
- Pentalogy of Fallot – includes atrial septal defect along with other features of Tetralogy of Fallot
- Cardiac dominance depends upon the source of origin of posterior inter ventricular artery
- Tributaries of azygos vein – right posterior intercostal vein (formed by 2, 3, 4 right posterior intercostal vein), superior and inferior hemiazygos, right bronchial vein, esophageal vein, pericardial vein and mediastinal vein
- Inferior hemiazygos – T8
- Superior hemiazygos – T7
- Branch from arch of aorta – brachiocephalic trunk, left subclavian artery, left common carotid.



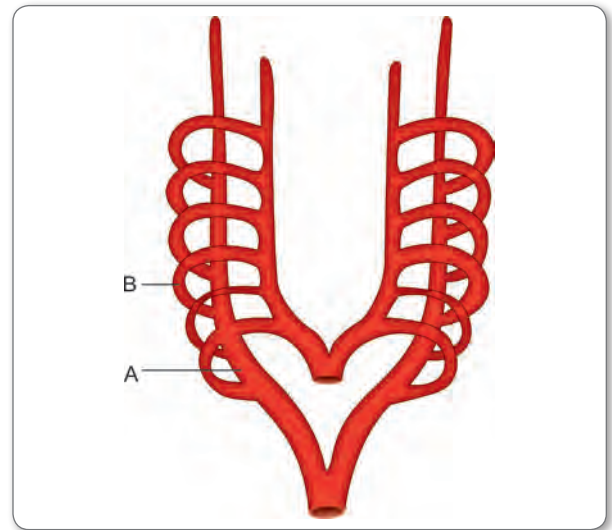
Multiple Choice Questions

- Diaphragm develops from all, except: (AI 2011)
 - Septum transversum
 - Dorsal mesocardium
 - Pleuro-peritoneal membrane
 - Cervical myotomes
- The below figure depicts section of embryo developing diaphragm. Congenital diaphragmatic hernia is mostly commonly due to defect in: (AIIMS May 2016)



- A
 - B
 - C
 - D
- Ligamentum arteriosum is a remnant of: (DNB 2005)
 - Ductus arteriosus
 - Ductus caroticus
 - Ductus venosus
 - None
 - What is true about sinus venosus? (Recent Question 2013)
 - Forms rough part of right atrium
 - Forms smooth part of right atrium
 - Forms right coronary sinus
 - Forms left leaflet of coronary sinus
 - Premature closure of foramen ovale results in (DNB 2003)
 - Under developed right atrium
 - Right ventricular hypertrophy
 - Left ventricular hypertrophy
 - Pulmonary stenosis
 - The membranous part of the atrioventricular part of interventricular septum is between (DNB 2005)
 - RA and LV
 - LA and RV
 - RA and RV
 - LA and LV
 - True regarding heart development is/are A/E: (AE PGI Nov. 2010)
 - Dorsal mesocardium forms transverse pericardial sinus
 - Myosites arise from splancholeptic mesoderm
 - Purkinje fibers from somatopleptic mesoderm
 - Neural crest form the spiral septum.
 - Cardiac jelly forms endocardial cushion
 - Unequal division of conus cordis resulting from anterior displacement of conotruncal septum gives rise to: (AIIMS 2003)
 - Persistent truncus arteriosus
 - Coarctation of aorta
 - Tetralogy of Fallot
 - Transposition of great vessels

- The structure derived from the left 4th aortic arch: (DNB 2008)
 - Right common carotid artery
 - Right subclavian artery
 - Arch of aorta
 - None of the above
- Fate of 6th aortic arch: (JIPMER May 2017)
 - Arch of aorta
 - Ductus arteriosus
 - Right brachiocephalic artery
 - Left subclavian artery
- Photograph shown below represents the stage of development of aortic arches. Abnormal subclavian artery results due to:



- Persistence of B and obliteration of A
 - Persistence of A only
 - Persistence of A and obliteration of B
 - Persistence of B only
- All of the following formed from vitelline vein, EXCEPT: (AI 1998)
 - Superior vena cava
 - Hepatic vein
 - Inferior vena cava
 - Superior mesenteric vein
 - All are accessory muscles of inspiration, EXCEPT: (AI 1993, DNB 2003)
 - Serratus anterior
 - Serratus posterior
 - Latissimus dorsi
 - Scaleni
 - 8, 9, 10 attached to 7th rib by (Recent Question 2014)
 - Fibrous
 - Synovial
 - Primary cartilaginous
 - Secondary cartilaginous
 - False rib: (Recent Question 2014)
 - 1st
 - 2nd
 - 7th
 - 10th
 - All of the following are attached to first rib, except: (Recent Question 2015)
 - Scalenus anterior
 - Scalenus posterior
 - Scalenus medius
 - Sibsons fascia



17. All the direct articulation of true rib, except: (AI 1991)
a. Costosternal b. Costochondral
c. Costotransverse d. Costo vertebral
18. While doing thoracentesis, it is advisable to introduce needle along (AI 2005)
a. Upper border of the lower rib
b. Lower border of the upper rib
c. In the center of the intercostals space
d. In anterior part of intercostals space
19. A patient presents with penetrating chest wound associated with intrathoracic haemorrhage. A thoracotomy is done by taking an incision in the 4th/5th intercostals space starting 1 cm away from the lateral margin of the sternum. This is done to avoid injury to the (AI 2012)
a. Pleura b. Intercostal artery
c. Internal thoracic artery d. Intercostal nerve
20. Attachment of sibsons fascia (Recent Question 2015)
a. C1 b. C2
c. C5 d. C7
21. True about sternal angle (Recent Question 2015)
a. Xiphisternal joint
b. T6-T7 level
c. Articulate with 2nd costal cartilage
d. None of the above
22. Pleural tapping in midaxillary line, muscle not pierced is: (AIIMS Nov. 2007)
a. Internal intercostals b. External intercostals
c. Innermost intercostals d. Transverses thoracis
23. Which of the muscle is not cut in posterolateral thoractomy: (PGI 1998)
a. Serratus anterior b. Pectoralis major
c. Latissimus dorsi d. Intercostals
24. Branches of internal thoracic artery, except: (Recent Question 2015)
a. Anterior intercostal artery
b. Posterior intercostals artery
c. Musculophrenic artery
d. Superior epigastric artery
25. True about anterior intercostal artery: (Recent Question 2015)
a. Present in 1 to 11 space
b. Each space contains has 2 anterior intercostals artery
c. Branch of internal thoracic artery
d. Branch of aorta
26. The regular arrangement of VAN arrangement is not seen in: (AIIMS 2013)
a. 1st intercostal space b. 2nd intercostal space
c. 3rd intercostal space d. 11th intercostal space
27. All are true about intercostal nerve, except: (Recent Question 2015)
a. Relation from above downwards is nerve, vein and artery
b. T4, 5, 6 are typically intercostals space
c. Lies between innermost intercostal and internal intercostal muscle
d. T7 to T11 supply the abdominal wall
28. In a case of chest pain with pericarditis with pericardial effusion, pain referred by: (AIIMS Nov. 2007)
a. Phrenic nerve b. Superficial cardiac plexus
c. Deep cardiac plexus d. Vagus nerve
29. Transverse sinus is present posterior to what structures: (Recent Question 2014)
a. Right atrium
b. Left atrium
c. Upper pulmonary artery
d. Aorta
30. The right coronary artery supplies all of the following parts of the conducting system in the heart, except: (Recent Question 2012, DNB 2004, AI 2003)
a. SA node b. AV node
c. AV bundle d. Right bundle branch
31. Blood supply of ventral 2/3 interventricular septum of heart (Recent Question 2015)
a. Right coronary artery
b. Left coronary artery
c. Posterior interventricular artery
d. Marginal artery
32. All of the following are true about coronary artery, except: (AI 2001)
a. Right coronary artery lies in right anterior coronary sulcus
b. Left anterior descending artery is a branch of left coronary artery
c. Usually 3 obtuse marginal arteries arise from the left coronary artery
d. In 85% of cases posterior descending interventricular artery arises from right coronary artery
33. Koch triangle has blood supply from
a. Right coronary
b. Left coronary
c. Left anterior descending
d. Anterior aortic sinus
34. If the circumflex artery gives off posterior interventricular artery, then arterial supply is called: (AIIMS Nov. 2007)
a. Right dominance b. Left dominance
c. Balanced dominance d. Undetermined
35. True regarding coronary circulation: (PGI 1995)
a. Dominance affects anterior surface
b. Most are left dominant
c. Left artery supplies more tissue in right dominance
d. Dominance depends on nodal artery and marginal artery
36. Branch of right coronary artery (PGI May 2004)
a. Obtuse marginal
b. Acute marginal
c. Posterior interventricular
d. Diagonal
37. All the following arteries are common sites of occlusion by a thrombus except (AIIMS May 2005)
a. Anterior interventricular
b. Posterior interventricular
c. Circumflex
d. Marginal
38. Anterior cardiac vein opens in to: (DNB 2010)
a. Right atrium b. Great cardiac vein
c. Coronary sinus d. Marginal vein
39. The middle cardiac vein is located at the (AI 2003)
a. Anterior interventricular sulcus
b. Posterior interventricular sulcus
c. Anterior AV groove
d. Posterior AV groove



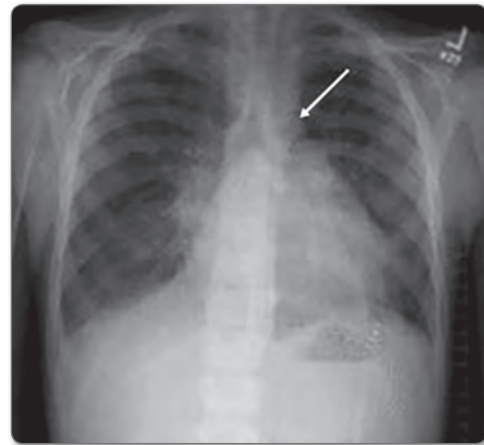
40. **Coronary sinus guarded by:**
- Crista terminalis
 - Thebesian valve
 - Mitral valve
 - Spiral valve
41. **True about coronary sinus** (PGI May 2011)
- Remnant of left horn of sinus venosus
 - Great, middle and small cardiac vein drains into it
 - Thebesian vein drains into coronary sinus
 - Opens into right ventricle
 - Thebesian valve guards the opening
42. **A 53-years old patient had Myocardial infarction. Coronary angiography showed involvement of left anterior descending (LAD) artery. All the following are the branches of LAD artery except** (JIPMER Dec 2016)
- Diagonal artery
 - Septal branches
 - Left conus artery
 - SA nodal artery
43. **Fossa ovalis is a remnant of:** (Recent Question 2014)
- Septum primum
 - Septum secundum
 - Ductus arteriosus
 - Ductus venosus
44. **Not form the boundary of triangle of Koch:** (AIIMS 2000)
- Coronary sinus
 - Tricuspid valve ring
 - Tendon of todaro
 - Limbus fossa ovalis
45. **Which of the following is situated in upper part of crista terminalis?** (Recent Question 2015)
- AV Node
 - Bundle of his
 - RBB
 - SA node
46. **Where is torus aorticus located:** (Recent Question 2015)
- Left atrium
 - Right atrium
 - Aorta
 - Left ventricle
47. **Base of the heart is formed by:** (Recent Question 2013)
- Right atrium
 - Left atrium
 - Left ventricle
 - Right ventricle
48. **True about right atrium** (AIIMS 1999)
- Auricle lies superolaterally
 - Related to central tendon of diaphragm at T10 level
 - Coronary sinus lies between fossa ovalis and IVC
 - SVC opening is guarded by endocardial valve
49. **True about anatomy of right ventricle** (PGI Dec. 2008)
- Situated posteriorly
 - More prominent trabeculation
 - Crista supraventricularis separate tricuspid valve and pulmonary valve
 - Apex trabeculated
 - Tricuspid valve and pulmonary valve share fibrous continuity
50. **A 59-year-old man complains of recurrent attacks of pain in the region of left shoulder radiating to sternum. The attacks of pain came at lengthy intervals until the last two days when it becomes continuous. The physician diagnosed it as angina pectoris. In this case pain pathway carried by:**
- Superior cervical cardiac nerve (AIIMS 2004)
 - Middle and inferior cervical cardiac nerve
 - Thoracic splanchnic nerve
 - Vagus
51. **Sympathetic innervations of heart by** (AI 2012)
- T1 - T3
 - T1 - T5
 - T3 - T7
 - L1 - L5
52. **True about SA node are all, except:** (Recent Question 2015)
- Supplied by nodal artery
 - Primary pace maker
 - Supplied by left vagus nerve
 - Made up of nodal cells and connective tissue
53. **Surface marking of mitral valve** (AI 2012)
- Behind sternal end of left 4th costal cartilage
 - Behind sternal end of right 4th costal cartilage
 - Left 4th intercostal space in the mid clavicular line
 - Left 3rd intercostal space in the mid clavicular line
54. **Which of the following statements is/are true about diaphragm** (PGI Nov. 2009)
- Left side pushed down by heart
 - Left side lower than right side
 - Right side lower than left
 - Right side pushed up by liver
 - Hernia common on left because of weak origin
55. **Aortic hiatus contains:** (Recent Question 2018, AIIMS May 2009)
- Left gastric vein and thoracic duct
 - Thoracic duct and hemiazygos vein
 - Azygos vein and thoracic duct
 - Left vagus and thoracic duct
56. **Structures passing through central tendon of diaphragm:** (AIIMS May 2017)
- Esophagus
 - Aorta
 - Thoracic duct
 - IVC
57. **Structure not passing through esophageal hiatus** (AIIMS Nov. 2011)
- Left phrenic nerve
 - Right vagus
 - Left vagus
 - Left gastric artery
58. **IVC pierces the diaphragm at what level of diaphragm** (Recent Question 2014)
- T6
 - T8
 - T10
 - T12
59. **True about esophageal hiatus** (PGI 2002)
- Lies between two crura of diaphragm
 - At the level of T12
 - Vagus pass through it
 - Lies in the right crus
 - Thoracic duct pass through it
60. **Diaphragmatic hernia can occur through all the following, except:** (AI 2002)
- Esophageal opening
 - Costovertebral triangle
 - Costal and sternal attachment of diaphragm
 - Inferior vena cava opening
61. **Bochdalek hernia occurs through:** (DNB 2004, AI 1998)
- Anteromedial part of diaphragm
 - Posterolateral part of diaphragm
 - Central tendon of diaphragm
 - Hiatus hernia
62. **True about foramen of morgagni:** (PGI Dec. 2004)
- It is femoral canal
 - Diaphragmatic opening
 - Superior epigastric vessels pass through it
 - Located posteriorly
 - Esophagus pass through it



63. The esophagus commences at the following level: (DNB 2002)
- Lower end of cricoid
 - C5 vertebra
 - 10 cm from incisor teeth
 - C7
64. IInd constriction in esophagus is seen at the following site: (DNB 2001, AI 1998)
- Where it crosses left main bronchus
 - Crossing of arch of aorta
 - At pharyngoesophageal junction
 - Where it pierces the diaphragm
65. Approximate distance of diaphragmatic constriction from nostril and incisor are: (DNB 2005, AI 1993)
- 7" and 6"
 - 11" and 10"
 - 17" and 16"
 - 23" and 22"
66. Blood supply of cervical part of esophagus:
- Aorta
 - Inferior thyroid artery
 - Gastric artery
 - Superior thyroid artery
67. True about esophagus: (PGI 2010, 2008, 2004)
- 25 cm length
 - Has columnar epithelium
 - Has squamous epithelium
 - Sphincter located at the upper end
 - Physiological sphincter at the lower end
 - Serosa located outside
 - Muscle layer in the upper part is skeletal
 - Mucosa contains lymphatics
 - Striated muscle in middle part
68. All of the following statements about venous drainage of esophagus are true except: (AIIMS May 2016)
- Left gastric vein meets the lower esophageal veins
 - Cervical part drains into brachiocephalic vein
 - Blood from esophagus drains into submucosal plexus
 - Thoracic part drains into azygos veins
69. Which is the upper most structure in left lung hilum: (AIIMS Nov. 2007)
- Pulmonary artery
 - Pulmonary vein
 - Left main bronchus
 - Bronchial artery
70. At hilum of lung, what enters: (Recent Question 2015)
- Primary/Principal bronchus
 - Secondary bronchus
 - Tertiary bronchus
 - Bronchiole
71. All of following lies between apex of lung and 1st rib: (AI 2012)
- Thoracic duct
 - Superior intercostals artery
 - First posterior intercostals vein
 - Sympathetic trunk
72. An inhaled foreign body is likely to lodge in the right lung due to all of the following features, except: (AI 2004)
- Right lung is shorter and wider than left lung
 - Right principal bronchus is more vertical than the left bronchus
 - Tracheal bifurcation directs the foreign body to the right lung
 - Right inferior lobe bronchus is in continuation with the principal bronchus
73. The right costophrenic recess extends up to the level of which rib in the midaxillary line: (DNB 2002, AI 1996)
- 6TH
 - 10TH
 - 8TH
 - 12TH
74. Not true about visceral pleura: (Recent Question 2013)
- Pain insensitive
 - Supplied by phrenic nerve
 - Has three borders
 - Develops from splanchnopleural mesoderm
75. A patient with recurrent chest infections present to the emergency department. He was ordered for an X ray. The patient says that he has an "azygos lobe" diagnosed few years back. What is the location of azygos lobe? (AIIMS 2015)
- Right Upper lobe
 - Left upper lobe
 - Right lower lobe
 - Left lower lobe
76. In the lung bronchial arteries supply the bronchopulmonary tree (AI 2008)
- Till the tertiary bronchi
 - Till the segmental bronchi
 - Till the respiratory bronchioles
 - Till alveolar sacs
77. Middle lobe of right lung contains segments (Recent Question 2014)
- Superior and inferior
 - Anterior and posterior
 - Medial and lateral
 - Apical and basal
78. Lingula is a part of: (DNB 2006)
- Left upper lobe
 - Left lower lobe
 - Right upper lobe
 - Right middle lobe
79. All the following are characteristic features of bronchopulmonary segment, except: (AIIMS Nov. 2004)
- It is surgically resectable
 - It is named according to the segmental bronchus supplying it
 - Intrasegmental – pulmonary vein
 - It is the largest subdivision of lobe
80. Bronchopulmonary segments in right and left lung (Recent Question 2015)
- 9, 11
 - 11, 9
 - 10, 10
 - 8, 10
81. True about bronchopulmonary segment: (PGI 2005)
- Avascular intersegmental planes
 - Complete vascular segment
 - Pulmonary vein occupy central in position
 - Pulmonary vein drains more than one segment
 - One pulmonary vein drain 1 segment
82. Which of the following statements is correct regarding the trachea? (PGI 2001)
- During deep inspiration, tracheal bifurcation may descend to T6
 - Left bronchus is wider and shorter
 - The arch of aorta lies over right bronchus and anterior to it
 - Sensory supply of trachea is by vagus
 - Esophagus lies anterior to the trachea



- 83. True regarding trachea is:** (JIPMER May 2015)
 a. Consists of 12 incomplete rings of cartilage
 b. 15cm long in the adult
 c. Lined by nonciliated pseudostratified columnar epithelium
 d. 2nd, 3rd and 4th tracheal rings are related with isthmus of thyroid
- 84. Anteroposterior diameter of trachea in male and female are respectively:** (May 2018, Dec 2016)
 a. 27 mm and 25 mm
 b. 25 mm and 23 mm
 c. 25 mm and 21 mm
 d. 20 mm and 15 mm
- 85. Respiratory bronchiole proceed to:** (Recent Question 2015)
 a. Terminal bronchiole b. Bronchi
 c. Tertiary bronchiole d. Alveolar duct
- 86. Carina is situated at which level:** (Recent Question 2015)
 a. T3 b. T4
 c. T5 d. T9
- 87. Thoracic duct crosses at:** (Recent Question 2014)
 a. T1 b. C7
 c. T5 d. T8
- 88. Thoracic duct does not drain:** (Recent Question 2013)
 a. Right upper part of body
 b. Left upper part of body
 c. Right lower part of body
 d. Left lower part of body
- 89. All are true about thoracic duct, except:** (Recent Question 2014)
 a. Begins as continuation of cistern chili
 b. Passes through esophageal opening
 c. Ends into junction between left subclavian and left internal jugular vein
 d. Largest lymphatic vessel
- 90. Not true about superior vena cava:**
 a. Opens into right ventricle (Recent Question 2015)
 b. Enters heart at level of 3rd costal
 c. Pierces pericardium at 2nd costal cartilage
 d. Receives azygos vein behind sternal angle
- 91. Vaso vasorum of ascending aorta arises from:**
 a. Left coronary artery (Recent Question 2015)
 b. Anterior interventricular artery
 c. Posterior interventricular artery
 d. Left atrium
- 92. All of the following drain into azygos vein except:**
 a. Hemi-azygos vein
 b. Posterior intercostal vein
 c. Left superior intercostal vein
 d. Right superior intercostal vein
- 93. True about right phrenic nerve:** (PGI Nov. 2010)
 a. Motor branch
 b. Sensory branch
 c. Arise from C4
 d. Shorter than left phrenic
- 94. True about left phrenic nerve** (AIIMS Nov. 2009)
 a. Anterior to scalenus anterior
 b. Posterior to brachial plexus
 c. Posterior to subclavian artery
 d. Posterior to hilum of the left lung
- 95. In the post ductal coarctation of aorta which of the following arteries not involved in collaterals:** (AIIMS May 2008)
 a. Axillary artery
 b. Posterior intercostals artery
 c. Suprascapula artery
 d. Vertebral artery
- 96. Which of the following not comes under chest wall proper?**
 a. External intercostals muscle (Recent Question 2016-17)
 b. Internal intercostals muscle
 c. Pectoralis major
 d. Sternocostalis
- 97. All of the following structures pass through the esophageal hiatus of the diaphragm, except:**
 a. Left vagus nerve (Recent Question 2015-16)
 b. Right vagus nerve
 c. Esophageal branch of left gastric artery
 d. Thoracic duct
- 98. Aortic orifice lies at the level of:** (Recent Question 2016-17)
 a. 2nd intercostal cartilage b. 3rd costal cartilage
 c. 3rd intercoastal space d. 2nd Intercoastal space
- 99. Pulmonary orifice is located along the left sternal border in:** (Recent Question 2016-17)
 a. 2nd intercostal cartilage b. 3rd intercostal cartilage
 c. 2nd intercostal space d. 3rd intercostal space
- 100. X-ray showing left border of heart. Identify the structure marked with the arrow:** (Recent question 2016-17)



- a. Root of aorta b. Pulmonary artery
 c. Left atrial appendage d. Aortic knuckle
- 101. Thymus location which mediastinum?** (Recent Question 2016-17)
 a. Anterior and superior b. Posterior and anterior
 c. Middle & superior d. Superior and posterior
- Lungs**
- 102. Posterior relation of hilum of lung is:** (Recent Question 2016-17)
 a. Vagus nerve b. Phrenic nerve
 c. Pulmonary ligament d. Pericardiophrenic arteries



103. In midaxillary line lower border of lung lies at the level of:

(Recent Question 2016-17)

- a. 6th rib
- b. 8th rib
- c. 10th rib
- d. None

104. Distance of cricopharyngeal constrictor from central incisor is:

(Recent Question 2016-17)

- a. 10 cm
- b. 15 cm
- c. 20 cm
- d. 22.5 cm

105. X-ray neck. (lateral view). Structure marked by the arrow is:

(Recent Question 2016-17)



- a. Cricoid
- b. Thyroid
- c. Hyoid
- d. Epiglottis

106. What distance from central incisor to arch of aorta crosses the esophagus:

(Recent Question 2016-17)

- a. 15 cm
- b. 20 cm
- c. 22.5 cm
- d. 25 cm

107. Relation of esophagus to thoracic duct and aorta:

(Recent Question 2016-17)

- a. Lies anterior to thoracic duct and aorta
- b. Lies posterior to thoracic duct and aorta
- c. Lies laterally to thoracic duct
- d. Not related closely

108. Sternocostal surface of heart not formed by:

(Recent Question 2016-17)

- a. RV
- b. LV
- c. RA
- d. LA

109. The distance between the upper incisor to hyoid bone:

(Recent Question 2016-17)

- a. 12 cm
- b. 15 cm
- c. 20 cm
- d. 18 cm

Heart

110. Cardiac dominance is based on:

(Recent Question 2013, 2016-17)

- a. Circumflex artery
- b. Posterior interventricular artery
- c. Anterior interventricular artery
- d. None of the above

Diaphragm

111. Aortic opening, thoracic duct and opening of azygos vein in diaphragm is situated at the level of:

(Recent Question 2016-17)

- a. T8
- b. T10
- c. T12
- d. T6

112. Posterior to sternum is:

(Recent Question 2013)

- a. Left atrium
- b. Left ventricle
- c. Right atrium
- d. Right ventricle

113. At saint Louis angle what crosses?

(Recent Question 2012)

- a. Arch of aorta
- b. Azygos vein
- c. Common carotid artery
- d. Innominate vein

114. Untrue about cardiac jelly:

(AIIMS 2006)

- a. Secreted by cardiac myocytes surrounding primitive heart tube
- b. Found exterior to endothelium
- c. Forms myocardium
- d. Transforms into the connective tissue of the endocardium

115. Foramen ovale closes because of fusion of:

(Recent Question 2012)

- a. Septum primum + Endocardial cushion
- b. Septum secundum + Endocardial cushion
- c. Septum primum + Septum secundum
- d. None

116. The structure present anterior to transverse pericardial sinus is:

(Recent Question 2012)

- a. Inferior vena cava
- b. Superior vena cava
- c. Aorta
- d. Pulmonary artery

117. Heart is fully developed at which age of intrauterine life?

(Recent Question 2013)

- a. 3rd month
- b. 4th month
- c. 5th month
- d. 6th month

118. Sinus venosus receives blood from all, except:

(Recent Question 2015)

- a. Vitelline vein
- b. Umbilical vein
- c. Common cardinal vein
- d. Subcardinal vein

119. Posterior to transverse pericardial sinus is:

(Recent Question 2015)

- a. Aorta
- b. Pulmonary trunk
- c. SVC
- d. Left atrium

120. Relationship of neurovascular bundle from above downward in intercostal space:

(Recent Question 2015)

- a. Nerve ->Artery->Vein
- b. Artery->Nerve->Vein
- c. Vein->Nerve->Artery
- d. Vein->Artery->Nerve

121. Scalene tubercle is a feature of:

(Recent Question 2015)

- a. 1st rib
- b. 2nd rib
- c. 3rd rib
- d. 4th rib

122. Intercostal nerve is a branch of:

(Recent Question 2015)

- a. Brachial plexus
- b. Dorsal rami of thoracic spinal nerves
- c. Ventral rami of thoracic spinal nerve
- d. Ventral rami of cervical spinal nerve

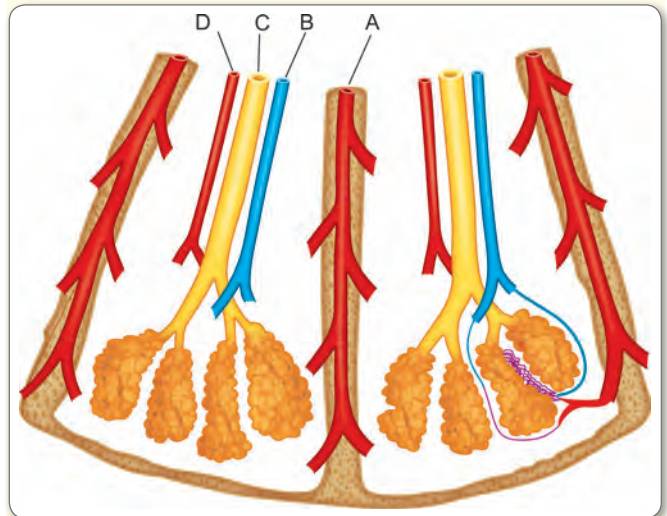
123. Intercostobrachial nerve is a branch of:

(JIPMER 2002)

- a. 1st Intercostal nerve
- b. 2nd Intercostal nerve
- c. 3rd Intercostal nerve
- d. Upper trunk of brachial plexus



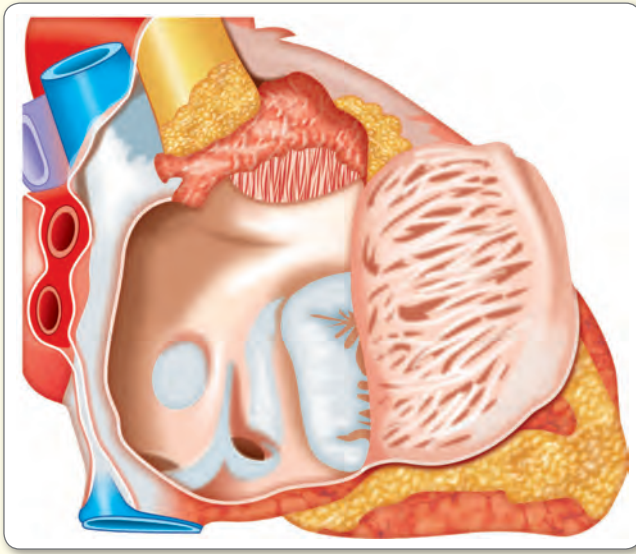
- 124. Upper two posterior intercostal arteries arise from:** (Recent Question 2015)
 a. Aorta
 b. Superior intercostal artery
 c. Internal mammary artery
 d. Bronchial artery
- 125. Left superior intercostal vein drains into:** (Recent Question 2015)
 a. Azygous vein
 b. Hemiazygos vein
 c. Left brachiocephalic vein
 d. Innominate vein
- 126. Superior vena cava opens into right atrium at the level of:** (Recent Question 2012)
 a. T1
 b. T3
 c. T4
 d. T5
- 127. The last tributary of the azygous vein is:** (Recent Question 2014)
 a. Right superior intercostal vein
 b. Hemi-azygos vein
 c. Right bronchial vein
 d. Accessory azygous vein
- 128. The opening in central tendon of diaphragm transmits:** (Recent Question 2013)
 a. Aorta
 b. Esophagus
 c. Right phrenic nerve branch
 d. Left gastric artery branch
- 129. The structures passing posterior to diaphragm are all, except:** (AIIMS 2006)
 a. Aorta
 b. Azygos vein
 c. Thoracic duct
 d. Greater splanchnic nerve
- 130. Surface marking of the oblique fissure of lung include all, except:** (Recent Question 2013)
 a. T 3 vertebra
 b. 5th rib
 c. 7th rib
 d. 6th costal cartilage
- 131. Which is NOT a lobe of lung:** (Recent Question 2015)
 a. Azygous
 b. Superior
 c. Inferior
 d. Lingula
- 132. Which of the following are related to the mediastinal part of right lung?** (Recent Question 2013)
 a. Arch of aorta
 b. SVC
 c. Pulmonary trunk
 d. Left ventricle
- 133. Inferior most structure of right hilum is:** (Recent Question 2007)
 a. Bronchus
 b. Inferior pulmonary vein
 c. Pulmonary artery
 d. Inferior bronchial vein
- 134. Which are segments of upper lobe in the right lung:** (Recent Question 2013)
 a. Anterior, posterior, medial
 b. Apical, anterior, posterior
 c. Lateral, medial, superior
 d. Basal, lateral, medial
- 135. Cardiac BPS of right lung is:**
 a. Medial
 b. Lateral
 c. Medial basal
 d. Anterior basal
- 136. Rasmussen's aneurysm involves:** (AIIMS 2008)
 a. Bronchial artery
 b. Pulmonary artery
 c. Intercostal artery
 d. Aorta
- 137. Torus aorticus is seen due to:** (Recent Question 2015)
 a. Atrium bulging into the aorta
 b. Aortic sinus bulging into left atrium
 c. Aortic sinus bulging into right atrium
 d. Aortic wall tear
- 138. Occlusion of the LAD will lead to infraction of which area:** (Recent Question 2012)
 a. Posterior part of the interventricular septum
 b. Anterior wall of the left ventricle
 c. Lateral part of the heart
 d. Inferior surface of right ventricle
- 139. Cardiac ganglion is situated:** (Recent Question 2015)
 a. Below arch of aorta
 b. Above arch of aorta
 c. Left side of ligamentum arteriosum
 d. Posterior to ligamentum arteriosum
- 140. The following statements are true regarding the SA node except:** (AIIMS 2005)
 a. Is located at the right border of the ascending aorta
 b. In contains specialized nodal cardiac muscle
 c. It is supplied by the artial branched of the right coronary artery
 d. It initiates cardiac conduction
- 141. Purkinje fibres are:** (Recent Question 2014)
 a. Modified nerve fibres
 b. Modified smooth muscle
 c. Modified cardiac muscle
 d. Fibrous tissue
- 142. All are true about mediastinum except:** (PGIC 2015)
 a. Heart passes through superior mediastinum
 b. Heart passes through middle mediastinum
 c. Thymus remnant may present in middle mediastinum
 d. Posterior boundary of posterior mediastinum corresponds to T1-T4 vertebrae
 e. Lower border of anterior mediastinum is extended more than posterior mediastinum
- 143. Left superior intercostal vein drains into:** (AIIMS Nov 2018)
 a. Hemi azygous vein
 b. Brachiocephalic vein
 c. Azygous vein
 d. Internal thoracic vein
- 144. Tendon of Todaro** (JIPMER May 2018)
 a. Raised interatrial septal ridge
 b. Connects IVC and right atrium
 c. Connects left atrium and right atrium
 d. Situated in smooth wall of right atrium
- 145. Identify the pulmonary vein in the given diagram**



- a. A
 b. B
 c. C
 d. D

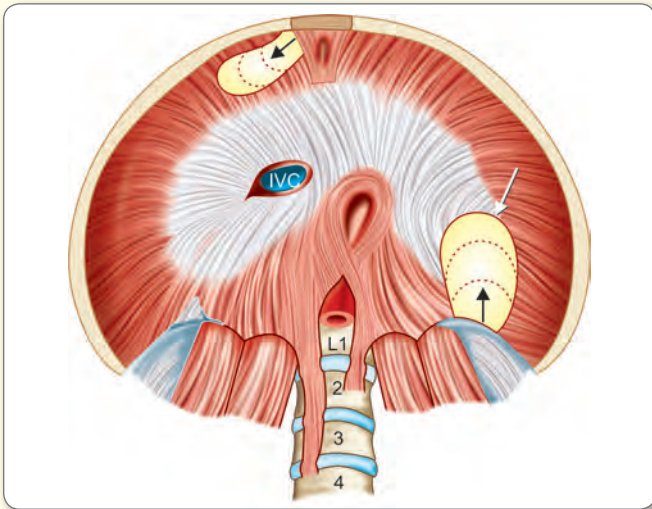


146. The marked structure in the given diagram develops



- a. Septum primum
- b. Septum secundum
- c. Septum spruim
- d. Foramen primum

147. Hernia occurs through marked opening (JIPMER Dec 2018)



- a. Bochdalek hernia
- b. Morgagnian hernia
- c. Eventeration of diaphragm
- d. Hiatus hernia

148. Which of the following is not pierced during pleural tapping

- a. Internal intercostal
- b. External intercostal
- c. Costal pleura
- d. Pulmonary pleura

149. Right coronary artery arises from

- a. Posterior aortic sinus
- b. Coronary sinus
- c. Left aortic sinus
- d. Right aortic sinus

150. In the aortic opening of diaphragm, which of the following structures passes:

- a. Azygous vein
- b. Thoracic duct
- c. Hemiazygos vein
- d. Esophagus
- e. Greater splanchnic nerve

151. Which of the following develop from 4th aortic arch:

- a. Pulmonary artery
- b. Right umbilical artery
- c. Arch of aorta
- d. Left subclavian artery
- e. Right subclavian artery

152. A case of pulmonary TB came to emergency department with complaints of recurrent hemoptysis. In this case which of the following vessel(s) should be considered for angiographic evaluation:

- a. Pulmonary artery
- b. Pulmonary vein
- c. Bronchial artery
- d. Bronchial vein
- e. Superior vena cava

153. Q. True about anatomy of heart:

- a. SA node lies in left atrial appendages
- b. SA node is located at junction of left atrial appendages & superior vena cava
- c. AV node located in triangle of Koch
- d. AV node located at atrial & ventricular junction
- e. Bundle of His lies posteroinferiorly in ventricular septum

154. Structures not passing through aortic opening in diaphragm

- a. IVC
- b. Phrenic nerve
- c. Azygous vein
- d. Thoracic duct
- e. Vagus nerve



Answers with Explanations

1. Ans. b. Dorsal mesocardium

[Ref: A.K. Datta Human Embryology, 6th ed. pg 151]

- Dorsal mesocardium – forms transverse sinus
- Muscular ingrowth from body wall is contributed by cervical somites C3–C5.

2. Ans. d. D

Bochdalek hernia – most common congenital diaphragmatic hernia – due to defect in pleuroperitoneal membrane

3. Ans. a. Ductus arteriosus

[Ref: A.K.Datta Human Embryology, 6th/ed.]

4. Ans. b. Forms smooth part of right atrium

- Rough part developed from primitive atrium

5. Ans. b. Right ventricular hypertrophy

[Ref: Langman's Medical Embryology, 11th ed. pg 197]

Development of Inter Atrial Septum

- Septum primum formed at the roof of right atrium
↓
- Ostium primum is the gap b/w septum primum and endocardial cushion
↓
- Septum primum fuse with endocardial cushion so closure of ostium primum and perforations occur at upper portion of septum primum (Osteum secundum)
↓
- Septum secundum appear at the right of the primum and grow downwards
↓
- Close the osteum secundum and form the foramen ovale.
↓
- After birth increased pressure in left atrium due to beginning of the lung circulation, approximation of the septum primum to the secundum and closure of foramen ovale.

Premature Closure of Foramen Ovale

- No shunt from the right atrium to left atrium
- Hypertrophy of right atrium
- Hypertrophy of right ventricle

6. Ans. a. RA and LV

[Ref: IB Singh Human Embryology. 7th ed. Pg 230]

- Muscular part of interventricular septum separates right and left ventricle
- Membranous part separates right atrium and left ventricle.

7. Ans. c. Purkinje fibers from somatopleuric mesoderm

[Ref: Langman's Medical Embryology, 11th ed. pg 165-168]

- Somato pleuric mesoderm form parietal layer of pericardium
- Neural crest forms conotruncal septum/spiral septum

8. Ans. c. Tetralogy of fallot

[Ref: Langman's Medical Embryology, 11th ed. pg 189]

- Unequal division of conotruncal division of corotruncal septum leads to
- Pulmonary stenosis, over riding of aorta
- Pulmonary stenosis leads to right ventricular hypertrophy
- Right ventricular hypertrophy leads to ventricular septal defect

HIGH YIELD POINTS

- If conotruncal septum fails to form spiral course then it leads to transposition of great vessels
- Conotruncal septum fails to form then leads to persistent truncus arteriosus

9. Ans. c. Arch of aorta

[Ref: A.K. Datta Human Embryology, 6th/ed.]

Left 4th arch – arch of aorta
Right 4th arch – right subclavian artery

10. Ans. b. Ductus arteriosus

Ductus arteriosus from distal part of left 6th arch artery

11. Ans. c. Persistence of A and obliteration of B

A – Dorsal aorta caudal part persist
B – Right 4th arch artery
So A persist and B disappear in abnormal right subclavian artery

12. Ans. a. Superior vena cava

[Ref: Langman's Medical Embryology, 11th ed. pg 192–195]

13. Ans. c. Latissimus dorsi

[Ref: Last Anatomy, 12th ed. pg 187,188]

Intercostal Spaces

- 11 in number
- Typical – 3rd, 4th, 5th and 6th
- Boundaries
- Above – Sharp lower margin of rib Below – Blunt upper margin of rib, in front – Lateral border of sternum and behind – Bodies of thoracic vertebrae
- Contents – Intercostal muscles, nerves and vessels.

14. Ans. b. Synovial

- Interchondral joints are synovial

15. Ans. d. 10th

- True ribs – joins with sternum – 1 to 7



- False ribs – joins with ribs not with sternum – 8 to 12
- Typical – share common feature – 3 to 9
- Atypical – 1, 2, 11, 12

16. Ans. b. Scalenus posterior

[Ref: BDC 6TH edition volume 1 pg 198, 199]

- Scalenus posterior not attached to first rib

17. Ans. a. Costosternal

- True ribs articulate with sternum through costal cartilage through chondrosternal joint not directly by costosternal joint

18. Ans. a. Upper border of the lower rib

[Ref: Last Anatomy, 12th ed. pg 189]

- Lower border of upper rib contains neurovascular structures.

19. Ans. c. Internal thoracic artery

[Ref: Last Anatomy, 12th ed. pg 189]

- Internal thoracic artery arises from 1st part of subclavian artery, 2 cm above the sternal end of clavicle and descends vertically 1 cm from lateral border of sternum. So thoracotomy done by giving incision 1 cm lateral to sternum to avoid injury to internal thoracic artery.

20. Ans. d. C7

- Attachment at transverse process of C7 to inner border of first rib and costal cartilage

21. Ans. c. Articulate with 2nd costal cartilage

- Vertebral level T4

22. Ans. d. Transverses thoracis

[Ref: Last Anatomy, 12th ed. pg 187-189]

- Transverses thoracis consists of innermost intercostals, subcostalis and sternocostalis
- In that only innermost intercostals muscle is pierced.

23. Ans. b. Pectoralis major

[Ref: Last Anatomy 12th Edition 187-189]

- Pectoralis major is cut in anterolateral thoracotomy.

24. Ans. b. Posterior intercostal artery

[Ref: BDC 6TH ed. Volume 1 pg 219]

- Posterior intercostals artery for 1st two spaces from superior intercostals artery branch of costocervical trunk
- Rest of spaces posterior intercostals artery branch of descending thoracic aorta

25. Ans. b each space contains two anterior intercostal artery

[Ref: BDC 6TH ed. Volume 1 pg 219]

- Anterior intercostal artery present in **upper 9 spaces**. 2 in number.
- 10 and 11 th space do not have anterior intercostals artery

- In upper 6 spaces, anterior intercostals artery derived from internal thoracic artery and 7, 8, 9, spaces from musculo phrenic artery.

26. Ans. a. 1st intercostal space

- Arrangement is vein, artery, nerve in the intercostals space except 1st space where the arrangement is nerve, artery and vein

27. Ans. a. Relation from above downwards is nerve, vein and artery

- Neurovascular structures present between internal and inner most intercostal muscle
- Arrangement is VAN
- T3, 4, 5, 6 Typical intercostals space
- T7 – T11 supply the anterior abdominal wall

28. Ans. a. Phrenic nerve

- Phrenic nerve supply the parietal pericardium

29. Ans. d. Aorta

[Ref: Last Anatomy, 12th ed. pg 197]

- In front of transverse sinus – ascending aorta and pulmonary trunk
- Posteriorly – superior vena cava.

30. Ans. d. Right bundle branch

[Ref: Last Anatomy 12th Edition Pg 203 -206; Clinical anatomy by Neeta v kulkarni, third edition, Volume 1 pg 446]

- AV bundle – also supplied by right coronary artery
- LBBB – also supplied by septal branch from posterior interventricular artery
- So right coronary artery supplies all part of conducting system except RBBB

31. Ans. b. Left coronary artery

- Anterior 2/3 of ventricular septum supplied by anterior inter ventricular artery
- Posterior 1/3 of ventricular artery supplied by posterior interventricular artery

32. Ans. c. Usually 3 obtuse marginal arteries arise from the left coronary artery

[Ref: Last Anatomy 12th Edition Pg 203 -206; BDC's Human Anatomy 6th ed. Vol: 1 /264-65]

- Left anterior descending (anterior interventricular artery) is branch of left coronary artery
- Only one marginal artery arise from left coronary artery
- 85% posterior inter ventricular artery arise from right coronary artery, 15% arise from continuation of circumflex artery

33. Ans. a. Right coronary

[Ref: Last Anatomy 12th Edition Pg 203 -206 Clinical anatomy by Neeta v kulkarni, third edition, volume 1 pg 446]

- Triangle of Koch lodges AV node.

**34. Ans. b. Left dominance**

[Ref: Last Anatomy 12th Edition Pg 203 -206]

Cardiac dominance

- Dominance depends posterior interventricular artery, if posterior interventricular artery arise from right coronary artery then right coronary dominance, if posterior interventricular artery arise from left coronary artery then left coronary dominance
- In balanced dominance, branches of right and left coronary artery run in posterior interventricular groove.

35. Ans. c. Left artery supplies more tissue in right dominance

[Ref: Last Anatomy 12th Edition Pg 203 -206]

- Mostly right dominant
- Left artery supplies more tissue than right coronary, term dominance is misleading in this questions.

36. Ans. b. Acute marginal, c. Posterior interventricular

[Ref: Last Anatomy 12th Edition Pg 203-206]

- Acute marginal, posterior interventricular branch are branches of right coronary artery
- Obtuse marginal, diagonal branch, anterior interventricular and circumflex are the branches of left coronary artery

37. Ans. d. Marginal

[Ref: Last Anatomy 12th Edition Pg 203-206]

- Left anterior descending (anterior interventricular) – 40 to 50% most common sites of MI
- Right coronary artery – 30 to 40% involved
- Circumflex branch – 15-20%

38. Ans. a. Right atrium

[Ref: Last Anatomy 12th Edition Pg 206]

39. Ans. b. Posterior interventricular sulcus

[Ref: Last Anatomy 12th Edition Pg 205, 206]

- Posterior interventricular sulcus contains – posterior interventricular artery and middle cardiac vein

40. Ans. b. Thebesian valve

[Ref: Last Anatomy 12th Edition Pg 205, 206]

41. Ans. a. Remnant of left horn of sinus venosus, b. Great, middle and small cardiac vein drains into it, e. Thebesian valve guards the opening

[Ref: Last Anatomy 12th Edition Pg 205, 206]

- There is no Thebesian vein
- Coronary sinus opens into right atrium

42. Ans. d. SA nodal artery

SA nodal artery – 85% from right coronary artery

43. Ans. a. Septum primum**44. Ans. d. Limbus fossa ovalis**

[Ref: Last Anatomy 12th Edition Pg 203 -206 Clinical anatomy by Neeta v kulkarni, third edition, volume 1 pg 446]

- Limbus fossa ovalis not form the boundary of triangle of Koch

45. Ans. d. SA node

- SA node in upper part of crista terminalis
- AV node in triangle of Koch

46. Ans. b. Right atrium

- Torus aorticus – non coronary elevation in right atrium.

47. Ans. b. Left atrium

- Base of heart – 2/3 of left atrium and 1/3 of right atrium so left atrium > right atrium.

48. Ans. c. Coronary sinus lies between fossa ovalis and IVC

[Ref: Grays Anatomy 40th Edition Pg 981-982]

- Auricle of right atrium lies superomedially
- Auricle of left atrium lies superolaterally
- Right atrium related to central tendon at level of T8
- SVC opening is not guarded by any valve.

49. Ans. b. More prominent trabeculation, c. Crista supraventricularis..., d. Apex trabeculated, e. Tricuspid valve and...

[Ref: Grays Anatomy 40th Edition Pg 962-966]

- Situated anteriorly
- Right ventricle is trabeculated and apex is more trabeculated
- Supraventricular crest separated inflow and outflow tract

50. Ans. c. Thoracic splanchnic nerve

[Ref: Last Anatomy 12th Edition Pg 193-194]

- Afferent fibers from heart run along sympathetic pathway and reach thoracic spinal nerves

51. Ans. b. T1 – T5

[Ref: Last Anatomy 12th Edition Pg 193-194]

- Sympathetic supply – T1 – T5
- Parasympathetic – vagus.

52. Ans. c. Supplied by left vagus nerve

- SA node – supplied by right vagus
- SA node generates impulse at rate of 70-100/min

53. Ans. a. Behind sternal end of left 4th costal cartilage

- Mitral valve situated in sternal end of left 4th costal cartilage.
- Aortic valve at sternal end of left 3rd costal cartilage lower border

54. Ans. a. Left side pushed down..., b. Left side lower than..., d. Right side..., e. Hernia common on...

[Ref: Grays 40th Edition Pg 1007-1010]

- Right part of the diaphragm is always higher than left due to heart depress the left side of the diaphragm (primary reason) and also due to liver pushing the right dome of the diaphragm



- Right dome of diaphragm reaches upper border of 5th rib, left dome reaches lower border of 5th rib.
- So left side of diaphragm is lower than right side
- Bochdalek hernia more common on left side – posterolateral aspect.

55. Ans. c. Azygos vein and thoracic duct

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 185]

56. Ans. d. IVC

IVC opening in central tendon

57. Ans. a. Left phrenic nerve

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 186]

- Left phrenic pierce the left cupola of diaphragm
- Right vagus – posterior vagal trunk, left vagus – anterior vagal trunk, left gastric artery branch, left gastric vein tributary pass through oesophageal opening

58. Ans. b. T8

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 186]

59. Ans. c. Vagus pass..., d. Lies in the right crus

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 186]

- Esophageal hiatus Lies in the right crus
- Vagus nerve pass through esophageal hiatus
- Ivc opening pass through central tendon
- Aortic opening present between right and left crus

60. Ans. d. Inferior vena cava opening

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 187]

61. Ans. b. Posterolateral part of diaphragm

[Ref: Grays 40th Edition Pg 1007-1010, Last Anatomy 12th Edition Pg 187]

62. Ans. b. Diaphragmatic opening, c. Superior epigastric vessels pass through it

[Ref: Grays 40th Edition Pg 1007-1010]

- It is diaphragmatic opening
- Located retrosternally
- Superior epigastric vessels pass through it.

63. Ans. a. Lower end of cricoids

[Ref: Last Anatomy, 12th ed. pg 208]

- Lower end of cricoid
- Begins at C6
- 6" or 15 cm from incisor teeth

64. Ans. b. Crossing of arch of aorta

[Ref: Last Anatomy, 12th ed. pg 208]

65. Ans. c. 17" and 16"

[Ref: Last Anatomy 12th Edition Pg 208]

- Diaphragmatic constriction at 15" inch or 16 "from incisor teeth
- Distance from nostril add one inch to incisor distance

66. Ans. b. Inferior thyroid artery

[Ref: Last Anatomy 12th Edition Pg 208]

67. Ans. a. 25 cm length, c. Has squamous epithelium, e. Physiological sphincter..., g. Muscle layer in the...

[Ref: Last Anatomy 12th Edition Pg 208]

- Lined by squamous (nonkeratinized stratified squamous epithelium)
- Physiological sphincter located at cardiac orifice
- No serosa since no peritoneum. (But abdominal part of esophagus is covered with peritoneum, so serous covering in the lower part of esophagus)
- Submucosa contains lymphatics
- Striated muscle in the upper part.

68. Ans. b. Cervical part drains into ...

- Cervical part drain into inferior thyroid vein
- Thoracic part drain into azygos and hemiazygos vein
- Submucosa contains the plexus of blood vessels, lymphatics and nerves.

69. Ans. a. Pulmonary artery

[Ref: Last Anatomy 12th Edition Pg 213,214]

- Left Lung Hilum Structures from above Downwards
- Pulmonary artery
- Left main bronchus
- Lower pulmonary vein

70. Ans. a. Primary/Principal bronchus

[Ref: BDC 6th/e Vol. 1 p. 237; Gray's 38th/e p. 642]

- Hilum of lung contains primary bronchus.

71. Ans. a. Thoracic duct

- Structures present between apex of lung and neck of first rib – sympathetic trunk, first posterior intercostal vein, superior intercostals artery and ventral rami of T1 spinal nerve

72. Ans. a. Right lung is shorter and wider...

[Ref: Last Anatomy 12th Edition Pg 215]

- Right bronchus is shorter and wider not the lung

73. Ans. b. 10TH

[Ref: Last Anatomy 12th Edition Pg 212 - 213]



74. Ans. **b. Supplied by phrenic nerve**

[Ref: Bdc 6Th Ed, Pg 229-231]

- Supplied by autonomic system
- Borders refer to pleural reflection, it has costomediastinal, costodiaphragmatic and posterior line of reflection.

75. Ans. **a. Right upper lobe**

[Ref: Gray's Anatomy 40th Edition 7th chapter]

- Lobe of Azygous vein – medial split part apex of right lung

76. Ans. **c. Till the respiratory bronchioles**

[Ref: GRAYS 41ST edition pg 968]

77. Ans. **c. Medial and lateral**

[Ref: Last Anatomy 12th Edition Pg 216]

78. Ans. **a. Left upper lobe**

[Ref: Last Anatomy 12th Edition Pg 213 - 217]

79. Ans. **c. Intrasegmental – pulmonary vein**

[Ref: Last Anatomy 12th Edition Pg 216; BDC 6th/e Vol. 1 p. 239-24]

- Bronchopulmonary segment is drained by intersegmental pulmonary vein.

80. Ans. **c. 10, 10**

- Both right and left lung contains 10 segments. But medial basal segment in lower lobe of left lung is suppressed

81. Ans. **d. Pulmonary vein drains more than one segment**

[Ref: BDC 6th/e Vol. 1 p. 239-241]

- Pulmonary vein is intersegmental in position
- One pulmonary vein drains more than one segment
- Each segment is drained by more than one pulmonary vein
- Bronchopulmonary segment is respiratory unit.

82. Ans. **d. Sensory supply of trachea is by vagus**

[Ref: Last Anatomy 12th Edition Pg 194-195]

- Trachea bifurcates at T4 in the cadaver
- Trachea bifurcates at T6 in the living, and descends further on inspiration
- Right bronchus are shorter and wider
- Arch of aorta related to left bronchus and posterior to it
- Esophagus lies posterior to it.

83. Ans. **d. 2nd, 3rd and 4th tracheal rings are related with isthmus of thyroid**

84. Ans. **d. 20 mm, 15 mm**

85. Ans. **d. Alveolar duct**

Bronchopulmonary division –

- Trachea – Principle bronchi – Lobar bronchi – Segmental bronchi – Terminal bronchiole – Respiratory bronchiole – Alveolar duct – Atria – Alveolar sac.

86. Ans. **b. T4**

[Ref: Essentials of human anatomy by AK datta 8th edition volume 1, pg 52]

- Trachea bifurcates at carina at T4
- Thoracic duct (Pecquet duct)
- Length 45 cm
- Begins at T12.
- Continuation of cisterna chyli.
- Enters the thorax (posterior mediastinum) through aortic orifice .
- At the level of T5 crosses from right to left and passes through superior mediastinum reaches root of neck.
- Ends at the level of C7 at the junction of left subclavian and left internal jugular vein.
- It drains all parts of body except right side of head and neck, chest wall, lung, upper limb, right surface of liver and heart.

87. Ans. **c. T5**

[Ref: Last Anatomy 12th Edition Pg 210-211]

88. Ans. **a. Right upper part of body**

[Ref: Last Anatomy 12th Edition Pg 210-211]

- Thoracic duct drains all parts of body except right side of head and neck, chest wall, lung, upper limb, right surface of liver and heart.

89. Ans. **b. Passes through esophageal opening**

[Ref: Last Anatomy 12th Edition Pg 210-211]

- Passes through aortic opening.

90. Ans. **a. Opens into right ventricle**

- Opens into right atrium

91. Ans. **a. Left coronary artery**

- Right and left coronary artery supply the vasa vasorum of ascending aorta
- Vasa vasorum of descending aorta arise from Intercostal artery

92. Ans. **c. Left superior intercostal vein**

[Ref: BDC 6th ed. vol. I / 221-222; Keith L. Moore 5th ed. / 105]

- Left superior intercostal vein Drains into left brachiocephalic vein



93. Ans. a. Motor branch, b. Sensory branch, c. Arise from C4, d. Shorter than left phrenic

[Ref: Grays Anatomy 40th Edition Pg 234; Last Anatomy 12th Edition Pg 194 - 195]

- Phrenic mixed so motor and sensory
- Root value – C3, 4, 5 – Chiefly C4

94. Ans. a. Anterior to scalenus anterior

[Ref Grays Anatomy 40th Edition Pg 234; Last Anatomy 12th Edition Pg 194-195]

- Crosses subclavian artery
- Pass in front of hilum of lung

95. Ans. d. Vertebral artery

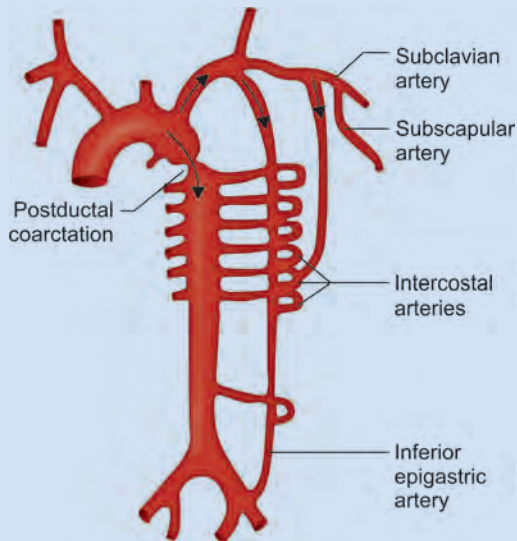
[Ref: Grays Anatomy 40th Edition Pg 984]

REMEMBER

Coarctation of aorta – obliteration of lumen of aorta.
Post ductal coarctation- After the ligamentum arteriosum

Features are

- Characteristic rib notching and high risk of cerebral hemorrhage
- Tortuous and enlarged blood vessels especially internal thoracic, intercostal, epigastric and scapular arteries
- Elevated BP in radial artery and decreased pressure in femoral artery
- Femoral pulse to occur after radial pulse (normally femoral pulse occur before radial pulse)
- Some important collaterals



Postductal Coarctation Collateral channels

- Anterior intercostal artery (internal thoracic artery)
Vs
- Posterior intercostal artery (costa cervical trunk, descending thoracic aorta)

Contd...

- Superior epigastric artery (internal thoracic artery)
Vs
- Inferior epigastric artery (external iliac artery)
- Superior intercostal artery (from costa cervical trunk)
Vs

3rd Posterior intercostal artery

- Suprascapular artery. Dorsal (through cervical trunk) scapular artery
Vs
- Subscapular artery, circumflex scapular + (axillary artery)
- Sub scapular artery, circumflex scapular + (axillary artery)

96. Ans. c. Pectoralis major

Pectoralis major not form the chest wall.

97. Ans. d. Thoracic duct

Thoracic duct pass through aortic orifice of diaphragm.

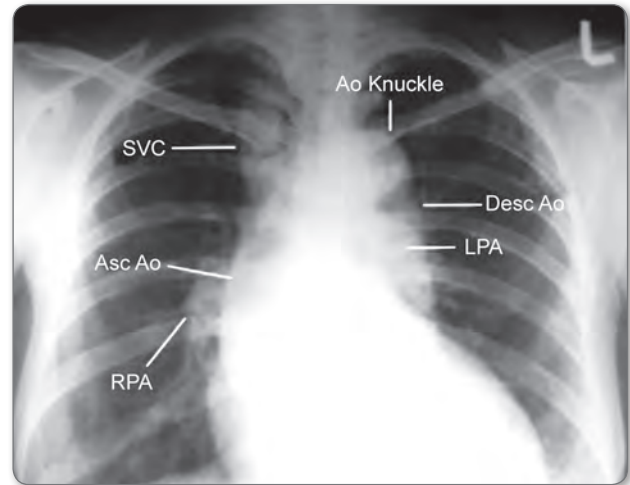
98. Ans. c. 3rd intercostals space

Aortic orifice at the level of left 3rd intercostals space.

99. Ans. b. 3rd intercostals cartilage

Pulmonary orifice at the level of left third costal cartilage

100. Ans. d. Aortic knuckle



101. Ans. a anterior and Superior mediastinum

- Sternohyoid and sternothyroid
- Arch of aorta and its branches
- Superior vena cava, right and left brachiocephalic vein
- Thymus
- Vagus nerve
- Phrenic nerve
- Trachea
- Esophagus

102. Ans. a. Vagus nerve

Phrenic nerve pass anterior to hilum. Vagus nerve pass posterior to hilum.

**103. Ans. b. 8th rib**

Lower border lung related to 6th rib in the mid clavicular line, 8th rib in mid axillary line and 10th rib in the axillary line.

104. Ans. b. 15 cm

Explained in tabular column 57 answer Crico pharyngeal constrictor is 6 inch from incisor teeth.

105. Ans. c. Hyoid bone**106. Ans. c. 22.5 cm**

Explained in tabular column 57 answer.

107. Ans. a. Lies anterior to aorta and thoracic duct

Posterior relations of esophagus – descending thoracic aorta, thoracic duct and azygos vein.

So esophagus is anterior to thoracic aorta and thoracic duct.

108. Ans. d. LA

Left atrium not contribute to sternocostal surface.

109. Ans. a. 12 cm

Hyoid bone situated at the level of C3
Distance from incisor teeth – 12 cm

110. Ans. b. Posterior interventricular artery

Cardiac dominance is determined by posterior inter ventricular artery.

111. Ans. c. T12

Aortic orifice is situated at T12
Esophageal opening at T10
Venal caval opening at T8

112. Ans. d. Right ventricle

- The sternocostal surface of heart is majorly constituted by the right ventricle

113. Ans. a. Arch of aorta

- At sterna angle of Louis arch of aorta begins (anteriorly) and ends (posteriorly), crosses from right to left

114. Ans. c. Forms myocardium

- Transforms into the connective tissue of endocardium

115. Ans. c. Septum primum + Septum secundum

- The septum primum and septum secundum press against each other and close the communication (foramen ovale) between the two artia, completed at around 3 months after birth

116. Ans. c. Aorta

- Anterior to the sinus are two arteries derived from truncus arteriosus: ascending aorta and pulmonary trunk not pulmonary artery

117. Ans. a. 3rd month

- The structural development of the heart which begins 16 days after fertilization is finished by the 10th week of pregnancy

118. Ans. d. Subcardinal vein

- Each horn of sinus venosus receives blood from following three pair of veins. Vitelline veins (from yolk sac), umbilical veins (from placenta) and common cardinal veins (from body wall)

119. Ans. c. SVC

- Transverse pericardial sinus lies between the aorta and pulmonary trunk anteriorly and the superior vena cava posteriorly

120. Ans. d. Vein->Artery->Nerve

- The arrangement of neurovascular bundle in the costal groove from above downwards is intercostals vein, artery and intercostals nerve

121. Ans. a. 1st rib

- Scalene tubercle is a small projection present at the medial (inner) border of 1st rib & It provides insertion for scalenus anterior

122. Ans. c. Ventral rami of thoracic spinal nerves

- Anterior (ventral) primary ramus of upper 11th thoracic spinal nerves give intercostals nerves and ventral ramus of T12 is called subcostal nerve

123. Ans. b. 2nd intercostals nerve

The lateral cutaneous branch of the 2nd intercostal nerve is called intercostobrachial nerve

124. Ans. b. Superior (highest) intercostal artery

- 1st and 2nd posterior intercostal arteries are branches of superior intercostal artery - branch of costocervical trunk

125. Ans. c. Left brachiocephalic vein

- Left superior intercostal vein drains into left brachiocephalic vein
- Right superior intercostal vein drains into azygos vein

126. Ans. d. T5

- Superior vena cava enters the right atrium at the level of T5 vertebra

127. Ans. c. Right bronchial vein

- Right bronchial vein is the last tributary

128. Ans. c. Right phrenic nerve branch

- Central tendon of diaphragm has an opening for the passage of inferior venae cava (at T-8 vertebrae level), along with that passes few branches of right phrenic nerve



129. Ans. d. Greater splanchnic nerve > b. Azygos vein

- Greater splanchnic nerve usually pierce through the crus of diaphragm to enter the thorax

130. Ans. d. 6th costal cartilage

- 6th costal cartilage doesn't come in the surface marking of oblique fissure
- Oblique fissure: passes anteroinferiorly from the spinous process of the T3 vertebra to cross the fifth rib in the midaxillary line
- It further continues inferiorly, crossing either the seventh rib on the right (fifth rib on the left), at the mid-clavicular line.

131. Ans. d. Lingula

- Lingula is a portion of the left upper lobe

132. Ans. b. SVC

- Arch of aorta and left ventricle are related to the mediastinal surface of left lung
- Pulmonary trunk is not related to any of the two lungs (mediastinal surfaces)

133. Ans. b. Inferior pulmonary vein

- Inferior pulmonary vein is the lowermost structure in the hila of each lung

134. Ans. b. Apical, anterior, posterior

- Upper lobe in the right lung has 3 bronchopulmonary segments: Apical, anterior and posterior

135. Ans. c. Medial basal

- Cardiac BPS of the right lung is medial basal (VII) segment of middle lobe. This BPS not well developed in the left lung

136. Ans. b. Pulmonary artery

- Rasmussen's aneurysm - an aneurysm of small to medium pulmonary artery branches that develop in the vicinity of a tuberculous cavity

137. Ans. c. Aortic sinus bulging into right atrium

- Torus aorticus is bulge on the right atrial septum, due to non-coronary aortic sinus into the right atrial wall

138. Ans. b. Anterior wall of left ventricle

- LAD (Left anterior descending) artery is also known as anterior interventricular artery and runs in the same named groove, supplying anterior 2/3 of interventricular septum lying deep to it and also the adjacent anterior wall of the left ventricle

139. Ans. a. Below arch of aorta

- The cardiac ganglion is present in the superficial cardiac plexus immediately below the aortic arch and to the right of the ligamentum arteriosum

140. Ans. a. Is located at the right border of the ascending aorta

SA node is located in the right atrium at the right side of superior vena cava

141. Ans. c. Modified cardiac muscle

- Purkinje fibres are sub-endocardial plexus of ventricular conduction cells

142. Ans. a. Heart passes through superior mediastinum; c. Thymus remnant may present in middle mediastinum; d. Posterior boundary of posterior mediastinum corresponds to T1-T4 vertebrae; e. Lower border of anterior mediastinum is extended more than posterior mediastinum

- Heart and pericardium in the middle mediastinum
- Thymus found in superior and anterior mediastinum
- Posterior boundary of posterior mediastinum is from T5-12 vertebra
- Lower border of posterior mediastinum extends quite inferior as compared with anterior mediastinum

143. Ans. b. Brachiocephalic vein

Intercostal veins		
Anterior	Posterior	
	Right	Left
Follow the arteries and drain into internal thoracic vein and musculophrenic vein	1st drain to right brachiocephalic vein	1st – drain to left brachiocephalic vein
	2, 3, 4– arch of azygos vein	2, 3, 4 to left brachiocephalic vein
	5 to 11 – Azygos vein	5, 6, 7 – Superior hemiazygos
		8, 9, 10, – Inferior hemiazygos vein

144. Ans. a. Raised interatrial septal ridge

Tendon of Todaro – sub endocardial ridge situated in inter atrial Septum
Tendon of Todaro forms boundary to triangle of Koch

145. Ans. a. A

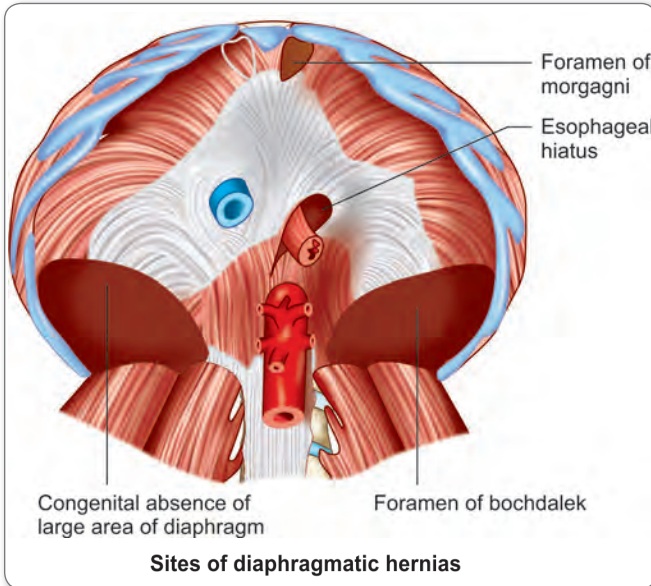
- A – pulmonary vein
- B – pulmonary artery
- C – tertiary bronchus
- D – bronchial artery

Bronchopulmonary Segment

- Segment of lung aerated by tertiary bronchus called bronchopulmonary segment.
- Separated from adjacent segment by inter segmental alveolar septum occupied by tributaries of pulmonary vein. But the pulmonary vein is intersegmental
- Each segment contains segmental bronchi, pulmonary artery, bronchial vessels

**146. Ans. b. Septum secundum**

Marked structure – limbus fossa ovalis
Develop from septum secundum

147. Ans. a. Bochdalek hernia**148. Ans. d. Pulmonary pleura****Pleural tapping**

The neurovascular structures for each intercostals space pass through the lower border of the upper rib. So it is advisable to do thoracotomy in upper border of lower rib.

Structures pierced during pleural tapping in mid axillary line

Skin, superficial fascia, deep fascia, serratus anterior, external intercostal, internal costal, inner most intercostal, endothoracic fascia, parietal pleura

149. Ans. d. Right aortic sinus

The right coronary artery arises from the anterior ('right coronary') aortic sinus
Left coronary artery arises from the left posterior (left 'coronary') aortic sinus

150. Ans. a. Azygous vein; b. Thoracic duct; c. Hemiazygous vein

Aortic opening transmits aorta, thoracic duct. Sometimes azygous vein
Hemiazygous vein pierce left crus of diaphragm, but sometimes pass through aortic opening

151. Ans. c. Arch of aorta; e. Right subclavian artery

Left 4th arch artery – arch of aorta
Right 4th arch artery – right subclavian artery

152. Ans. a. Pulmonary artery; c. Bronchial artery

Massive hemoptysis involve bleeding from bronchial artery or from pulmonary artery
Rasmussens aneurysm – dilatation of pulmonary artery

153. Ans. c. AV node located in triangle of Koch; e. Bundle of His lies posteroinferiorly in ventricular septum

SA node – at junction of SVC opening and right atrium
AV node in triangle of Koch
Bundle of his – posteroinferior border of membranous part of interventricular septum

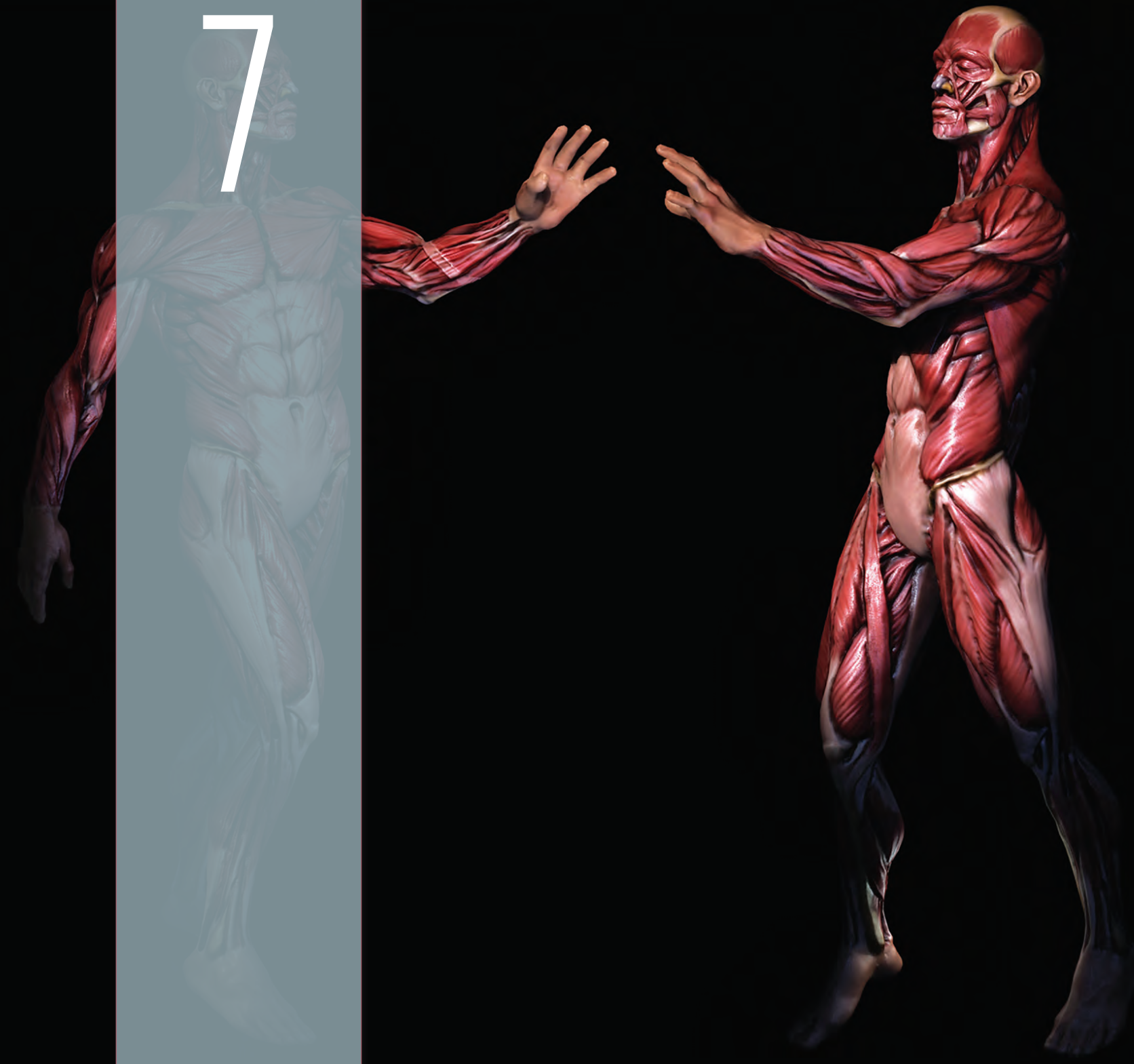
154. Ans. a. IVC; b. Phrenic nerve; e. Vagus nerve

Structures passing through aortic opening in diaphragm aorta, azygous vein, thoracic duct

NOTES

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7



ABDOMEN AND PELVIS



OVERVIEW

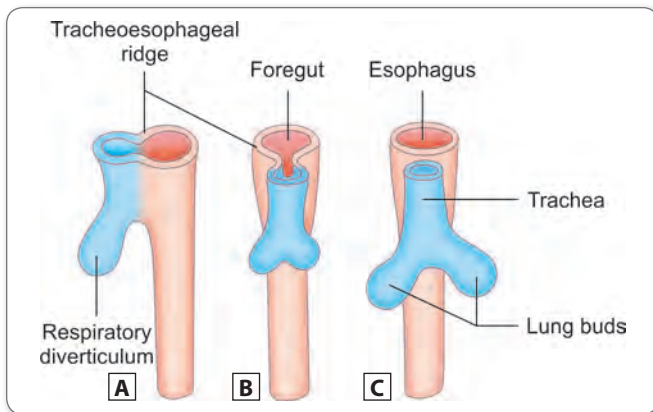
- Due to incorporation of dorsal part of yolk sac into embryo due to craniocaudal folding and lateral folding of the embryo leads to formation of primitive gut tube
- Primitive gut tube extends from oropharyngeal membrane to cloacal membrane and divides into foregut, midgut and hindgut
- Epithelial lining and glands of the mucosa are derived from **endoderm** and other components are derived from visceral **mesoderm**

Table 1: Features of foregut, midgut and hindgut

	Foregut	Midgut	Hindgut
Extent	Up to second part of duodenum Opening of ampulla of Vater	From second part of duodenum opening of ampulla of Vater to Right two-thirds of transverse colon	Rest of the gut
Artery	Celiac trunk	Superior mesenteric artery	Inferior mesenteric artery
Veins	Portal vein	Portal vein	Portal vein
Sympathetic supply	Greater splanchnic nerve T5-9	Lesser splanchnic nerve T10, 11	Least splanchnic nerve T12 and also from L1 and L2
Parasympathetic supply	Vagus	Vagus	S2, S3, S4
Lymph	Celiac nodes	Superior mesenteric nodes	Inferior mesenteric nodes
Pain radiates to	Epigastrium	Periumbilical region	Suprapubic area

DEVELOPMENT OF FOREGUT

Esophagus



Figs 1A to C: Splitting of foregut into esophagus and trachea

- **Foregut** is divided into esophagus dorsally and trachea ventrally by tracheoesophageal fold
- The fold fuses to form tracheoesophageal septum

Clinical Aspect

- **Esophageal atresia:** The tracheoesophageal septum divides dorsally and causes the esophagus to end as closed tube. These patients also have other defects, such as **VATER (Vertebral defects, anal atresia, Tracheoesophageal fistula, Renal defects)** and **VATERCL defects (VATER defects + Cardiovascular defects, upper Limb defects)**. Esophageal atresia Associated with **polyhydramnios**
- **Vascular compression of esophagus:** Abnormal right subclavian artery passes behind the esophagus and causes dysphagia lusoria

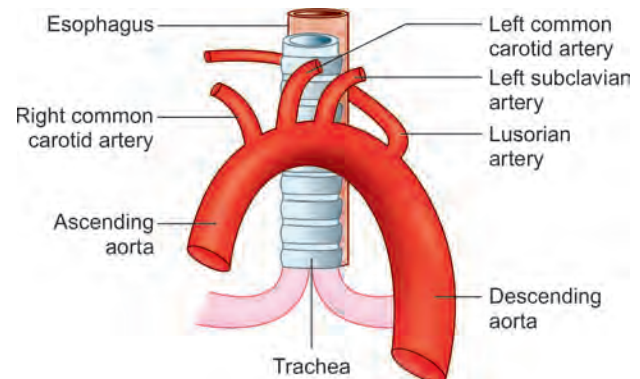


Fig. 2: Vascular compression of esophagus



Note

- Esophagus is compressed **posteriorly** in **aberrant right subclavian artery**
- Esophagus compressed **anteriorly** by **pulmonary sling**

Pulmonary sling

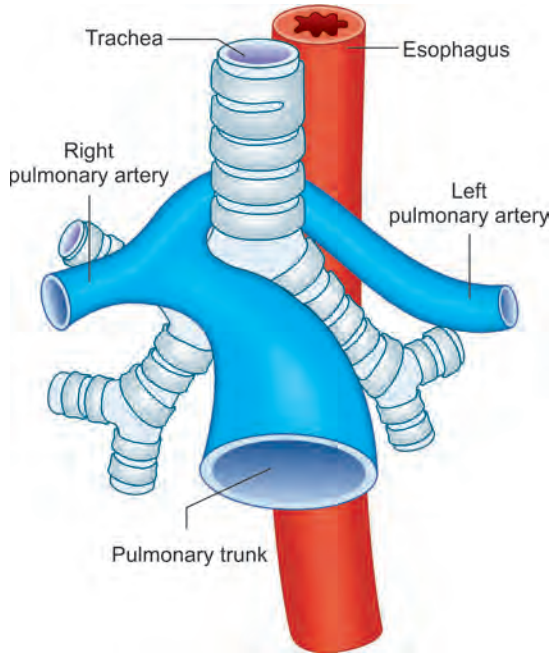


Fig. 3: Pulmonary sling

- Left pulmonary artery arising from right pulmonary artery instead of arising from trunk
- Pulmonary artery form sling and compress esophagus in front side & cause dysphagia.
- **Achalasia cardia:** Due to loss of ganglion cells in the Auerbach plexus, lower esophageal sphincter fails to relax. Results in dysphagia. And barium study of achalasia gives bird beak sign

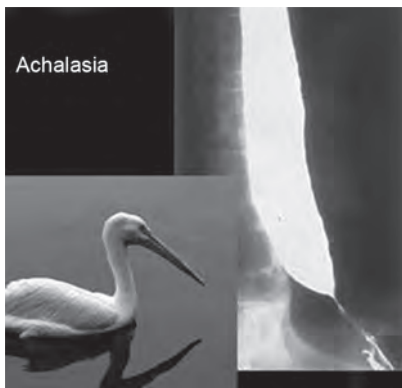


Fig. 4: Bird beak sign in achalasia

Stomach

- Stomach rotates 90° clockwise in vertical axis, so that posterior part of tube comes to left side and anterior part to right side
- Stomach rotates 90° clockwise in anteroposterior axis, so cardiac end comes to left side and pyloric end comes to right side
- Left border or greater curvature grows more rapidly and it becomes superficial, so **left vagus continues as anterior vagal trunk**
- Right border or lesser curvature grows slowly and become posterior so that **right vagus continues as posterior vagal trunk**
- Stomach connected to anterior and posterior abdominal wall by ventral and dorsal mesogastrum, respectively.

Mesentery

- Gut tube suspended from body wall within the peritoneal cavity by ventral and dorsal mesentery

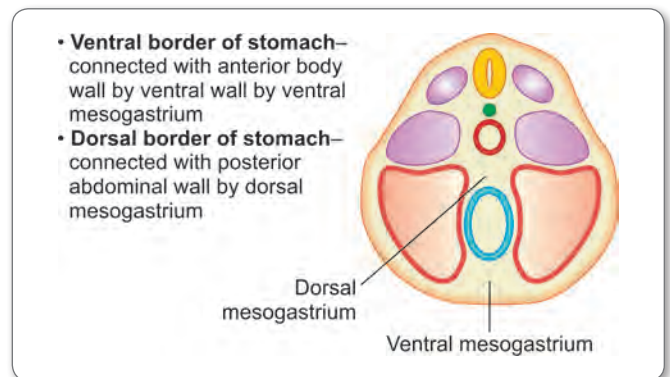


Fig. 5: Mesogastrum

- **Ventral border of stomach**—connected with anterior body wall by ventral wall by ventral mesogastrum
- **Dorsal border of stomach**—connected with posterior abdominal wall by dorsal mesogastrum

Table 2: Derivatives of ventral and dorsal mesogastrum

Ventral mesogastrum	Dorsal mesogastrum
<ul style="list-style-type: none"> • Lesser omentum • Falciform ligament • Coronary ligament • Triangular ligament. <p>Mn - FACT</p>	<ul style="list-style-type: none"> • Greater omentum (Gastrosplenic ligament Gastrocolic ligament Lienorenal ligament) • Spleen develops in dorsal mesogastrum (spleen is mesodermal in origin, since it is lymphatic organ) • Mesentery of small intestine, mesoappendix, transverse mesocolon, sigmoid mesocolon.



Clinical Aspect

Hypertrophic Pyloric Stenosis

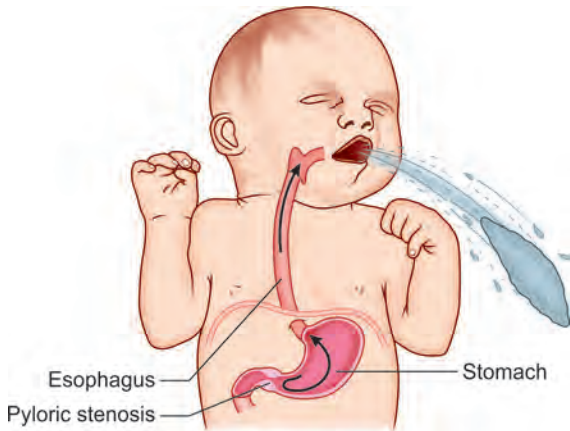


Fig. 6: Hypertrophic pyloric stenosis

- Muscularis externa in the pyloric region hypertrophies and small palpable mass causing narrow pyloric lumen. Due to faulty migration of neural crest cells
- Associated with projectile vomiting **nonbilious after** feeding and small palpable mass at the right costal margin.

Note: Bilious vomiting seen in duodenal atresia

Developed from Two Sources

- Hepatic bud outgrowth from foregut forms the **parenchyma of the liver, biliary system.**
- Septum transversum (mesoderm) forms **Küpfers cells, sinusoids, hematopoietic cells, capsule and connective tissue of liver.** Septum transversum also contributes to diaphragm.

Gallbladder

- Junction between hepatic bud and foregut tube forms primitive bile duct.
- Primitive bile duct forms gallbladder rudiment and cystic duct.
- Cystic duct divides the primitive bile duct into common hepatic duct and bile duct.

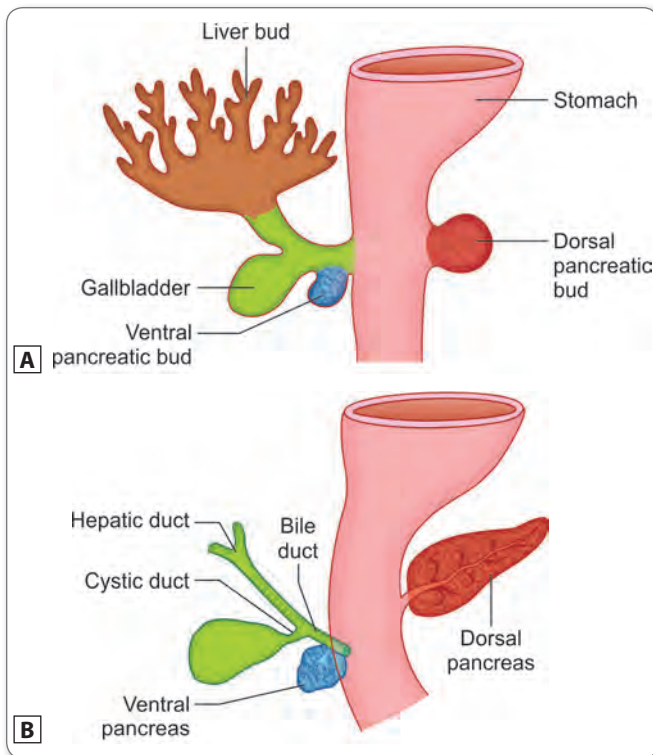


Clinical Aspect

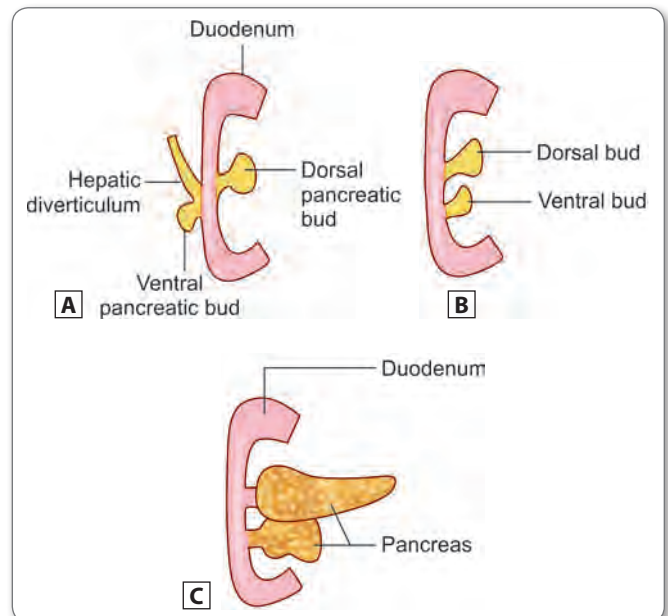
Biliary Atresia

- Obliteration of extrahepatic and intrahepatic ducts
- The ducts are replaced by fibrous tissue
- Clinical feature: Progressive neonatal jaundice, passing white clay colored stool and dark colored urine.

Liver

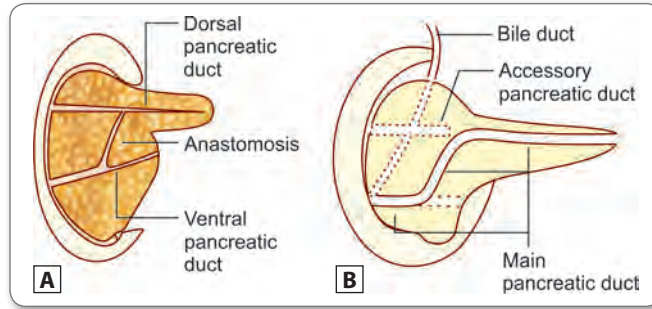


Figs 7A to B: Development of liver and gallbladder



Figs 8A to C: Development of pancreas

- Main duct (Wirsung): Develops from distal part of dorsal duct + anastomosis of dorsal and ventral duct + ventral duct.
- Accessory duct (santorini): From proximal part of dorsal duct.

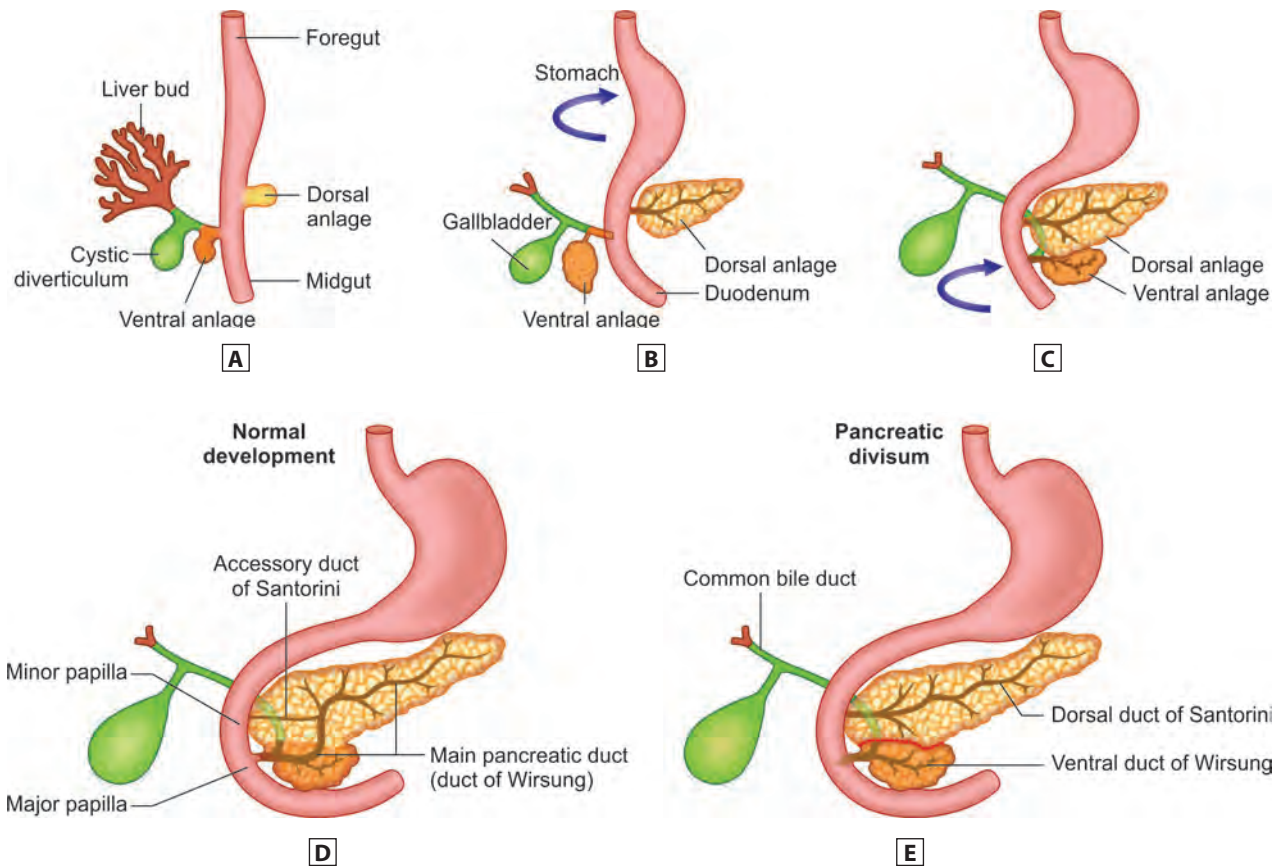


Figs 9A and B: Development of pancreatic ducts

Minor duct – more anterior and proximal
Major duct – in posterior plane and distal

Clinical Aspect

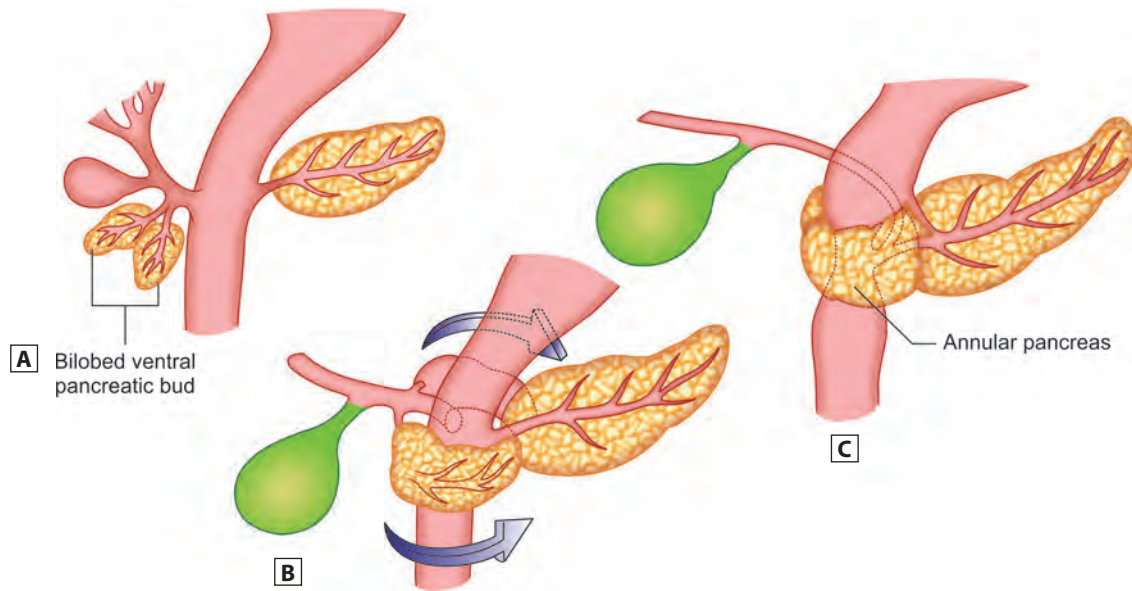
Pancreatic Divisum



Figs 10A to E: Normal development of pancreas and pancreatic divisum

- Distal two-thirds of dorsal duct and ventral duct fails to anastomose and there by forming two separate duct system
- Dorsal duct drains portions of head, body and tail of pancreas and open into minor duodenal papillae
- Ventral duct drains uncinate process and portion of head of pancreas and open into major duodenal papillae
- These patients are prone to pancreatitis

Contd...

**Annular Pancreas**

Figs 11A to C: (A) Ventral pancreatic bud may consist of two lobes. If the lobes migrate around the duodenum in opposite directions to fuse with the dorsal pancreatic bud; (B) An annular pancreas is formed (C)

- Ring of pancreatic tissue form around duodenum and causes duodenal obstructions
- Radiological study shows double bubble sign



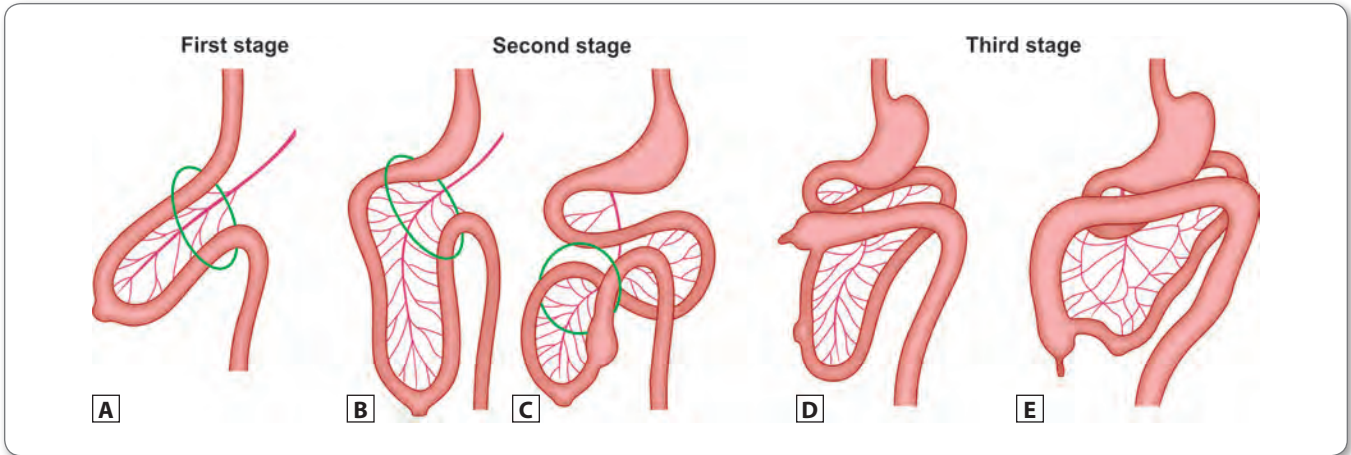
Fig. 12: Double bubble sign

Ectopic Pancreas

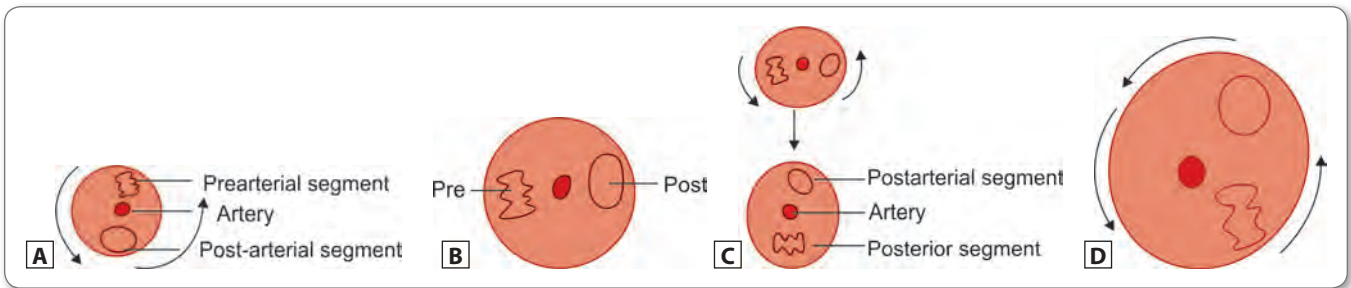
Ectopic pancreas found in stomach, duodenum, jejunum, Meckel's diverticulum, gallbladder
Most common site – duodenum

DEVELOPMENT OF MIDGUT**Rotations of the Midgut**

- Midgut loops herniate into yolk sac due to lack of space. Most of the space in the abdominal cavity is occupied by massive liver
- 6th week → physiological hernia occurs
- At 10th week → reduction of hernia takes place
- If hernia is not reduced then it leads to **omphalocele**
- Mid gut is divided into prearterial segment and postarterial segment by superior mesenteric artery
 - Prearterial segment → Jejunum and ileum
 - Postarterial segment → Cecum, ascending colon and transverse colon right two-third.



Figs 13A to E: Rotation of midgut. (A) 6 weeks' gestation; (B) 8 weeks' gestation; (C) 9 weeks' gestation; (D) 11 weeks' gestation and (E) 12 weeks' gestation



Figs 14A to D: Rotations of prearterial and postarterial segments with respect to superior mesenteric artery

- Midgut rotates first 90° anticlockwise so prearterial segment comes to left side and postarterial segment to right side
- Prearterial segment elongates (jejunum and ileum). Enters into abdominal cavity, during this it rotates 90° anticlockwise; by end of 2nd-90° anticlockwise rotation, cecum subpyloric in position (postarterial segment)
- Postarterial segment enters the abdominal cavity and undergoes 3rd 90° anticlockwise rotation and it comes to its right iliac fossa position.

Clinical Aspect

Malrotation–Rotational Anomaly

- **Nonrotation:** No rotation. Large intestine (Cecum and ascending colon) in left side and small intestine in right side

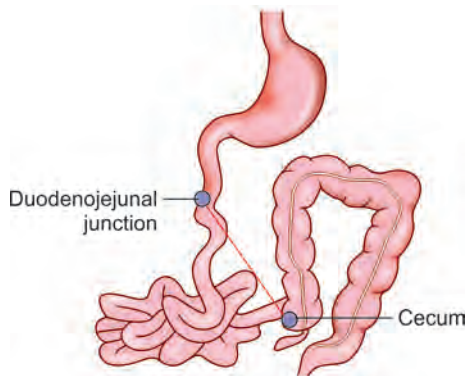


Fig. 15: Nonrotation

Barium study image of nonrotation



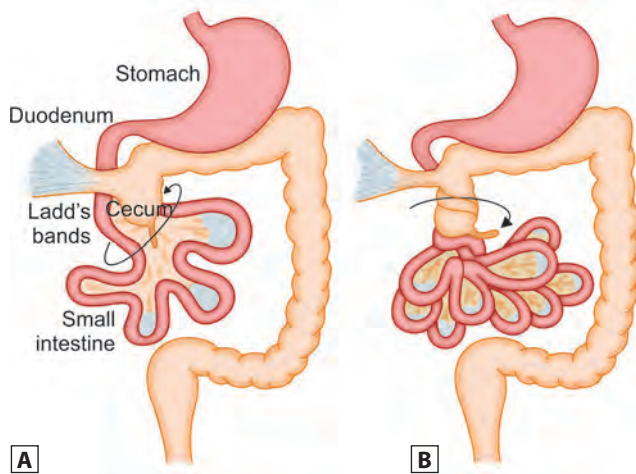
Fig. 16: Barium study of nonrotation

Contd...



Mixed Rotation – (Rotation + Nonrotation)

Mixed rotation first two 90° anticlockwise rotation takes place, 3rd 90° anticlockwise rotation not takes place. So cecum (postarterial segment) subpyloric in position.



Figs 17A and B: (A) Intestinal malrotation; (B) Midgut volvulus

- **Ladd's band** formed. (Tissue connecting cecum to posterior abdominal wall).
- **Volvulus** formed (Twisting of small intestine around the vascular pedicle).
- Duodenal obstruction from LADDs band causes bilious vomiting
- **Whirlpool sign**

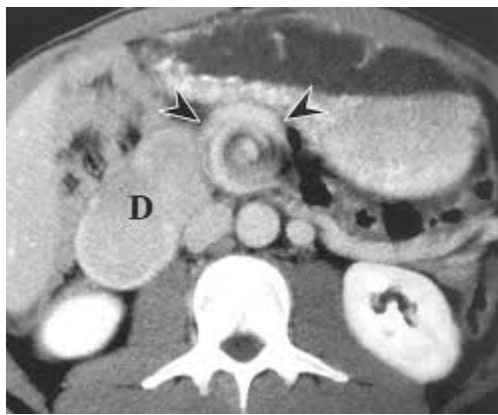


Fig. 18: Whirlpool sign

The **whirlpool sign** of the mesentery, also known as the **whirl sign**, is seen when the bowel rotates around its mesentery leading to whirls of the mesenteric vessels.

Reverse Rotation

- Reverse rotation: First 90° rotation in clockwise direction and remaining 180° rotation in anticlockwise direction
- Normally superior mesenteric artery—Anterior to III duodenum. Superior mesenteric artery—posterior to transverse colon

- In reverse rotation, superior mesenteric artery goes posterior to 3rd part of duodenum. Superior mesenteric artery is anterior to transverse colon

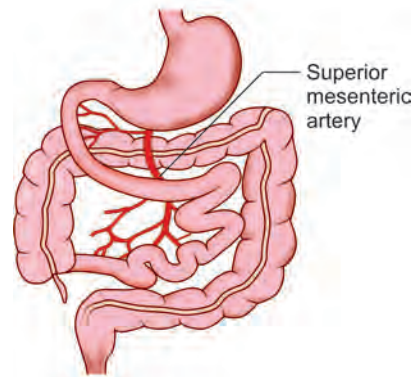


Fig. 19: Reverse rotation

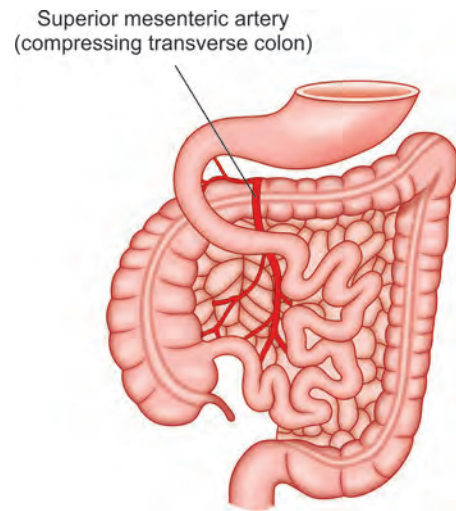
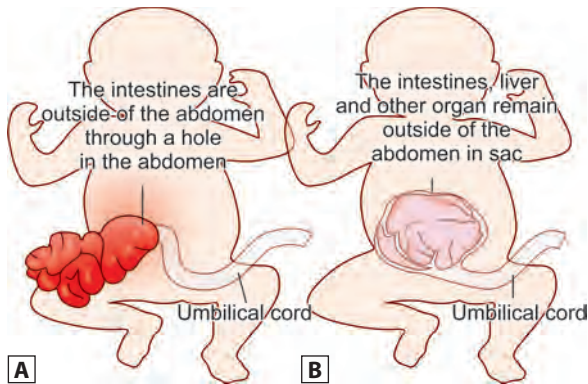


Fig. 20: Reverse rotation

Differences between Omphalocele and Gastroschisis

Omphalocele	Gastroschisis—formed at the site of regression of right umbilical vein
• Midline swelling	• Notmidline swelling
• Umbilical cord normal in position	• Umbilical cord not normal in position
• Lined by amnion	• Not lined by amnion
• Associated with other congenital anomalies	• Not associated with congenital anomalies
• Liver, intestine and other organs can be the contents	• Only intestine remain outside



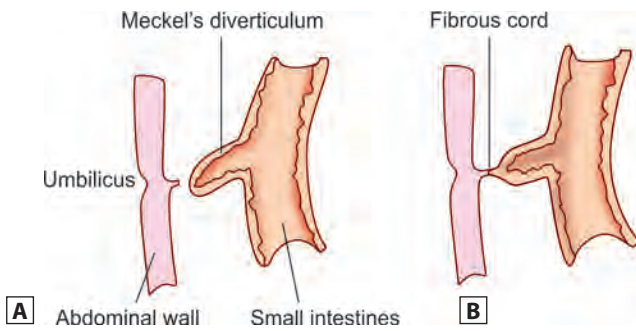
Figs 21A and B: (A) Gastroschisis; (B) Omphalocele

- Persistent proximal part of the vitellointestinal duct
- Present in **2%** of population, situated in the antimesenteric border
- Most common ectopic mucosa - gastric (most common is gastric 60%), pancreatic, colonic, Brunner's glands and endometriosis
- **2 inches** long. Length varies with age, not 2 inch always.
- **2 feet** from the ileocecal valve
- Outpouching connects to umbilicus via fibrous cord or fistula
- Heterotrophic gastric tissue may ulcerate, perforate and produce gastrointestinal bleeding. Symptoms usually resemble appendicitis
- Littre's hernia – Meckel's as content in the sac

Littre Hernia

- Any hernia containing the Meckel diverticulum.

Meckel's Diverticulum – Most Common Congenital Anomaly of GIT



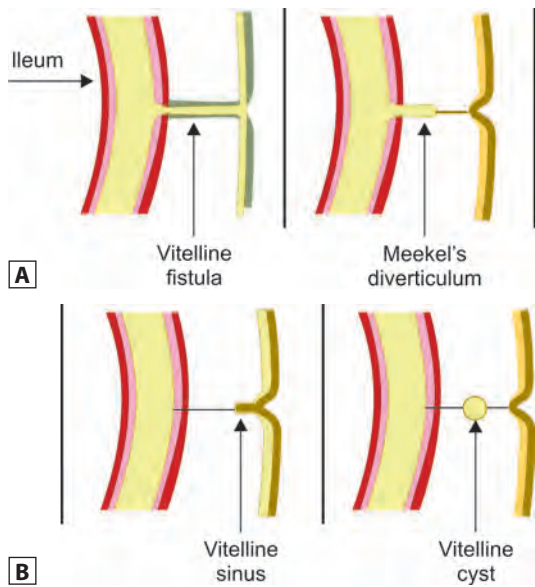
Figs 22A and B: Meckel's diverticulum



Fig. 24: Littre hernia

Note:

- Enterocystoma: Persistence of intermediate part of vitello-intestinal duct
- Raspberry tumor: Persistence of distal part of vitellointestinal duct.

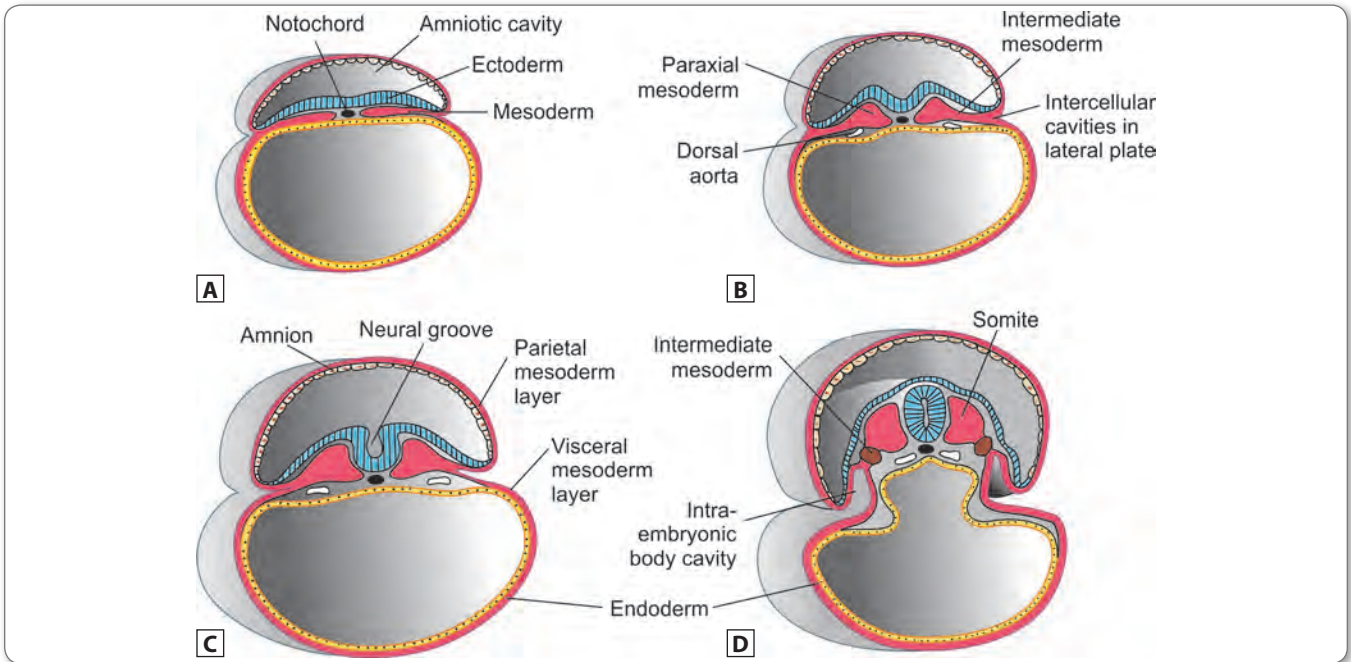


Figs 23A and B: Vitelline duct anomalies



DEVELOPMENT OF BODY CAVITIES

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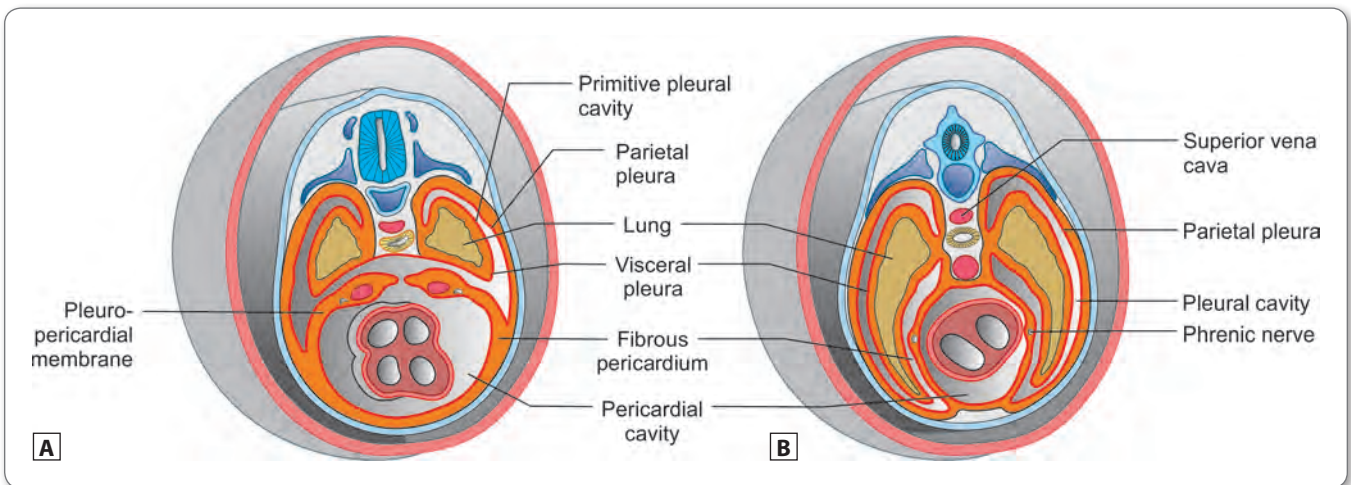
Figs 25A and B: Development of body cavity

- Formation of intraembryonic coelom
- Formation of intraembryonic coelom begins when spaces coalesce within the lateral mesoderm and form horse shoe shaped space that opens into chorionic cavity on the right and left side
- Intraembryonic coelom undergoes remodeling due to craniocaudal folding and lateral folding of embryo
- Intraembryonic coelom provides the needed room for the growth of various organs.

Partitioning of Intraembryonic Coelom

Intraembryonic coelom is initially one continuous space.

To form the definitive adult pericardial, pleural and peritoneal cavities, two portions must develop
Two partitions are the paired pleuropericardial membrane and diaphragm



Figs 26A and B: Partitioning of intra embryonic coelom



Paired Pleuropericardial Membrane

This membrane is sheets of somatic mesoderm that separate pericardial cavity and pleural cavity.

These membranes develop into definitive fibrous pericardium surrounding the heart.

DIAPHRAGM DEVELOPMENT IS EXPLAINED IN THORAX PERITONEUM

Parietal layer	Visceral layer
<ul style="list-style-type: none"> Derived from somatic layer of lateral mesoderm Innervated by somatic nerve 	<ul style="list-style-type: none"> Derived from splanchnopleuric lateral mesoderm Innervated by autonomic nervous system

DEVELOPMENT OF HINDGUT

- Cranial end of hind gut develops into distal one-third of transverse colon, descending colon and sigmoid colon
- The terminal end of hind gut is derived from cloaca
- Cloaca contacts with surface ectoderm of the proctodeum to form cloacal membrane
- Upper part of the anal canal develops from cloaca and lower part of anal canal derived from proctodeum (surface ectoderm).



Clinical Aspect

Colonic Aganglionosis (Hirschsprung's Disease) Congenital Megacolon

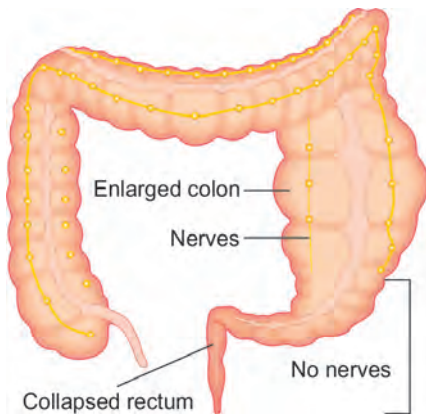


Fig. 27: Colonic aganglionosis (Hirschsprung's disease)

- Due to nonmigration of neural crest cells to distal part of gut tube most commonly seen in sigmoid colon and rectum
- Absence of ganglionic cells in myenteric plexus and submucosal plexus (these ganglions are responsible for fecal evacuation)

Contd...

- So the most characteristic finding is failure of internal sphincter to relax so rectal distension
- Clinically associated with distended abdomen, inability to pass meconium, gushing of fecal material on per rectal digital examination
- Most common site – rectosigmoid colon

Rectovesical Fistula

- Abnormal communication between rectum and urinary bladder due to abnormal formation of urorectal septum
- Associated with passage of meconium in the urine

Rectourethral Fistula

Abnormal communication between rectum and urethra due to abnormal formation of urorectal septum

Rectovaginal Fistula

Abnormal communication between rectum and vagina due to abnormal formation of urorectal septum

Imperforate Anus

Anal membrane perforates by 7th week. Imperforate anus occurs when the anal membrane fails to perforate.

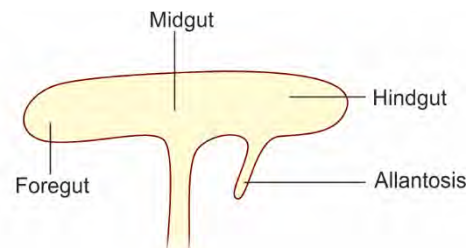


Fig. 28: Cloaca – part of hindgut distal to allantois

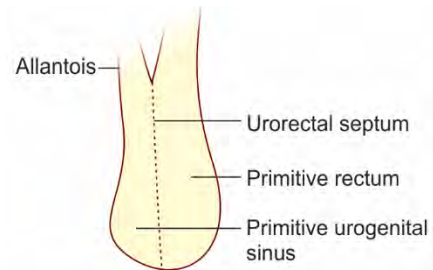
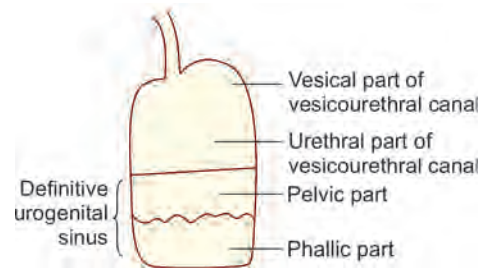


Fig. 29: Urorectal septum divides cloaca into primitive urogenital sinus and primitive rectum





HIGH YIELD POINTS

Gut tube has endodermal origin—So does cloaca (endodermal)

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DEVELOPMENT OF PELVIS

Urogenital system develops from two sources:

- Intermediate mesoderm
- Cloaca

DEVELOPMENT OF KIDNEY

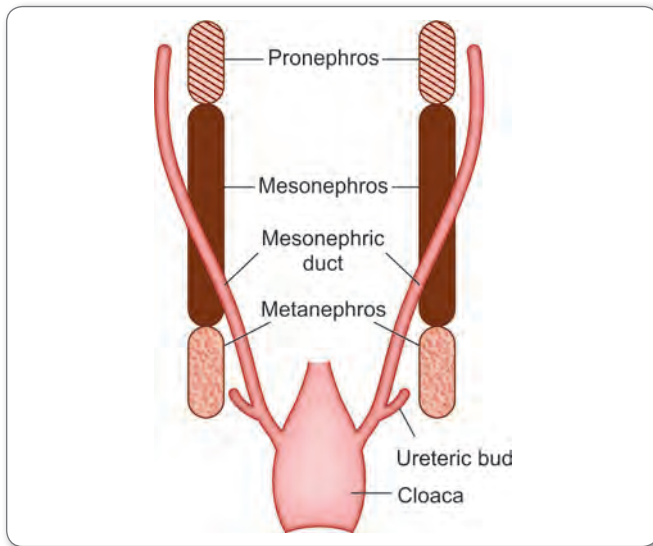


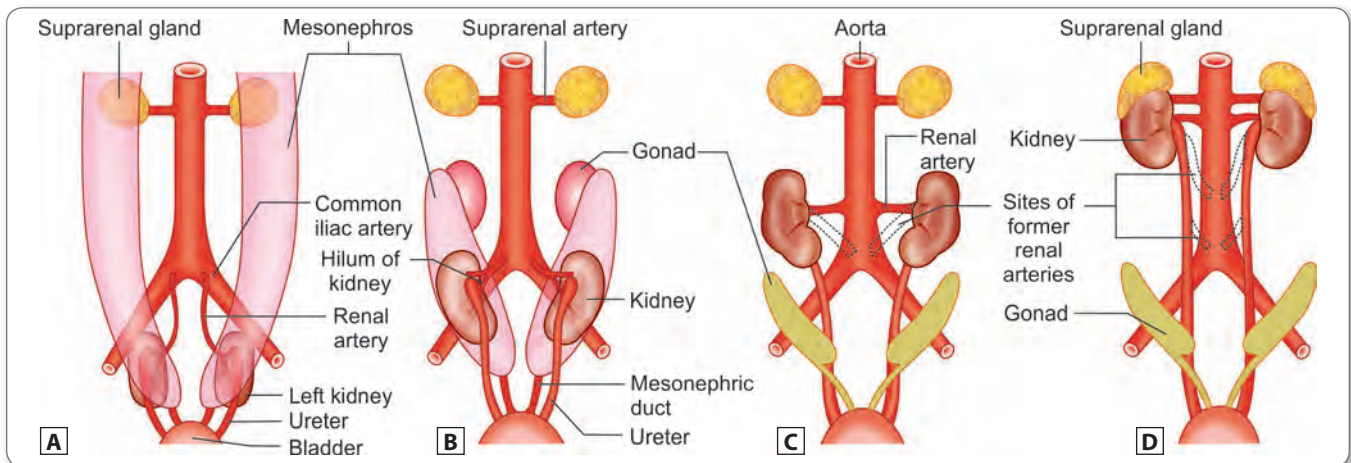
Fig. 30: Development of kidney

- Intermediate mesoderm forms the longitudinal elevation along the dorsal body wall called urogenital ridge
- Portion of urogenital ridge forms nephrogenic cord
- Nephrogenic cord forms pronephros, mesonephros and metanephros:
 - Pronephros: Cranial most nephric structure, regresses completely by week 5. Pronephros is not functional in humans
 - Mesonephros: Middle nephric structure and form mesonephric tubules and mesonephric duct. Most of mesonephric tubules disappear, but mesonephric duct persists and open into urogenital sinus. Mesonephros is functional for short period
 - Metanephros: Caudal most nephric structure. Forms at 5th week and becomes functional at 10th week. Develops into adult kidney:
 - Metanephros forms excreting part, ureteric bud form collecting part
 - Malpighian capsule, proximal convoluted tubule, loop of henle, distal convoluted tubule, connecting tubule from — metanephros
 - Collecting tubule, minor calyx major calyx renal pyramids, renal pelvis ureter from **ureteric bud**
 - Connecting tubule: Part connects distal convoluted tubule and collecting duct.

Table 3: Derivatives of metanephros and ureteric bud

Metanephros derivative	Malpighian capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule and connecting tubule
Ureteric bud derivative	Collecting tubule, minor calyx major calyx renal pyramids and renal pelvis ureter

Relative Ascent of Kidney



Figs 31A to D: Ascent of kidney

- Kidney is formed at S1-S2, whereas the definitive adult kidney is T12-L3
- The change in location results from a disproportionate growth of the embryo caudal to the metanephros
- During the relative ascent, kidney rotate 90° so that hilum which initially faces ventrally to finally face medially



Blood Supply of Kidney

- During the relative ascent, kidney will receive their blood supply from arteries at progressively higher levels until the definitive renal arteries develop at L2
- Arteries formed during ascent may persist and are called supernumerary arteries
- Supernumerary arteries are end arteries. Therefore any damage to them will result in necrosis of kidney parenchyma.



Clinical Aspect

Renal Fusion

- Most common type: Horse-shoe shaped kidney
- Inferior poles of the kidneys fuse across the midline
- Normal ascent of the kidneys arrested because of fused portions trapped behind **inferior mesenteric artery**

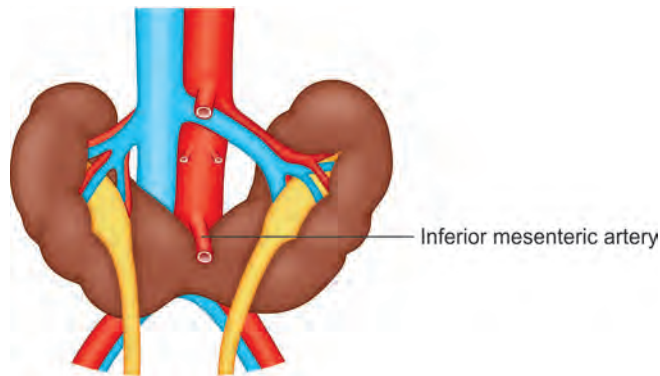
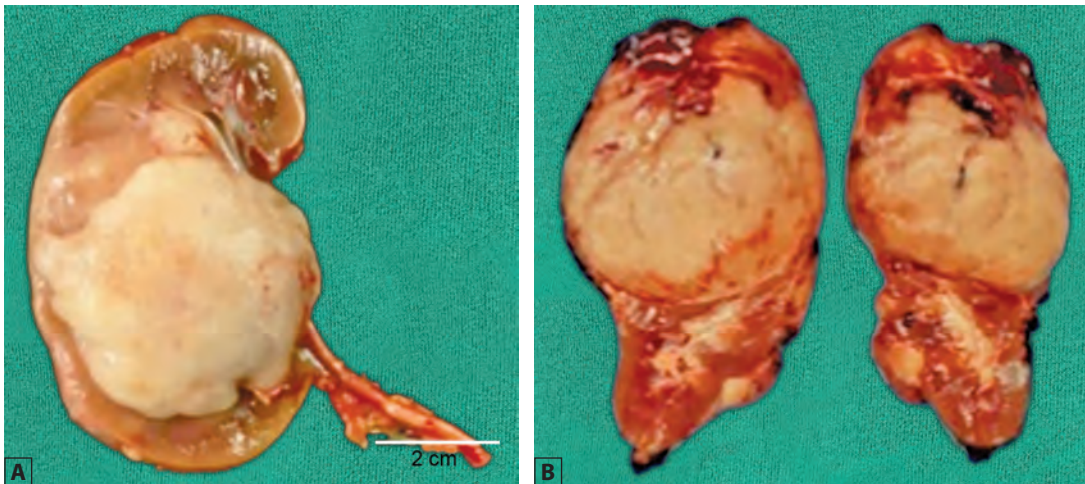


Fig. 32: Horse-shoe shaped kidney

Wilms' Tumor



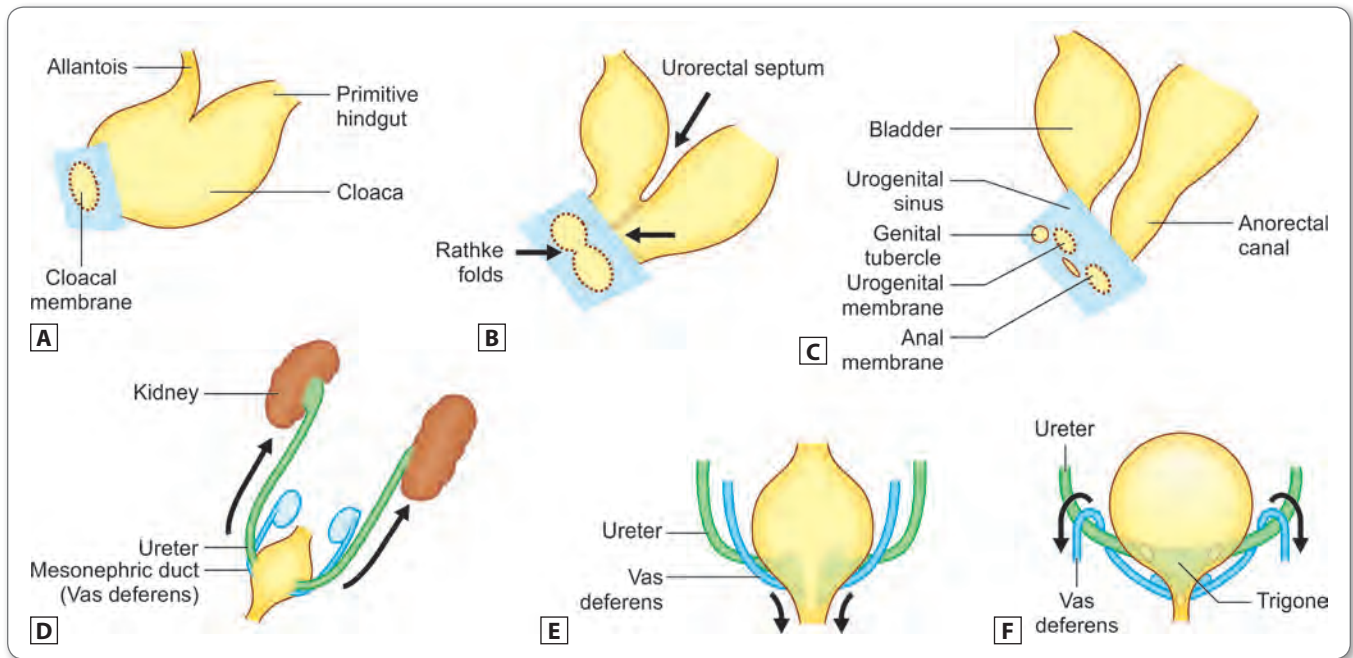
Figs 33A and B: Wilms' tumor

- Most common renal malignancy of childhood
- Three classical histological areas are described based on stages of embryonic development
 - **Metanephric blastema:** Metanephric blastema consisting of clumps of small, tightly packed embryonic cells
 - **Stromal cells**
 - **Tubular cells:** Epithelial elements in the stages of forming tubules or glomeruli



DEVELOPMENT OF BLADDER

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Figs 34A to F: Stages of development of bladder

Development of bladder occurs from vesical part of vesicourethral canal (endoderm), which is continuous with allantois. So transitional epithelium lining of the bladders derived from endoderm.

- Allantois forms Urachus
- Entire bladder is endodermal in origin except trigone of bladder which is developed from absorbed part of mesonephric duct, so trigone is mesodermal in origin
- Mesonephric duct opens into the urogenital sinus below the bladder

Note

- Epithelium of bladder – vesical part of vesicourethral canal (endodermal)
- Trigone of bladder – absorbed mesonephric duct (mesodermal)
- Muscles and serous coats of bladder – splanchnopleuric intra embryonic mesoderm
- Urachus – allantois

DEVELOPMENT OF URETHRA

Female

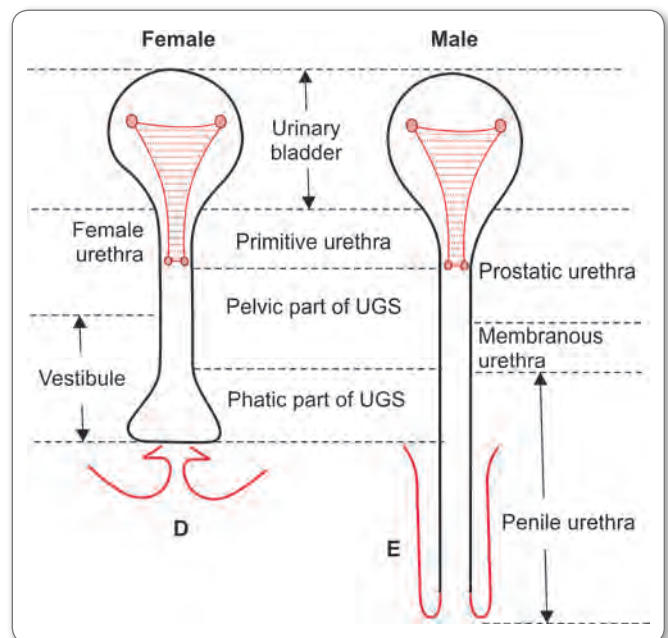


Fig. 35: Development of urethra

Develops from urethral part of vesicourethral canal and from pelvic part definitive urogenital sinus

Phallic part of urogenital sinus forms vestibule



Male

- Prostatic urethra above the opening of ejaculatory duct forms urethral part of urethral canal
- Prostatic urethra below the ejaculatory duct and membranous urethra forms pelvic part of definitive urogenital sinus
- Spongy urethra forms phallic part.

DEVELOPMENT OF THE REPRODUCTIVE SYSTEM

- Phenotypically male and female are indistinguishable till 6 weeks so it is called as indifferent gonad
- However, genotype is determined at fertilization itself
- By 7th week-testis begins to form
- By 10th week-ovary begins to form
- Phenotypic sexual differentiation is determined by SRY gene
- **SRY gene** encodes for testes determining factor
- So indifferent gonad develops into Testes. Then Leydig cells differentiate to produce testosterone and Sertoli cells secrete Müllerian-inhibiting factor
- In the presence of TDF, Testosterone and MIF, indifferent gonad is directed to male phenotype formation
- In the absence of TDF, Testosterone and MIF, indifferent gonad is directed to female phenotype formation
- Mesonephric duct/Wolffian duct is the main genital duct of males
- Paramesonephric duct/Müllerian duct is the main genital duct of females.

Development of Female Genital Tract

Development of Ovary

- Intermediate mesoderm forms longitudinal elevations along the dorsal body wall—urogenital ridge
- Coelomic epithelium and underlying mesoderm of the urogenital ridge proliferate to form gonadal ridge
- Primary sex cords develop from gonadal ridge
- Primordial germ cells originate from epiblast in 2nd week

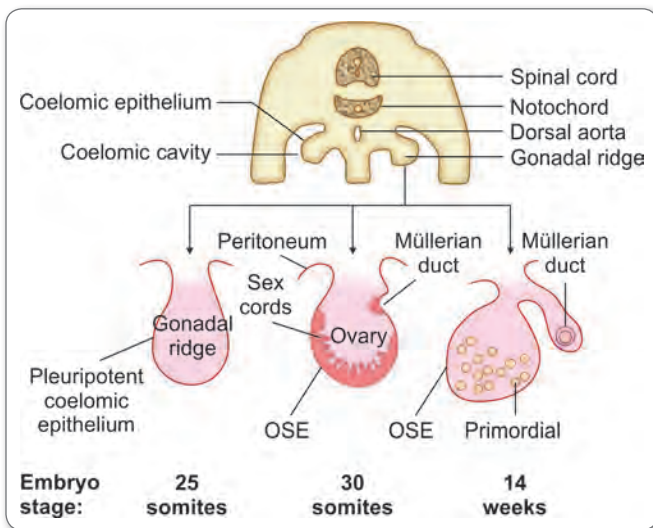


Fig. 36: Development of ovary.

Abbreviation: OSE, ovarian surface epithelium

- Primary sex cords develop into rete ovarii and later degenerates.
- Later secondary sex cords develops and incorporates primordial germ cells
- Secondary sex cords form primordial follicles.

Development of Genital Ducts

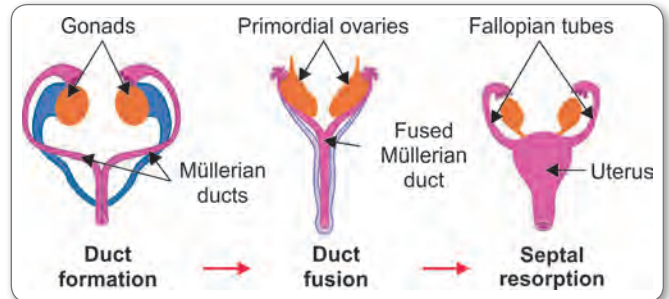


Fig. 37: Development of genital duct

- Paramesonephric duct develop as mesodermal invaginations of the lateral surface of the urogenital ridge
- Cranial part of paramesonephric duct develop into uterine tubes
- Caudal part fuse in the middle to form uterovaginal canal and thereby bring together two peritoneal folds called broad ligament
- Uterovaginal canal forms uterus, cervix and upper part of vagina
- Paramesonephric duct project into cloaca and forms SINOVAGINAL bulb
- Sinovaginal bulbs fuse to form vaginal plate which canalize and form lower part of vagina

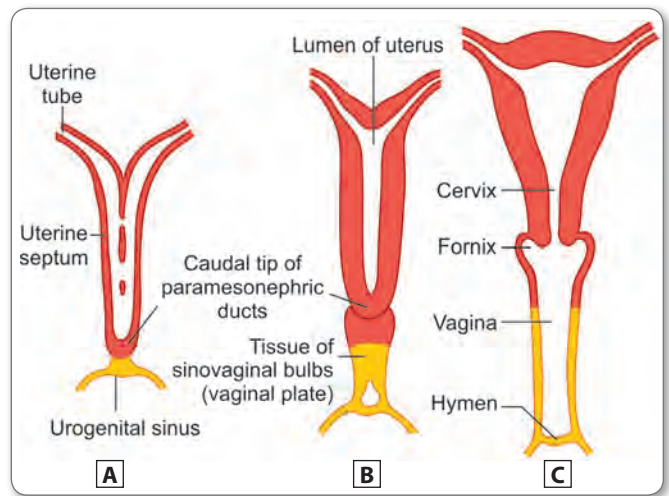
Development of Vagina

Vagina is developed from 2 sources:

- **Upper part of vagina including fornices** → from uterovaginal canal (**paramesonephric duct**) mesodermal in origin.
- **Lower part** → from urogenital sinus (endodermal origin)
- **Vestibule** – phallic part of definitive urogenital sinus

Note

- **Hymen** is formed at the junction of vagina and phallic part of urogenital sinus.



Figs 38A to C: Development of vagina



VESTIGIAL REMNANTS

- Hydatid cyst of Morgagni – from paramesonephric duct
- Koblet cyst – from appendix vesiculosa (remnant of mesonephric duct)
- Paroöphoron & epoöphoron – from mesonephros
- Gartner's duct – remnant of mesonephric duct

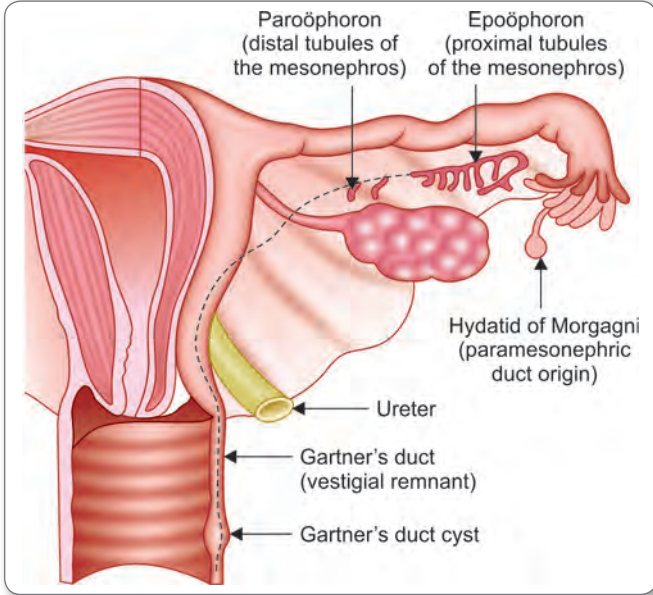
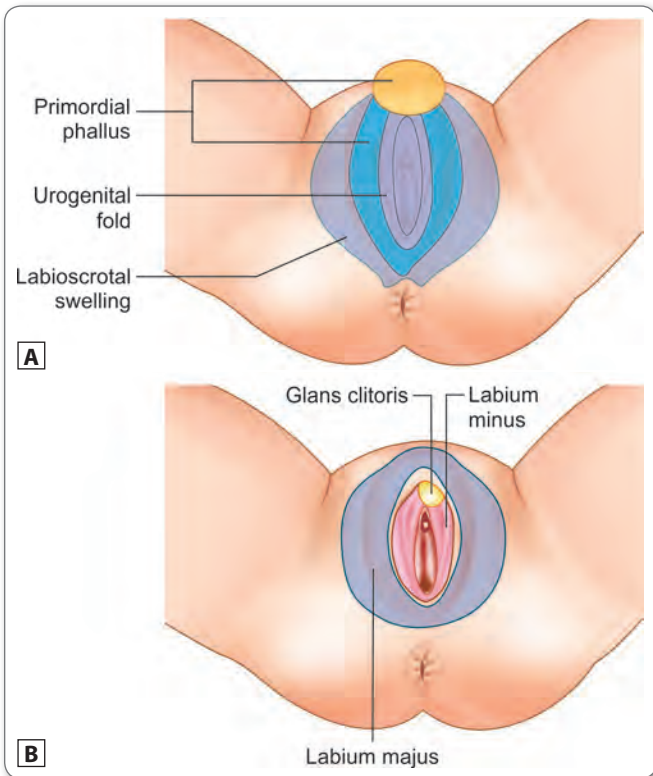


Fig. 39: Vestigial remnants of female reproductive system

Development of Female External Genitalia



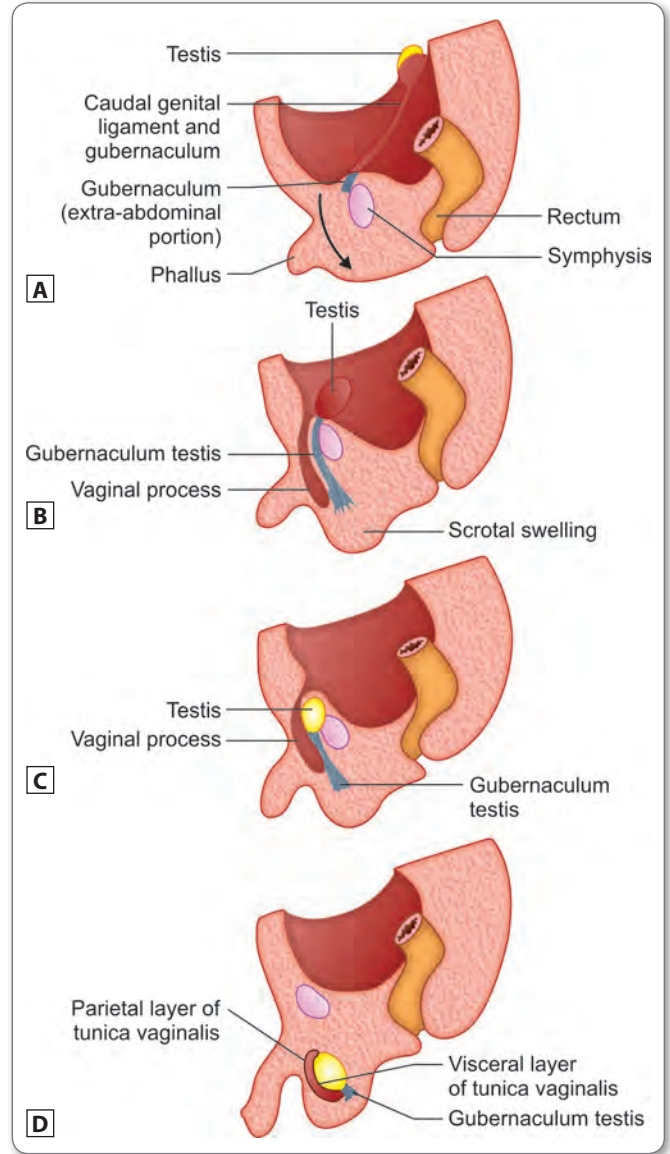
Figs 40A and B: Development of external genitalia female

From 3 structures:

- Phallus – forms clitoris
- Urogenital folds – labia minora
- Labioscrotal swellings – labia majora

Development of Male Genital Tract

Development of Testis



Figs 41A to D: Stages of descent of testis

- Testis develops in the lumbar region and descends into the scrotum
- The peritoneal cavity of the abdominal cavity forms the processus vaginalis of testis
- Intermediate mesoderm forms longitudinal elevations along the dorsal body wall – urogenital ridge
- Coelomic epithelium and underlying mesoderm of the urogenital ridge proliferate to form gonadal ridge
- Primary sex cords develop from gonadal ridge



- Primordial germ cells originate from epiblast in 2nd week
- Primary sex cords form seminiferous cords, tubuli recti and rete testis
- Seminiferous cords consist of primordial germ cell and sertoli cells
- Mesoderm of seminiferous cords gives rise to Leydig cells
- Seminiferous cords remain as solid cords until puberty later acquire lumen and it is called seminiferous tubules.

- Vestigial remnants
- Appendix of testis – from paramesonephric duct
- Appendix of epididymis – vestigial remnants of mesonephric duct
- Paradidymis – vestigial remnants of mesonephric tubules

Descent of Testis

Testis develop in abdomen and then undergo relative descent into scrotum:

- 4th month at iliac fossa
- 7th month at deep inguinal ring
- 7th and 8th month at inguinal canal
- 9th month reach the scrotum

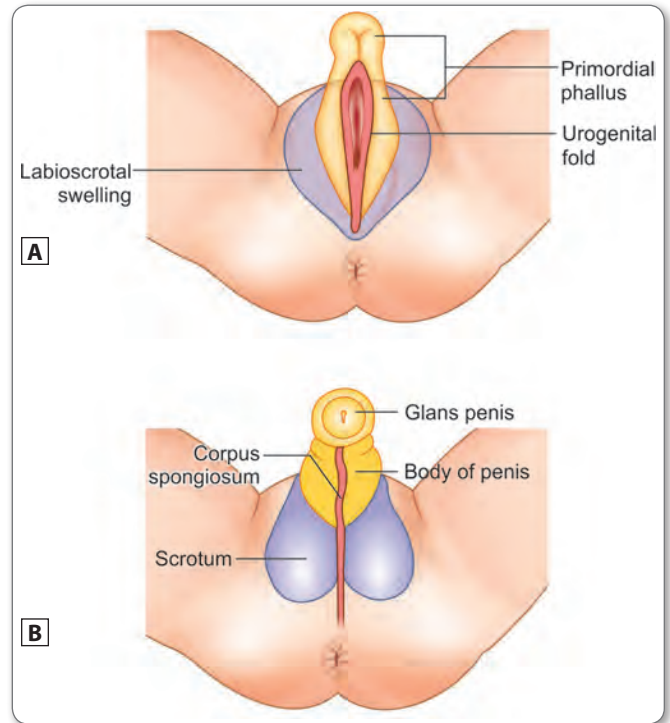
Factors for the Descent

- **Gubernaculum of testis**—one end attaches to bottom of testis, peritoneal cavity (peritoneal cavity descends along with testis, soon cavity obliterates and forms the process vaginalis). Other end gubernaculum split into many layers called **tail of lockwood**, which attach to bottom of scrotum, perineum, symphysis pubis and saphenous opening of thigh
- Intra-abdominal pressure
- Intra-abdominal temperature
- Internal secretion of fetal testis

Development of Duct System

- Paramesonephric duct develop as mesodermal invaginations of the lateral surface of urogenital ridge
- Cranial part parallel to mesonephric ducts
- Caudal part fuse in the midline to form uterovaginal canal
- Under the influence of Mullerian Inhibiting Factor, paramesonephric duct and uterovaginal canal regress
- Mesonephric duct and tubules develop in male as part of urinary system because these ducts are critical in the formation of definitive metanephric kidney
- Mesonephric duct forms epididymis, vas, seminal vesicle and ejaculatory duct
- Mesonephric tubules form efferent tubules of the testes

External Genitalia



Figs 43A and B: Development of male external genitalia

- Phallus – penis
- Urogenital fold – ventral aspect of penis
- Labioscrotal swelling – scrotum

Table 4: Fate of the structures derived from undifferentiated genital system

	Male	Female
Genital ridge	Testes	Ovary
Primordial germ cells	Spermatogonia	Oogonia
Mesenchyme	Leydig cells	Theca cells
Surface epithelium	Sertoli cells	Follicular cells
Gubernacular cord	Gubernaculum testis	Proximal part - Ovarian ligament Distal part - Round ligament of uterus
Mesonephros (Wolffian body)	<ul style="list-style-type: none"> • Cranial part - Efferent ductules • Caudal part - Paradidymis (Organ of Giraldes) 	<ul style="list-style-type: none"> • Appendices vesiculosae • Epooophoron (Organ of Rosenmüller) • Paroophoron

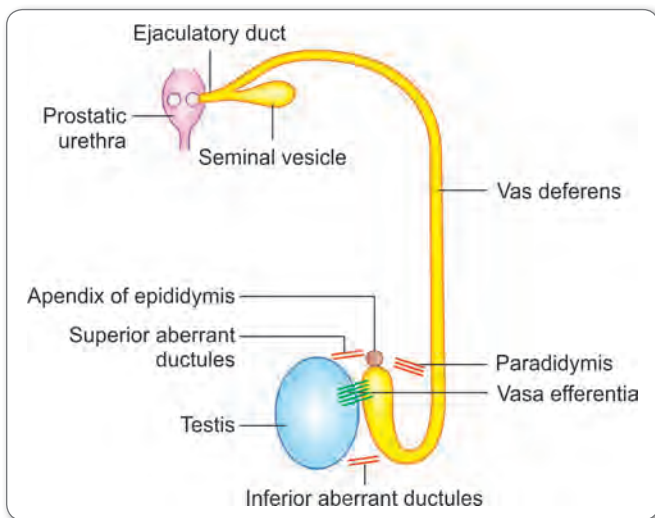


Fig. 42: Development of duct system in males

Contd...



	Male	Female
Mesonephric duct (Wolffian duct)	<ul style="list-style-type: none"> Duct of Epididymis Vas deferens Seminal vesicle Ejaculatory duct 	<ul style="list-style-type: none"> Duct of Epoophoron (Gartner's duct)
Paramesonephric duct (Mullerian duct)	<ul style="list-style-type: none"> Appendix of testis (Hydatid of Morgagni) Prostatic utricle 	<ul style="list-style-type: none"> Uterine tube Uterus Upper part of vagina
Cloaca (Two parts)	Divided by urorectal septum	
Dorsal part (Anorectal canal)	Rectum and upper part of anal canal	Rectum and upper part of anal canal
Ventral part (Urogenital sinus)	<ul style="list-style-type: none"> Most of bladder Part of prostatic urethra Prostate gland Bulbourethral glands Rest of urethral glands 	<ul style="list-style-type: none"> Most of bladder Urethra Greater vestibular glands, paraurethral glands of skene Vestibule Lower portion of vagina
Genital tubercle	Glans penis	Clitoris
Labioscrotal swellings	Scrotum	Labia majora
Urethral fold	Penile urethra	Labia minora

ABDOMEN

- Divided topographically by two horizontal and two longitudinal planes into nine regions
- Right and left hypochondriac, epigastric, right and left lumbar, umbilical, right and left iliac and hypogastric region

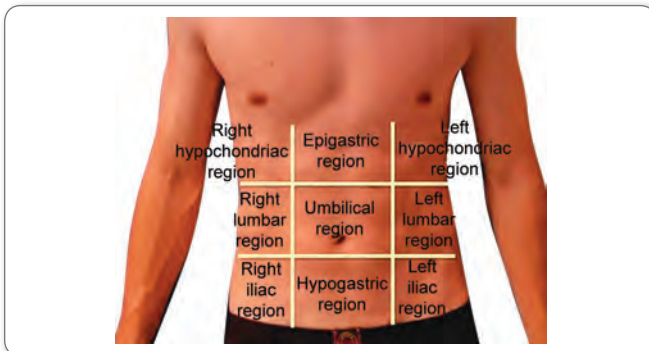


Fig. 44: Nine regions of abdomen

UMBILICUS

- Remnant of fetal end of the umbilical cord
- Situated at the level of **L3/L4**
- Supplied by **T10** (gonads or vermiform appendix are also supplied by T10) Pain in the umbilical region may be local in origin or referred from gonads and vermiform appendix
- Umbilicus, vocal folds, pectinate line act as watershed line
- Lymphatics from above the umbilicus drain to **axillary node**
- Lymphatics from below the umbilicus drain to **superficial inguinal node**
- Anterior abdominal wall divided into 9 regions by 2 vertical and horizontal planes

HORIZONTAL PLANES

- Transpyloric plane of Addison passes through anterior tip of 9th costal cartilage and posterior L1. Structures passing through this plane are origin of superior mesenteric artery, pylorus of stomach, fundus of gallbladder, hilum of kidney, and termination of spinal cord.
- Transtubercular plane: Passes through tubercles of iliac crest at the level of L5
- Vertical plane: Midclavicular plane

ANTERIOR ABDOMINAL WALL

Fasciae and Ligaments of Anterior Abdominal Wall

Table 5: Fasciae of anterior abdominal wall

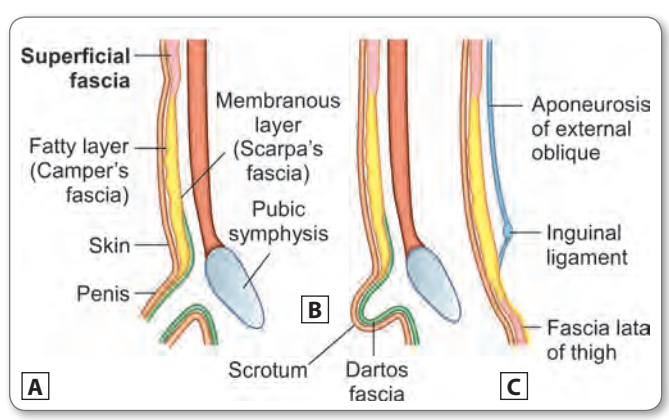
Superficial fatty layer of anterior abdominal wall	Camper's fascia
Deep membranous layer of anterior abdominal wall	Scarpa fascia
Superficial fatty layer of perineum	No specific name
Deep membranous layer of perineum	Colles fascia
Superficial fascia of penis	Buck's fascia
Anterior layer of perirenal fascia	Fascia of Gerota
Posterior layer of perirenal fascia	Fascia of Zuckerkandl's
Condensation of endopelvic fascia	Hypogastric sheath
Inferior fascia of urogenital diaphragm	Perineal membrane
Rectovesical septum in female and rectoprostatic in male	Fascia of Denonvilliers

Layers of Anterior Abdominal Wall

- Skin
- Superficial fascia - two layers
- External oblique
- Internal oblique
- Transverse abdominis muscle
- Fascia transversalis
- Extra peritoneal tissue
- Parietal layer of peritoneum



Superficial Fascia



Figs 45A to C: Superficial fascia

- Superficial **fatty** layer of superficial fascia (**camper fascia**) continues over the inguinal ligament to merge with superficial fascia of thigh. Continues over the pubis and perineum as the superficial layer of superficial perineal fascia
- **Membranous layer** of superficial fascia (**scarpa fascia**) attached to fascia lata just below the inguinal ligament. Continues over pubis and perineum as colles fascia of superficial perineal fascia.

Linea Alba

- Tendinous median raphae between two rectus abdominis muscle formed by fusion of aponeuroses of external oblique, internal oblique and transversus abdominis
- Extends from xiphoid process to pubic symphysis.

Clinical Aspect

Epigastric Hernia

- Protrusion of extraperitoneal fat or greater omentum through defect in linea alba above the umbilicus
- It may contain small portion of intestine, which may be trapped within the hernia leading to incarcerated or strangulated hernia

Linea Semilunaris

- Curved line along the lateral border of rectus abdominis

Arcuate Line

- Crescent shaped line marking the inferior limit of posterior layer of rectus sheath just below the level of iliac crest

HIGH YIELD POINTS

- Deep fascia is absent in anterior abdominal wall
- Inguinal ligament – poupart's ligament
- Folded lower border of aponeurosis of external oblique
- Extending between anterior superior iliac spine and pubic tubercle
- Forms the floor of inguinal canal

Extensions of Inguinal Ligament

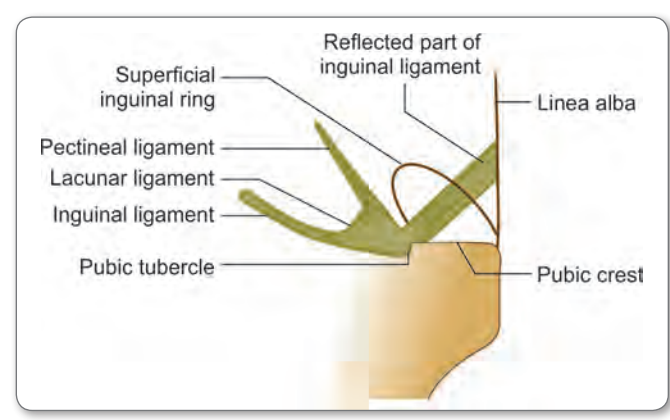


Fig. 46: Extensions of inguinal ligament

Lacunar Ligament–Gimbernat's Ligament

- Represents medial triangular expansion of inguinal ligament to pectinate line of pubis
- Forms the **medial relation** of femoral ring

Pectineal Ligament of Cooper

- Inguinal ligament extends laterally from lacunar ligament along the pectineal line of pubis

Reflected Part of Inguinal Ligament

- Fibers derived from medial portion of inguinal ligament
- Runs upward over the conjoint tendon to the linea alba

Falx Inguinalis–Conjoint Tendon

- Formed by aponeurosis of **internal oblique and transversus abdominis** (2/3 by transversus abdominis and 1/3 internal oblique) and inserted to pubic tubercle and crest
- Posterior wall of the inguinal canal is strengthened medially by conjoint tendon.

Transversalis Fascia

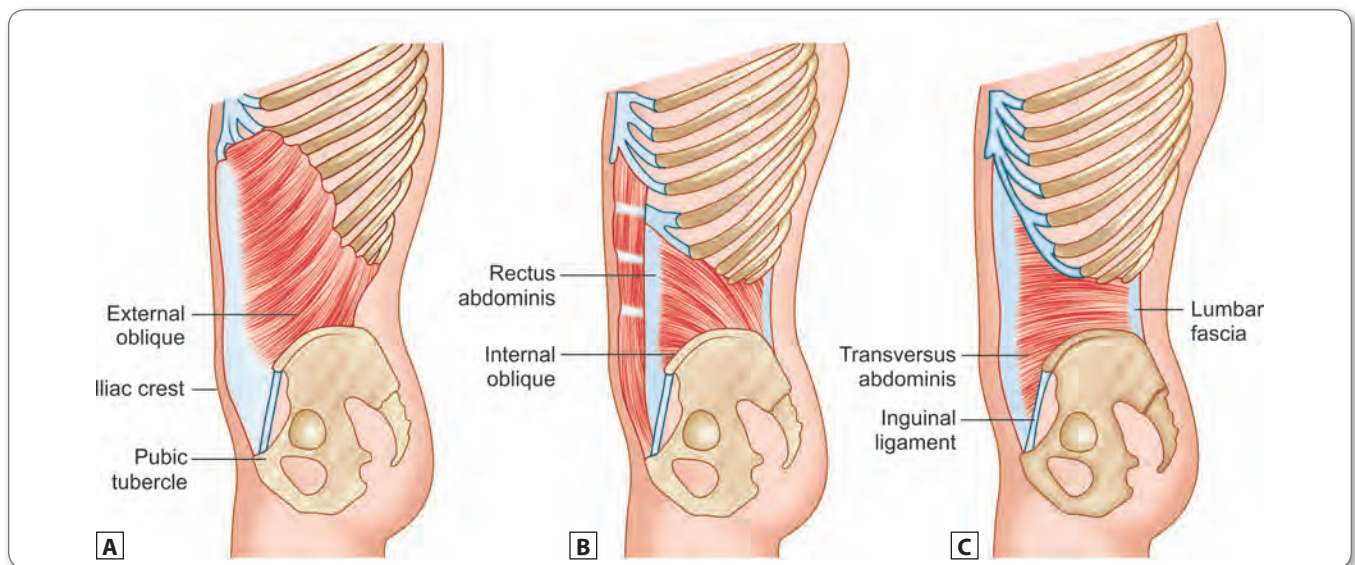
- It is the lining fascia of entire abdominopelvic cavity between parietal peritoneum and inner surface of abdominal muscles
- Continuous with diaphragmatic, psoas, iliac, pelvic and quadratus lumborum fascia
- Forms **deep inguinal ring** and gives rise to femoral sheath and **internal spermatic fascia**
- Is directly in contact with rectus abdominis below the arcuate line
- Fascia displays thickening called as iliopubic tract which forms boundary to triangle of pain.



MUSCLES OF ANTERIOR ABDOMINAL WALL

Table 6: Muscles of anterior abdominal wall

Muscle	Origin	Insertion	Nerve supply	Action
External oblique	Lower border and outer surface of lower 8 ribs	Outer lip of iliac crest and form aponeurosis, which attaches to linea alba from xiphoid process to symphysis pubis	Ventral rami of lower 6 thoracic nerves	Retention, protection and compression of abdominal viscera It also flexes the vertebral column
Internal oblique	Lateral 2/3 inguinal ligament, intermediate lip of iliac crest, thoracolumbar fascia	Lower margin of last 4 ribs and to linea alba and forms conjoint tendon along with transversus abdominis		Retention, protection and compression of abdominal viscera
Transversus abdominis	Lateral 1/3 inguinal ligament, inner lip iliac crest, thoracolumbar fascia, lower 6 costal cartilages	Line alba and forms conjoint tendon along with internal oblique		It also flexes the vertebral column
Cremaster muscle	Middle of inguinal ligament and from internal oblique	Pubic tubercle and pubic crest and surrounds the spermatic cord	Genitofemoral nerve	Pulls the testis towards superficial ring



Figs 47A to C: Muscles of anterior abdominal wall

HIGH YIELD POINTS

Cremasteric Reflex

- Cremaster muscle – well developed in male and poorly developed in female
- Upon stroking the skin of the upper part of the medial side of the thigh, there is reflex contraction of the cremaster muscle, as evidenced by elevation and retraction of the testis. The reflex is more brisk in children. In upper motor neuron lesions above segment L1, the reflex is lost.
- **Innervation of Cremasteric Reflex**
 - **Afferent:** Femoral branch of genitofemoral nerve and ilioinguinal nerve
 - **Efferent:** Genital branch of genitofemoral nerve

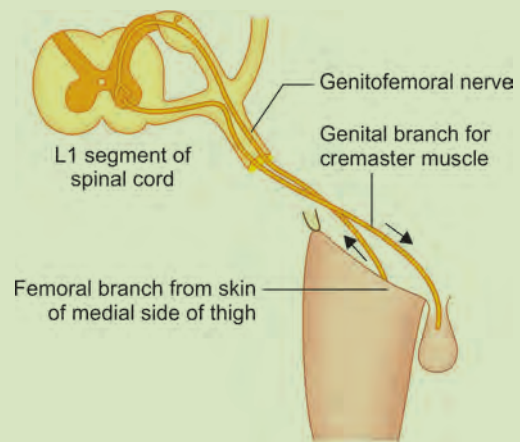


Fig. 48: Cremasteric reflex



PARACENTESIS

- Procedure in which needle is inserted 1–2 inch through the abdominal wall into peritoneal cavity to obtain a sample or drain fluid while patient is sitting upright
- Entry site is midline at approximately 2 cm below the umbilicus or lateral to McBurnery's point avoiding injury to inferior epigastric vessels

RECTUS SHEATH FORMATION

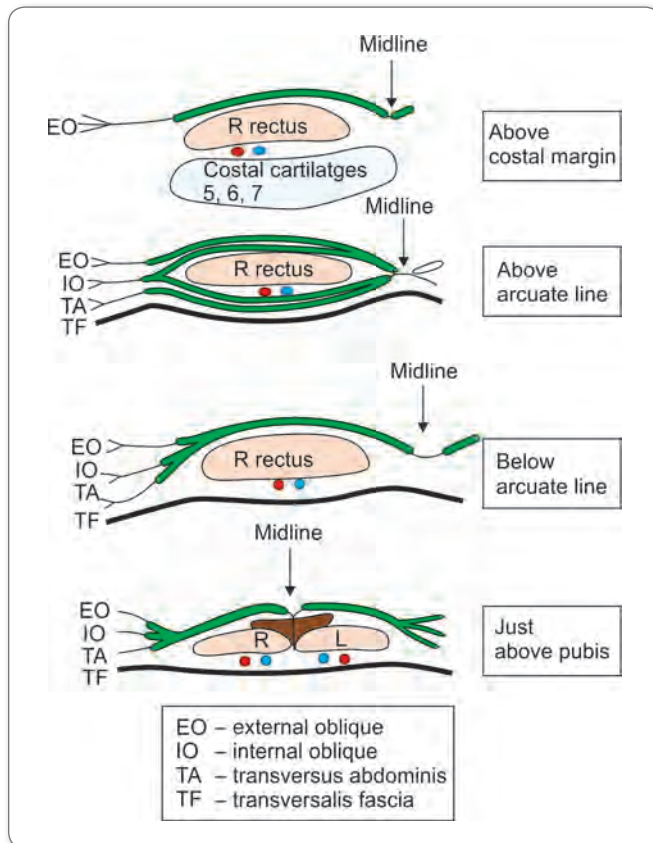


Fig. 49: Formation of rectus sheath

- Formed by fusion of aponeurosis of external oblique, internal oblique and transverse abdominis
- Encloses rectus abdominis and pyramidalis muscle
- Also contains:
 - Arteries—superior epigastric artery (internal mammary artery) anastomose with inferior epigastric artery (external iliac artery)
 - Nerves—lower 6 Thoracic Nerves

Table 7: Anterior and posterior walls of rectus sheath in various regions

Area	Anterior wall	Posterior wall
Above the costal margin	Formed only by aponeurosis of external oblique	Deficient
Above the arcuate line	Formed by aponeurosis of external and internal oblique	Formed by aponeurosis of internal oblique and transversus abdominis
Below the arcuate line	Formed by aponeurosis of external, internal oblique and transversus abdominis	Deficient

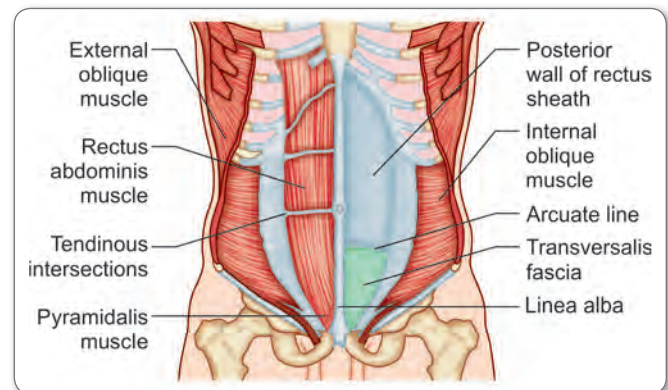


Fig. 50: Anterior abdominal wall muscles

Table 8: Rectus abdominis and pyramidalis

	Rectus abdominis	Pyramidalis
Origin	Pubic symphysis, pubic crest and pubic tubercle	Pubic symphysis, pubic crest
Insertion	Xiphoid process, 5th 6th and 7th costal cartilage	Linea alba
Nerve supply	Lower five intercostal nerve and subcostal nerve	Subcostal nerve
Action	<ul style="list-style-type: none"> • Flexion of vertebral column • Compress the abdominal viscera and maintain intra • Abdominal pressure • Protection to abdominal viscera from external injury 	Tensor of linea alba



INGUINAL CANAL – HOUSE OF BASSINI

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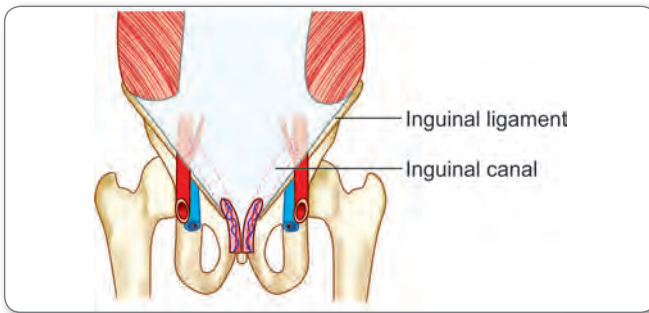


Fig. 51: Inguinal canal

- Musculoaponeurotic tunnel (4 cm)
- Extends from deep ring to superficial ring
- Canal is directed downward, forward and medially above and parallel to medial half of inguinal ligament

Contents

- Spermatic cord in male and round ligament of uterus in female
- Ilioinguinal nerve (partial content)

Table 9: Boundaries of inguinal canal

Anterior wall	<ul style="list-style-type: none"> • Skin, superficial fascia, aponeurosis of external oblique • Strengthened laterally by fibers of internal oblique
Posterior wall	<ul style="list-style-type: none"> • Fascia transversalis • Strengthened in the medial half by conjoint tendon and in the medial one-fourth by reflected part of inguinal ligament
Roof	<ul style="list-style-type: none"> • Arched fibers of internal oblique and transversus abdominis
Floor	<ul style="list-style-type: none"> • Grooved upper surface of inguinal ligament • Medially floor formed by lacunar ligament
Inlet	<ul style="list-style-type: none"> • Deep inguinal ring (gap in transversalis fascia) • Situated 1.25 cm above the mid inguinal point • Contents (spermatic cord/round ligament enter the canal through deep ring) • Inferior epigastric artery is situated medially to deep ring
Outlet	<ul style="list-style-type: none"> • Superficial inguinal ring (gap in external oblique aponeurosis) • Superficial ring is situated above and lateral to pubic crest • Structures passing through superficial ring • Ilioinguinal nerve spermatic cord/round ligament

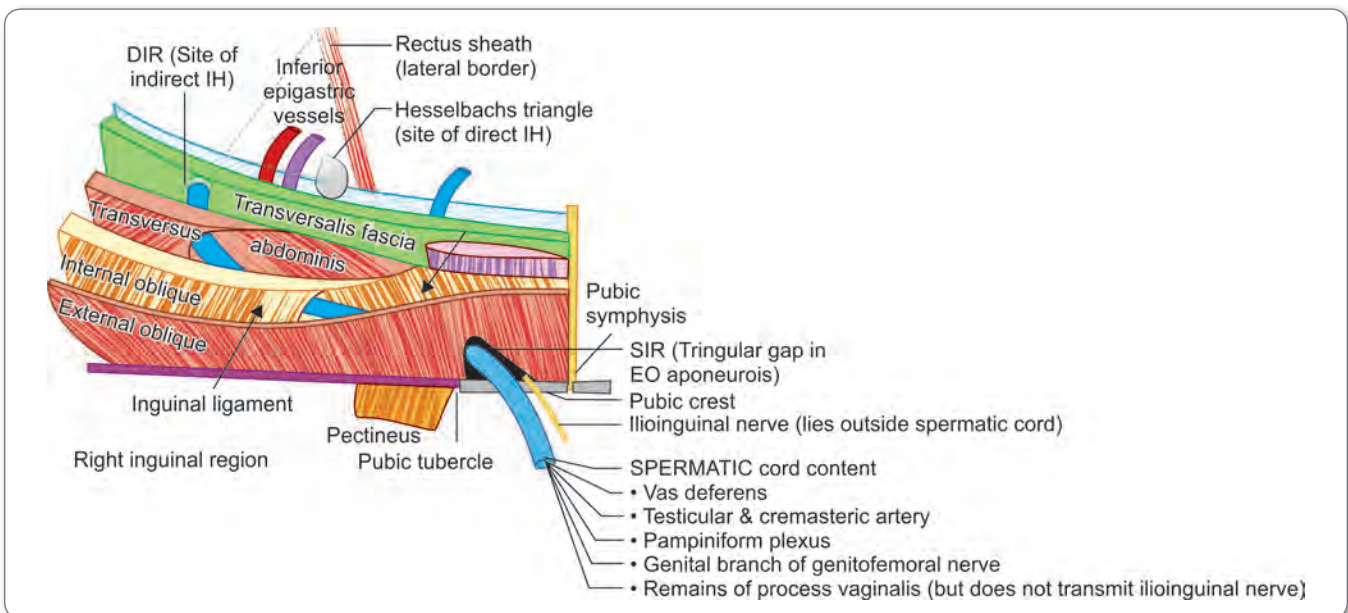


Fig. 52: Inguinal canal



Clinical Aspect

- **Inguinal hernia**
 - Arises when part of intestine protrudes through weak spot in the inguinal canal or in Hesselbach's triangle
 - Inguinal hernia occurs superior to inguinal ligament and lateral to pubic tubercle
 - Occurs more common in males
- **Reducible hernia:** Hernia in which the contents of the hernial sac can be returned to their normal position
- **Incarcerated hernia:** In which the contents of the sac are entrapped in groin
- **Strangulated hernia:** Irreducible hernia, in which circulation is arrested and gangrene occurs and requires immediate surgery

Table 10: Differences between direct and indirect hernia

Indirect hernia	Direct hernia
<ul style="list-style-type: none"> • Enters through deep ring • Neck of the sac lateral to inferior epigastric artery • Unilateral • Occur in young patients • It is congenital • Directed downwards, forwards and laterally • Reach the scrotum so covered by spermatic fascia 	<ul style="list-style-type: none"> • Enters through Hesselbach's triangle • Neck of the sac medial to inferior epigastric artery • Bilateral • Occurs in old people • Due to weakness of abdominal wall • Directed straight • Do not reach the scrotum, so no spermatic fascia

Note:

- Most common hernia in elderly – direct
- Most common hernia in children – umbilical hernia
- Most common inguinal hernia in children – indirect
- In females most common inguinal hernia indirect > direct

HIGH YIELD POINTS

Hesselbach's Triangle

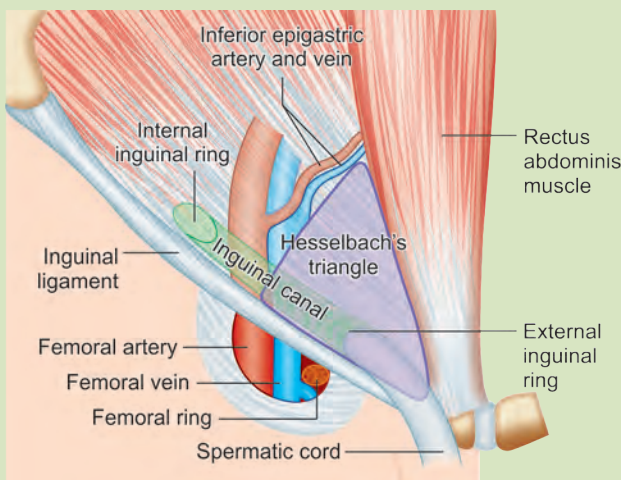
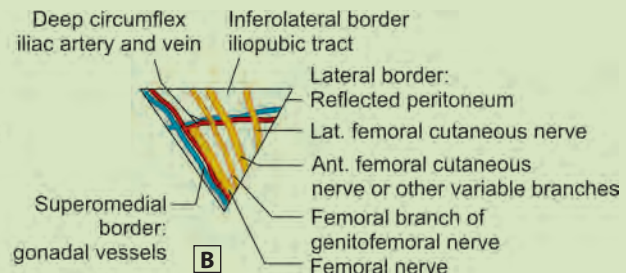
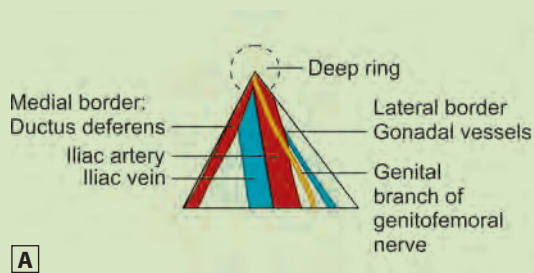


Fig. 53: Hesselbach's triangle

Boundaries

- Medially: Lateral border of rectus sheath.
- Laterally: Inferior epigastric artery.
- Below: Inguinal ligament.

Triangle of Doom



Figs 54A and B: (A) Triangle of doom and (B) Triangle of pain



- Medial—vas deferens
- Lateral—gonadal vessels
- Base—peritoneal reflections
- Apex—deep inguinal ring

It contains external iliac vessels

Dangerous bleeding occurs if you put staples in this triangle so laparoscopic dissection should be careful.

Triangle of Pain - Contains Nerves

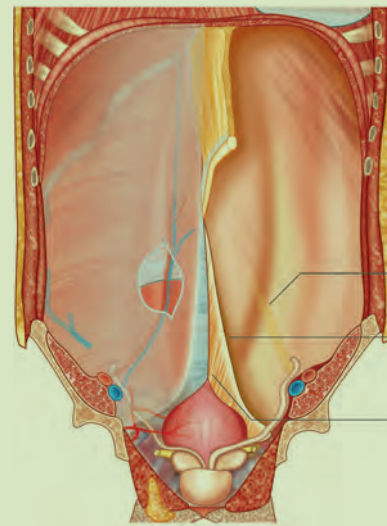
- Medial—gonadal vessels
- Lateral—iliopubic tract
- Base – skin incision
- Content—femoral branch of genitofemoral nerve, anterior femoral cutaneous nerve and lateral femoral cutaneous nerve.
- Stapling here causes neuralgia



Clinical Aspect

- Triangle of doom and triangle of pain need to be taken care of while doing laparoscopic hernia repair
- Most common nerve injured in laparoscopic repair - lateral cutaneous nerve of thigh > genitofemoral nerve
- Most common nerve injured in open hernia procedure – ilioinguinal nerve > genitofemoral nerve

Umbilical Fold



- Lateral umbilical fold**
Inferior epigastric vessels
- Medial umbilical fold**
Obliterated umbilical a.
- Median umbilical fold**
Median umbilical lig.

Fig. 55: Umbilical ford

- Medial umbilical fold (remnant of fibrous cord urachus) extends from apex of the bladder to umbilicus
- Medial umbilical fold (remnant of obliterated (distal) umbilical artery) extends from side of bladder to umbilicus (Proximal part of umbilical artery forms superior vesicle artery)
- Lateral umbilical fold: It is fold of peritoneum that covers inferior epigastric artery and extends from medial side of deep inguinal ring to arcuate line

Fossa in the Anterior Abdominal Wall

- Supravesical fossa: Depression between median and medial umbilical fold
- Edial inguinal fossa: Depression between medial and lateral umbilical fold. Direct inguinal hernia occurs here
- Lateral inguinal fossa: Depression lateral to lateral umbilical fold.

NERVES OF ANTERIOR ABDOMINAL WALL

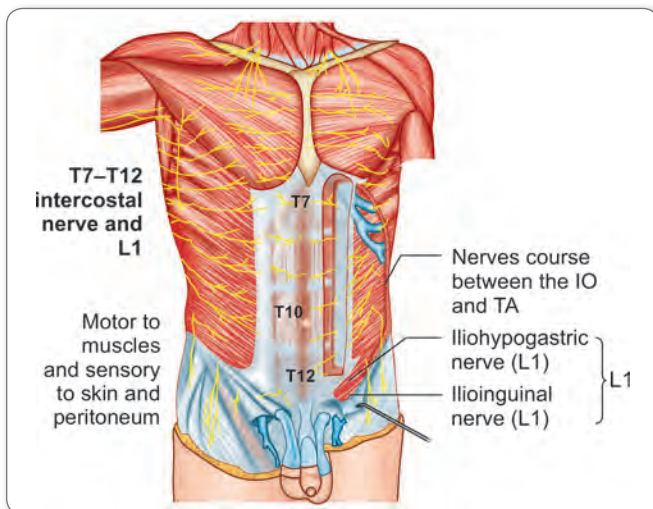


Fig. 56: Nerves of an anterior abdominal well

Subcostal Nerve t12 – Mixed Nerve

It is the ventral rami of t12

Innervates muscles of anterior abdominal wall

Has lateral cutaneous branch that innervates the skin of side of hip

Iliohypogastric Nerve L1 – Mixed Nerve

From l1 (lumbar plexus) and runs in the neurovascular plane (between internal oblique and transverse abdominis muscle) and innervates these two muscles.

Divides into lateral cutaneous branch to supply the skin of lateral side of the buttocks and anterior cutaneous nerve to supply the skin above the pubis.

Ilioinguinal nerve–l1 - mixed nerve.

From l1–pierce the internal oblique near the deep inguinal ring and accompanies the spermatic cord through inguinal canal and then through superficial inguinal ring.

Innervates internal oblique and transverse abdominis.



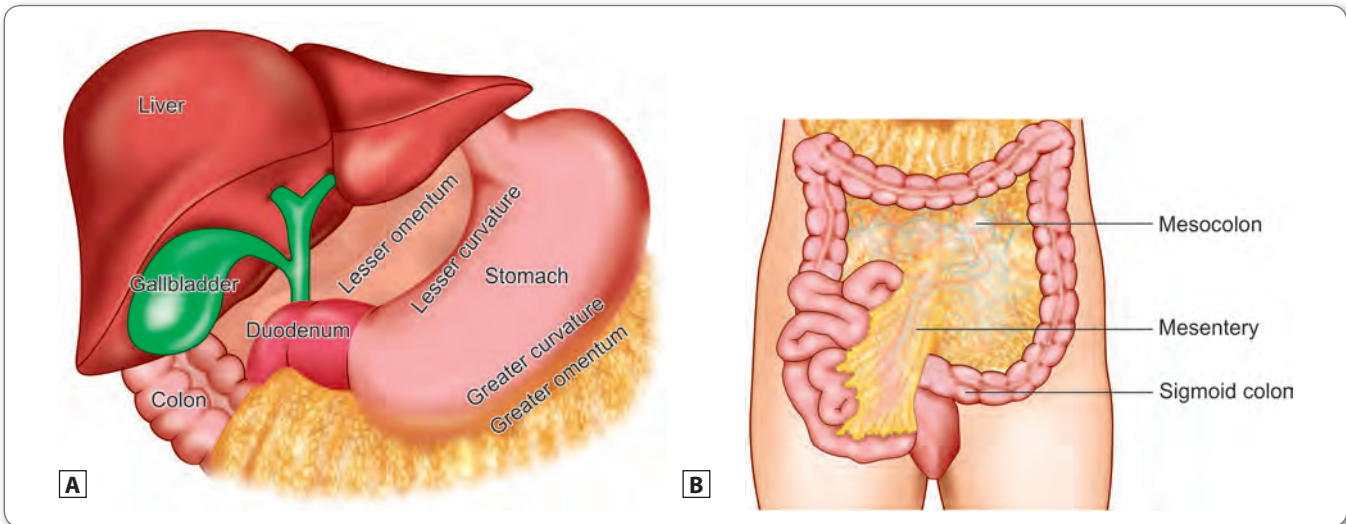
Gives rise to femoral branch which supplies upper and medial aspects of thigh and anterior scrotal nerve which innervate the skin of root of penis (mons pubis in female) and anterior part of scrotum (labia majora).

PERITONEUM

Serous membrane lined by mesothelial cells.

Table 11: Comparison between visceral and parietal layers of peritoneum

Visceral layer	Parietal layer
Lines the viscera	Lines abdominal and pelvic wall
Develops from splanchnopleuric mesoderm	Develops from somatopleuric mesoderm
Insensitive to pain	Sensitive to pain



Figs 57A and B: Peritoneal folds (A) Greater and lesser omentum; (B) Mesocolon

Table 12: Peritoneal folds

Omentum	Mesentery	Mesocolon
<p>Connects stomach to other organs</p> <p>Greater omentum</p> <ul style="list-style-type: none"> Derived from dorsal mesogastrium Connects stomach to transverse colon 4 layers, 1st layer continues as 4th layer and 2nd layer continues as 3rd layer Store house of fat Referred as policeman of abdomen Consists of gastrosplenic, lienorenal, gastrophrenic, gastrocolic ligaments Contains left and right gastroepiploic vessels. <p>Lesser omentum</p> <ul style="list-style-type: none"> Derived from ventral mesogastrium Extends from porta hepatis of liver to stomach and beginning of duodenum 2 parts hepatogastric (liver to stomach), hepatoduodenal (liver to duodenum) Contains right and left gastric artery free margin contains portal vein, proper hepatic artery common bile duct 	<p>Suspends jejunum and ileum from posterior abdominal wall</p> <p>Root of mesentery 15 cm extends from duodenojejunal flexure (on left side L2) to sacroiliac joint on right side</p> <p>Structures crossing root of mesentery</p> <ul style="list-style-type: none"> III part of duodenum, abdominal aorta Inferior vena cava Right gonadal vessel Right psoas major Right genitofemoral nerve Right ureter Right sacroiliac joint 	<p>Transverse mesocolon: Connects transverse colon to posterior abdominal wall contains middle colic vessels.</p> <p>Mesoappendix: Connects appendix to ileal mesentery contains appendicular vessels sigmoid mesocolon.</p> <p>Sigmoid mesocolon: Connects sigmoid colon to posterior abdominal wall contains sigmoid vessels.</p> <p>Mesorectum: Contains superior rectal vessels, lymphatics, branch from inferior mesenteric plexus.</p>



Peritoneal Cavity

- Potential space between parietal and visceral layer of peritoneum. Contains thin film of fluid
- It is closed cavity in male, but in female it is open through fallopian tube, uterus, vagina
- Divided into lesser sac and greater sac

Lesser Sac (Omental Bursa)

Sac behind the stomach and lesser omentum and in front of the pancreas and retroperitoneum.

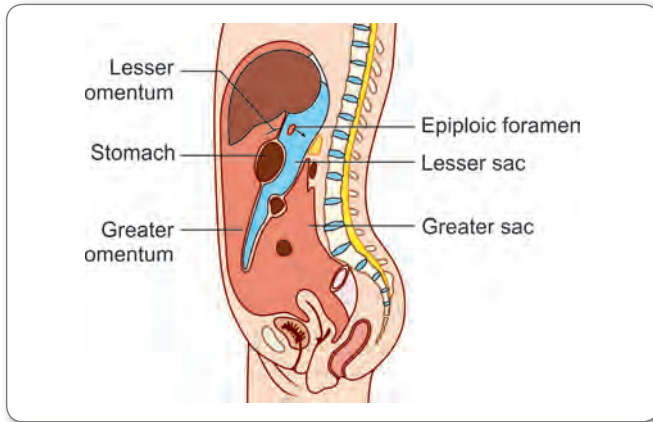


Fig. 58: Peritoneal cavity

Boundaries

- Anterior wall: Caudate lobe, lesser omentum, peritoneum coverings of stomach and the second layer of greater omentum.
- Posterior wall: 3rd layer of greater omentum, transverse colon, upper layer of transverse mesocolon and body of pancreas, part of left suprarenal and left kidney and undersurface of the diaphragm
- Upper margin: Reflection of peritoneum from the diaphragm to the upper end of caudate lobe of liver.
- Lower margins: Fused 2nd and 3rd layer of greater omentum.
- Right margin: Right free margin of greater omentum, peritoneal reflection from neck of pancreas to posterior surface of 1st part of duodenum
- Left margin: Left free margin of greater omentum, inner layer of gastrosplenic and lienorenal ligament and gastrophrenic ligament.

Recess

- Presents three recess
- Superior recess lies behind the stomach, lesser omentum and left lobe of liver
- Inferior recess lies behind stomach, extending into layers of greater omentum
- Splenic recess extends to left at the hilum of spleen

Greater Sac

- Sac surrounds the majority of abdominal and pelvic viscera. Presents numerous recess

- Suprahepatic recess: Peritoneal pocket between diaphragm and anterior and superior part of liver. Separated into right and left recess by falciform ligament
- Subhepatic recess (hepatorenal pouch of Morison) it is the deep peritoneal pocket between liver anteriorly and, kidney and supra renal gland posteriorly. Communicate with the lesser sac through the epiploic foramen and also with pelvic cavity through right paracolic gutter
- Paracolic recess (Gutters) lies lateral to ascending colon (right paracolic gutter) and descending colon (left paracolic gutter)

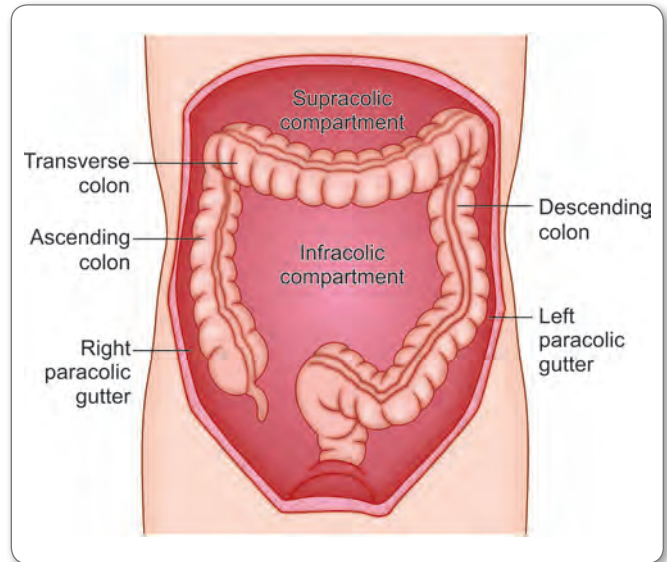


Fig. 59: Spaces in abdomen

- Epiploic foramen (Aditus to lesser sac or Foramen of Winslow)

OTHER LIGAMENTS

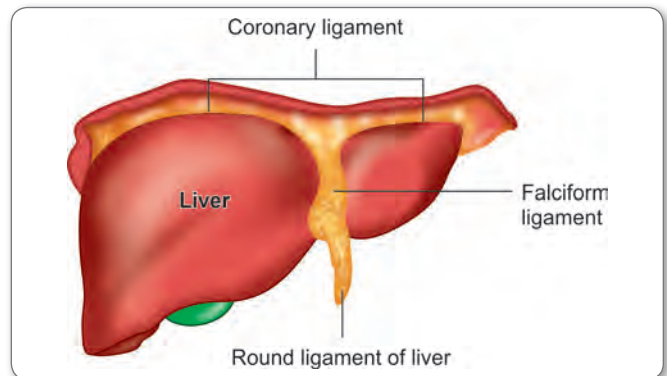


Fig. 60: Ligaments of liver

- Phrenicocolic ligament—runs from left colic flexure to diaphragm
- Falciform ligament, it is
 - Sickle-shaped peritoneal fold connecting liver to anterior abdominal wall
 - Contains ligamentum teres hepatis/paraumbilical vein (which connects left branch of portal vein to subcutaneous vein around umbilicus)



- Round ligament of liver
 - Extends from umbilicus to inferior surface of liver and lying in the fissure that forms left boundary of quadrate lobe
 - It is remnant of left umbilical vein
- Coronary ligament
 - Peritoneal reflections from diaphragmatic surface of liver to diaphragm
 - Right and left extensions of coronary ligament is called as right and left triangular ligament
 - On the right side, it Encloses triangular bare area
- Ligamentum venosum
 - Remnant of ductus venosus
 - Forms the left boundary of caudate lobe

EPIPLOIC FORAMEN OR FORAMEN OF WINSLOW

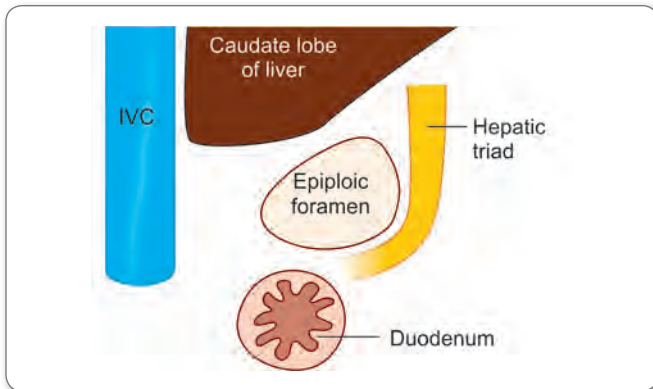


Fig. 61: Epiploic foramen

Epiploic foramen presents in the right free margin of lesser omentum at T12.

Epiploic foramen communicates right side with **hepatorenal pouch of Morison** of greater sac and on the left side with lesser sac.

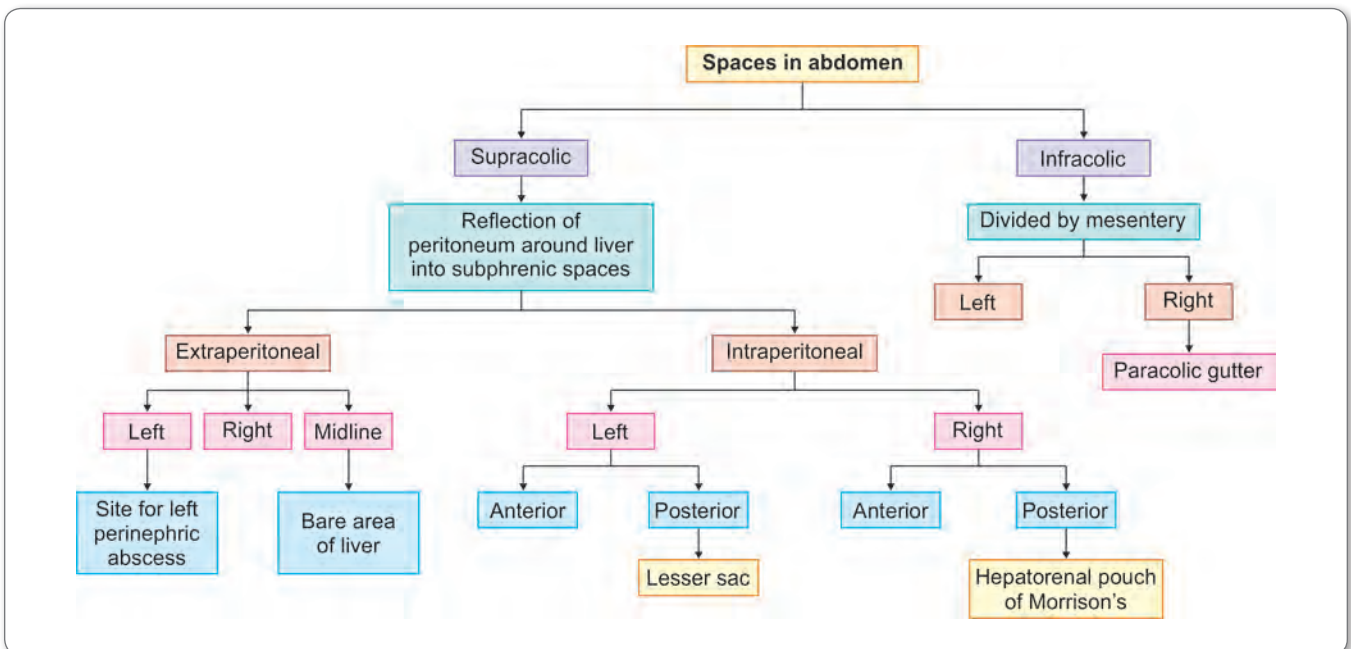
Boundaries

- Anterior: Structures in the right free margin of lesser omentum portal vein, bile duct, hepatic artery proper, hepatic plexus of nerves and lymphatics
- Posterior: Inferior vena cava
- Above: Caudate process of the liver
- Below: First part of the duodenum

Two main compartments: Supracolic and infracolic compartments separated by transverse colon and mesocolon.

SUPRACOLIC COMPARTMENT

Flow chart 1: Flow chart of supracolic and infracolic spaces in abdomen



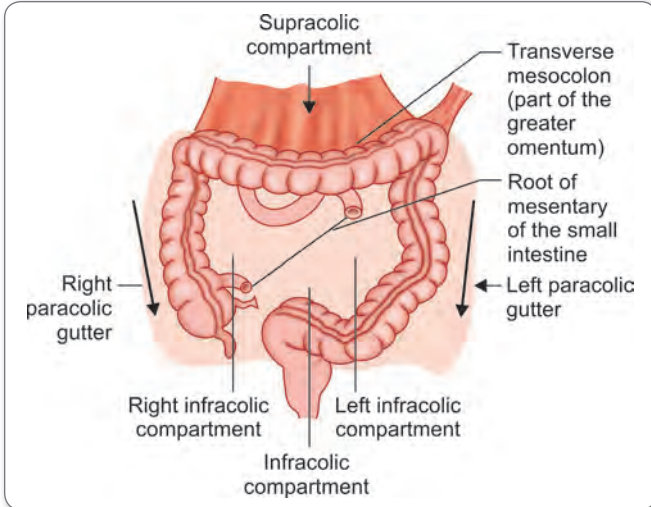


Fig. 62: Supracolic and infracolic compartment of abdomen

Spaces on Right Side

Right side, the following spaces are present:

- **Right suprahepatic recess**
- **Right subhepatic recess** is also known as **hepatorenal pouch of Morison**
- Right extraperitoneal space

Hepatorenal Pouch of Morison

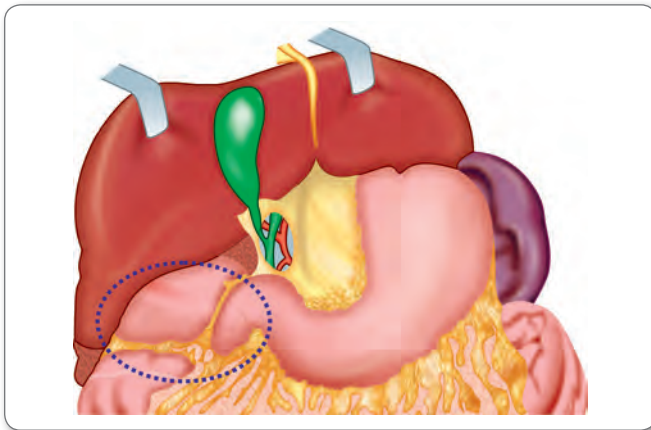


Fig. 63: Hepatorenal pouch of Morison

- It is right posterior intraperitoneal recess
- It is the most dependent space of peritoneal cavity in supine position.

Boundaries

- In front: Inferior surface of right lobe of liver
- Behind: Anterior surface of right kidney, suprarenal gland and right colic flexure
- Below: Communicates with infracolic compartment of greater sac along external right paracolic gutter and thus open into pelvic peritoneum

- Above: Inferior layer of coronary ligament
- Left side: Communicates with omental bursa through epiploic foramen
- Right side: Limited by diaphragm and communicates with right anterior intraperitoneal recess around the free margin of right triangular ligament

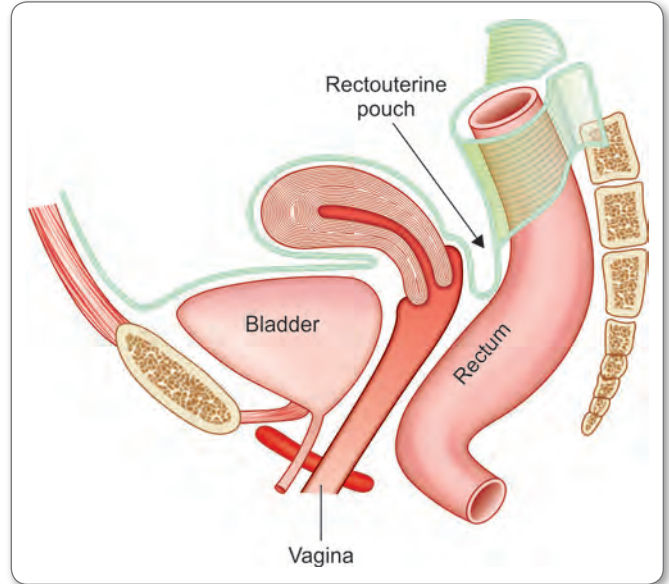


Fig. 64: Rectouterine pouch (Pouch of Douglas)

- Pouch between rectum posteriorly and uterus anteriorly
- Most dependent part of abdominal cavity in standing
- Most dependent part of the abdomen in lying down position is hepatorenal pouch of Morison

Spaces on Left Side

On the left, the following spaces are present:

- **Left suprahepatic recess**
- **Left subhepatic recess lesser sac:** Already explained
- **Left extraperitoneal space**

HIGH YIELD POINTS

Must know Points about Recesses

Lesser sac	Largest recess and present behind the stomach
Duodenal recesses	6 recesses, which are explained under duodenum
Cecal recess	<ul style="list-style-type: none"> • Superior ileocecal recess contains branch of ileocolic artery • Retrocecal recess contains appendix • Inferior ileocaecal recess: Avascular (bloodless fold of Treves)
Intersigmoid recess	Left ureter present here



Clinical Aspect

- When perforated ulcer affects posterior wall of stomach, gastric contents escape to omental bursa. Since the inflammatory fluid seals the epiploic foramen, bursa becomes distended and insertion of drainage tube into bursa is essential
- Infected fluid from leaking ulcer of the anterior wall of stomach or duodenum may appear in supracolic compartment and remain localized due to adhesion between greater omentum and anterior abdominal wall. Subsequently the pus trickles around right free margin of lesser omentum and collects in hepatorenal pouch and right suprahepatic recess. Since peritoneal lymphatics communicate freely with pleura through diaphragm, empyema or abscess of lung may develop as complication of peritonitis.

STOMACH

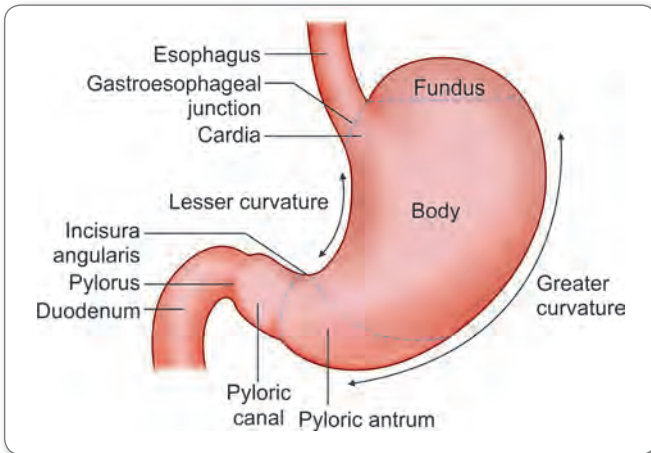


Fig. 65: Stomach

- Situated in left hypochondriacal, epigastrium and umbilical region
- Stomach divided into four regions: Cardiac end, fundus, body and pylorus
- Fundus lies inferior to apex of the heart at the level of 5th rib
- Pylorus is divided into pyloric antrum and pyloric canal
- Gastroesophageal junction—(**cardiac end**) situated 2.5 cm to left of midline, **at the level of T11**, behind left 7 costal cartilage, 40 cm from incisor teeth and **most fixed part** of the organ
- Gastroduodenal junction (**pylorus**) situated at the level of **L1** to the right of midline.

Note:

Prepyloric Vein of Mayo – landmark for pyloroduodenal junction.

Table 13: Comparison between lesser curvature and greater curvature

Lesser curvature	Greater curvature
• Right border	• Left border
• Fixed	• Movable
• Situated in more posterior plane	• More superficial
• Gives attachment to <i>lesser omentum</i>	• Gives attachment to <i>gastrophrenic ligament, gastrosplenic ligament and greater omentum</i>
• Left and right gastric vessels present here	• Greater omentum contains left and right gastroepiploic vessels

- Rugae: Temporary longitudinal fold of mucous membrane, which disappears on distension
- True pyloric sphincter is composed of thick circular muscle layer.
- Incisura angularis is a notch and is most dependent part in lesser curvature of stomach.

Structures Forming Stomach Bed

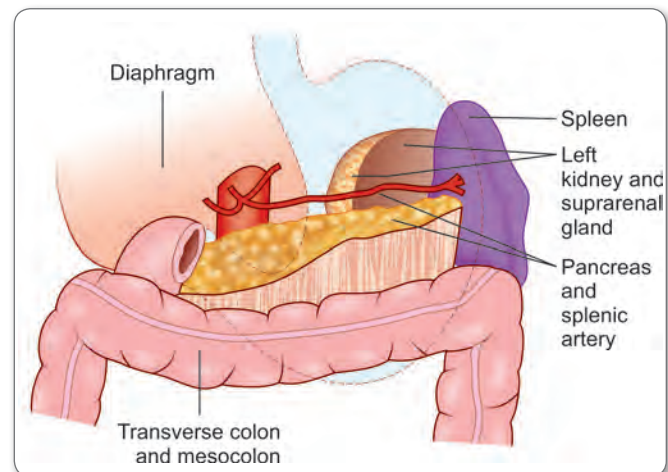


Fig. 66: Stomach bed

- Left crus of diaphragm
- Splenic artery
- Pancreas except tail
- Transverse mesocolon
- Upper part of left kidney
- Left suprarenal gland
- Spleen
- Left colic flexure



Blood Supply

Arterial Supply (Discussed on Arterial Supply Diagram Refer Fig. 101)

Venous Drainage

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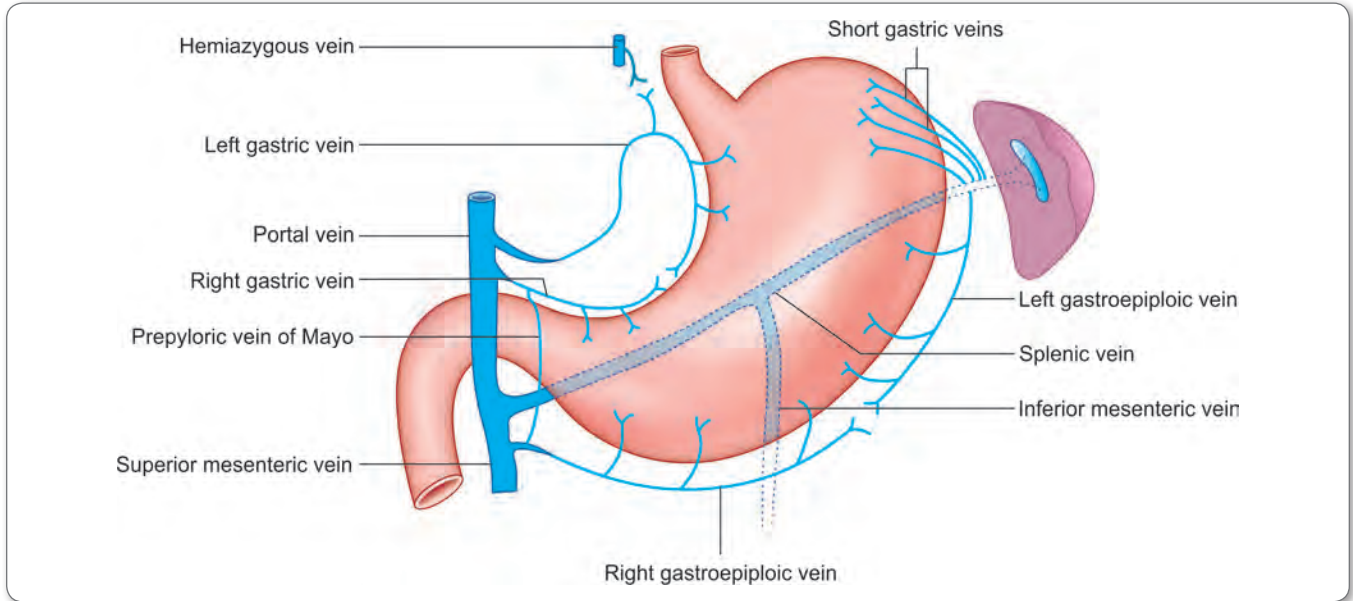
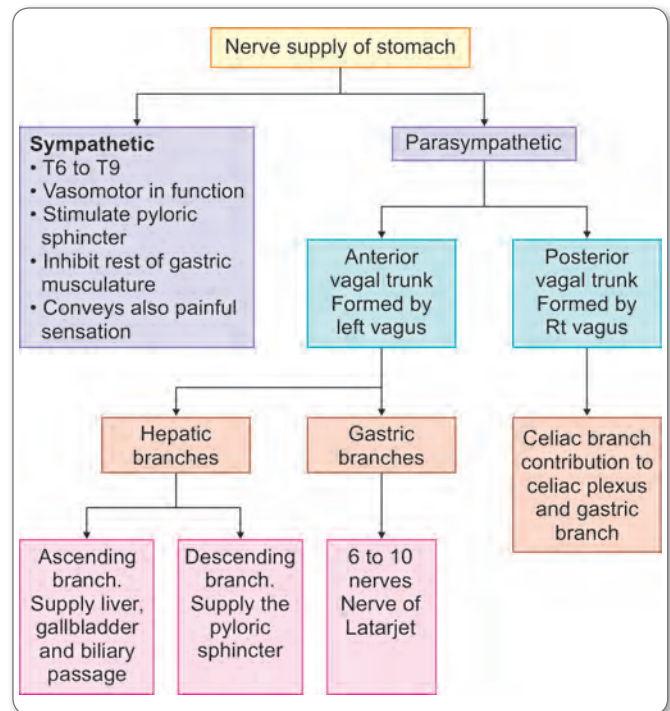


Fig. 67: Venous drainage of stomach

- Right and left gastric vein drain into portal vein
- Short gastric vein and left gastroepiploic vein drain into splenic vein
- Right gastroepiploic vein drain into superior mesenteric vein.

Flow chart 2: Nerve supply of stomach



Nerve Supply

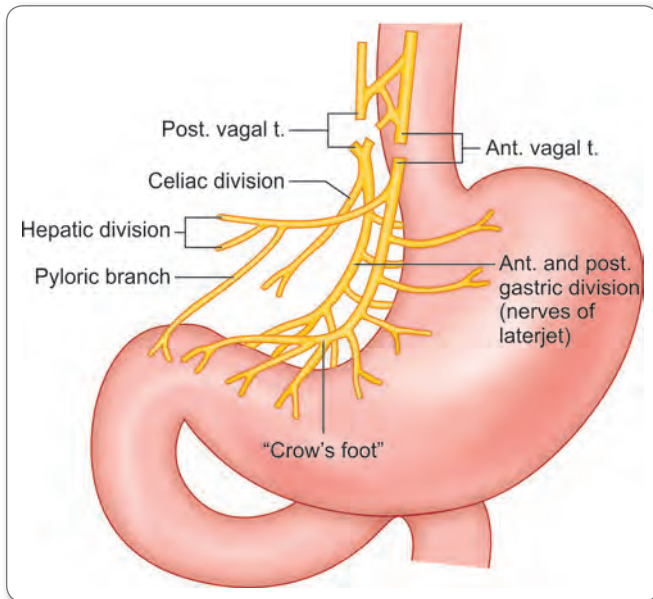


Fig. 68: Nerve supply of stomach

- Gastric branch of posterior vagal trunk – **nerve of Latarjet** and also gives **criminal nerve of Grazi** which supplies the fundus.



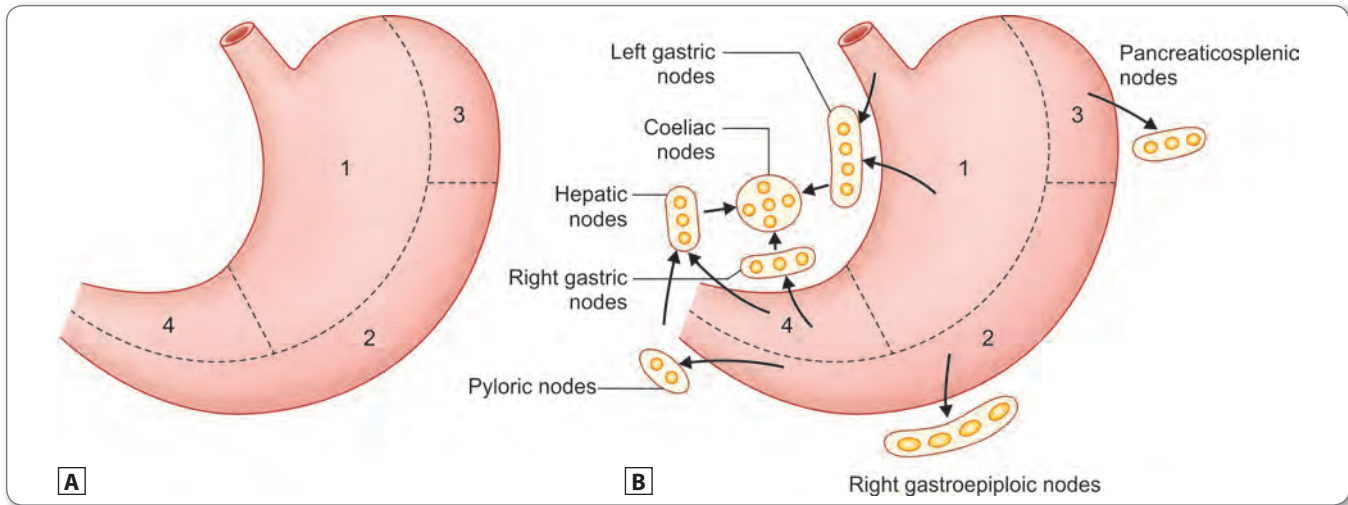
Applied

High selective vagotomy:

- Gastric branches which supplying parietal cells cut preserving the nerve of Latarjet (which supply the pylorus)

- Advantages
 - Nerve supply to gallbladder and liver not affected
 - Pyloric function preserved – gastric emptying normal – no drainage procedure is required.

Lymphatic Drainage



Figs 69A and B: Lymphatic drainage of stomach

Area 1: Drains into left gastric node

Area 2: Pyloric antrum, pyloric canal & along greater curvature of stomach drain into right gastroepiploic nodes and pyloric nodes

Area 3: Drain into pancreaticosplenic nodes

Area 4: Pyloric antrum, pyloric canal & along lesser curvature – drain into right gastric nodes and hepatic nodes

- Eventually all nodes reach coeliac nodes

- **Virchow nodes** are enlarged and palpable left supraclavicular nodes usually seen in cases of cancer stomach. This could be the first sign of gastric cancer (**Trosier's sign**).

- **Traube's area:** Tympanic note of fundus of stomach is percussed here.

Transperitoneal spread of gastric carcinoma leads to ascites, Krukenberg tumor (metastasize to ovary), sister Mary Joseph nodule – deposit around umbilicus & Bloomer's shelf (deposits in rectovesical pouch)



Clinical Aspect

- Gastric ulcers commonly bleed from posterior wall.
 - If bleeds posteriorly → collect into lesser sac and erodes pancreas and splenic artery (Source of hemorrhage is left gastric artery)
 - If bleeds anteriorly → collect freely into peritoneal cavity (Source of hemorrhage is gastroduodenal artery)
- Duodenal ulcers may erode pancreas or gastroduodenal artery causing burning and epigastric pain
 - Artery of hemorrhage in gastric ulcer – left gastric artery
 - Artery of hemorrhage in duodenal ulcer – gastroduodenal artery

Peptic Ulcer

In Stomach – lesser curvature close to incisura angularis is the most common site of gastric ulcer.

In duodenum – proximal 2.5 cm is the most common site overall
Gastric carcinoma – most common site – antrum lesser curvature of stomach

DUODENUM

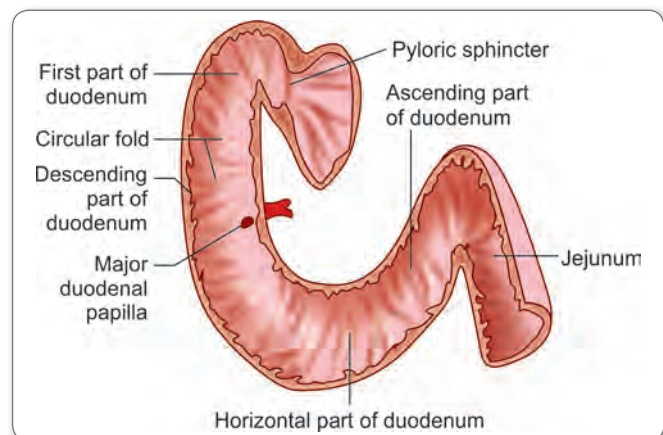


Fig. 70: Duodenum

Contd...



- C-Shaped tube surrounding head of pancreas
- Retroperitoneal organ except the first part, which provides attachment of hepatoduodenal part of lesser omentum
- Derived from both foregut and midgut (up to 2nd part of duodenum – ampulla of Vater – foregut) so supplied by celiac trunk and superior mesenteric artery

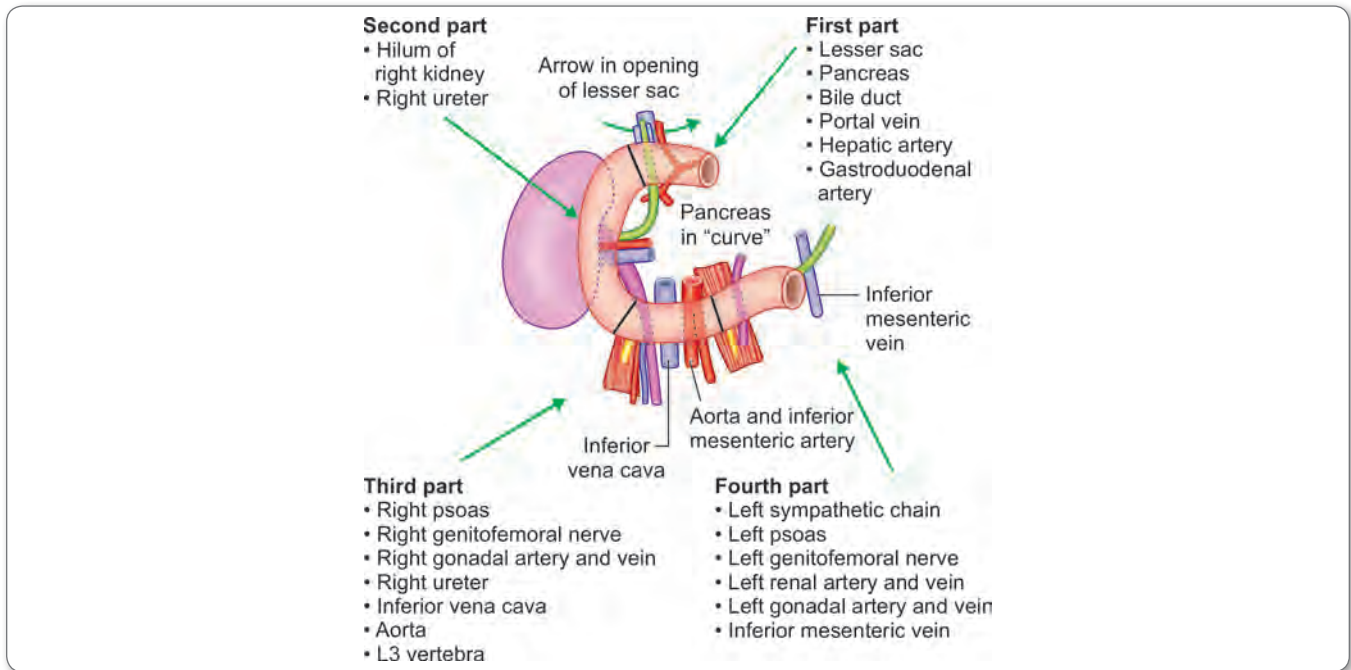


Fig. 71: Posterior relations of duodenum

Parts of Duodenum

Table 14: Parts of duodenum

	Superior – 5 cm	Descending – 8 to 10 cm	Horizontal – 10 cm	Ascending – 2.5 cm
Extent	Pylorus to superior duodenal flexure	Superior duodenal flexure to inferior duodenal flexure	Inferior duodenal flexure to front of aorta	Aorta to duodenojejunal flexure
Vertebral levels	L1	Right of L2	L3	Left of L2
Anterior	<ul style="list-style-type: none"> • Peritoneum • Gallbladder • Quadrate lobe of liver 	<ul style="list-style-type: none"> • Nonperitoneal in the middle • Fundus and body of gallbladder • Transverse colon • Few coils of jejunum 	<ul style="list-style-type: none"> • Peritoneum • Root of mesentery • Superior mesenteric vessels 	<ul style="list-style-type: none"> • Peritoneum • Transverse colon and its mesocolon • Posteroinferior surface of stomach separated by lesser sac
Posterior	<ul style="list-style-type: none"> • Gastroduodenal artery • Common bile duct • Portal vein • IVC 	<ul style="list-style-type: none"> • Hilum of kidney • Renal vessels • Right psoas major • IVC • Right ureter (plus or minus) 	<ul style="list-style-type: none"> • Right ureter • Right psoas major • Right gonadal vessel • IVC • Aorta 	<ul style="list-style-type: none"> • Aorta • Left sympathetic trunk • Left psoas • Left renal and gonadal vessel • Inferior mesenteric vein
Above	<ul style="list-style-type: none"> • The proximal half (upper border) attachment to free margin of lesser omentum • Forms floor of epiploic foramen 	<ul style="list-style-type: none"> • Medial head of pancreas • Ventral and dorsal anastomosis of pancreaticoduodenal vessel • Bile duct, main pancreatic duct, ampulla of Vater 	<ul style="list-style-type: none"> • Head of pancreas • Inferior pancreaticoduodenal vessels 	Body of pancreas
Below	<ul style="list-style-type: none"> • Head and neck of pancreas • Proximal half of lower border – anterior two layers of greater omentum 	–	Coils of jejunum	



1st Part of Duodenum

- Supplied by **end artery**
- No circular folds in the first part of duodenum, so **duodenal cap** formed in the barium study

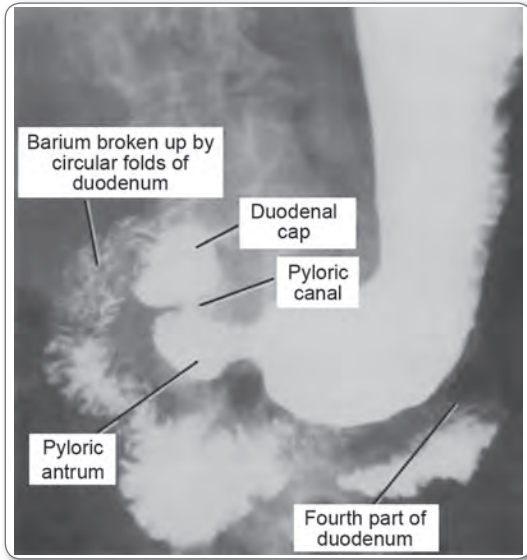


Fig. 72: Duodenal cap

2nd Part of Duodenum

- Major duodenal papillae: Present in the posteromedial part of 2nd part of duodenum.
- **Common bile duct and major pancreatic ducts (Wirsing and Hoffman's) pierce the wall separately and joins to form ampulla of Vater, which opens in the major duodenal papillae.**
- Sphincter is called sphincter of **Oddi**
- Minor duodenal papillae: Accessory pancreatic duct (of **Santorini and Bernard's**) open here.

3rd Part of Duodenum

- **Wilkie's syndrome (Aorticomesenteric occlusion)** results from compression of **3rd** part of duodenum between abdominal aorta and SMA.

4th Part of Duodenum

- Duodenal recesses are found in 4th part of duodenum.

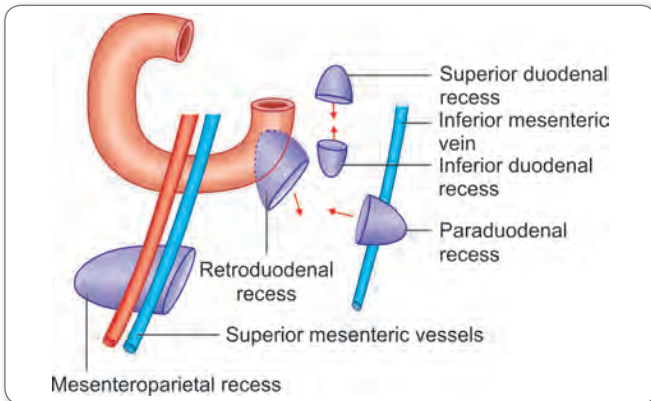


Fig. 73: Duodenal recesses

- Superior duodenal: Present in 50% of individuals.
- Inferior duodenal: Present in 75% individuals.
- Paraduodenal: In 20%, orifice looks to right—contains **Inferior mesenteric vein** in free edge.
- **Retroduodenal: Largest**, rarely present, orifice looks to left.
- DJ or Mesocolic recess: 20%, looks downward.
- Mesentricoparietal: **Contains superior mesenteric artery (SMA) and superior mesenteric vein (SMV)**, orifice looks to left.

Suspensory Ligament of Treitz

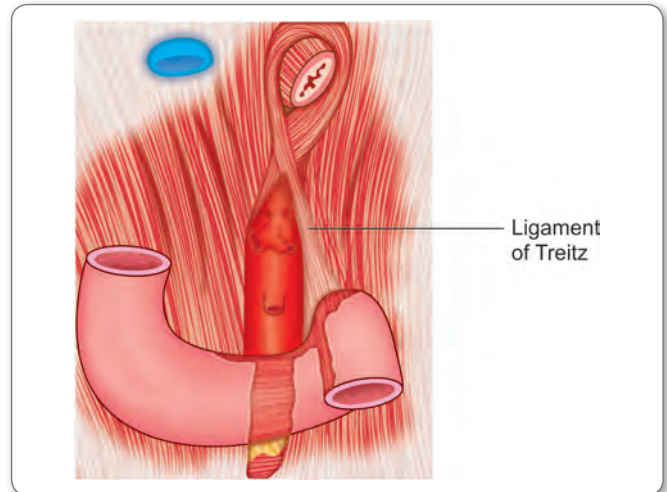
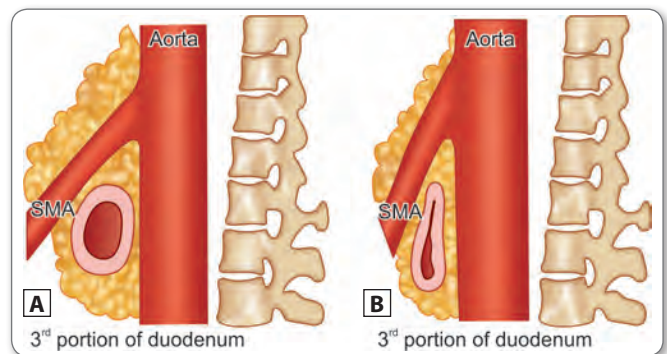


Fig. 74: Suspensory ligament of the duodenum

- Ligament of Treitz it is a fold containing the suspensory muscle of duodenum
- Fibromuscular band from right crus of diaphragm to posterior surface of duodenal jejunal flexure
- Developed from **superior retention band of primitive midgut**

WILKIE'S DISEASE

- Superior mesenteric artery syndrome or Wilkie's disease
- This condition due to reduced angulation of superior mesenteric artery at its origin with abdominal aorta resulting in compression of III part of duodenum



Figs 75A to B: Wilkie's disease

- A – Normal
- B – Wilkie's Disease

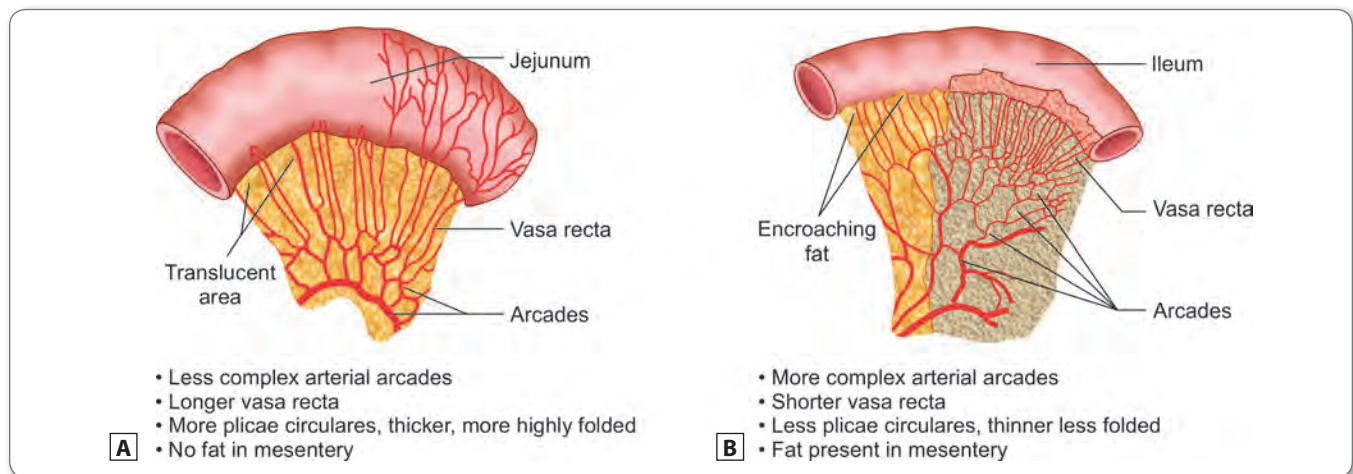


JEJUNUM AND ILEUM

Table 15: Features of jejunum and ileum

Features	Jejunum	Ileum
Wall	Thick	Thin
Vascularity	More vascular	Less vascular
Lumen	Wider and often empty	Narrower and often loaded
Mesentery	<ul style="list-style-type: none"> Attached above and left of aorta Jejunum have Windows Vasa recta longer and fewer 1–2 arterial arcade 	<ul style="list-style-type: none"> Attached below and right to aorta Ileum does not have windows Vasa recta shorter and more numerous 3 or 6 arterial arcades
Circular mucosal fold	More prominent in jejunum	Circular folds gradually decreasing in ileum and in the lower part of ileum circular folds completely absent
Barium study features	Feathery appearance	Distal ileum featureless
Villi	Leaf like and more abundant	Finger like and less abundant
Payers patch	Absent	Present
Solitary lymphatic Follicles	Few	More

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Figs 76A and B: (A) Jejunum; (B) Ileum

Clinical Aspect

- Kocher maneuver is a surgical maneuver to expose structures in the retroperitoneum behind the duodenum and pancreas.
- Annular pancreas can lead to obstruction to 2nd part of duodenum.

- Sigmoid colon—15 inch – 37.5 cm
- Transverse colon—20 inch – 50 cm
- Cecum—6 cm
- Rectum—12 cm
- Anal canal—3.8 cm

LARGE INTESTINE

Extends from ileocecal junction to anus.

Measurement

- Ascending colon—5 inch – 12.5 cm
- Descending colon—10 inch – 25 cm

Characteristics of Large Gut

- **Taenia coli:** Three thick bands produced by aggregations of the longitudinal muscles of the large gut. It is absent in vermiform appendix and in rectum.
- **Taenia libera** is placed anteriorly in cecum, ascending, descending and sigmoid. Placed inferiorly in transverse.
- **Taenia mesocolica** is placed posteromedially in cecum, ascending, descending and sigmoid, placed posteriorly on transverse colon.

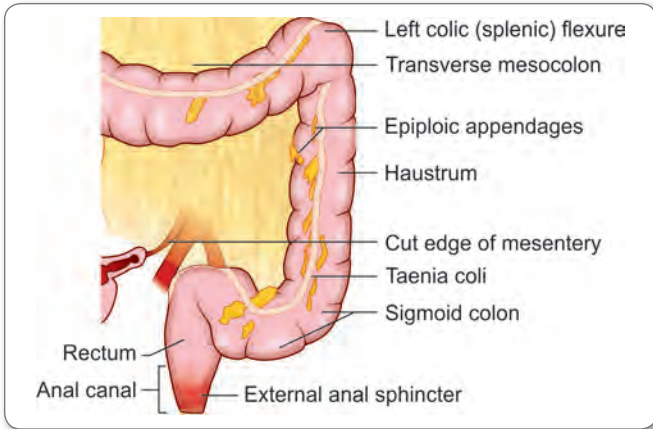
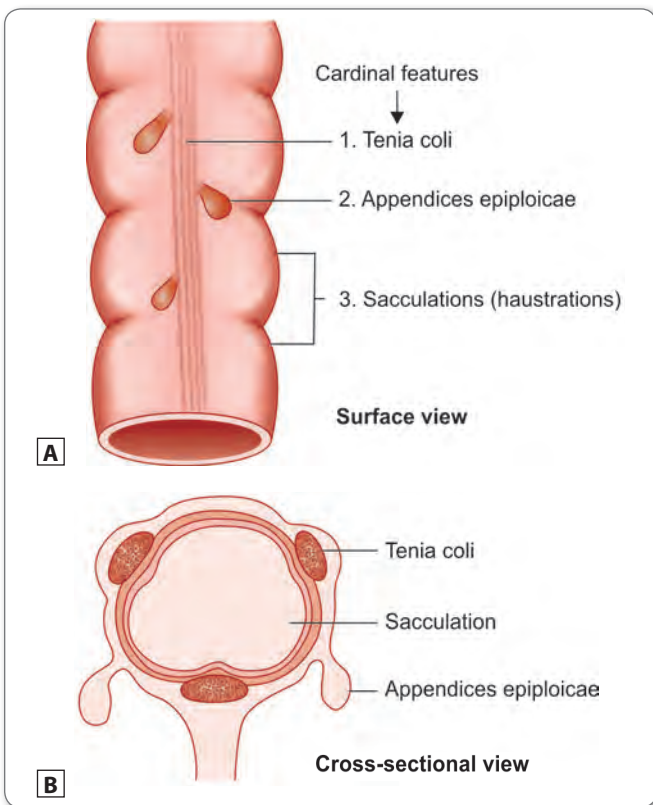


Fig. 77: Characteristics of large gut



Figs 78A and B: Features of large intestine

- **Taenia omentalis** in posterolateral position in cecum, ascending, descending and sigmoid but anterosuperior in transverse
- **Sacculations or haustrations** are present where taeniae coli exist.
- **Appendices epiploicae:** Peritoneal pouches containing fat, absent in cecum, appendix and rectum. **More in sigmoid colon and transverse colon.**

REMEMBER

Tenia coli	• Absent in appendix and rectum
Appendices epiploicae	• Absent in cecum, appendix and rectum
	• More in transverse colon and sigmoid colon

Clinical Aspect

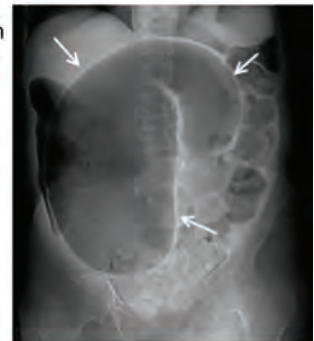
- **Diverticulitis:** Inflammation of diverticula of the intestinal wall, commonly found in colon—sigmoid colon. Symptoms are abdominal pain in the lower quadrant of the abdomen, chills, fever and constipation
- Saw tooth appearance – in barium enema – diverticulosis



- **Sigmoid volvulus:** Sigmoid colon is the most common site of volvulus
- Twisting of sigmoid colon (anticlockwise > clockwise) around mesentery creating colonic obstruction and may cause intestinal ischemia that may progress to infarction, necrosis and peritonitis
- Coffee bean sign

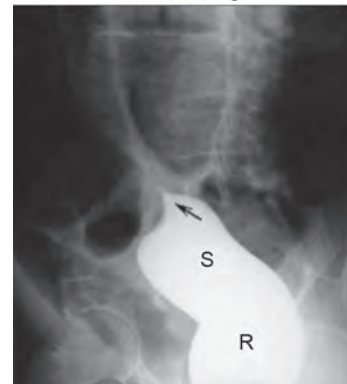
Coffee bean sign

Dilated sigmoid colon in SIGMOID VOLVULUS thought to resemble giant coffee beans.



Bird beak sign in barium enema of sigmoid volvulus

Sigmoid volvulus
Bird beak sign





Appendix

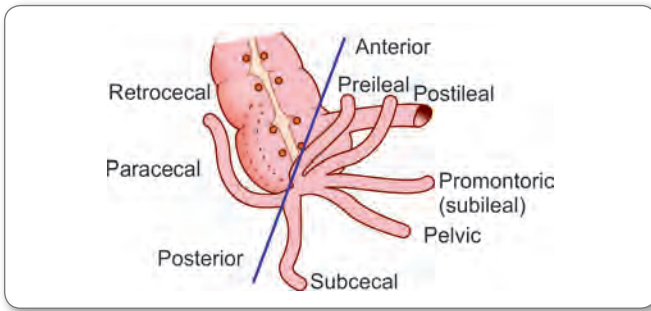


Fig. 79: Positions of appendix

- Narrow, hollow, muscular tube with aggregations of lymphoid tissue
- Suspended from the terminal ileum by small mesentery (mesoappendix) contains appendicular vessels
- **McBurney point:** Occurs at the junction of lateral one-third of line between right anterior superior iliac spine and umbilicus. It is the site of maximum tenderness
- Opening of appendix into cecum is guarded by 'valve of Gerlach', which is 2 cm below and behind ileocecal junction.
- Submucosa of appendix contains numerous lymphatic aggregates/follicles known as **abdominal tonsils**.

Presenting Parts

- Base – 2 cm below the ileocecal junction on posteromedial wall of cecum. Appendicular orifice is guarded by valve of Gerlach
- Tip – projecting in various directions

Table 16: Positions of appendix

Position	Percentage	Clock position
Subcecal	2% cases	11 o'clock
Retrocecal	60% cases	12 o'clock
Splenic	1–2%	2 o'clock
Promontoric	Very rare	3 o'clock
Pelvic	30%	4 o'clock
Midinguinal	Very rare	6 o'clock

- Promontoric: Tip passes in front (preileal) or behind (postileal) the terminal ileum. Preileal most dangerous because infection spreads to peritoneal cavity.
- Blood supply: Appendicular branch of ileocolic artery and it gives recurrent branch, which anastomose with posterior cecal artery.



Clinical Aspect

Acute Appendicitis

- Acute inflammation of appendix
- Symptoms rebound tenderness, periumbilical pain that may move to right iliac fossa on McBurney's point accompanied by fever, vomiting, diarrhea, constipation
- It may rupture and cause peritonitis

Contd...

- **Murphy's triad** – migratory pain, vomiting, fever
- **Blumberg's sign** – rebound tenderness
- **Rovsing's sign** – palpation on LIF produce pain in the RIF due to shift of bowels
- **Sherren's triangle of hyperesthesia** – due to irritation of lower abdominal nerves. Triangle is formed by ASIS, Umbilicus and pubic symphysis

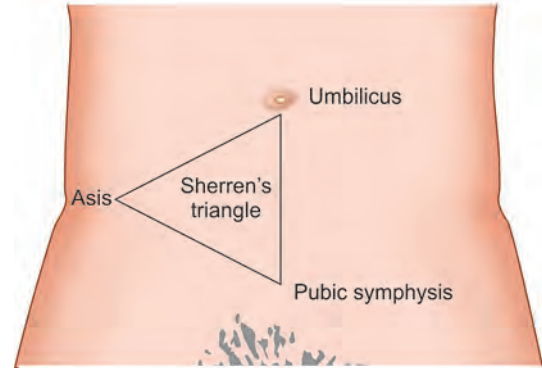


Fig. 80: Sherren's triangle

- **Dunphy sign** – pain on coughing at RIF
- **Ten horn sign** – pain in RIF on traction of right testicle
- **Copes psoas sign** – retrocaecal appendicitis – exacerbation of pain on hip extension due to irritation of psoas major
- **Copes obturator sign** – pelvic appendicitis – flexion and internal rotation of hip stretches the obturator muscles and cause pain

Rectum

- 12 cm long extends from sigmoid canal to anal canal
- Name rectum is misnomer, because rectum is not straight, but curved in anteroposterior direction and side to side
- Rectum **does not have Taeniae coli and Appendices epiploicae**
- Lower one-third of rectum is not covered with peritoneum (upper third covered with peritoneum in front and side, middle-third covered only in front).

Relations

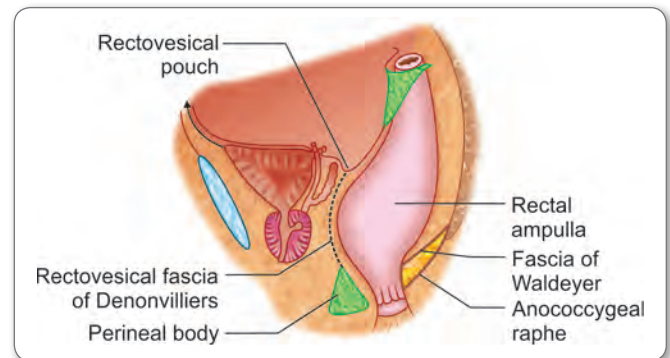


Fig. 81: Relations of rectum in a male



- In front: In male, base of bladder, seminal vesicle, ampulla of vas deferens. The above structures separated from rectum by rectovesical fascia of Denonvillier. In female—posterior vaginal wall
- Behind: Sacrum, coccyx, anococcygeal raphe, ganglion impar, median sacral vessels, **fascia of Waldeyer** which extends from anorectal junction to coccyx and it is formed by thickening of pelvic fascia.
- Laterally: Sigmoid colon, levator ani and ischioanal fossa.

HIGH YIELD POINTS

Houston Valves

Houston valves – seen in rectoscope

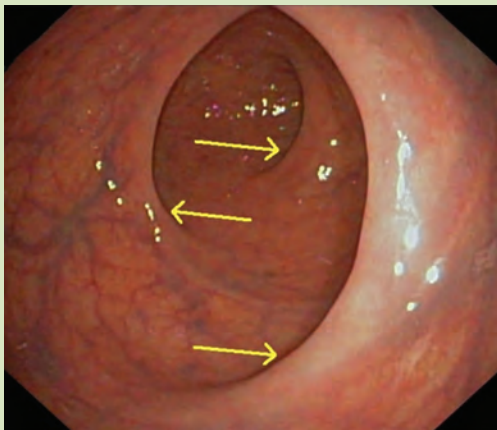


Fig. 82: Houston valves

- Permanent transverse mucous folds, semilunar in shape
- Situated in concavity of lateral curve
- Each valve is reduplication of mucous membrane containing submucous tissue and circular muscles
- First valve: Not constant, 2.5 cm above the middle valve present in concavity of upper lateral curve
- Second valve: Most constant present on the right side along the concavity of middle lateral curve
- Third valve: 2.5 cm below the middle second valve present along the concavity of lower lateral curve.

Blood Supply

Arterial Supply

- Unpaired superior rectal artery: Continuation of inferior mesenteric artery
- Paired middle rectal artery: Branch of anterior division of internal iliac artery
- Paired inferior rectal artery: Branch of internal pudendal artery.
- Median sacral artery: Branch of aorta

Venous Drainage

- Superior rectal vein drain into inferior mesenteric vein
- Middle rectal vein drain into internal iliac vein
- Inferior rectal vein drain into internal pudendal vein.

Lymphatic Drainage

- Upper half to inferior mesenteric nodes
- Lower half to internal iliac nodes

Nerve Supply

- Sympathetic derived from inferior hypogastric plexus L1 L2. Vasomotor center stimulates internal sphincter and inhibits rest of the musculature.
- Parasympathetic: (Pelvic splanchnic nerve) S2, 3, 4.
- Secretomotor center and stimulates the peristalsis and relaxes the sphincters.

Supports of Rectum

- **Puborectal sling of levator ani** maintains the anorectal flexure
- Reflection of pelvic fascia from parietal layer to visceral layer
- Fascial sheet of Waldeyer and lateral ligament of rectum
- Pelvirectal fat and ischioanal fat.



Clinical Aspect

Colorectal Cancer

- Develops in epithelial cells lining the lumen of colon and rectum
- Risk factors: High fat diet, family history and polyps
- Rectal CA: Spread along lymphatic and venous channel Superior rectal vein tributary of portal vein – so CA metastasize to liver.
Cancer may penetrate posteriorly and invade sacral plexus producing sciatica and invade ureter laterally and anteriorly uterus, bladder, prostate or seminal vesicles.

REMEMBER

Table 17: Structures palpated during perrectal examination

Infront	Behind	Each side
In male • Condition of bladder • Prostate • Seminal vesicle • Vas deferens • Perineal body • Urogenital diaphragm • Terminal part of ureters • Bulb of penis • Spongy urethra • In female • Condition of uterus and vagina	• Sacrum • Coccyx • Anococcygeal raphae	Structures of lateral pelvic wall • Ischial spine • Ischial tuberosity • Contents of ischioanal fossa • Condition of uterine tube, ovary and broad ligaments in female • Internal iliac nodes only when enlarged



Anal Canal

- Terminal part of alimentary canal
- Measurement – 3.8 cm
- From anorectal junction to anal orifice.

Table 18: Division of interior of anal canal

	Upper area	Intermediate area (Area of pecten or transitional zone)	Lower area (anal verge)
Measurement	1.5 cm	1.5 cm	0.8 cm
Lined by epithelium	Simple columnar	Nonkeratinized stratified squamous	Keratinized stratified squamous
Features	Containing anal column of Morgagni, anal valves of Ball and anal papillae	Without sweat glands, sebaceous gland and hair follicle	With sweat glands, sebaceous gland and hair follicle
Nerve supply	Autonomic supply therefore insensitive to pain	Somatic supply therefore sensitive to pain	Somatic supply therefore sensitive to pain

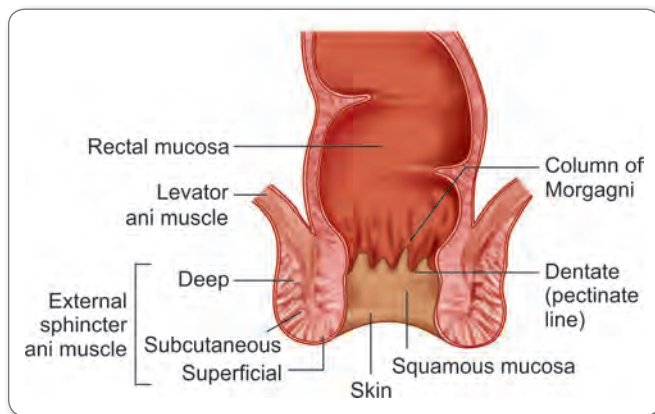


Fig. 83: Interior of anal canal

Pectinate Line or Dentate Line

- It is the mucocutaneous junction of the anal canal
- Pectinate line act as watershed line

Table 19: Area above and below the pectinate line

Area above the pectinate line	Area below the pectinate line
<ul style="list-style-type: none"> • Developed from endodermal cloaca • Upper area supplied by superior rectal artery • Drained into portal system • Upper area drains into internal iliac nodes • Supplied by autonomic nerves • Simple columnar epithelium 	<ul style="list-style-type: none"> • Developed from ectodermal proctodeum • Lower area supplied by inferior rectal artery • Drained into systemic veins • Lower area drains into superficial inguinal • Supplied by somatic nerves • Nonkeratinized stratified squamous epithelium

Clinical Aspect

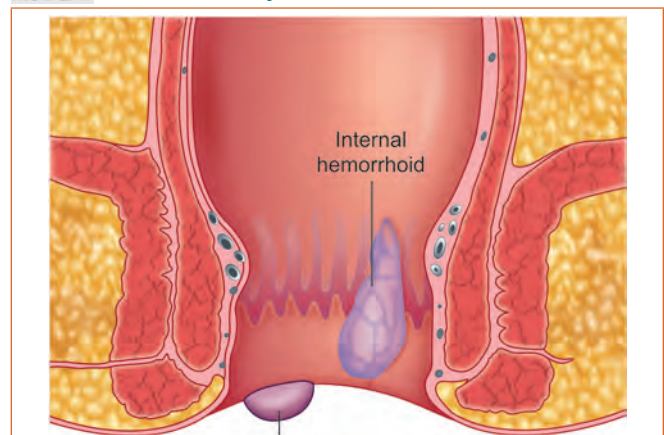


Fig. 84: Internal and external hemorrhoids

Table 20: Internal and external hemorrhoids

Internal hemorrhoids	External hemorrhoids
<ul style="list-style-type: none"> • Situated above the pectinate line • Painless • Innervated by autonomic system 	<ul style="list-style-type: none"> • Situated below the pectinate line • Painful • Innervated by somatic nerve

HIGH YIELD POINTS

Hiltons Line

Represented by anal intersphincteric groove situated at the lower end of internal sphincter muscle.



Blood Supply of Anal Canal

- Superior rectal artery
 - Inferior rectal artery
 - Median sacral artery

Note: Middle rectal artery does not supply the anal canal

Anal Sphincters

Internal Anal Sphincter

Thickening of inner circular muscle. Lower end of this sphincter corresponds with Hilton’s white line and its middle corresponds with pectinate line

External Anal Sphincter

- Striated muscle
- Consists of three bands
 - Subcutaneous (lower): Encircles terminal part of anal canal
 - Superficial part (middle): Arises from the tip of coccyx and from anococcygeal raphae and inserted to perineal body. Surrounds the lower part of internal sphincter.
 - Deep part (upper): Surrounds the anorectal junction
- **Anorectal ring- marks the junction between rectum and anal canal formed by**
 - Deep external sphincter,
 - Highest part internal sphincter
 - Conjoined longitudinal muscle and
 - Puborectal sling (part of levator ani - Most important ring to maintain the continence is this angle)

Note:

Surgical incision of this sling produces incontinence of feces.

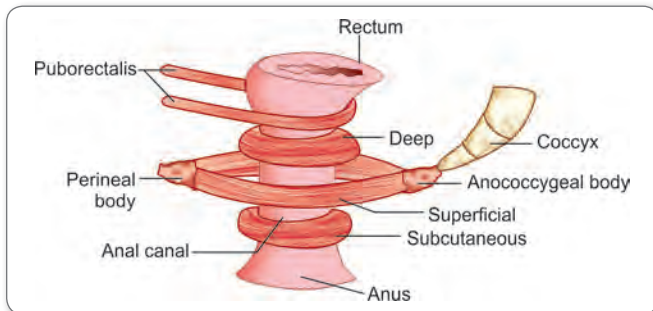


Fig. 85: External anal sphincters

LIVER

- Situated in right hypochondrium, epigastrium and extends into left hypochondrium
- Covered by Glisson’s capsule

- Surrounded by peritoneum and attached to diaphragm by coronary ligament, falciform ligament and right and left triangular ligaments
- **Bare area of liver** (devoid of peritoneum) limited by layers of coronary ligament
- Apex–right triangular ligament,
- Base by groove of inferior vena cava
- On either side by superior and inferior layer of coronary ligament.
- Contains portal triad: Consists of branches of portal vein, hepatic artery and bile duct at the every corner of lobule
- Divided into right and left lobe by cholecystocaval line

Lobes of Liver

- Right lobe: Divided into anterior/posterior segments each of which is sub: Divided into superior and inferior segments
- Left lobe: Divided into medial and lateral segments each of which is sub divided into superior and inferior segments.

Fissures and Ligaments of Liver

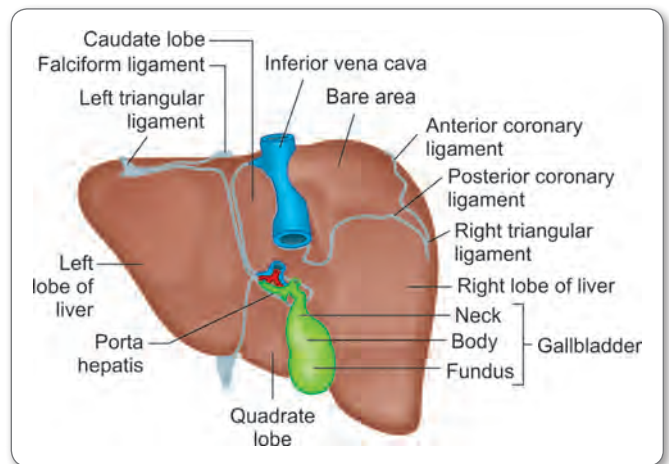


Fig. 86: Fissures and ligaments of liver

- Fissure for round ligament: Located between lateral portion of left lobe and quadrate lobe.
- Fissure for ligamentum venosum: Located between caudate lobe and lateral portion of the left lobe.
- Fossa for gallbladder: Located between quadrate lobe and major part of right lobe.
- Fissure for IVC: Located between caudate lobe and major part of right lobe.
- Porta hepatis: Transverse fissure on visceral surface between quadrate and caudate lobe lodges hepatic artery, hepatic duct, branches of portal vein, hepatic nerves and lymphatic vessels.



Segmental Anatomy of Liver

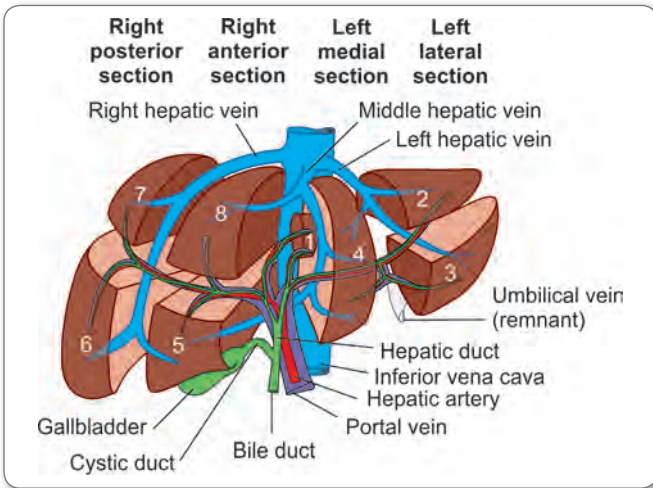


Fig. 87: Segmental anatomy of liver

- Couinaud used portal vein, hepatic vein and bile duct distribution and divided liver into eight functional segments.
- Liver is divided into segments by means of three major and three minor fissures.
- Three major fissures harbor three main hepatic veins and three minor fissures are present in the liver surface.
 - Main fissure, right and left fissure.
 - Main fissure – extending from groove for IVC and fossa of gallbladder. Divide the liver into right and left lobe of liver
 - Right fissure – subdivide the right lobe of the liver
 - Left fissure – subdivide the left lobe of the liver

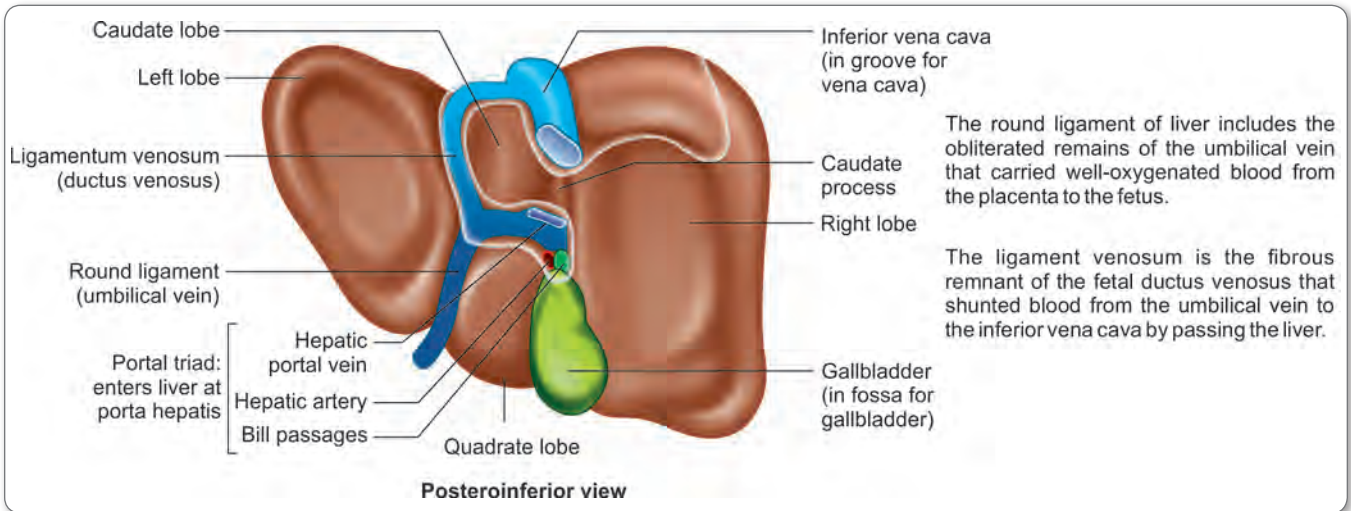


Fig. 88: Round ligament of liver and ligamentum venosum

- **Three minor fissure** as is visible on the surface as clefts, where as three main fissures are not visible
- Umbilical fissure (minor): 3rd segment separated from the fourth by this fissure. Contains main branch of left umbilical vein (umbilical fissure vein), umbilical portions of left portal vein, branch of left hepatic duct and left hepatic artery.
- Venous fissure (minor): Umbilical fissure continues on the undersurface as venous fissure. Contains caudate lobe and ligamentum venosum (segment 1 and 4).
- Gans fissure (minor): Present on the undersurface of right lobe over the fossa of gallbladder.
- Intersectorial veins (three) are hepatic veins present between the above-mentioned sectors.
- Each sector is then subdivided into two segments.
- Segments are numbered in anticlockwise direction. **Caudate lobe is Segment I**
- Caudate segment is independently drain into inferior vena cava, receives blood from right and left hepatic artery. Bile duct from this segment drains to either left or right duct.
- Quadrate lobe receives blood from left hepatic artery and drains bile into left hepatic duct
- Segments in left lobe. Left hepatic vein divided into medial and lateral.

Table 21: Segments in the left-lobe of the liver

Left lobe	Segment
Left lateral superior	II
Left lateral inferior	III
Left medial superior	IV A
Left medial inferior	IV B



- Segments in right lobe are divided into anterior and posterior sectors

Table 22: Segments present in the right of the liver

Lobe	Segment
Right inferior anterior	V
Right inferior posterior	VI
Right superior posterior	VII
Right superior anterior	VIII

Types of hepatectomy

- Right hepatectomy—removal of 5–8 segments
- Left hepatectomy—removal of 2–4 segments
- Extended right hepatectomy—removal of 5–8 segments along with 4th segments
- Extended left hepatectomy—removal of 2–4 segments along with 5 and 8

Brisbane 2000 is the latest naming for hepatectomy

- Right hemihepatectomy—removal of 5–8 segments
- Right trisectionectomy—extended right hepatectomy
- Left hemihepatectomy—removal of 2–4 segments
- Left trisectionectomy—extended left hepatectomy
- Left lateral hepatectomy—removal of 2 and 3 segments

REMEMBER

Bismuth is used in hepatic artery, portal vein, hepatic vein, bile duct and lymphatic drainage to classify the segments and modified Couinaud system.

- Falciform ligaments: Sickle shaped peritoneal fold connecting anterior superior surface of liver to anterior abdominal wall. Contains ligamentum teres and paraumbilical vein. Ligamentum teres is remnant of left umbilical vein.
- Coronary ligaments: Contains superior and inferior layer which connect liver to diaphragm.
- Triangular ligaments: Connects right and left lobes of liver with diaphragm.

Blood Supply

- Dual blood supply: 80% nutrition by portal vein and 20% nutrition by hepatic artery.
- Vein drains into hepatic veins and then into inferior vena cava.
- Aberrant right hepatic artery—from SMA and runs posterior to pancreas head.
- Accessory left hepatic artery—from left gastric artery



Clinical Aspect

- Liver is best palpated in → Supine position in deep inspiration.
- Liver biopsy is performed in the right 9th–10th intercostal space in midaxillary line.
- **Runner's stitch** → Severe diaphragmatic activities in runners may lead to vascular engorgement of liver, which can cause right hypochondrial pain and tenderness.

Contd...

- **Cantlie's line** divides liver into right and left halves. It passes through the fossa of gallbladder (or cystic notch posteriorly) to the groove for inferior vena cava.
- Transjugular liver biopsy is accomplished by passing catheter into right internal jugular vein and guiding it through SVC, IVC, right hepatic vein and needle is inserted through catheter and biopsy sample is obtained.

GALLBLADDER

- Gallbladder is pear-shaped organ lying on the inferior surface of liver in the fossa between right and quadrate lobe and it is in contact with duodenum and transverse colon
- Gallbladder stores and concentrates bile.
- Located at the junction of right 9th costal cartilage and lateral border of rectus abdominis which is the site of maximum tenderness in inflammation of gallbladder.

Measurements

- Length: 7 to 10 cm
- Breadth: 3 cm
- Capacity: 30 to 50 ml

Parts

- Fundus projects beyond the inferior surface of liver: Rounded blind end located at the tip of the 9th costal cartilage in mid-clavicular line and contacts the transverse colon.
- Body lies in the fossa of gallbladder and rest on the duodenum
- Neck is s-shaped. Extends from body to cystic duct. Small diverticulum called **Hartmann's pouch** projects from neck.

Cystic Duct

- 3–4 cm in length—from neck of the bladder and joins with common hepatic duct
- Interior of cystic duct contains spiral valve called **valve of Heister**.

Blood Supply

- Arterial supply—cystic artery **branch of right hepatic artery. Accessory hepatic artery from gastro duodenal artery.**
- Venous drainage—cystic vein which do not accompany the artery and drain into IVC and sometimes to portal vein.

Nerve Supply

- Mainly by sympathetic through celiac and hepatic plexus.
- **Phrenic nerve** carrying postganglionic fibers to gallbladder. **So pain is referred to shoulder.**

Anomaly

Most common anomaly of gallbladder – Phrygian cap – fundus constricted and turned back on itself.

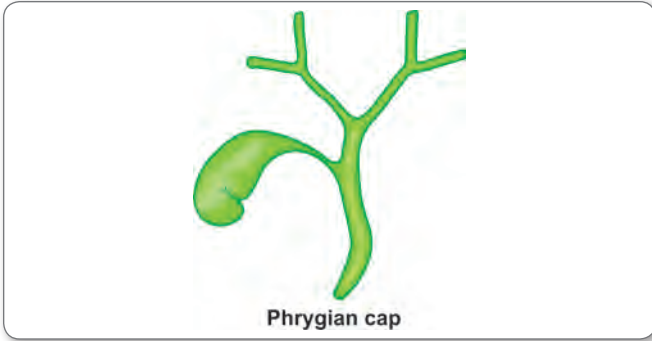


Fig. 89: Phrygian cap gallbladder

Common Bile Duct

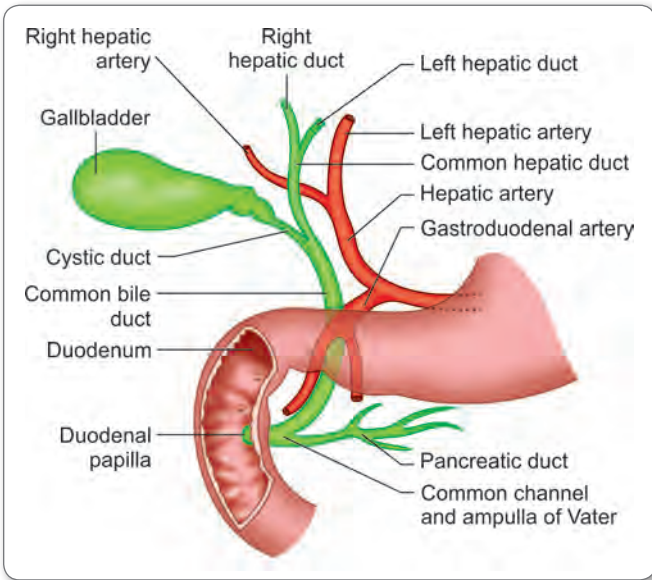


Fig. 90: Extrahepatic biliary tree and its arterial supply

Formation	Measurements	Course
Common hepatic duct and cystic duct unites to form common bile duct	<ul style="list-style-type: none"> • 7.5 cm in length • 6 mm in caliber • Opens 8 to 10 cm distal to pylorus 	<ul style="list-style-type: none"> • First it passes downwards in right free margin of lesser omentum and in front of epiploic foramen. • Then descends behind the 1st part of duodenum and lodges in groove behind the head of pancreas. • In the posteromedial wall of 2nd part of duodenum, bile duct and pancreatic duct pierces the duodenal wall separately and unite to form ampulla of Vater. • Ampulla opens on the summit of major duodenal papillae.

REMEMBER

Sphincter of Oddi complex consists of 4 sphincters – relaxed by CCK hormone.

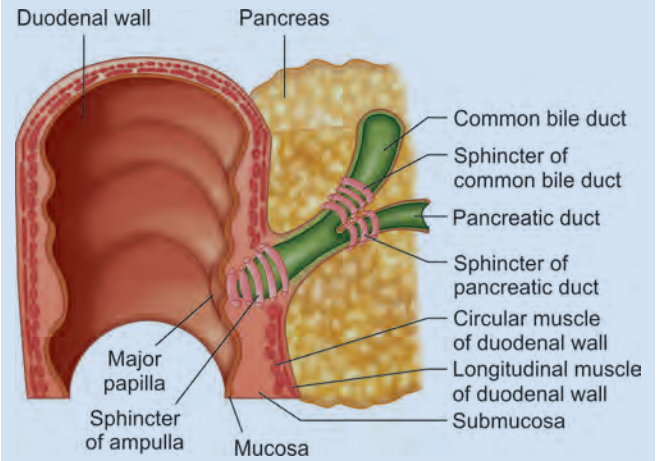


Fig. 91: Sphincter of Oddi

- Superior and inferior Sphincter choledochus (sphincter of Boyden): Around periampullary part of bile duct
- Sphincter pancreaticus: Around the periampullary part of pancreatic duct
- Sphincter of Oddi proper: Around the termination of ampulla.

Common bile duct divided into three parts by means of first part of duodenum.

Table 23: Relations of common bile duct

Supraduodenal part	Retroduodenal part	Infraduodenal part
Behind–portal vein And IVC Left side–hepatic artery	In front–1 st part of duodenum Behind–portal vein And IVC Left side–gastroduodenal artery	In front–head of pancreas Behind–inferior vena cava Left side–superior mesenteric and formation of Portal veins

HIGH YIELD POINTS

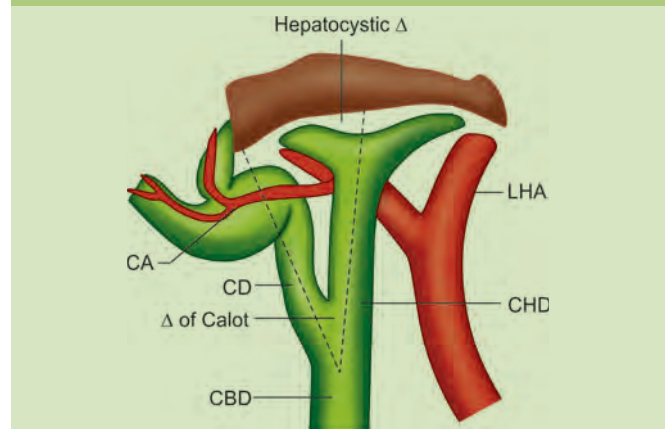


Fig. 92: Calot's triangle

Contd...



Calot's Triangle

Triangular space situated with the following boundaries

- Superiorly—cystic artery
- Inferolaterally—cystic duct
- Medially—common hepatic duct
- Contents—cystic node of lund

Hepatocystic Triangle

Triangle to be noted while doing cholecystectomy to ligate the cystic artery

- Superiorly—inferior surface of liver
- Inferolaterally—cystic duct
- Medially—common hepatic duct
- Contents—cystic artery and cystic node of lund

Courvoisier law: In patient with obstructive jaundice, if obstruction is due to stones in CBD – gallbladder not palpable. Obstruction is due to malignancy in CBD, gallbladder will be palpable.

Murphy's Point: It is the point of intersection at linea semilunaris and right costal margin at the tip of ninth costal cartilage. When the anterior abdominal wall is pressed at this point patient winces due to pain in acute cholecystitis.

Murphy sign: Inspiratory arrest with deep palpation in the right upper quadrant pain in the acute cholecystitis.

PANCREAS

Extending from concavity of duodenum to the hilum of spleen.

Presenting Parts

- Head: Contained within the curve of duodenum
- Head of pancreas is divided into head proper and uncinate process.
- Neck: Lies in front of formation of portal vein (portal vein = superior mesenteric vein + splenic vein). Anterior to body of L1 – L2
- Junction between head and neck, in front separated by groove for gastroduodenal artery
- Body: Extends from the front of aorta to the front of left kidney
- Tail: Extends between the two layers of lienorenal ligament and reaches spleen.



Clinical Aspect

Gall Stones

- Commonly seen in forty, fatty, fertile, female
- Gall stones may lodged in fundus of gallbladder—ulcerate through fundus and reach the transverse colon—pass naturally into rectum
- Gall stones may lodged in body of gallbladder—ulcerate through body and reach the duodenum—then held up in ileocecal junction producing intestinal obstruction
- Gall stones in bile duct—obstruct the bile flow leading to jaundice
- Stones in hepatopancreatic ampulla—block both biliary and pancreatic duct system bile may enter the pancreas and cause noninfectious pancreatitis
- Gall stones are commonly impacted in → Distal end of hepatopancreatic ampulla.
- Artery which can be mistaken for the cystic artery and is liable to injury during lap cholecystectomy → Right hepatic artery.
- *Rokitansky-Aschoff sinuses* in gallbladder indicates acute cholecystis/gangrene. They occur when gallbladder mucosa penetrates deep into muscularis externa.
- Caterpillar hump – **MOYNIHYAN'S HUMP** – right hepatic artery tortuous seen in calot's triangle instead of cystic artery



Boas sign: Hyperaesthesia below right scapula in acute cholecystitis.

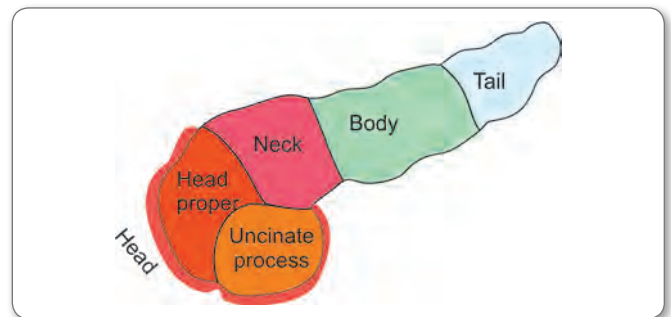


Fig. 93: Parts of pancreas

Relations

Head of Pancreas

Posterior surface	Upper border
Inferior vena cava with both renal veins Aorta	Overlapped by first part of duodenum

Uncinate Process

- Head of pancreas extends on the lower and left side forms uncinate process
- In front—superior mesenteric vessels
- Behind—abdominal aorta

Contd...



Neck of Pancreas

- Infront: Pylorus of stomach
- Behind: Lower part to superior mesenteric vessels and in the upper part by portal vein.

Tunnel of Love

- Tunnel behind the neck of pancreas whereas superior mesenteric vein enters and comes out as portal vein.

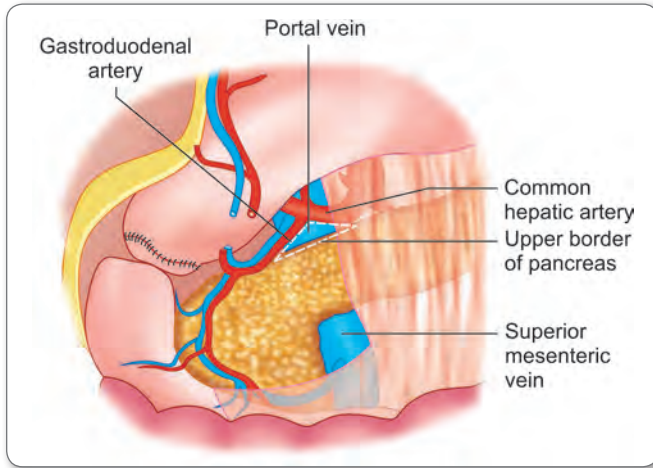


Fig. 94: Tunnel of love

Body of Pancreas

- Longest part and triangular in cross section.
- Anterior border: Attachment to transverse mesocolon
- Superior border: Celiac trunk
- Inferior border: Superior mesenteric artery
- Anterior surface: Covered with peritoneum related to lesser sac
- Posterior surface: Splenic vein, abdominal aorta, renal vessels, left suprarenal vein, left gonadal vein, left kidney and left suprarenal gland
- Inferior surface: Duodenojejunal flexure, coils of jejunum and left colic flexure.

Tail-Contain Maximum Islets

- Infront–stomach separated by lesser sac
 - Behind–spleen and splenic vessel
 - Below–left colic flexure.
- Total islets in pancreas – 1 million
- Duct of Wirsung:** Main pancreatic duct – arises from tail and terminates at ampulla of Vater.
- Duct of Santorini:** Minor pancreatic duct – Extends from main duct to enter duodenum at minor papilla. Lying more anteriorly and 2 cm proximal to ampulla.

Clinical Aspect

- In case of pancreatitis, the inflammatory fluid collects between the lesser sac and pancreas and forms **pseudopancreatic cyst**.
- Pancreatic carcinoma is common in → **Head** of pancreas.
- ERCP is used to visualize → **Ducts of pancreas and bile ducts**.
- Pancreatic structure likely to be injured during splenectomy → Tail of pancreas.
- CA pancreas – in head – compress the bile duct – cause obstructive jaundice
- CA pancreas – in neck and body – infiltrates portal vein and splenic vein, also causes IVC obstruction as pancreas overlies these veins
- Most common site of pancreatic cancer – head > peri ampullary cancer
- **Double duct sign**

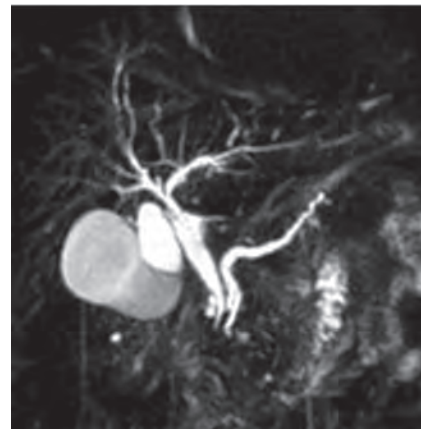


Fig. 95: Double duct sign

The double duct sign refers to the presence of simultaneous dilatation of the common bile and pancreatic ducts. The two most common causes of the double duct sign are carcinoma of the head of the pancreas and periampullary tumours

Prayer sign – bending forward sign – acute pancreatitis
 Grey turner's sign – loin pigmentation in hemorrhagic pancreatitis
 Cullen's sign – periumbilical pigmentation in hemorrhagic pancreatitis



Figs 96A and B: (A) Gullen's sign; (B) Grey turner's sign

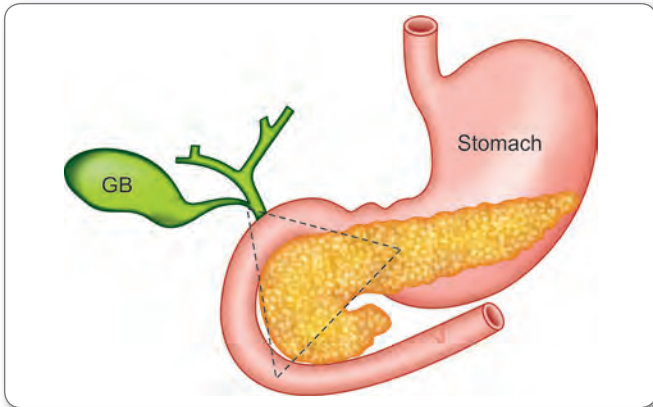


Fig. 97: Passaro's triangle

Passaro's Triangle

- Junction between the head and neck of the pancreas
- Junction of cystic duct with CBD
- Junction between the 2nd and 3rd parts of the duodenum

The **gastrinoma triangle** (or **Passaro's triangle**) is an anatomical area in the abdomen, from where the majority (90%) of **gastrinomas** are thought to arise.

SPLEEN

- Situated in left hypochondrium
- Developed from dorsal mesogastrium
- Axis-10th rib
- Projects into greater sac
- Composed of white pulp consists of primarily lymphatic tissue around central artery and is the prime site of immune and phagocytic action
- Red pulp consists of venous sinusoids and splenic cords

Presenting parts

- Medial end-blunt
- Lateral end-like border
- Superior border-notched
- Visceral surface-stomach, renal impression, left colic flexure and tail of pancreas related to spleen
- Nerve supply-celiac plexus
- Arterial supply-splenic branch of splenic artery
- Common location of accessory spleen-hilum of spleen.

Ligaments of Spleen

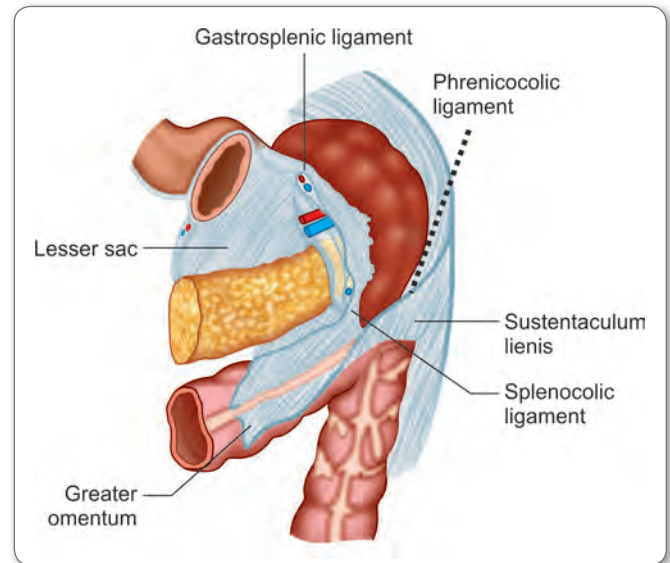


Fig. 99: Ligaments of spleen

REMEMBER

Harris dictum of odd numbers

- 1 inch – thickness
- 3 inch – breadth
- 5 inch – length
- 7 oz in weight
- 9 to 11 – ribs in contact
- Axis of spleen – 10th rib.

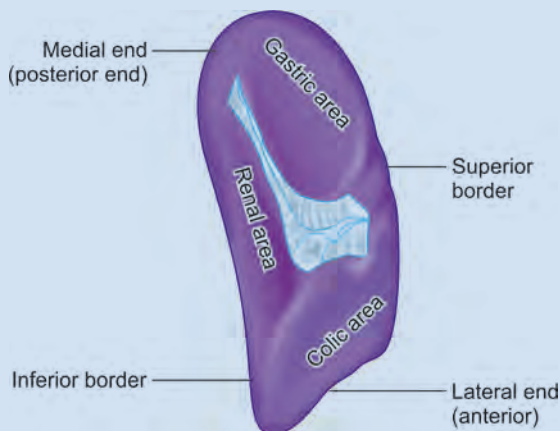


Fig. 98: Spleen

Table 24: Contents of splenic ligaments

Gastrosplenic	Lienorenal	Lienophrenic	Phrenicocolic
Contents • Short gastric vessels • Left gastroepiploic vessels	Contents • Splenic vessels • Tail of pancreas	Suspensory ligament of spleen - Suspends spleen from above	From left colic flexure to diaphragm. Prevents the downward displacement of spleen Sustentaculum lienis

- Arterial supply-splenic branch of splenic artery (end artery)
- Venous drainage-splenic vein
- Nerve supply-by celiac plexus

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Clinical Aspect

- Palpation of spleen follows the spinoumbilical line toward the left costal margin.
- Splenic puncture is done in the **left 10th intercostal space** in midaxillary line to record the portal venous pressure. Splenic pulp pressure reflects the pressure in splenic vein.
- Fractures of 9th-12th rib can cause laceration injury to spleen.
- Spleen is palpable when it enlarges **double** of its size.
- **Kehr's sign** → In case of ruptured spleen, splenic blood irritates left dome of diaphragm and pain is referred to left shoulder.
- **Right isomerism** is characterized by asplenia and left isomerism is characterized by polysplenia.

BLOOD SUPPLY OF GIT

- Blood supply to foregut: Celiac trunk
- Blood supply to midgut: Superior mesenteric artery
- Blood supply to hindgut: Inferior mesenteric artery

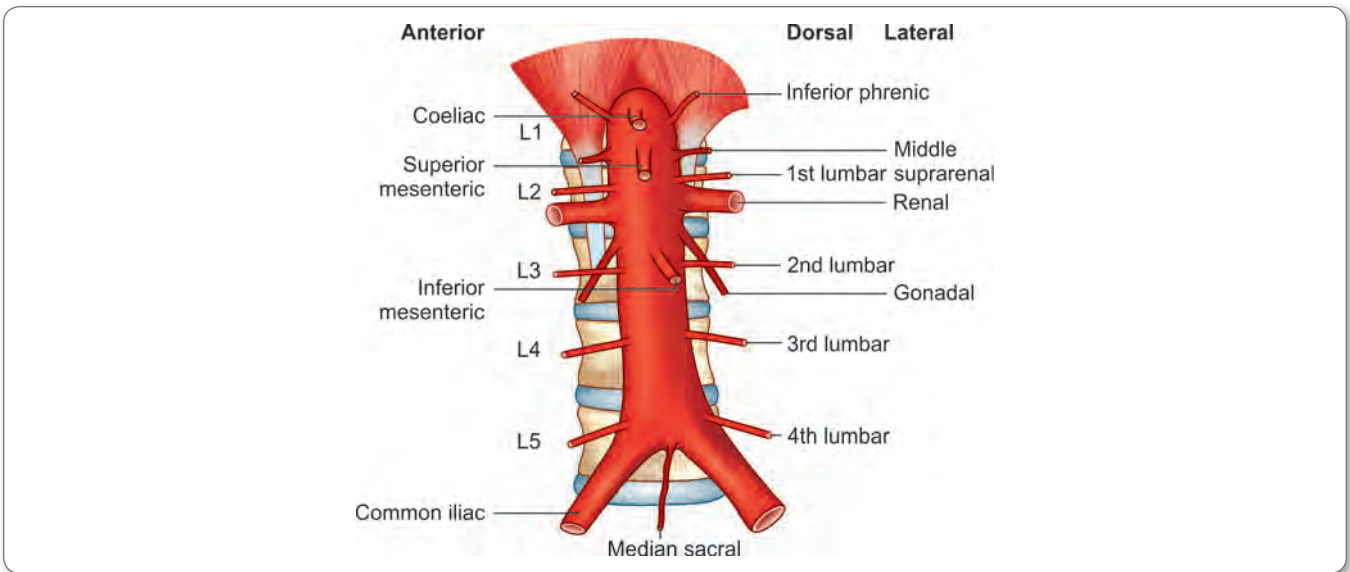
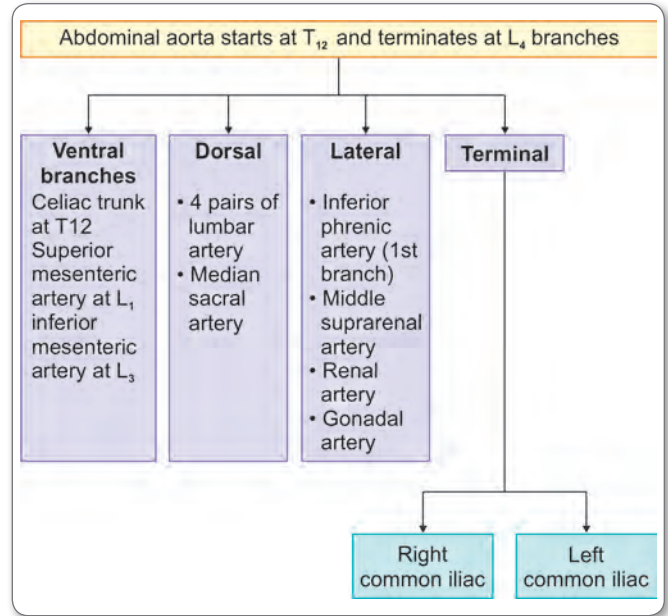


Fig. 100: Branches of aorta

Table 25: Blood supply of GIT organs

Stomach	Duodenum	Pancreas	
<ul style="list-style-type: none"> • Lt gastric artery (Branch of celiac trunk) • Rt gastric artery (Branch of common hepatic artery) • Rt gastroepiploic artery (Branch of gastroduodenal artery) • Lt gastroepiploic artery (Branch of splenic artery) • Short gastric artery (Branch of splenic artery) 	Except 1st part of duodenum rest of parts supplied by <ul style="list-style-type: none"> • Superior pancreaticoduodenal artery branch of gastroduodenal artery • Inferior pancreaticoduodenal artery branch of superior mesenteric artery 1st part duodenum supplied Supraduodenal artery (end artery) (artery of Wiki) Branch of retroduodenal artery Branch of gastroduodenal artery	Head and Neck Supplied by Superior and inferior pancreaticoduodenal artery	Body and Tail Supplied by pancreatic branches of splenic artery



Celiac Trunk

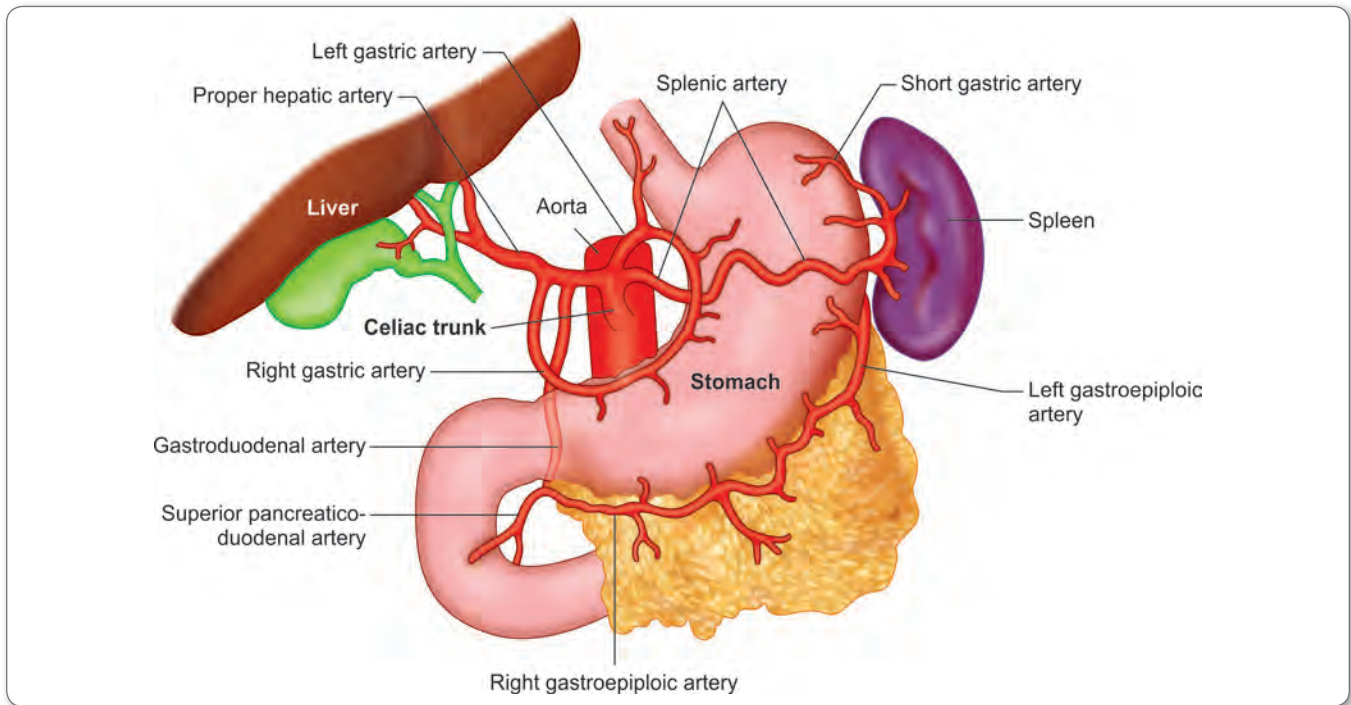
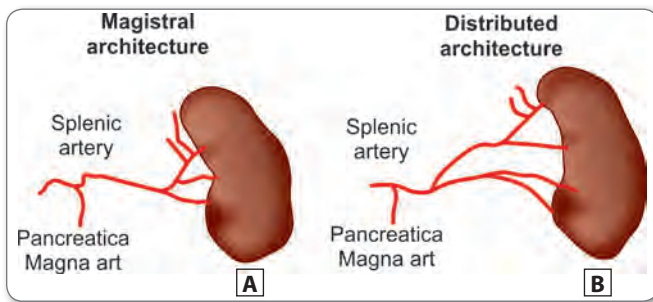


Fig. 101: Celiac trunk

- Arises from front of the aorta immediately below the aortic hiatus of the diaphragm between right and left crura
- Divides into left gastric, splenic and common hepatic artery
- **Left gastric artery**
 - Smallest branch
 - Runs upward and to left toward cardiac end giving esophageal branch and hepatic branch and runs in lesser curvature anastomose with right gastric artery
- **Splenic artery**
 - Largest branch of the trunk
 - Tortuous in course
 - Gives the following branches
 - Short gastric artery: Supplies the fundus of stomach
 - Left gastroepiploic artery: Reaches greater omentum and anastomose with right gastroepiploic artery
 - Pancreatic branches: Supplies the entire pancreas except head
- Splenic artery – two types
 - **Magistral type** – 30% - branches into terminal and polar branches near the hilum of spleen
 - **Distributed type** – 70% - gives off branches early
- **Common hepatic artery**
 - Runs to right along the upper border of pancreas and divides into proper hepatic artery, gastroduodenal artery and right gastric artery
 - Proper hepatic artery: Runs in the free margin of lesser omentum and divides into left and right hepatic artery Right hepatic artery also gives cystic artery
 - Right gastric artery: Anastomose with left gastric artery in lesser omentum
 - Gastroduodenal artery: Descends behind the first part of duodenum and gives supraduodenal artery and divides into right gastroepiploic artery (anastomose with left gastroepiploic artery) and superior pancreaticoduodenal artery runs between duodenum and pancreas and further divides into anterior-posterior division, which is anastomosis with anterior and posterior division of inferior pancreaticoduodenal artery.



Figs 102A and B: Splenic artery: (A) Magistral; (B) Distributed



Pringle Maneuver

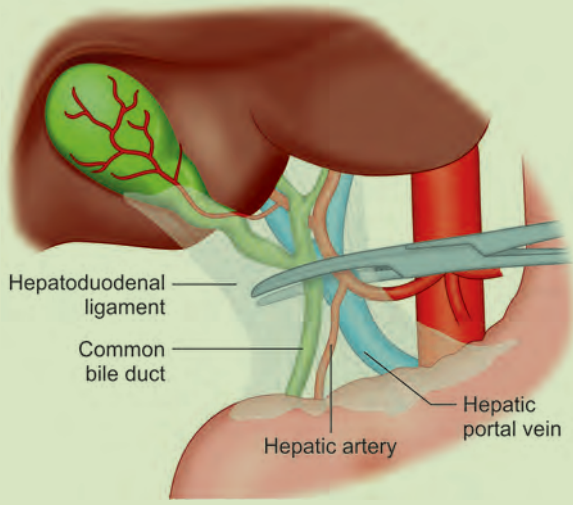
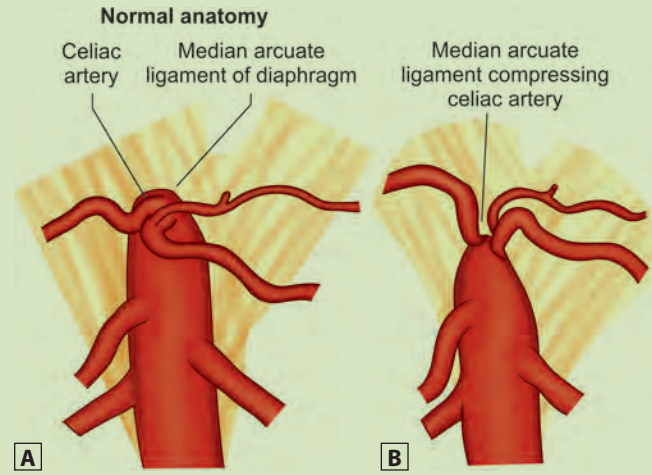


Fig. 103: Pringle maneuver

Temporary clamping of hepatoduodenal ligament containing portal triads at the epiploic foramen for control of hepatic bleeding during liver surgery.

Dunbar Syndrome or Celiac Artery Compression Syndrome or Median Arcuate Ligament Syndrome



Figs 104A and B: Dunbar syndrome

Higher or lower origin of celiac trunk leads to compression of celiac trunk by median arcuate ligament

Superior Mesenteric Artery–Ventral Branch of Aorta at L1 (Refer the Chart, Artery)

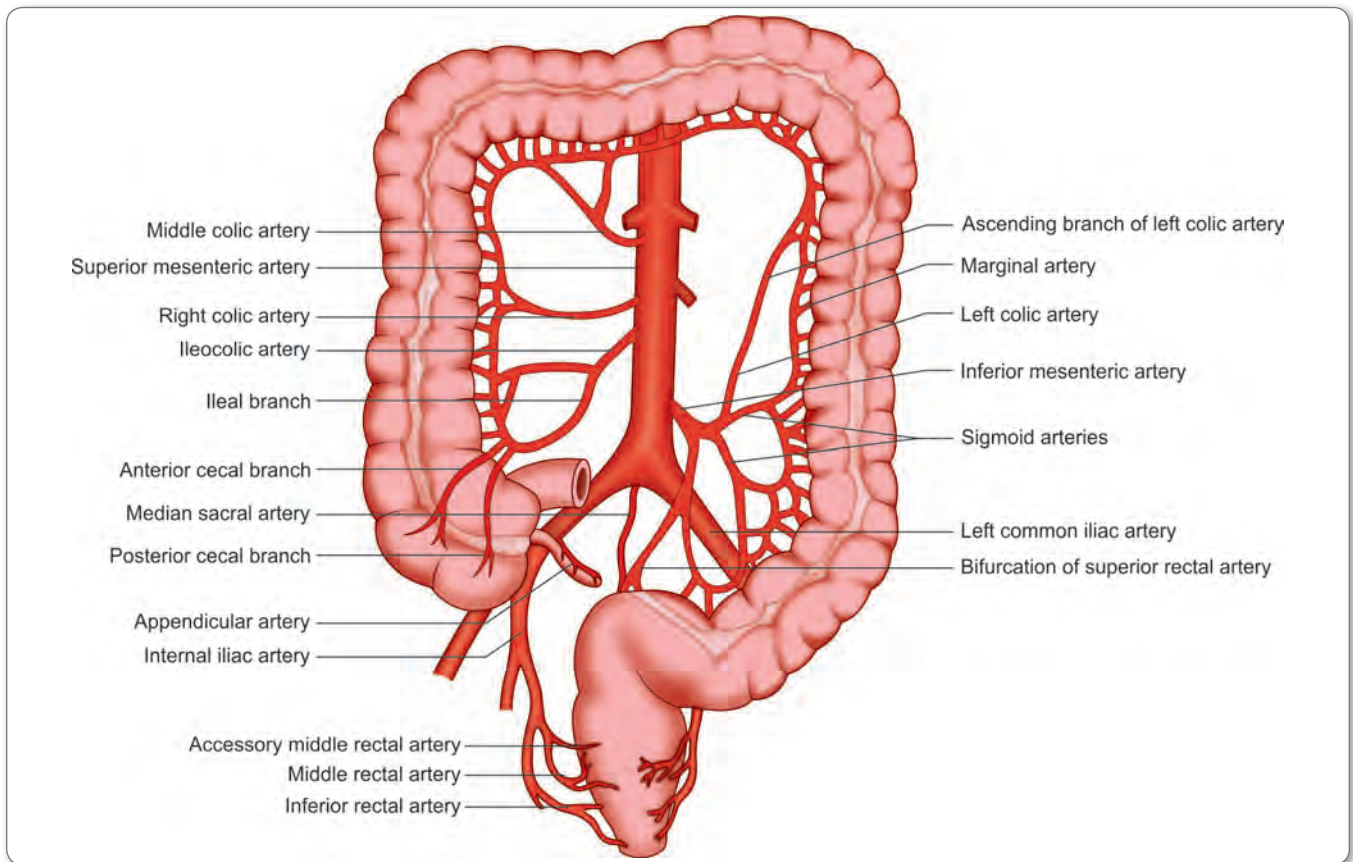


Fig. 105: Branches of superior mesenteric artery



- Arises from aorta behind the neck of pancreas
- Descends across the uncinate process of pancreas and third part of duodenum and then enters root of mesentery behind the transverse colon to run to the right iliac fossa
- Gives the following branches.

Branches

- From convex side—Jejunal and ileal branches
- From concave side
 - Inferior pancreaticoduodenal artery: Further divides into anterior–posterior division, which is anastomose with anterior and posterior division of superior pancreaticoduodenal artery.
 - Middle colic artery: Enters transverse mesocolon and divides into right branch (anastomose with right colic artery) and left branch (anastomose with ascending branch of left colic artery).
 - Right colic artery gives ascending and descending branches
 - Ileocolic artery gives ascending branch, which anastomose with descending branch of right colic artery. Other branches of ileocolic artery are anterior and posterior cecal. Appendicular and ileal branch inferior branch of ileocolic artery anastomose with terminal superior mesenteric artery.

Applied

Griffith Point

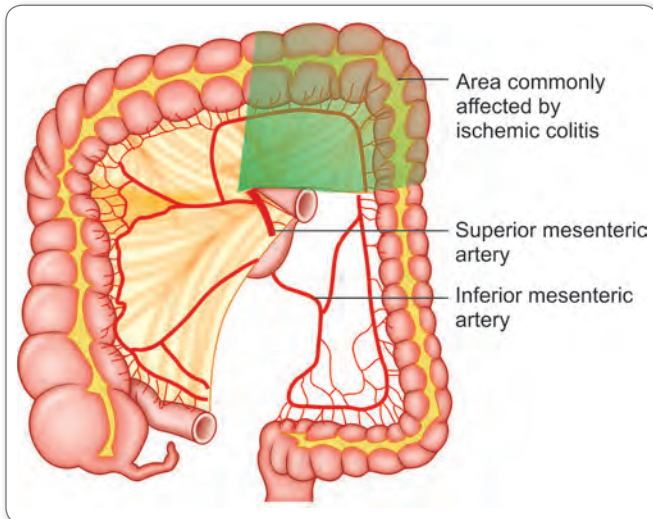


Fig. 106: Ischemic colitis common in splenic flexure – Griffith point

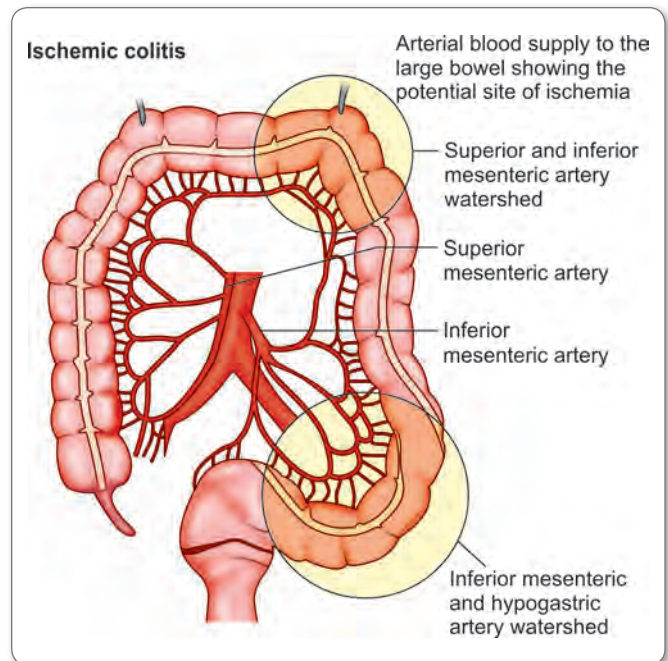


Fig. 107: Superior and inferior mesenteric artery

Inferior Mesenteric Artery–Ventral (Branch at L3)

Passes to left behind peritoneum and supplies hind gut.

Branches

- Left colic artery: Runs to left behind peritoneum toward the descending colon and divides into ascending and descending branches.
- Sigmoid arteries: Two to three in numbers, run toward sigmoid colon and divide into ascending and descending artery.
- Inferior mesenteric artery continue as superior rectal artery – anastomose with middle and inferior rectal artery.

HIGH YIELD POINTS

- Marginal artery of Drummond— anastomosing arterial arcade formed by ileocolic, right colic, middle colic and left colic artery.
- Critical point of Sudeck: Lowest sigmoidal artery fails to anastomose with superior rectal artery. This discontinuity of marginal artery is Critical Point of Sudeck.



Portal Vein

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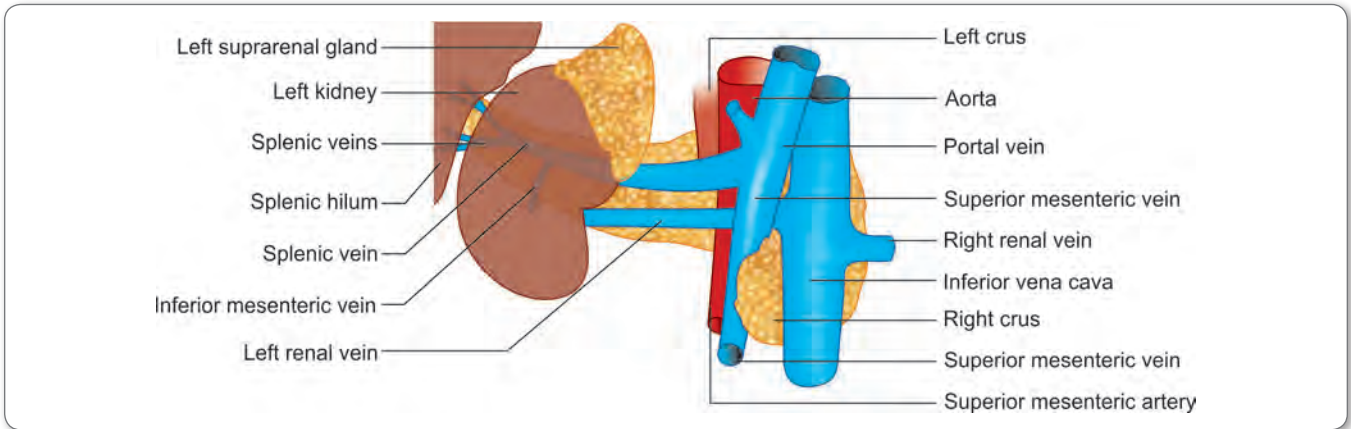


Fig. 108: Portal vein

- Portal vein: **Union of superior mesenteric and splenic vein** behind the neck of pancreas at L2.
- Then pass upward **posterior to neck of pancreas and superior part of duodenum**
- Enters the **right free margin of lesser omentum** (bile duct, hepatic artery lies anterior to it in the free border of lesser omentum) then reaches porta hepatis where it divides into right and left branches
- Portal vein devoid of valves but developmentally valves are present
- Normal portal pressure is about **5–10 mm Hg**
- Varices formed at pressure > 10 mm hg
- Variceal bleeding occurs > 12 mm hg
- Tributaries of portal vein
 - Right gastric
 - Left gastric
 - Splenic
 - Superior mesenteric,
 - Cystic (to right branch)
 - Paraumbilical (to left branch)
- Portal vein divided into three parts by supraduodenal, infraduodenal and retroduodenal parts.

Table 26: Sites of portacaval anastomosis

Sites	Portal	Systemic
Lower end of esophagus	Esophageal branch of left gastric vein	Esophageal branch of hemiazygos
Lower end of rectum and anal canal (up to pectinate line)	Superior rectal vein	Middle and inferior rectal veins
Umbilicus	Paraumbilical vein	Veins of anterior abdominal wall
Bare area of liver	Portal radicals of liver	Diaphragmatic veins
Posterior abdominal wall	Splenic and colic veins	Renal and Lumbar veins
Falciform ligament	Paraumbilical vein	Diaphragmatic veins
Fissure for ligamentum venosum -Ductus venosus	Left branch of portal vein	Inferior vena cava

Supraduodenal Part

- Anterior: Hepatic artery, bile duct.
- Posterior: Inferior vena cava.

Infraduodenal Part

- Anterior: Neck of pancreas.
- Posterior: Inferior vena cava.

Retroduodenal Part

- Anterior: 1st part of duodenum.
- Posterior: Inferior vena cava.



Clinical Aspect

- Portal hypertension results from liver cirrhosis or thrombosis in the portal vein forming esophageal varices, caput medusae and hemorrhoids. Treated by diverting blood from portal to caval system by portocaval shunt – achieved by creating shunt between portal vein and IVC
- Splenic renal (warren shunt) joining splenic vein and left renal vein

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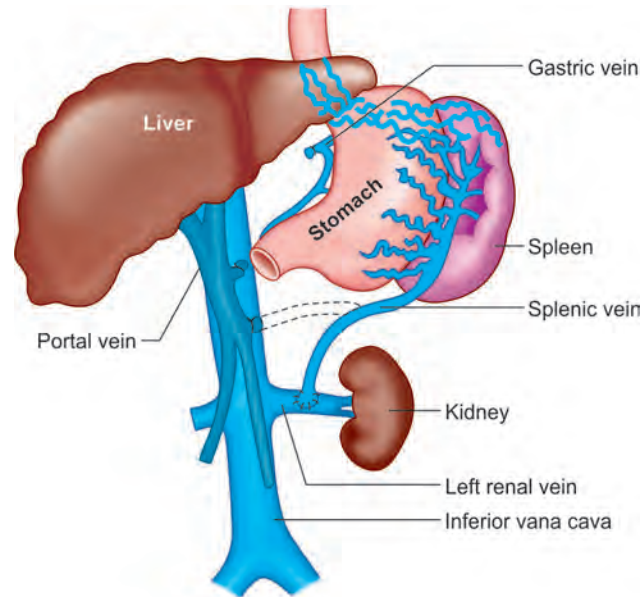
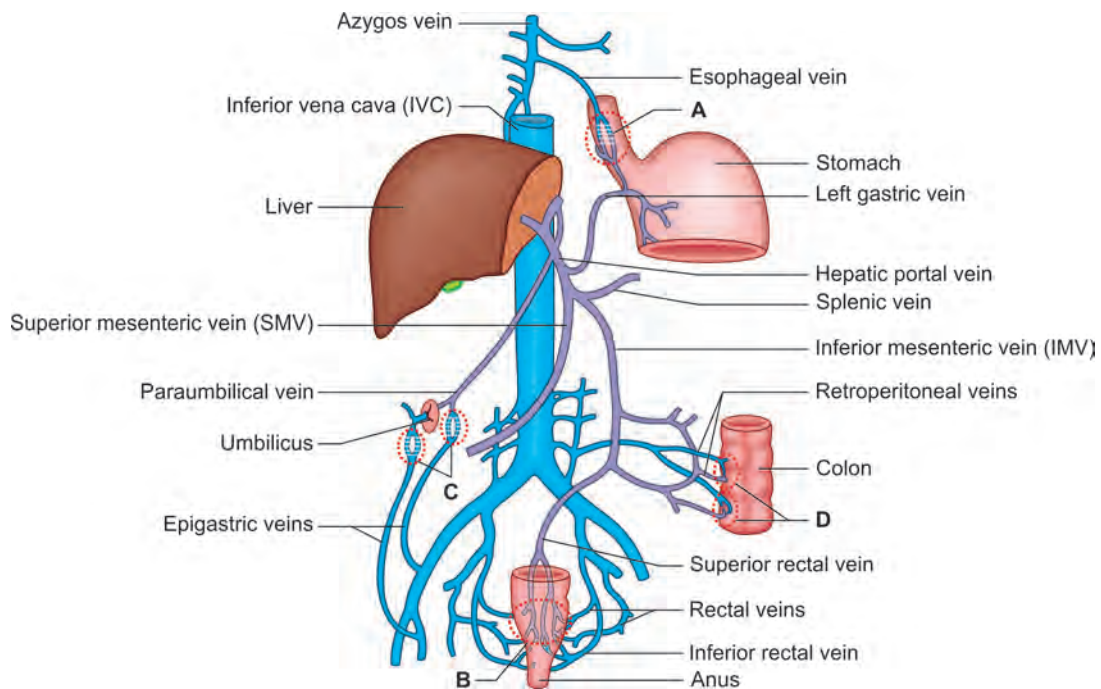


Fig. 109: Warren shunt

- Also treated by TIPS (Transjugular Intrahepatic Porto-systemic shunt): Catheter is placed per cutaneously into right jugular vein through which an intrahepatic shunt is created between hepatic vein and branch of portal vein within the liver. Thus, the blood flows from portal vein into the hepatic vein and then into IVC.



Figs 110A to D: Sites of portacaval anastomoses. (A) Lower end of esophagus; (B) Anal canal; (C) Paraumbilical region; (D) Retroperitoneal

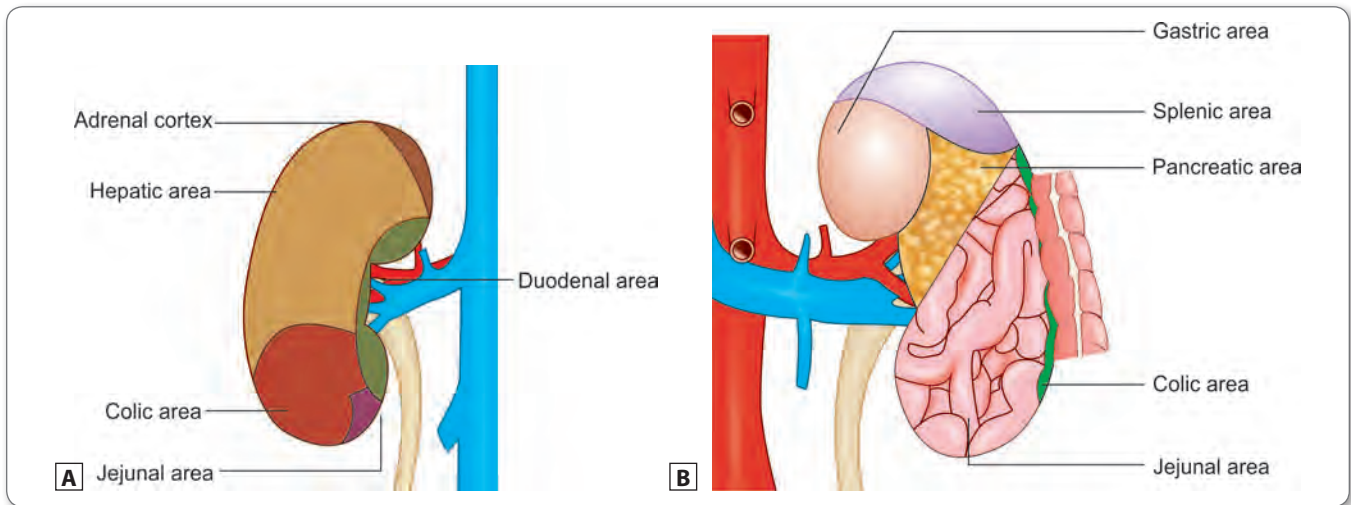


KIDNEY

- Retroperitoneal organ from T12 to L3.
- Coverings (from inward to outward)
 - Renal capsule (true capsule) condensation of fibrous stroma
 - Perinephric fat (space of Gerota): Situated between renal capsule and renal fascia.
 - Renal fascia (false capsule) consists of two layers— anterior layer fascia of Toldt and posterior layer fascia of Zuckerkandl
 - Paranephric fat.
- Upper pole: Situated 2.5 cm away from midline at T12 and is related to suprarenal gland
- Lower pole: Situated 7.5 cm away from midline at L3.

Table 27: Anterior relations of right and left kidney

Structures related to right kidney anteriorly	Structures related to left kidney anteriorly
<ul style="list-style-type: none"> • Suprarenal gland (not covered with peritoneum) • Duodenal 2nd part (not covered with peritoneum) • Liver (covered with peritoneum) • Right colic flexure (not covered with peritoneum) • Jejunum (covered with peritoneum) 	<ul style="list-style-type: none"> • Suprarenal gland (not covered with peritoneum) • Spleen (covered with peritoneum) • Stomach (covered with peritoneum) • Pancreas (not covered with peritoneum) • Left colic flexure (not covered with peritoneum) • Jejunum (covered with peritoneum)



Figs 111A and B: Anterior relations. (A) Right kidney; (B) Left kidney

Table 28: Posterior relations of both kidneys

Muscles	Neurovascular structures	Bones
<ul style="list-style-type: none"> • Diaphragm (arising from medial and lateral arcuate ligaments) • Psoas major • Quadratus lumborum • Transversus abdominis 	<ul style="list-style-type: none"> • Subcostal nerve and vessels • Iliohypogastric nerve • Ilioinguinal nerve • Fourth lumbar artery only on right side 	<ul style="list-style-type: none"> • 11th and 12th rib on left side • 12th rib only on right side

REMEMBER

Renal Angle

- Angle between **lower border of 12th rib** and lateral border of erector spinae (**sacrospinalis**) muscle.
- It is the area where tenderness of kidney can be elicited

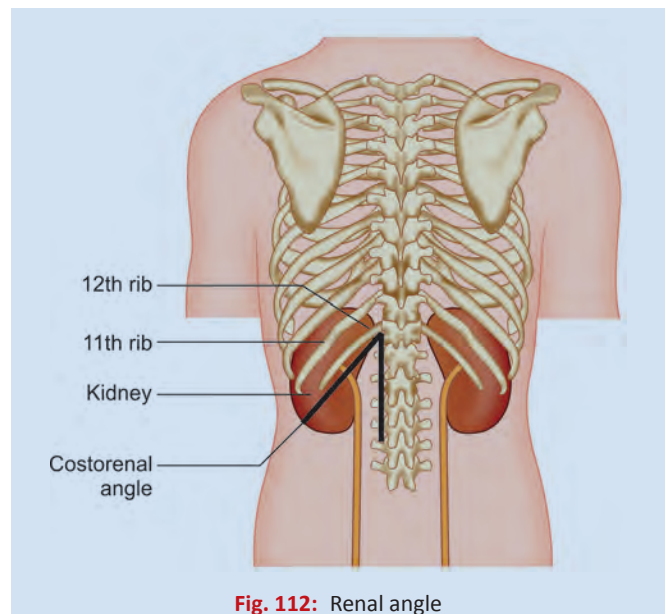


Fig. 112: Renal angle

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Blood Supply of Kidney

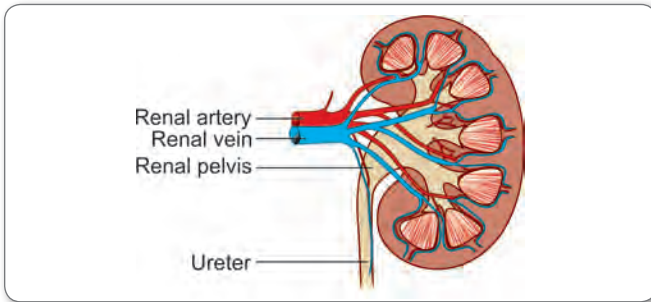
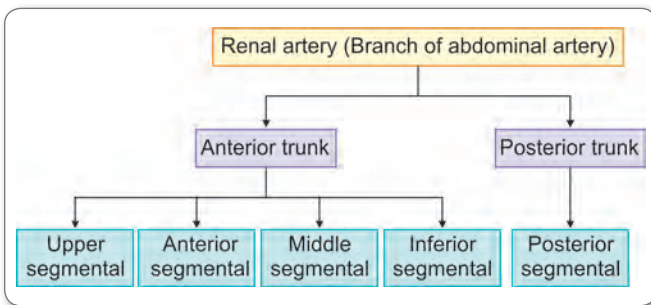
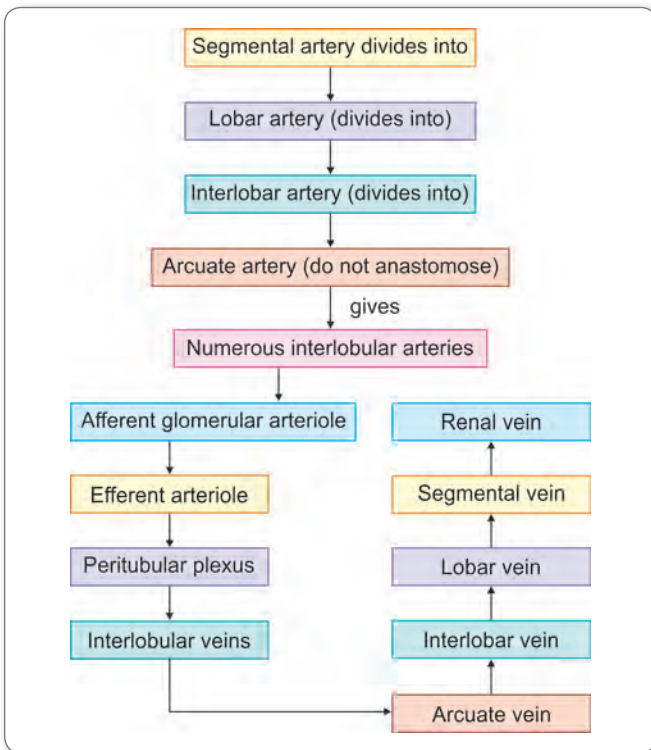


Fig. 113: Blood supply of kidney

Arterial Supply



- Segmental arteries are end arteries



Peculiarities of Renal Artery

- Branches of renal arteries are end artery
- Amount of blood circulating through the cortex is about four to five times more abundant than medulla
- Each kidney presents 5 independent vascular segments
- Segmental artery divides into lobar artery. Each lobar artery before piercing the kidney usually divides into inter lobar artery
- At the junction of cortex and medulla, interlobar artery divides dichotomously into arcuate artery. These arcuate arteries do not anastomose with one another.

Venous Drainage

- Each kidney drains into inferior vena cava by corresponding renal vein. **Left renal vein is larger** than right and left renal vein receives left gonadal vein and left suprarenal vein
- Stellate veins are renal vein below the true capsule. These satellite veins drain superficial zone of renal cortex.

Blood Supply of Fetal Kidney

- Initially kidney is in pelvis and is **supplied by common iliac artery**
- After that kidney ascends to lumbar region. During the ascent, renal arteries are derived from various levels of aorta
- Neonatal kidney is supplied by aorta

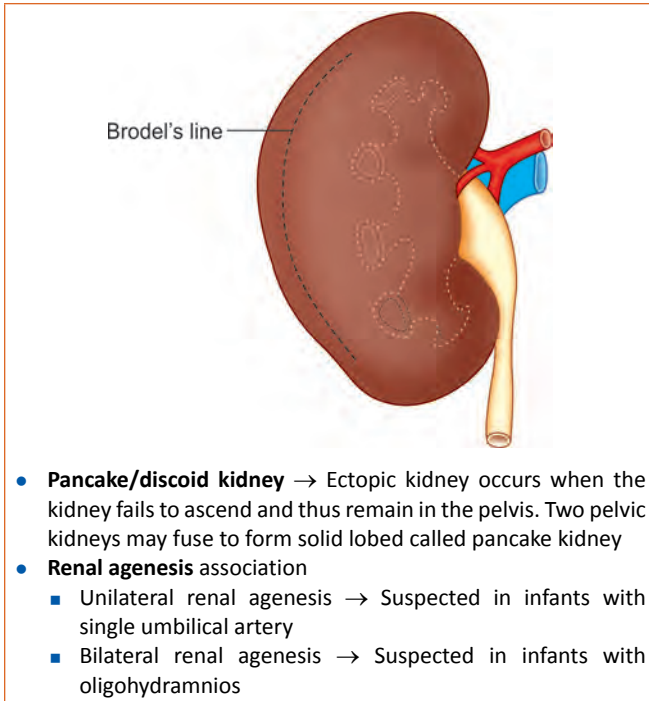
Nerve Supply

Renal plexus branch from celiac plexus contains sympathetic fibers T10-L1

Clinical Aspect

- Loss of renal fascia and perinephric fat leads to → **Nephroptosis** (Floating kidney).
- Nephroptosis can be differentiated from ectopic kidney by → **Ureteric length**.
Surgical removal of kidney is usually approached by → **Posterolateral abdominal incision**.
To avoid injury to pleura during nephrectomy incision must be → **Inferior to 12th rib**.
- During renal transplantation left kidney is preferred because of longer renal vein. The donor kidney is placed in retroperitoneum in iliac fossa with the hilum parallel to the external iliac vessels.
- Renal collar is formed by circumaortic left renal vein
- **Brodie's white line** → Avascular line between anterior and posterior segments of kidney, an approach used for removal of staghorn renal calculi.

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SUPRARENAL GLAND

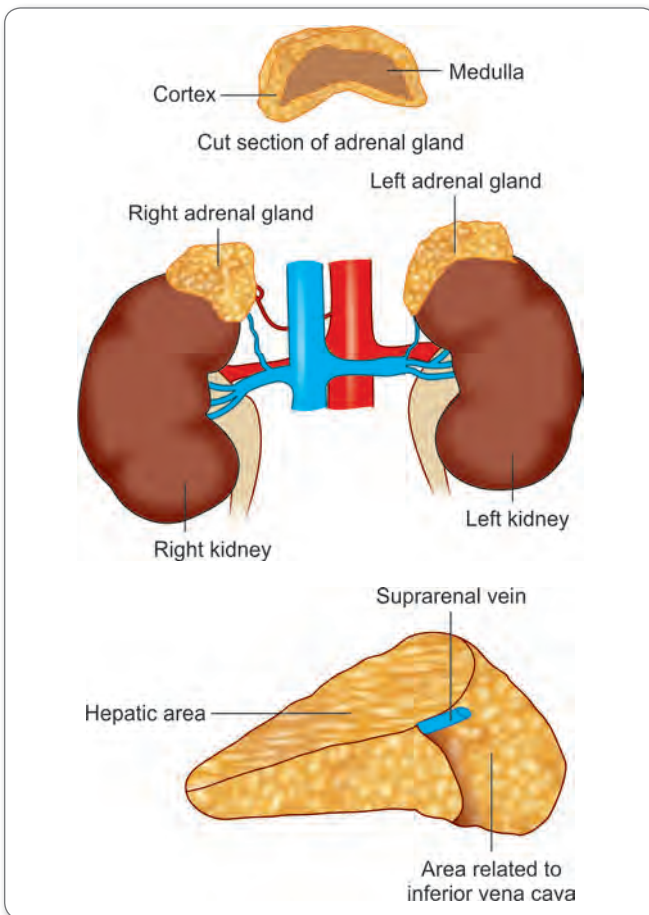


Fig. 114: Suprarenal glands

Right Adrenal Gland

Pyramidal shape

Presenting Parts

- Base: Directed below overlaps upper end of right kidney.
- Apex: Directed above. Close to apex anterior surface presents a hilum.
- **Anterior surface** – medial area related to IVC
- Lateral area related to **liver**
- Posterior surface – upper area related to diaphragm
- Lower area related to kidney
- Lateral border – overlapped by liver
- **Medial border** – related below with celiac ganglion
- Above with **inferior phrenic artery**

Left Adrenal Gland

Semilunar Shape

Presenting Parts

- Lower end: Rounded, close to anterior surface presents hilum.
- Upper end: Narrow, related to medial end of spleen.
- Anterior surface: Upper area related to stomach bed.
- Lower area: Overlapped by body of Pancreas and crossed by tortuous splenic artery.
- Posterior surface: Lateral area with left kidney.
- Medial area with left crus of diaphragm.
- Lateral border: Overlaps left kidney.
- Medial border: Related below with celiac ganglion.
- Above with **inferior phrenic artery**.
- Suprarenal gland consists of outer cortex and inner medulla.
- Cortex derived from intermediate mesoderm consists of three zones.
- Outer zona glomerulosa – produces mineralocorticoids – aldosterone.
- Middle zona fasciculata: Produces glucocorticoids—mainly cortisol and corticosterone.
- Inner zona reticularis produce androgens—sex steroids.
- Medulla derived from neural crest cells – receives preganglionic sympathetic nerve fibers directly and secretes epinephrine and norepinephrine.

Blood Supply

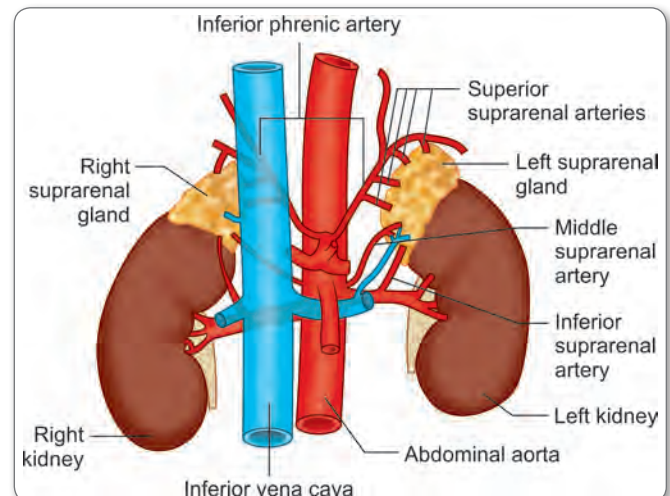


Fig. 115: Blood supply of suprarenal glands



Arterial Supply

- Superior suprarenal artery derived from inferior phrenic artery
- **Middle suprarenal artery** derived from **abdominal aorta**
- Inferior suprarenal artery derived from renal artery

Venous Drainage

- Right suprarenal vein drain into inferior vena cava
- Left suprarenal vein drain into left renal vein

Nerve Supply

- Adrenal cortex is devoid of nerve supply (stimulated by ACTH)
- Supra renal gland receive only sympathetic innervation
- Sympathetic fibers from coeliac plexus conveying fibers from located in T10-L1
- These sympathetic fibers pierce the cortex and made synaptic connections with chromaffin cells which act as postganglionic neurons



Clinical Aspect

- **Addison's disease:** Disorder caused by adrenocortical insufficiency (insufficient production of cortisol or in some cases by aldosterone) caused by autoimmune destruction of suprarenal cortex.
- **Cushing's syndrome:** Excess production of glucocorticoids. Symptoms and signs: Trunk obesity, moon face, muscle weakness, high blood pressure, high blood sugar and kyphosis.
- **Conn's syndrome:** Excess production of aldosterone. Symptoms and signs: Hypertension, head ache, muscle cramps, fatigue, polyuria, polydipsia.
- **Hirsutism:** Excess production of androgens. Symptoms and signs—excess hair growth in both male and female.

URETER

- Measures 25 cm long
- Consists of three parts pelvis of ureter, abdominal part and pelvic part
- Pelvis of ureter from hilum up to the lower end of corresponding kidney
- Abdominal part (retroperitoneal) passes downward in front of bifurcation of common iliac artery or at the origin of external iliac vessels.

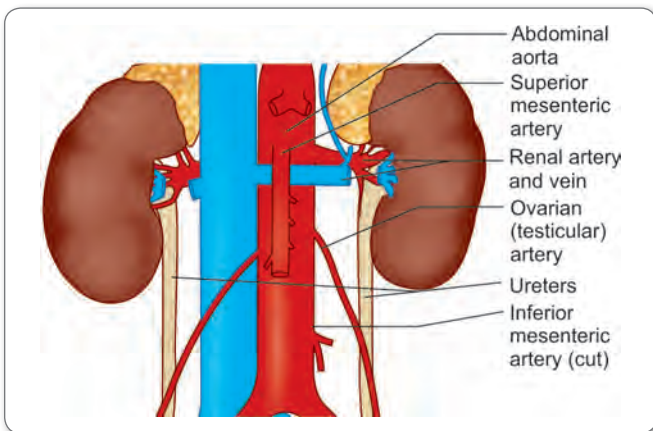


Fig. 116: Ureter

Relations

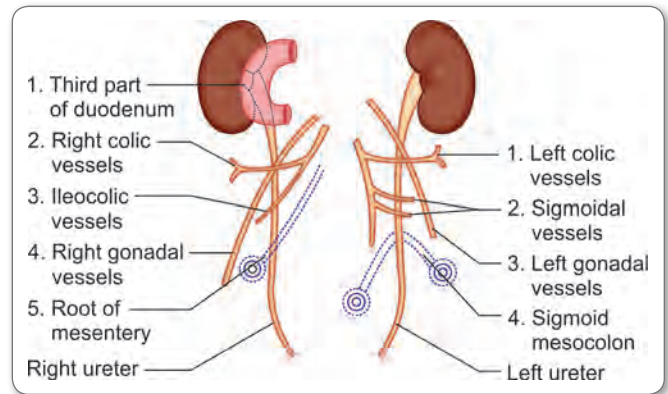


Fig. 117: Relations of right and left ureters

Anterior

Table 29: Anterior relations of right and left ureters

Right ureter	Left ureter
<ul style="list-style-type: none"> • Parietal peritoneum • Right gonadal vessels • Mesentery – root • Duodenum (2nd part) • Terminal part of ileum • Colic branches (Right and ileocolic branches of superior mesenteric artery) 	<ul style="list-style-type: none"> • Parietal peritoneum • Left gonadal vessels • Colic branches (left and sigmoid branches of inferior mesenteric artery) • Apex of sigmoid mesocolon

Posterior

- Genitofemoral nerve
- Psoas major and its fascia
- Tips of transverse process of all lumbar vertebra (Mn – GP – tips)

Pelvic Part of the Ureter

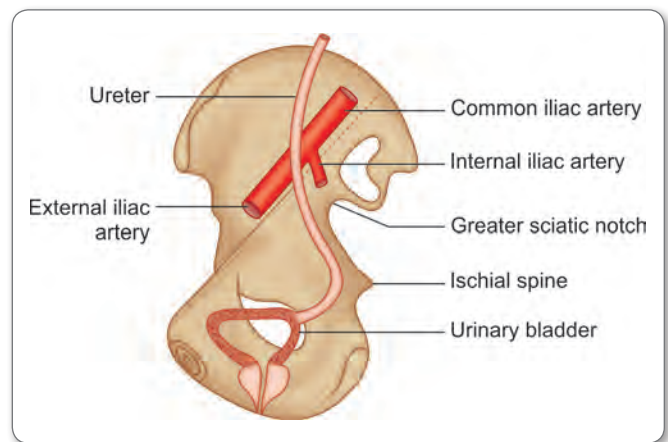


Fig. 118: Pelvic part of ureter



- Ureter passes downward and reaches ischial spine (straight course)
- From ischial spine, ureter passes obliquely and reaches superolateral surface of bladder
- Intravesical part: No sphincter at the vesicoureteric junction.

Relations of Pelvic Part of Ureter

Straight Part

Behind	Laterally
<ul style="list-style-type: none"> • Internal iliac vessels • Lumbosacral trunk • Sacroiliac joint 	<ul style="list-style-type: none"> • Obturator vessels and nerve • Inferior vesicle vessels (vaginal artery in female) • Uterine artery in female

Oblique Part

Male	Female
<ul style="list-style-type: none"> • Above and medially – crossed by vas • Below – seminal vesicle 	<ul style="list-style-type: none"> • Above – uterine artery • Below – Mackenrodt’s ligament, lateral fornix of vagina

Blood Supply of Ureter

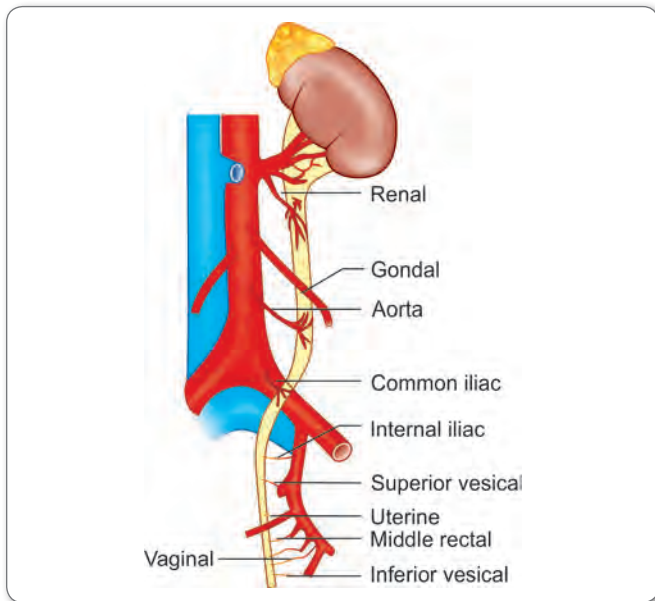


Fig. 119: Blood supply of ureter

Ureter derives its blood supply from renal artery, gonadal artery, lumbar artery, common and internal iliac artery, middle rectal artery, vesical artery, uterine and vaginal artery.

Nerve Supply

Sympathetic supply from **T10 to L1** and parasympathetic supply from **S2 to S4**.

REMEMBER

Anatomical Constrictions of Ureter

Three constrictions are present in the ureter

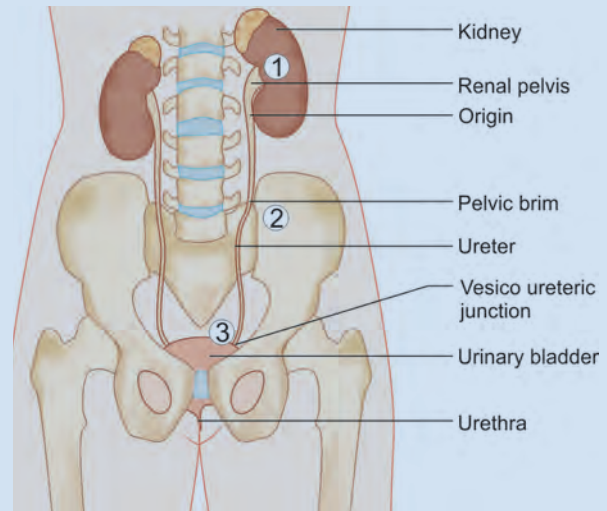
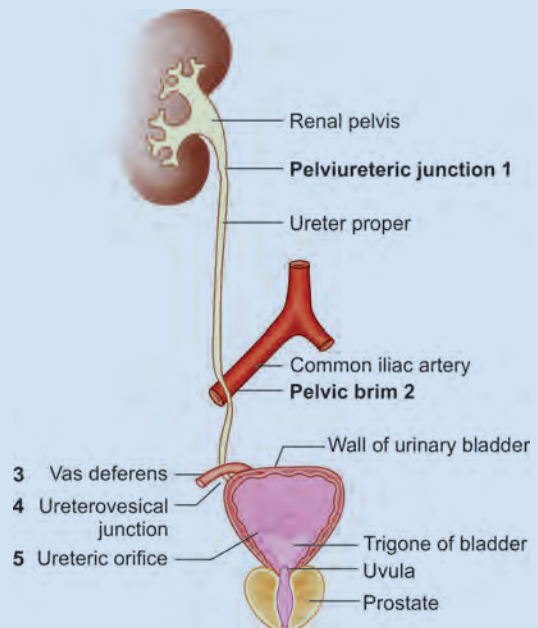


Fig. 120: Constrictions of ureter

- At the pelviureteric region, which corresponds with the lower pole of kidney
- At the pelvic brim where it crosses the common iliac vessels
- At the point where ureter pierces the bladder wall. It is the narrowest of all constrictions.

Surgical Constrictions of Ureter



1. Ureteropelvic junction
2. Ureter crosses pelvic brim
3. Juxtaposition of vas
4. Vesicoureteric junction – narrowest
5. Ureteric orifice



Clinical Aspect

- Obstruction of ureter: Kidney stones get lodged in pelviureteric junction, pelvic brim, where ureter pierces the bladder. Kidney stones at those narrow points results in hydroureter and hydronephrosis.
- In female, ureter may damage during hysterectomy or during surgical repair of prolapsed uterus because ureter runs under uterine artery.
- Hydronephrosis: Fluid filled enlargement of renal pelvis and calyces – as result of ureter. Occurs due to obstruction of urine flow by kidney stones in the ureter, by compression on the ureter by abnormal blood vessels or by developing fetus at the pelvic brim.

POSTERIOR ABDOMINAL WALL

Consists of bony part, muscular part and fascial part.

Thoracolumbar Fascia

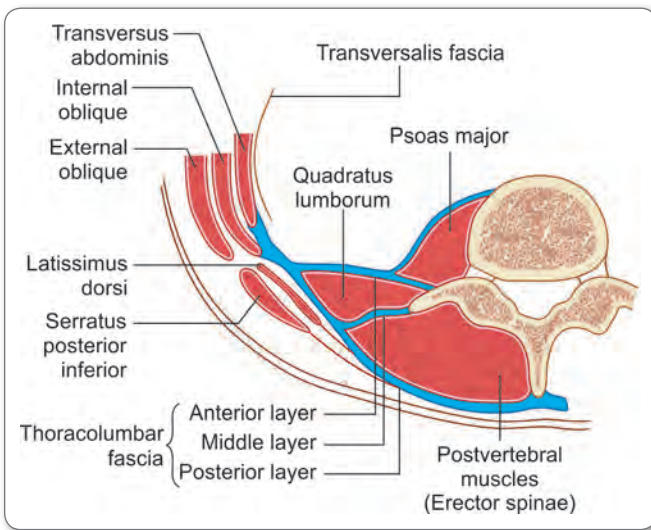


Fig. 121: Thoracolumbar fascia

Consists of anterior, middle and posterior layer.

- Quadratus lumborum: Present between anterior layer and middle layer
- Erector Spinae: Between middle and posterior layer

Their attachments to lumbar vertebra

- Anterior layer attached to anterior surface of transverse process
- Middle layer attached to tip of the transverse process
- Posterior process attached to spine of the lumbar vertebra

Muscles attached to thoracolumbar fascia

- Diaphragm
- Transverses abdominis and internal oblique
- Latissimus dorsi, serratus posterior inferior and few fibers of gluteus maximus

Bony Part

Consists of lumbar vertebra, inner surface of lower rib, iliac fossa and alae of sacrum.

Muscular Part

Table 30: Muscles of posterior abdominal wall

Muscle	Origin	Insertion	Nerve supply	Action
Psoas major	Transverse process and body and intervertebral disc of T12 to L5	Lesser trochanter	Ventral rami of L2, L3 (directly from lumbar plexus)	Chief flexor of hip joint Lateral flexion of lumbar spine
Iliacus	Iliac fossa and ala of sacrum	Lesser trochanter	Femoral nerve	Flexion of hip joint
Quadratus lumborum	Posterior 1/3 of inner lip of iliac crest and from iliolumbar ligament	Lower border of T12 and anterior surface of transverse process of L1 – L4	T12 – L1, L2, L3, L4	Fixes the last rib, lateral flexor of trunk



AORTA

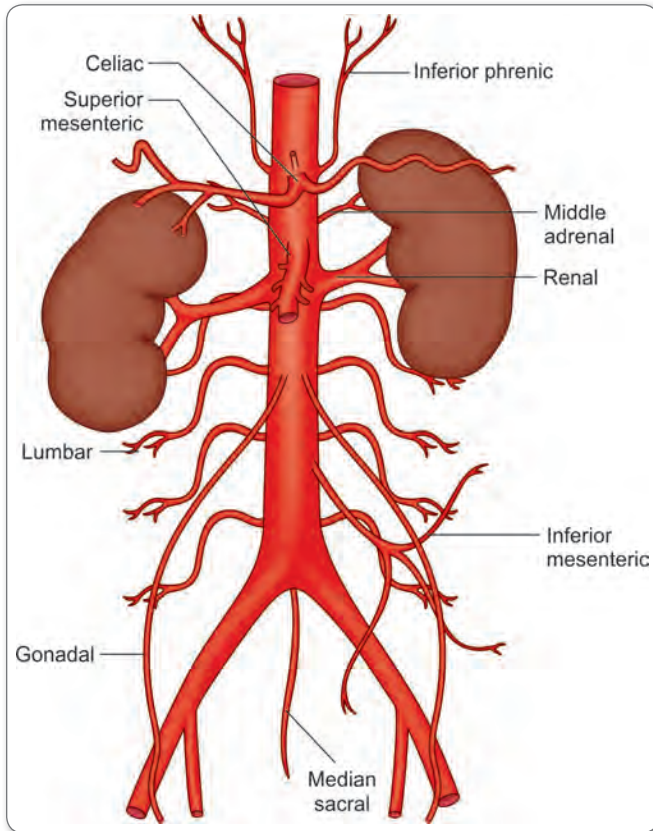


Fig. 122: Abdominal aorta and its branches

- Passes through aortic hiatus in the diaphragm at the level of T12 and descends anterior to the vertebral bodies and bifurcates into right and left common iliac artery anterior to L4
- Ventral branches—celiac trunk, superior mesenteric artery, inferior mesenteric artery (already explained)
- Lateral branches:
 - Inferior phrenic artery—first branch of abdominal aorta. Supply the diaphragm and gives superior suprarenal artery
 - Middle suprarenal artery: Passes superior to renal arteries
 - Renal artery: It is longer and little lower than the left and passes posterior to IVC. Left artery passes posterior to left renal vein
 - Gonadal artery: Descends retroperitoneally and run laterally on the psoas major and across ureter. Testicular artery accompanies vas and passes into scrotum where it supplies spermatic cord, epididymis and testis. Ovarian artery enters the suspensory ligament of the ovary and supplies ovary and anastomoses with ovarian branch of uterine artery
- Posterior branch:
 - Lumbar artery (4 to 5 pairs) runs posterior to sympathetic trunk, IVC, psoas major, quadratus lumborum. Divides into anterior and posterior branch, which supply the muscles

- Median sacral descends in front of sacrum and ends in the coccygeal body. Supplies rectum and anal canal and anastomose with lateral sacral and superior and inferior rectal arteries.

INFERIOR VENA CAVA

- At L5, formed by union of right and left common iliac vein
- Longer than aorta and ascends on the right side
- Enters thorax through vena caval orifice at T8 and opens into right atrium and opening is guarded by Eustachian valve.

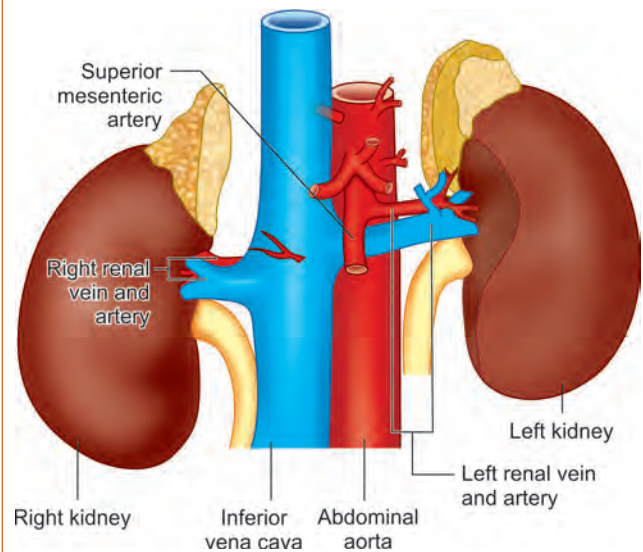
Tributaries of Inferior Vena Cava

(☛ Refer the Chart, Venous System)

- A pair of common iliac veins (formative)
- Lumbar veins—3rd, 4th lumbar vein directly drains into inferior vena cava. 1st and 2nd lumbar vein unites to form ascending lumbar vein, which opens indirectly into inferior vena cava.
- A pair of renal veins
- A pair of phrenic veins
- Right suprarenal vein
- Right gonadal vein
- Hepatic veins

Clinical Aspect

Left renal vein is sandwiched between superior mesenteric artery and abdominal aorta.



So, it may get compressed and this is called as nutcracker syndrome

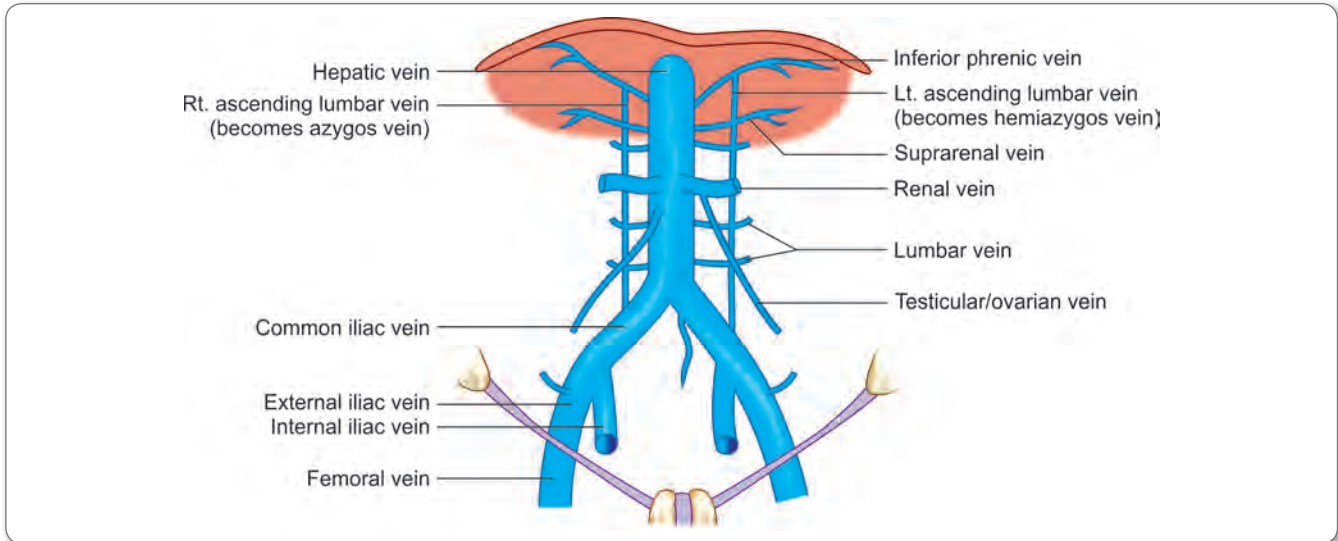


Fig. 123: Tributaries of inferior vena cava

Clinical Aspect

- Inferior vena cava obstruction leads to collateral circulation between superior and inferior vena cava
- In the obstruction of upper inferior vena cava, the azygos, hemiazygos and vertebral venous plexuses are main collateral channels. These veins connect superior vena cava and inferior vena cava and communicate with common iliac vein by ascending lumbar vein.

Table 31: Collaterals for inferior vena cava obstruction

Dilated collateral route	Inferior vena cava component	Superior vena cava component
Thoracoepigastric dilation	<ul style="list-style-type: none"> • Superficial epigastric • Superficial circumflex iliac veins • Prevertebral 	Lateral thoracic veins
Epidural venous plexus dilation	Ascending lumbar vein	Azygos venous system
Internal thoracic epigastric route	Inferior epigastric vein	<ul style="list-style-type: none"> • Superior epigastric vein • Internal thoracic vein

AUTONOMIC NERVOUS SUPPLY IN ABDOMEN

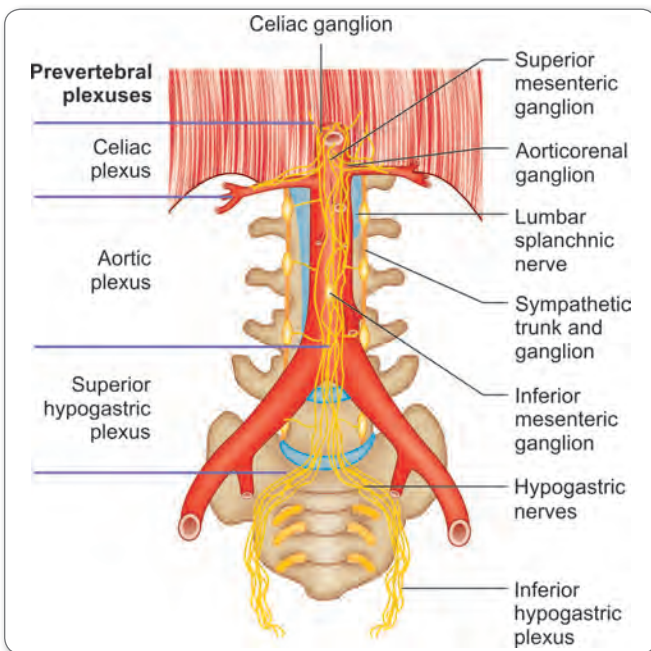


Fig. 124: Autonomic nervous supply in abdomen

Autonomic Ganglia

- Paravertebral ganglia: Composed of ascending and descending preganglionic sympathetic general visceral efferent (GVE), general visceral afferent (GVA) fibers with cell body located in dorsal root ganglia.
- Prevertebral ganglia: Includes celiac, superior mesenteric and inferior mesenteric ganglia usually located near the origin of respective arteries. Formed by cell bodies of postganglionic sympathetic fibers. Receive preganglionic sympathetic fibers by way of greater, lesser and least splanchnic nerves.

Splanchnic Nerves

- Thoracic splanchnic nerves: Contain preganglionic sympathetic fibers GVE with cell bodies located in the lateral horn of spinal cord and GVA fibers whose cell bodies located in dorsal root ganglia.
- Greater splanchnic nerve enters celiac ganglion, lesser splanchnic nerve enters aorticorenal ganglion, least splanchnic nerve joins the renal plexus.

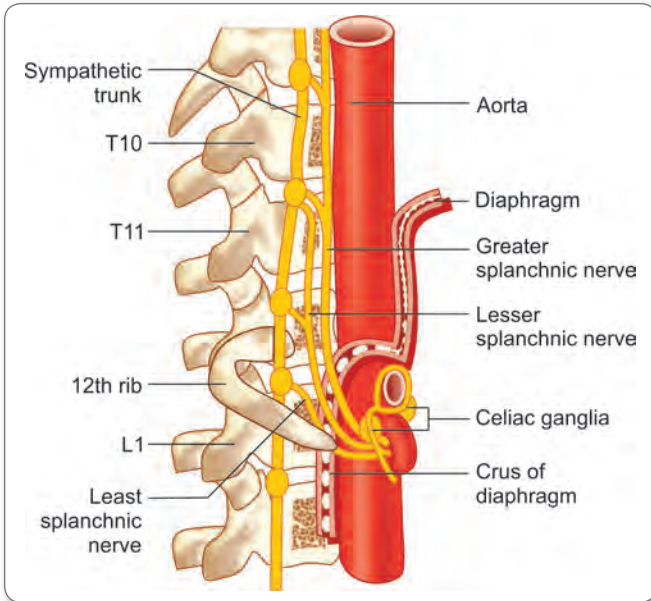


Fig. 125: Splanchnic nerves

Table 32: Comparison between para- and prevertebral ganglion

Paravertebral ganglion	Prevertebral ganglion
4 ganglia on each side in sympathetic chain	Situated in front of aorta and include celiac, superior mesenteric and inferior mesenteric ganglion
Carry preganglionic fibers	Carry postganglionic fibers

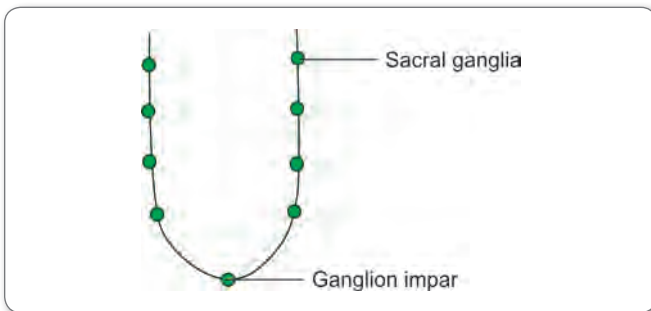


Fig. 126: Sacral ganglia

Autonomic Plexus

Celiac Plexus

- Formed by splanchnic nerves and branches from the vagus
- Also contains celiac ganglia, which receives greater splanchnic nerve
- Lies in front of abdominal aorta at the origins of celiac trunk and superior mesenteric and renal arteries

- Extends along the branches of celiac trunk and forms subsidiary plexus, which is named according to arteries along which they pass

Solar Plexus

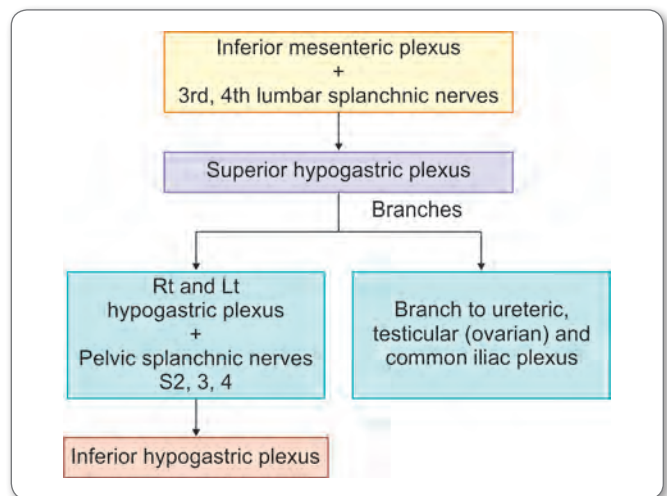
Combined nerve plexus of celiac and superior mesenteric plexus.

Intermesenteric Plexus

- Present between superior and inferior mesenteric arteries
- Downward continuation of celiac plexus
- Receives contribution from lumbar splanchnic nerves and provides extension which joins with superior hypogastric plexus

Inferior Mesenteric Plexus

- Derived from intermesenteric plexus and accompanies inferior mesenteric artery.



Enteric Division

- Consists of myenteric plexus which is located between longitudinal and circular muscle layers and submucosal plexus which is located in submucosa. Both parts consist of preganglionic and postganglionic parasympathetic fibers, postganglionic sympathetic fibers and GVA fibers
- Sympathetic fibers inhibit GI motility and secretion and constrict GI sphincters, parasympathetic fibers stimulate GI motility and secretion and relax GI sphincters.

LYMPHATIC DRAINAGE

Cisterna Chyli

- Dilated lymphatic sac
- Measurement 5–7 cm
- Situated in front of L1 and L2
- Receives lymph from abdominopelvic organ, abdominal wall and lower extremities
- Upper end continue as thoracic duct.



Aortic Nodes

Table 33: Preaortic and para-aortic nodes

Preaortic nodes	Para-aortic nodes
<ul style="list-style-type: none"> Situated in front of aorta Afferent from GIT, liver, spleen and pancreas Efferent form intestinal trunk and drain into cisterna chyli 	<ul style="list-style-type: none"> On either side of aorta Afferents from kidney, suprarenal, testis, ovary, fallopian tube and uterus Efferent form lumbar trunk and drain into cisterna chyli

Iliac Nodes

- External iliac, internal iliac and common iliac nodes
- External iliac nodes—drain from inguinal nodes, anterior abdominal wall below the umbilicus, membranous urethra, prostate, bladder, cervix and part of vagina. Their efferent drain into common iliac nodes
- Internal iliac nodes—from pelvic organs, perineum, gluteal region. Efferents pass to common iliac nodes.
- Common iliac nodes—from external and internal iliac nodes and efferent pass through lateral aortic nodes.

PELVIS AND PERINEUM

Pelvic cavity contains terminal part of digestive system, urinary system and genital system.

PELVIC FASCIA

- Continues above with fascia of abdominal wall and below with fascia of perineum. Consists of two layers parietal layer and visceral layer
 - Parietal layer: Lines the pelvic wall and name varies according to muscle with lines. For example, fascia over obturator internus – obturator fascia.
 - Visceral layer: Lines pelvic viscera like vagina, uterus including cervix, urinary bladder, urethra and rectum.
- Endopelvic fascia: Condensation of endopelvic fascia.
 - Lies along the posterolateral wall and carries neurovascular structures
 - Also provides support to pelvic viscera
- Hypogastric sheath forms 3 types of lamina
 - Anterior: Forms lateral ligament of bladder contains superior vesical vessels.
 - Middle: In males rectovesical septum, female cardinal ligament.
 - Posterior: Lateral ligament of rectum contains middle rectal vessels.

PELVIC FLOOR

- Pelvic diaphragm levator ani (consists of pubococcygeus and iliococcygeus), which forms **the pelvic floor**
- Pubococcygeus consists of pubococcygeus proper
 - Puborectalis
 - Puboanalis
 - Pubovesicalis/pubovaginalis.

Nerve Supply

Posterior part supplied by 4th sacral nerve and anterior part by perineal surface of 2nd and 3rd sacral nerve via perineal nerve

REMEMBER

Branches of Inferior Hypogastric Plexus

- Middle rectal plexus: Supplies the rectum
- Prostatic plexus: Supplies the prostate, seminal vesicle and ejaculatory duct
- Vesical plexus: Supplies the bladder and terminal part of ureter
- Uterovaginal plexus: Supplies the uterus, fallopian tube, ovary and vagina.

BONY PELVIS

- Formed by hip bone, sacrum and coccyx
- Divided by pelvic brim into pelvis major (false pelvis) above and pelvis minor (true pelvis) below
- Outlet is closed by coccygeus and levator ani muscles which form the floor of the pelvis.

Pelvic Brim

- Superior rim of the pelvic cavity, bounded posteriorly by promontory of sacrum and anterior border of ala of the sacrum, laterally by arcuate line, anteriorly by pectinate line, pubic crest and pubic symphysis.
- Crossed by ureter, gonadal vessels, middle sacral vessels, ilio-lumbar vessels, lumbosacral trunk, obturator nerve, spermatic cord, round ligament of uterus, sympathetic trunk and suspensory ligament of ovary.

Pelvic Outlet

Diamond shaped perineum – boundaries are described already.

Table 34: Pelvic outlet in males and females

	Male	Female
Pelvic inlet	Heart shape	Oval shape
Pelvic outlet	Smaller	Larger
Pelvic cavity	Narrow and deep	Wide and shallow
Sub pubic angle	Smaller and less	Large and greater
Sacrum	Long and narrow	Short and wider
Obturator foramen	Round	Oval or triangular
Preauricular sulcus	Scarcely visible	Prominent
Ischiopubic rami	Thick and everted Due to attachments of crura of penis	Thin and not everted



Table 35: Joints in the pelvis

Joint	Types
Sacroiliac	Synovial joint
Sacrococcygeal	Cartilaginous joint
Pubic symphysis	Secondary cartilaginous joint

LIGAMENTS AND FOLDS OF PELVIS

Broad Ligaments of Uterus

- Consists of two layers of peritoneum extending from lateral margin of uterus to pelvic wall
- Consists of uterine tube, uterine vessels, round ligament of uterus, ovarian ligament, ureter, uterovaginal nerve plexus and lymphatic plexus.
- **Mesovarium:** Connects anterior surface of ovary with posterior layer of broad ligament.
- **Mesosalpinx:** Fold of broad ligament that suspends uterine tube
- **Mesometrium:** Major part of broad ligament below the mesosalpinx.

Round Ligament

- It is remnant of gubernaculum
- Attached to uterus in front and below the attachment of fallopian tube and runs within the layers of broad ligament and keeps the uterus in anteverted and anteflexed position.
- Enters the inguinal canal at deep inguinal ring, emerges from superficial ring and lost in the subcutaneous tissue of labia majora.

Ovarian Ligament

Fibromuscular cord extends from ovary to uterus below the fallopian tube running within the layers of broad ligament.

Suspensory Ligament of Ovary

Band of peritoneum extends upward from ovary to pelvic wall and transmits ovarian vessels, nerves and lymphatics.

Transverse Cervical Ligaments

- Condensation of pelvic fascia from cervix to lateral pelvic wall.
- Plays major role in supports of uterus – cardinal ligament – Mackendrot’s ligament.

Pubocervical Ligament

- Connective tissue extends from posterior surface of pubis to cervix of the uterus
- Pubovesical ligaments (female): Puboprostatic in male
- Pelvic fascia extends from neck of the bladder or the prostate to pelvic bone.

Rectouterine Pouch

- Recess formed by fold of peritoneum between rectum and uterus
- Lies behind posterior fornix of vagina and contains peritoneal fluid.

Rectovesical Pouch

Peritoneal recess between bladder and rectum in male, vesicouterine pouch – sac between bladder and uterus in female.

Denonvillier’s Fascia - Rectoprostatic Fascia

- **Rectoprostatic fascia:** Membranous partition at the lowest part of rectovesical pouch.
- It is anterior surface of mesorectum—easier to identify in males. Less obvious in female
- Lower third of rectum separated from prostate & urinary bladder in male.

Waldeyer’s Fascia

Presacral fascia: Lines anterior aspect of sacrum enclosing sacral vessels and nerves. It continues anteriorly as the pelvic parietal fascia enclosing entire pelvic cavity.

Lower third of rectum separated from sacrum and coccyx by this fascia.



Clinical Aspect

Culdocentesis

Aspiration of fluid from the culde sac of Douglas by needle puncture of posterior vaginal fornix.

Rectouterine pouch is the lowest portion of the peritoneal cavity, it can collect fluid during conditions like ruptured ectopic pregnancy or ovarian cyst.

URINARY BLADDER

- **Position**
 - In children: Abdominopelvic in position
 - Adult–pelvic organ when empty
- **Shape**–Tetrahedral when empty, ovoid when distended
- **Capacity**
 - Average capacity: 120–320 mL
 - Mean capacity: 220 mL
 - Sense of filling starts at 100–150 mL
 - Desire to micturate: 150–250 mL
 - Painful sensation starts at 450 mL
 - Beyond voluntary control: 800 mL

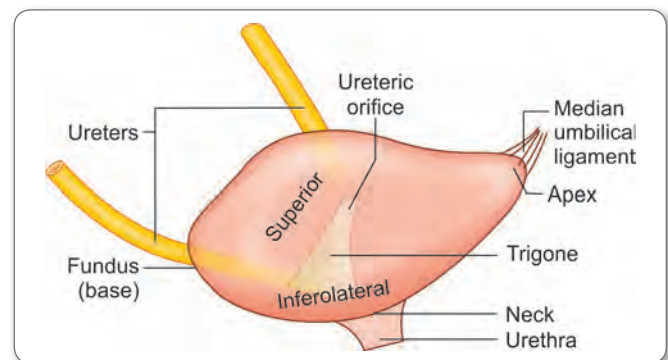


Fig. 127: Surfaces of urinary bladder



- Apex: Attachment to median umbilical ligament extends up to umbilicus.
- Base: Upper part is peritoneal in male.
- In male: Ampulla of rectum, seminal vesicle, ampulla of vas, rectovesical fascia.
- In female: Upper part of anterior vaginal wall, anterior surface of supravaginal part of cervix.
- Neck: Lowest point from which urethra begins, situated 3–4 cm behind the lower border of pubic symphysis.
- Uvula: Small eminence at apex of the trigone, projecting into the orifice of the urethra.
- Superior surface: Covered with peritoneum. Sigmoid colon, coils of intestine and in female anteverted uterus.
- Inferolateral surface: Related to pubis, puboprostatic ligaments, levator ani and obturator internus. These structures are separated from bladder by space of Retzius.

- Features: Developed from mesoderm whereas rest of bladder developed from endoderm.
- Submucous coat absent it is then replaced by trigonal muscle of Bell.
- It has bundles of smooth muscles known as detrusor muscle of bladder.

Blood Supply

- Superior vesicle artery, inferior vesicle artery, obturator artery, inferior gluteal artery, uterine artery.
- Lymphatics-external iliac nodes.

Nerve Supply

- Sympathetic: Preganglionic fibers arise from T11 to L2 and make synaptic connection with nerve cell in superior hypogastric plexus. Postganglionic cells – arising from the plexus and form right and left hypogastric nerves supplies the sphincter muscle and inhibits the detrusor so **sympathetic– nerve of filling**.
- Parasympathetic: Preganglionic fibers arise from S2, 3, 4. After relay in inferior hypogastric plexus, postganglionic fibers supply the detrusor muscles. Parasympathetic–**nerve of emptying**.

REMEMBER

Space of Retzius

- In front: Symphysis and body of pubis
- Behind and on each side: Posterior true ligament of bladder
- Above: Peritoneum of the paravesical fossa
- Below: Pubovesical ligament
- Medially: Inferolateral surface of bladder
- Laterally: Fascia covering levator ani and obturator internus muscles
- Contents: Retropubic fat and vesical plexus of veins. This space acts as bursa to allow the expansion of bladder.

Interior of Bladder

- Temporary mucous folds or rugae present in entire bladder except trigone.

Trigone of Bladder

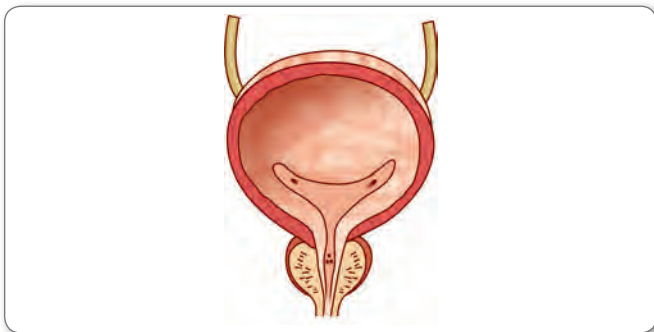


Fig. 128: Trigone of bladder

- Apex: Internal urethral orifice. Round elevation called uvula vesical present in male, which is formed by median lobe of prostate.
- Base: Interureteric ridge – **Mercier’s bar** (line connecting two ureteric orifice).
- Posterolateral angle: Ureteric orifice.

PERINEUM–PELVIC OUTLET

- Diamond shaped fossa.
- Inferior aperture of pelvis which presents with openings of urethra, vagina and anal canal.

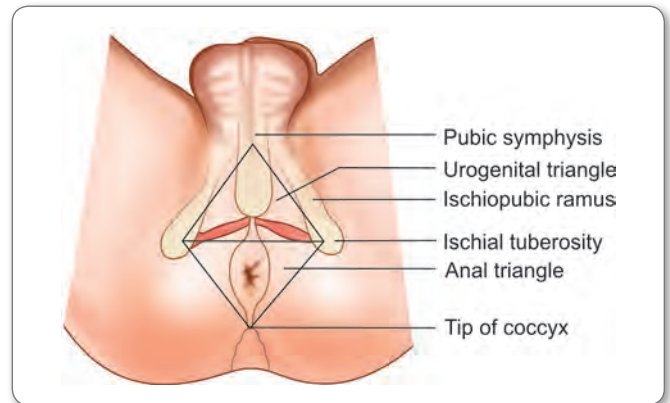


Fig. 129: Boundaries of perineum

Boundaries

- Anteriorly: Pubic symphysis
- Anterolaterally: Ischiopubic ramus
- Laterally: Ischial tuberosity
- Posterolaterally: Sacrotuberous ligaments
- Posteriorly: Tip of coccyx
- Perineum is divided into anal triangle behind and urogenital triangle in front by the imaginary line connecting two ischial tuberosity.

Anal Triangle

- Anal triangle contains muscles and ischioanal fossa



Muscles Present in Anal Triangle

- External anal sphincter
- Levator ani
- Obturator internus
- Coccygeus muscle

ISCHIORECTAL FOSSA

- Potential space on either side of the anorectum and separated from the pelvis by levator ani and its fascia
- Contains ischial fat, which allows the distension of the anal canal during defecation.

Boundaries

Table 36: Boundaries of ischioirectal fossa

Laterally	Obturator internus muscle
Medially	Levator ani muscle
In front	Transverse perinei superficialis and profundus
Behind	Sacrospinous ligament covered by Gluteus maximus
Apex	Fusion of anal fascia and obturator fascia
Base	Skin and superficial fascia

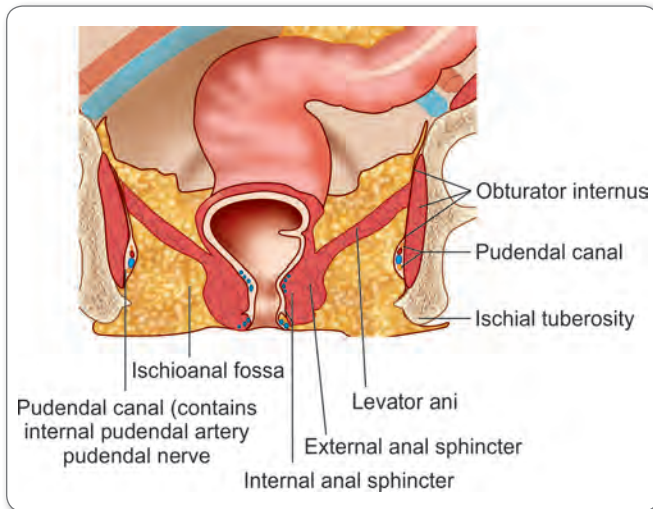


Fig. 130: Ischioirectal fossa

Contents

- Inferior rectal vessels/nerves: Branch of internal pudendal artery/pudendal nerve
- Posterior scrotal vessels/nerve
- Perineal branch of 4th sacral nerve and perforating branch of 2nd and 3rd sacral nerve. Pad of fat.
- Internal pudendal vessels and pudendal nerve in pudendal canal.

PUDENDAL CANAL (AL COCK'S CANAL)

- Situated in the lateral wall of the ischioirectal fossa
- Extends from lesser sciatic foramen to deep perineal pouch
- Canal formed by splitting of obturator fascia or between lunata fascia and obturator fascia
- Contents—internal pudendal vessels and pudendal nerve. Pudendal nerve divides into perineal nerve and dorsal nerve of penis/clitoris.

Clinical Aspect

- Abscess in one side of the fossa spread to the opposite side of ischioirectal fossa of the opposite side posteriorly
- Because posteriorly ischioirectal fossa communicating with opposite side like horse shoe

UROGENITAL TRIANGLE

Structures from superficial to deep in urogenital triangle.

- Skin
- Fatty layer of superficial fascia
- Membranous layer of superficial fascia or fascia colles
- Contents of superficial perineal pouch
- Perineal membrane/inferior fascia of urogenital triangle
- Contents of deep perineal pouch
- Superior fascia of urogenital triangle

Perineal Fascia

Consists of two layers **superficial and deep**

- **Superficial layer** consists of
 - Fatty layer and
 - Colles fascia
- **Deep perineal fascia** consists of
 - Inferior fascia of urogenital diaphragm or perineal membrane
 - Superior fascia of urogenital diaphragm

Colles Fascia

- Strong sheet of fascia which stretches across the pubic arch and forms the lower boundary of superficial perineal pouch
- Attachments
 - On each side – attached to lower margins of ischiopubic ramus
 - Behind – continuous with posterior margin of perineal membrane around the transversus perinei superficialis
 - In front – continuous with dartos muscle of scrotum, fascia of penis and hence with fascia scarpa of anterior abdominal wall
 - Structures piercing fascia
 - Perineal branch of posterior femoral cutaneous nerve
 - In female urethra and vagina.



Perineal Membrane

- It is the inferior fascia of urogenital diaphragm and this forms the inferior boundary of deep perineal pouch and superior boundary of superficial perineal pouch
- Lies between urogenital diaphragm and external genitalia
- It is thickened anteriorly to form transverse ligament of perineum

Structures Piercing the Perineal Membrane

- Two posterior scrotal (labial) vessels and nerves
- Deep artery of penis/clitoris
- Dorsal artery of penis/clitoris
- Urethra
- Duct of bulbourethral glands and artery to bulb of penis
- In female, vagina behind the urethra

SUPERFICIAL PERINEAL POUCH

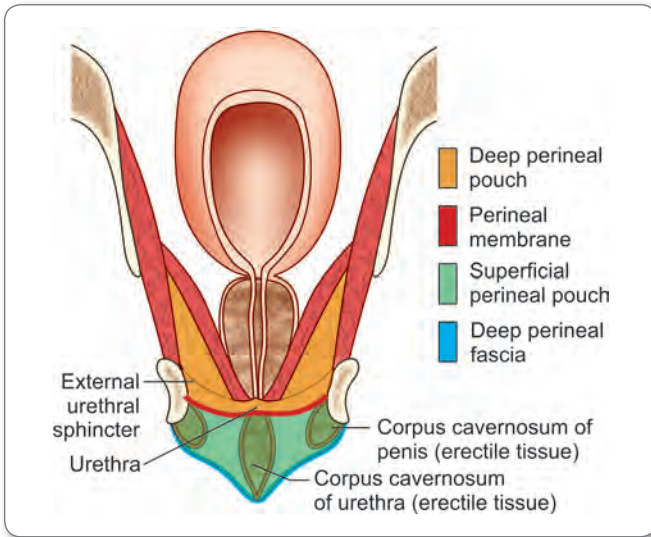


Fig. 131: Superficial and deep perineal pouch

Space lies between perineal membrane and colles fascia. It is the open space because in front this superficial perineal pouch communicates with anterior abdominal wall.

Boundaries

- Above: Perineal membrane
- Below: Fascia colles
- In front: Pouch is open
- Behind: Closed by fusion of perineal membrane and fascia colles.

Contents

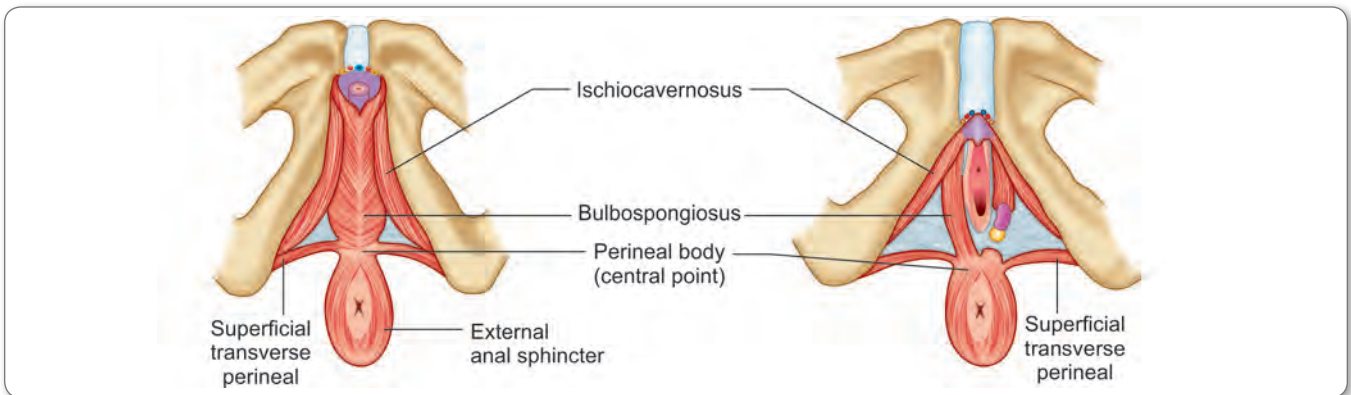


Fig. 132: Contents of superficial perineal pouch

Root	Crus penis/clitoris, bulb of penis with spongy urethra in male
Muscles	Ischiocavernosus, bulbospongiosus, superficial transverse perinei
Nerves	Posterior scrotal nerve, perineal branch of posterior cutaneous nerve of thigh
Arteries	Two posterior scrotal in male (labial in female) vessels, transverse perineal vessels
Other	In female, urethra and vagina in the middle, bulb of vestibule, greater vestibular gland on each side of vagina

HIGH YIELD POINTS

Greater vestibular glands (Bartholin's glands) female present, in superficial pouch its counterpart in male bulbourethral glands (Cowper's gland) are present in deep perineal pouch.



DEEP PERINEAL POUCH

- Located superior to perineal membrane
- Between superior and inferior fascia of urogenital diaphragm
- Above: Superior fascia of urogenital diaphragm
- Below: Perineal membrane. Deep perineal pouch is closed on all sides.

Contents

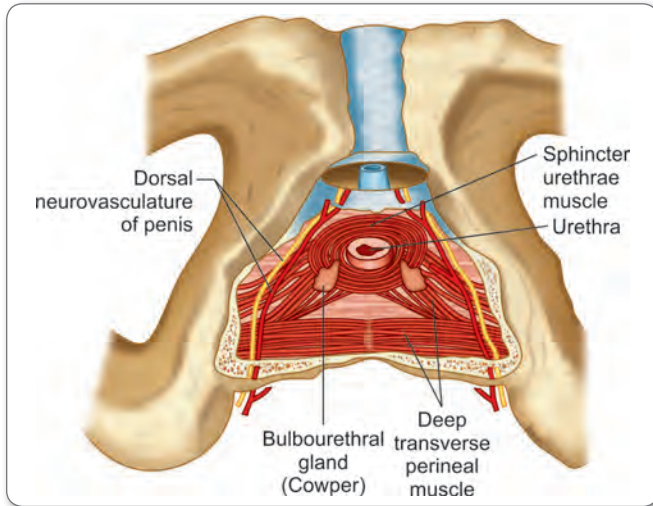


Fig. 133: Contents of deep perineal pouch

Table 37: Contents of deep perineal pouch

Muscles	Sphincter urethrae, transversus perinei profundus
Vessels	3 terminal branches of internal pudendal artery. Deep artery of penis, dorsal artery of penis and artery to bulb of penis
Nerve	Dorsal nerve of penis or clitoris
Others	Membranous urethrae, in female vagina behind the urethra, in male bulbourethral glands

UROGENITAL DIAPHRAGM

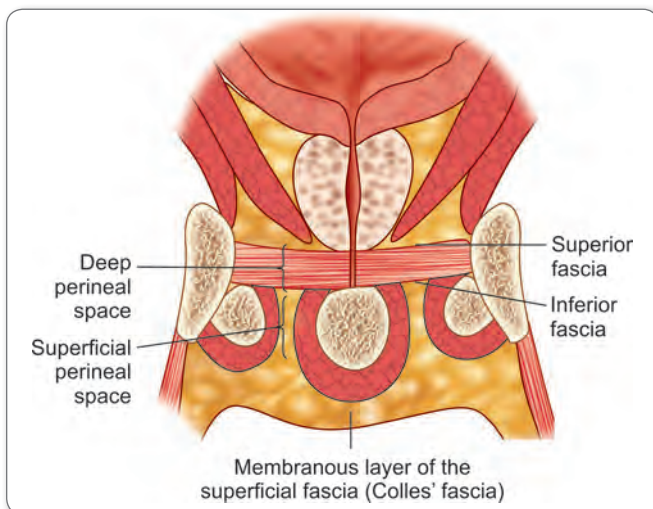


Fig. 134: Urogenital diaphragm

- Musculofascial partition across the pubic arch and separates the pelvic cavity from the anterior part of the pelvic outlet
- Pierced by urethra in male and by urethra and vagina in female
- Urogenital diaphragm is **less defined in female** due to presence of vagina and it is predominantly fibrous so it is called as **triangular ligament**.

Contents

- Superior fascia of urogenital diaphragm (thin fascia covering the upper surface of the muscles of the urogenital diaphragm)
- **Inferior fascia of urogenital diaphragm (perineal membrane)**
- In between these two fasciae, two muscles present.
 - Sphincter urethrae encircles the membranous urethrae.
 - Transversus perinei profundus.

PERINEAL BODY

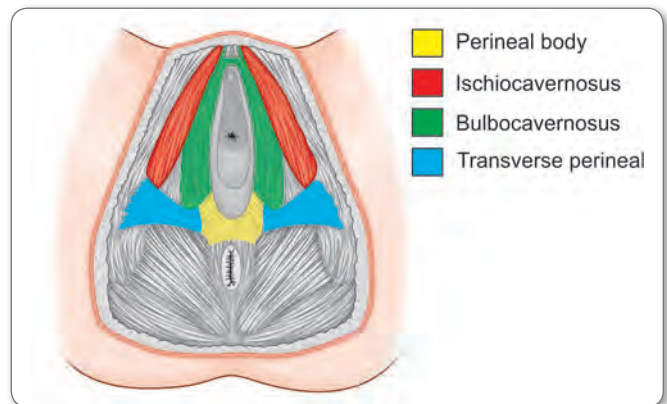


Fig. 135: Perineal body

- Fibromuscular node presents between urogenital opening and anal opening
- Receives muscles in three stratum
 - Deep stratum – levator ani
 - Intermediate stratum – deep transverse perinei and deep part of external sphincter
 - Superficial stratum – bulbospongiosus, superficial transverse perinei and superficial part of external sphincter.
- Greater vestibular glands: Bartholin glands
 - Lies in the superficial perineal space deep to vestibular bulb in female
 - Homologous to bulbourethral glands: Cowper's gland in male
 - Secrete mucus that lubricates vagina
 - Ducts open into the vestibule between labia minora below the hymen
- Bulbourethral glands–Cowper's gland
 - Lies among the fibers of sphincter urethrae in deep perineal pouch in male
 - Ducts pass through inferior fascia of urogenital diaphragm to open into bulbous portion of spongy urethrae.



PUDENDAL NERVE

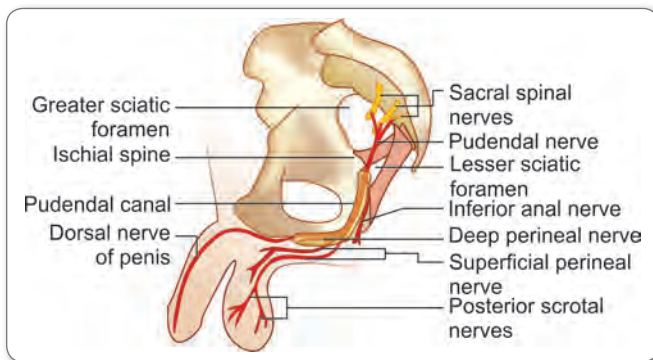


Fig. 136: Course of pudendal nerve

- Supplies perineum and external genital organ.
- Branch of sacral plexus S2, S3 and S4
- Course originates in pelvis and leaves pelvis and reaches gluteal region through greater sciatic notch, crosses ischial spine and enters the perineum through lesser sciatic notch
- Enters pudendal canal and gives inferior rectal nerve and perineal nerve and terminates as dorsal nerve of penis/clitoris
- Inferior rectal nerve: Arises within the pudendal nerve canal and supplies sphincter ani externus and skin around the anus.

PERINEAL NERVE

- Arises in the pudendal canal and divides into superficial branch (sensory branch—supplies scrotum and labia majora and deep branch—supplies all perineal muscles)
- Dorsal nerve of penis/clitoris
- Sensory branch—supplies skin, prepuce and glans.

Pudendal Nerve Block

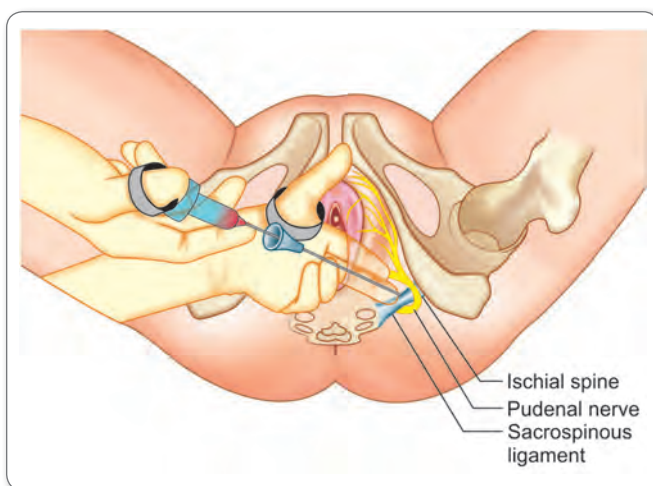


Fig. 137: Pudendal nerve block

- Paralyse the skeletal muscles of perineum and anesthetizes the skin over the perineum

- Palpate the ischial spine through vagina
- Needle is guided by the finger to the ischial spine
- 1% lignocaine solution is injected transvaginally
- Ilioinguinal nerve, genitofemoral nerve, perineal branch of posterior femoral cutaneous nerve should be anaesthetized for complete perineal block.

INTERNAL PUDENDAL ARTERY

- Arises from anterior division of internal iliac artery
- Leaves the pelvis through greater sciatic foramen and enters the perineum through lesser sciatic foramen by hooking around the ischial spine
- Passes along lateral wall of ischiorectal in the pudendal canal
- Branches
 - Inferior rectal artery
 - Perineal artery
 - Artery to bulb
 - Deep artery of penis
 - Dorsal artery of penis

Branches (☛Refer the Chart, Artery)

MALE REPRODUCTIVE SYSTEM

Testis

- **Left testis** is slightly **lower** than right one
- Epididymis is situated on posterolateral surface
- Sinus of epididymis—epididymis separated from testis by semi-lunar recess—the sinus of epididymis
- Upper end: Connected to head of epididymis by efferent tubules. Appendix of testis is related to upper end
- Lower end: Connected to tail of epididymis.

Measurements

- Length: 5 cm
- Breadth: 2.5 cm
- Weight: 10–14 g.

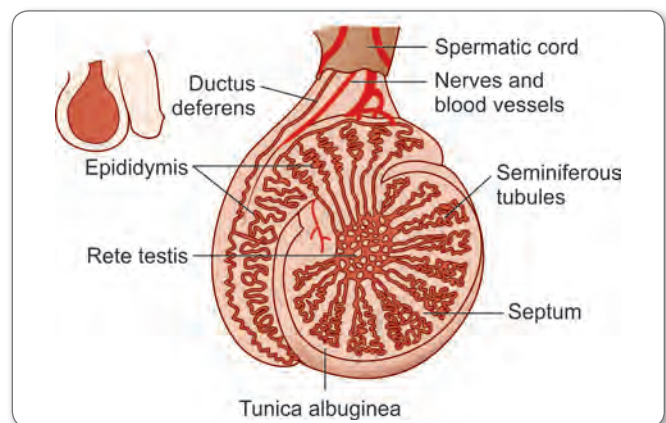


Fig. 138: Internal structure of testis



Intrinsic Covering of Testis

- Tunica vaginalis
- Tunica albuginea: Thick fibrous membrane, which invests testis and projects into interior of the organ from posterior border as partition called mediastinum of testis
- Tunica vasculosa: Areolar vascular membrane which individual lobes of testis
- 200–300 lobules in the testes, each lobule consists of one to three seminiferous tubule so almost **400–600 seminiferous tubule**.
- Straight part of seminiferous tubules form the mediastinum
- 12 to 20 efferent ductules from mediastinum form the canal of epididymis
- Canal of epididymis: Head, body and tail of epididymis then continues as vas deferens

Blood Supply

Arterial Supply

Testicular artery branch of abdominal aorta

Venous Drainage

Veins from testis and epididymis form pampiniform plexus

HIGH YIELD POINTS

Pampiniform Plexus

- 15–20 veins form **pampiniform plexus**, which forms the bulk of spermatic cord.
- At the superficial inguinal ring four veins and
- At deep ring further joins to form two veins.
- Finally single vein enters the posterior abdominal wall.
- **Right testicular vein drains into inferior cava and left testicular vein into left renal vein.**

Lymphatic Drainage

Para-aortic nodes and lumbar nodes

REMEMBER

Sequence of sperm from testis to urethra: Seminiferous tubule → straight tubule → rete testis → efferent tubule → epididymis → vas deferens → ejaculatory duct → prostatic urethrae.



Clinical Aspect

- Testicular torsion: Spermatic cord became twisted and obstructs the blood supply to the testis and causing sudden urgent pain. Requires emergency treatment otherwise testicular necrosis will occur.
- Testicular carcinoma: Tumors affect the germ cell–germ cell tumor or affect the Leydig cell which produces androgen (Leydig cell tumor) or affect Sertoli cell which nourishes the germ cell–Sertoli cell tumor
- Cryptorchidism–undescended testis. Reduce the fertility and increased risk of testicular carcinoma. Undescended testis brought down into the scrotum in infancy by surgical procedure called orchiopexy or orchidopexy.
- HIGH orchidectomy – means removal of cord structures about 2 cm proximal to deep ring along with testis.

REMEMBER

Lymphatics of testis and epididymis drain into preaortic and lateral aortic lymph nodes

Epididymis

- Head of epididymis: Efferent ductules coil and form head
- Body and tail: Made up of coiling of duct of epididymis
- Tail: Continue as vas deferens.

Vas Deferens

- Begins from tail of epididymis – 45 cm
- Principal constituent is spermatic cord
- Traverse superficial ring then deep ring
- At deep ring, lateral to inferior epigastric artery
- Crosses the ureter at the ischial spine and terminal part forms the ampulla and joins with duct of seminal vesicle form the ejaculatory duct.



Clinical Aspect

Vasectomy – male sterilization procedure. Surgical excision of portion of vas. It stops the passage of spermatozoa but neither amount of ejaculate nor diminish the sexual desire.

Ejaculatory Duct

- Formed by union of vas and duct of seminal vesicle.
- Opens into prostatic urethra on colliculus seminalis just lateral to prostatic utricle.

Seminal Vesicles

- Lobulated glandular structure
- Situated against the base of the bladder
- Contribute alkaline constituents like fructose and choline
- Do not store spermatozoa



Clinical Aspect

Fructose provides forensic determination for occurrence of rape, choline provide the basis for determination of the presence of semen – Florence test

Prostate Gland

- Gland in fibromuscular stroma
- Its counterpart in female **paraurethral glands of Skene**
- Covered by true and false capsule (visceral layer of pelvic fascia)
- Between true and false capsules, venous plexus are present

Lobe Anatomy – 5 Lobes

- Median lobe–apex directed below the colliculus seminalis and base forms uvula vesicae. Situated between urethra and ejaculatory gland. It is **fibromuscular** with mucous gland. BPH affected in this lobe.



- Two lateral lobes: Lie on each side of urethrae. **Cancer affects this lobe.**
- Posterior lobe: Lateral lobes continue behind urethra as posterior lobe and below the ejaculatory duct.
- Anterior lobe: Lateral lobe continue as isthmus in front of urethra. Isthmus devoid of gland. It is considered as anterior lobe.

Zonal Anatomy

- Central zone—constitutes 25% of glandular tissue, situated around the ejaculatory duct. Mostly it is not involved in any disease
- Transitional zone—constitutes 5% of glandular tissue. Surrounds the proximal urethra. **Benign prostatic hyperplasia** involves this zone
- Peripheral zone—major part up to 70% of gland. Surrounds the central and transition zone. Cancer prostate affects this zone.

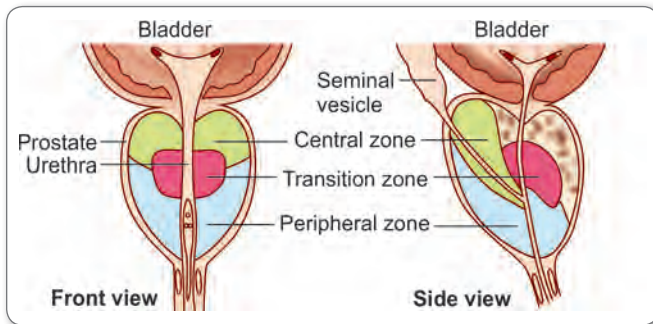


Fig. 139: Prostate gland

Arterial Supply

- Inferior vesicle artery
- Middle rectal artery
- Internal pudendal artery

Venous Drainage

- Veins drain into prostatic venous plexus (which is situated between true and false capsule)
- Plexus then communicate with vesicle plexus (receives deep dorsal vein of penis)
- Finally it drains into internal iliac vein.



Clinical Aspect

Hypertrophy of the Prostate

- Benign enlargement of prostate
- Occurs in the middle lobe
- Obstructing internal urethral orifice and leads to dysuria, urgency and nocturia

TURP

- Transurethral Resection of Prostate
- Surgical removal of prostate by means of cystoscope passed through urethra

Contd...

Prostate Cancer

- Slow growing tumor in posterior lobe
- So no urinary obstruction symptoms in the early stages
- CA can spread to bony pelvis, pelvic lymph nodes, vertebral column, skull, also metastasizes to heart, lungs and IVC. Can be detected by PR examination, ultrasound imaging device inserted into rectum or PSA test.
- PSA concentration in normal male – less than 4 ng/mL

Spermatic Cord

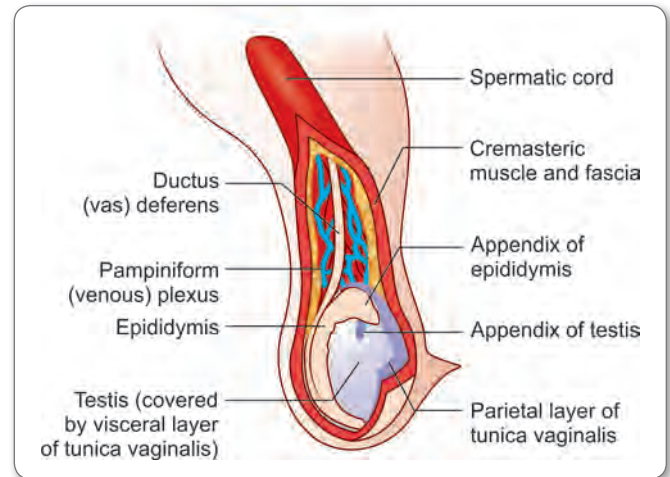


Fig. 140: Spermatic cord

- Tubular sheath extends from deep inguinal ring to the upper part of posterior border of testis.
- Length – 7.5 cm
- Receives 3 sheath–
 - Internal spermatic fascia from fascia transversalis at the margin of deep ring
 - **Cremaster muscle and fascia** from transverse abdominis and internal oblique
 - External spermatic fascia from external oblique at superficial ring

REMEMBER

Contents of Spermatic Cord

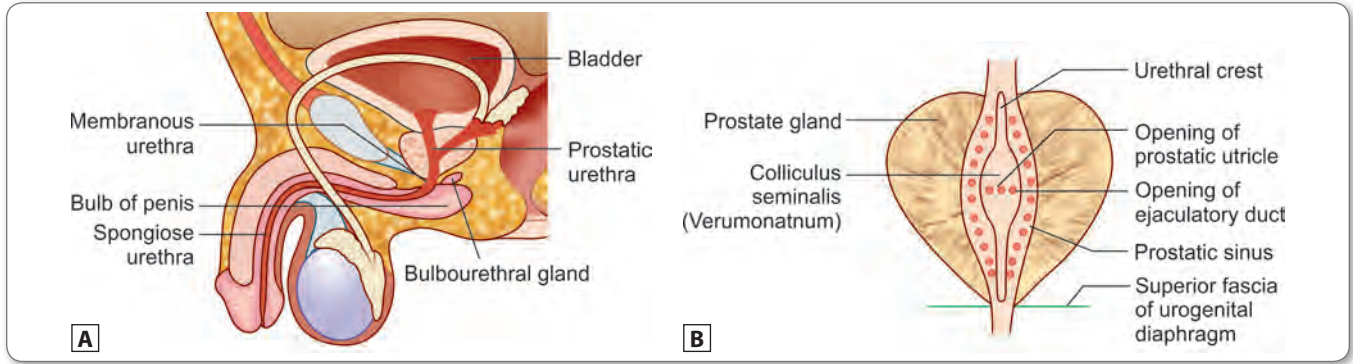
- Vas deferens
- Pampiniform plexus
- Arteries
 - Testicular artery from abdominal aorta
 - Artery to vas from superior or inferior vesical artery
 - Cremasteric artery from inferior epigastric
- Nerves
 - Genital branch of genital femoral nerve supplies cremaster
 - Testicular plexus of sympathetic nerves
- Vestige of processus vaginalis
- Accessory suprarenal tissue



Male Urethra

Male urethra consists of four parts preprostatic, prostatic, membranous and spongy or penile

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Figs 141A and B: Male urethra

Table 38: Parts of male urethra

	Prostatic part	Membranous part	Penile part
Size	<ul style="list-style-type: none"> • 3 cm long (Most dilated and widest part) 	<ul style="list-style-type: none"> • Anteriorly 2 cm • Posteriorly 1.5 cm • (Second narrowest part after external urethral orifice) 	<ul style="list-style-type: none"> • Longest part 15 cm
Cross section appearance	<ul style="list-style-type: none"> • Crescentic 	<ul style="list-style-type: none"> • Stellate or irregular 	<ul style="list-style-type: none"> • At bulb—trapezoid • At the body—transverse slit • At base of glans—inverted t shaped • At external orifice—sagittal slit
Features	<ul style="list-style-type: none"> • Urethral crest, colliculus seminalis (verumontanum) present • Colliculus presents 3 orifices middle one for prostatic utricle and two on either side for ejaculatory duct 	<ul style="list-style-type: none"> • Surrounded by sphincter urethrae and bulbourethral glands of Cowper 	<ul style="list-style-type: none"> • Urethral glands of Littre open in lacuna of Morgagni • Presents two dilatations intrabulbar fossa within the gland and navicular fossa within the glans

Lining Epithelium of Urethra

- Above the colliculus: Transitional epithelium
- From colliculus seminalis to terminal fossa—stratified columnar
- External urethral orifice—nonkeratinized stratified squamous

Note:

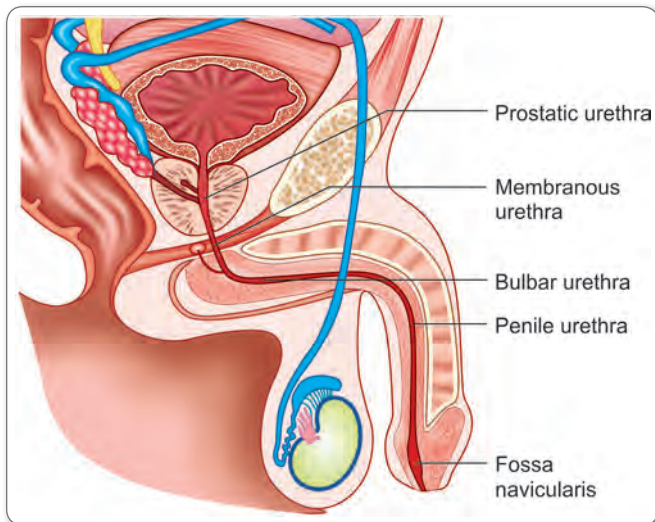


Fig. 142: Lining epithelium of urethra

- Posterior urethra includes (prostatic and membranous urethra) – injured due to pelvic fractures
- Anterior urethra (includes bulbar and penile urethra) – injured due to direct blow to perineum – straddle injuries.

Clinical Aspect

Extravasation of Urine

- **Due to rupture of spongy urethra below the perineal membrane causes urine to accumulate in – superficial extravasation.**

If buck fascia is intact, extravasation of blood and urine confined to penile shaft.

If buck fascia is disrupted

- Superficial perineal pouch
- Scrotum
- Around penis
- Lower part of anterior abdominal wall
- Urine cannot escape to
 - Deep perineal pouch (because of perineal membrane)
 - Ischioanal fossa (because of Colles fascia)
 - Thigh (fascia lata)

Contd...



- Due to rupture of membranous urethra above the perineal membrane causes urine to accumulate in – deep extravasation.
 - Deep perineal pouch
 - Extra peritoneal space
 - Space of Retzius (space around bladder and prostate)
 - Superficial perineal space if perineal membrane also ruptured

Urethral Sphincters

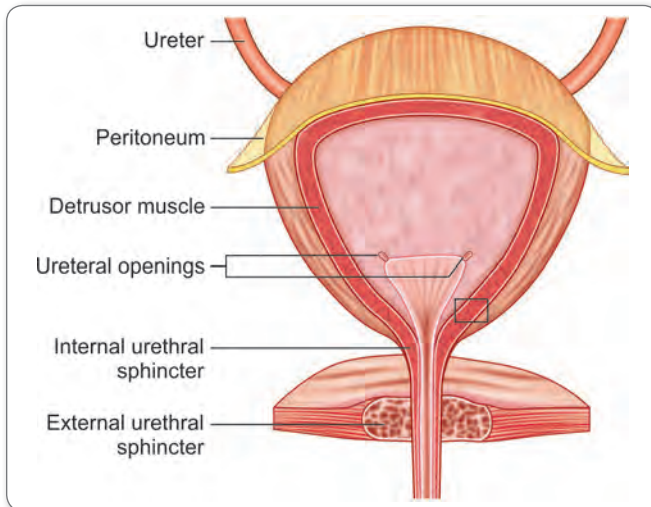


Fig. 143: Urethral sphincters

- Internal urethral sphincter – made up of smooth muscles – under involuntary control
- External sphincter – made up of skeletal muscles – under voluntary control.
- Turp – gold standard procedure for bph
- When turp is done – distally we must not extend beyond the vermontanum, when you go beyond this limit then patient will have incontinence
- Proximal point up to which TURP is done – bladder neck
- Most common complication of TURP – retrograde ejaculation – due to injury of internal sphincter.

External Genitalia

Penis

- Deep fascia of penis–**Buck's fascia**–it is prolongation from colle's fascia of perineum and proximally continues with scarpa fascia.
- Consists of root and body
 - **Root:** Consists of bulb (posterior end of corpus spongiosum) and 2 crus (continue forward as corpus cavernosum)
 - **Body:** Consists of right and left corpus cavernosum and median corpus spongiosum
- **Glans penis:** Terminal expanded part of corpus spongiosum

Arterial Supply

- Deep artery of penis
- Dorsal artery penis

- Artery to bulb of penis
- These three are branches **form internal pudendal artery.**
- Helicine arteries–deep artery of penis arranges in spiral manner and finally empty into cavernous space.

Venous Drainage

- Superficial vein–receives blood from skin and prepuce and drain into great saphenous vein
- Deep vein–begins from glans and drains into prostatic venous plexus. During the course it receives blood from corpus spongiosum and corpus cavernosum.

Lymphatic Drainage

- Skin including prepuce to superficial inguinal nodes
- Glans drain to deep inguinal nodes.

Nerve Supply

- Somatic nerve–dorsal nerve of penis branch of pudendal nerve which supplies the skin, prepuce and glans.
- Parasympathetic (**nerve of erection**)–via **nervi erigentes S2, 3, 4**
- Sympathetic (**nerve of ejaculation**)–from superior and inferior hypogastric plexus.



Clinical Aspect

Epispadias

Congenital malformation (VERY RARE) in which spongy urethra opens as groove on the dorsum of penis–frequently associated with the bladder exstrophy

Hypospadias

Most Common Congenital malformation of Urethra in which urethra opens on the undersurface of penis because of two urethral folds fail to fuse completely

Note: Most common congenital abnormality of upper urinary tract is duplication of renal pelvis

Sentinel node for ca penis – Cabana Node – superficial inguinal node

Scrotum

Layers of Scrotum

- Skin
- Dartos muscle (subcutaneous smooth muscle derived from camper's fascia)–supplied by sympathetic nerve from superior hypogastric plexus.
- External spermatic fascia (derived from ext. oblique aponeurosis)
- Cremaster muscle and fascia (derived from internal oblique and transversus abdominis)
- Internal spermatic fascia (derived from transversalis fascia)



Table 39: Scrotal layers derived from anterior abdominal wall

Anterior abdominal wall layers	Scrotal layer
• Skin continues as	• Skin
• Superficial fascia—membranous layer (Scarpa’s fascia)	• Dartos muscle
• Superficial fascia—membranous layer (Scarpa’s fascia)	• Continue as Colle’s fascia of perineum
• External oblique muscle	• External spermatic fascia
• Internal oblique and transversus abdominis	• Cremasteric muscle
• Fascia transversalis	• Internal spermatic fascia

Nerve Supply

- Anterior two-third supplied by ilioinguinal nerve and genital branch of genitofemoral nerve.
- Posterior one-third supplied by posterior scrotal nerves and perineal branch of posterior cutaneous nerve of thigh.



Clinical Aspect

- Hydrocele—accumulation of fluid in the cavity of tunica vaginalis
- Varicocele—enlargement of pampiniform plexus—gives the appearance of bag of worms in the scrotum. It may cause dragging like pain, atrophy of testis and infertility. It is more common on left side.

HIGH YIELD POINTS

Fetal Structures

Processus vaginalis testis

- Peritoneal diverticulum in the fetus that evaginates into developing scrotum
- Forms two layers visceral and parietal layer
- Normally closes after birth, in some cases it may persists and form congenital indirect inguinal hernia

Tunica Vaginalis

- Double layer serous sac (peritoneal sac that covers front and sides of testis and epididymis)
- It is the inner most layer of scrotum

Gubernaculum Testis

- Fetal ligament that connects bottom of testis to scrotum
- Plays an important role in descent of testis
- Homologous to round ligament of uterus/ovarian ligament in female.

FEMALE REPRODUCTIVE SYSTEM

Ovary

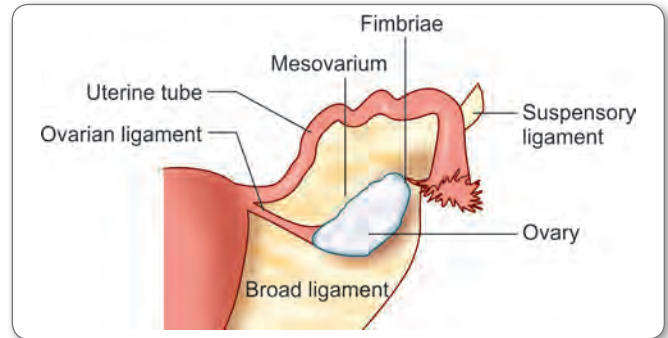


Fig. 144: Ovary

- Axis vertical
 - Upper end—related to uterine tube
 - Lower end—related to angle of uterus
 - Anterior border—attached to broad ligament
 - Posterior border—free
- Lateral surface—ovarian fossa (ovaries where rest). Boundaries are
 - Above and in front: Obliterated umbilical artery
 - Above: External iliac vein
 - Behind: Ureter and internal iliac vessels
 - Laterally: Obturator vessels and nerves.

Arterial Supply

Ovarian artery and also by uterine artery

Venous Drainage

Right ovarian vein drains into inferior vena cava and left ovarian vein drain into left renal vein.

Lymphatic Drainage

Para aortic nodes

Nerve Supply

Sympathetic T10, T11 so pain refers to umbilical region (same segmental innervation T10). Pain also refer to medial thigh because Lateral surface of ovarian fossa related to obturator nerve (Obturator nerve—supplies the adductor compartment of thigh)



Clinical Aspect

- Ovarian cancer develops from germ cell that produces ova or eggs—germ cell tumor
- Or in stromal cell that produces estrogen or progesterone
- Or in epithelial cell that lines outer surface of ovary.



Fallopian Tube

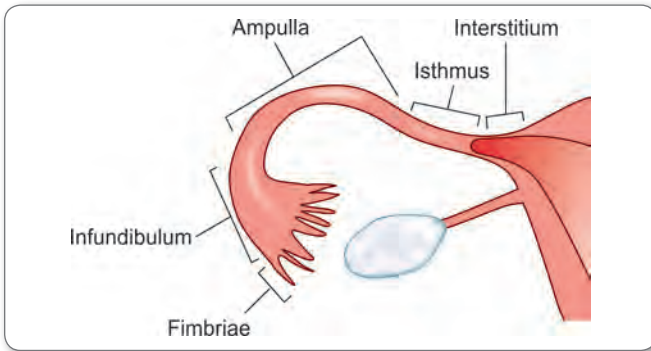


Fig. 145: Fallopian tube

- Extends from uterus to the uterine end of ovaries and connect the uterine cavity to peritoneal cavity
- Conveys the fertilized or unfertilized oocytes to the uterus by ciliary action and muscular coordination which takes 3–4 days.

Consists of Four Parts from Medial to Lateral

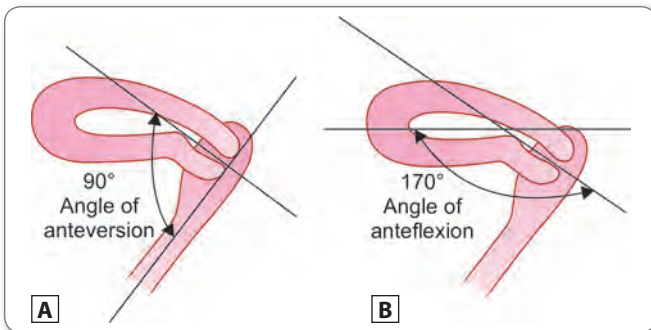
- *Intramural*: 1 cm, traverses the musculature of the uterus
- *Isthmus* – 3 cm, musculature > the size of the lumen. So act as **functional/anatomical sphincter**
- *Ampulla* – 5 cm, thin walled, dilated and tortuous. Fertilization takes place here.
- *Infundibulum* – 1 cm, trumpet like. It presents pelvic ostium and provided with fimbriae.

Blood Supply

- Medial two-thirds uterine artery and lateral one-third by ovarian artery. And blood drained to ovarian vein and uterine vein.
- Lymphatics–paraortic nodes. From isthmus drain into superficial inguinal nodes.

Uterus

Position of the uterus is anteverted and anteфлекed position



Figs 146A and B: Position of the uterus: (A) Anteversion; (B) Anteфлекion

- **Anteversion** – 90° angle between vagina and cervix (angle between pelvic inlet/outlet)
- **Anteфлекion** – 170° angle between body and cervix (angle between mobile and immobile part)
- Anterior surface rests on the posterosuperior surface of bladder
- Divided into four parts fundus, body, isthmus and cervix
- Fundus of uterus–rounded part of the uterus located superior and anterior to plane of entrance of the Fallopian tube. It is the area devoid of uterine cavity
- Body of uterus: Main part, located inferior to fundus and superior to isthmus. Uterine cavity is triangular in coronal section. Continues with lumen of the uterine tube and with internal os.

Relations of Uterus

- Anterior surface–related to bladder
- Posterior surface–related to rectouterine pouch, sigmoid colon
- Lateral surface–broad ligament
- Lateral angle/cornua–uterine tube, round ligament and ligament of ovary isthmus–constricted part of the uterus located between body and cervix. It corresponds with internal os.

Cervix

- Anterior surface: Nonperitoneal related to base of bladder
- Posterior surface: Peritoneal and related to rectouterine pouch
- On each side–ureter, uterine artery, Mackendrot’s ligament
- Cervix is surrounded by circular gutter of vaginal canal which inturn divided into 4 fornices
 - Anterior fornix (nonperitoneal related to base of bladder)
 - Posterior fornix–peritoneal and related to rectouterine pouch.
 - Two lateral fornix–related to ureter, uterine artery, Mackendrot’s ligament.

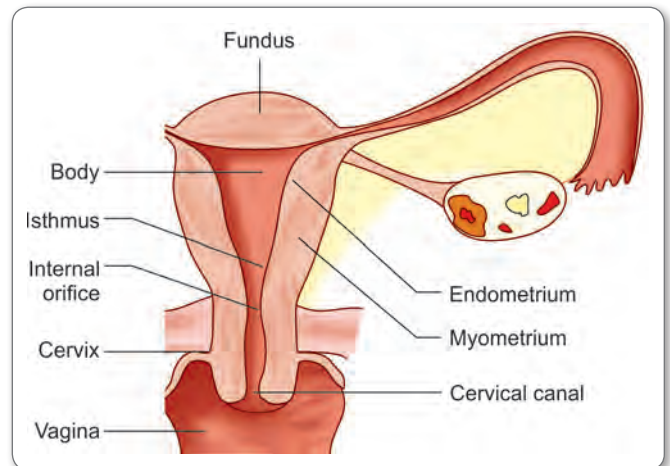


Fig. 147: Internal structure of uterus



Lymphatic Drainage

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ABDOMEN AND PELVIS

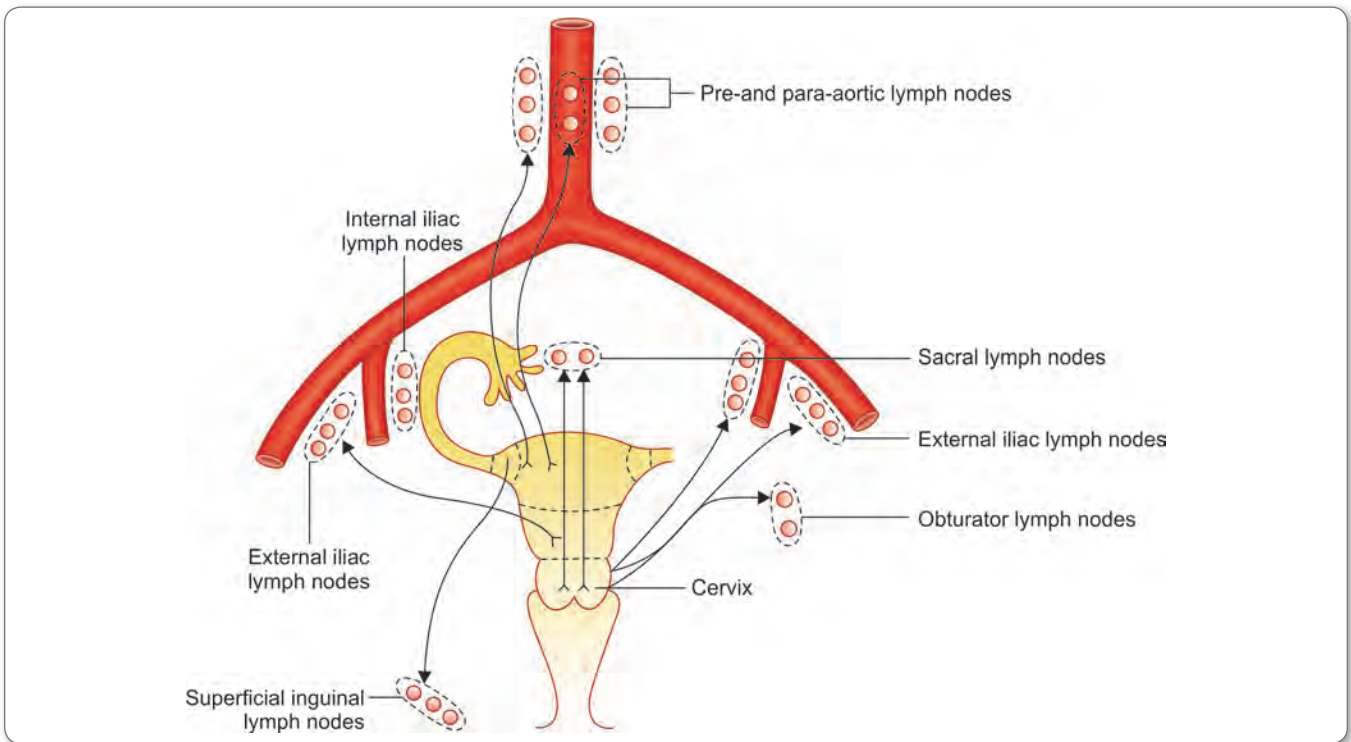


Fig. 148: Lymphatic drainage

- Fundus and Upper part of body—preaortic/para aortic, superficial inguinal nodes
 - Middle part to external iliac nodes
 - Rest of the parts—external iliac nodes, sacral nodes, internal iliac nodes, obturator nodes.

Blood Supply

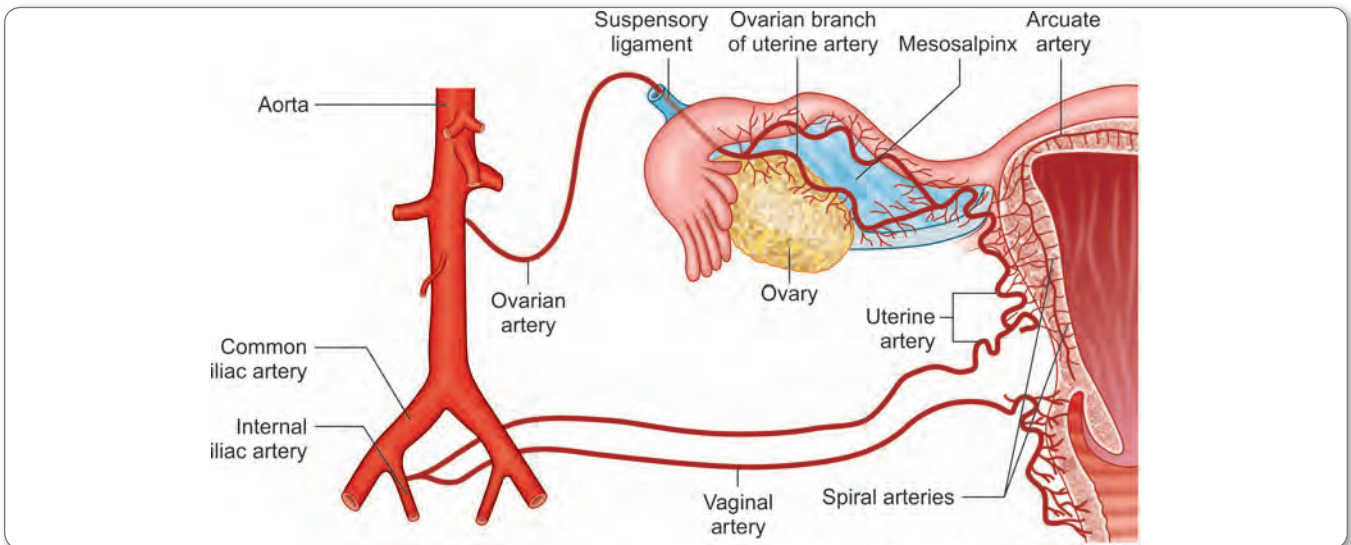


Fig. 149: Blood supply of uterus

- Uterus is supplied by uterine artery (branch from anterior divisions of internal iliac artery) and also by ovarian artery (from abdominal aorta)
- Uterine artery is homologous to artery of ductus deferens in male
- Uterine artery runs medially in the base of broad ligament to reach the junction of cervix and body of the uterus above the ureter & near the lateral fornix of vagina

New SARP Series Anatomy



- Then ascends along the margin of uterus and ends by anastomosing with ovarian artery
- Uterine artery supplying uterus, fallopian tube (medial 2/3rd), ovary, vagina and ureter.

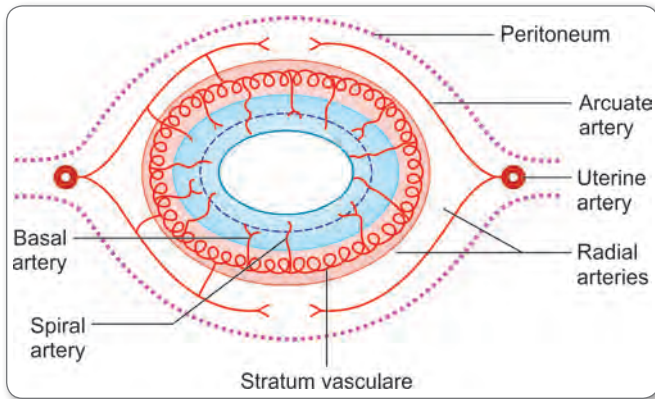


Fig. 150: Cross section of uterus showing its blood supply

- Uterine artery gives arcuate artery which run transversely on anterior and posterior surface of the body and anastomose with branches of opposite side across middle line.

- From arcuate artery, radial artery arises & pierce the myometrium forming stratum vasculare in the middle of muscle coat
- Two sets of branches arise from stratum vasculare – basal artery and spiral artery which supply the endometrium
- Basal artery supply the basal zone
- Spiral artery supplies the functional zone of endometrium.

Nerve Supply

- Uterus is supplied by sympathetic and parasympathetic nerves via ovarian and utero vaginal plexuses
- Preganglionic sympathetic fibres arising from T12 – L1 and make synapse with superior hypogastric plexus in front of sacral promontory via presacral and lumbar splanchnic nerves
- Postganglionic fibres from these neurons reach uterovaginal plexus and distribute the fibres to uterus and vagina
- Sympathetic motor fibres act as vasoconstrictors and stimulate the uterine musculature
- Parasympathetic preganglionic fibres arising from S2-4 reach para cervical ganglia via pelvic splanchnic nerves
- Parasympathetic fibers inhibit the uterine musculature and act as vasodilators.

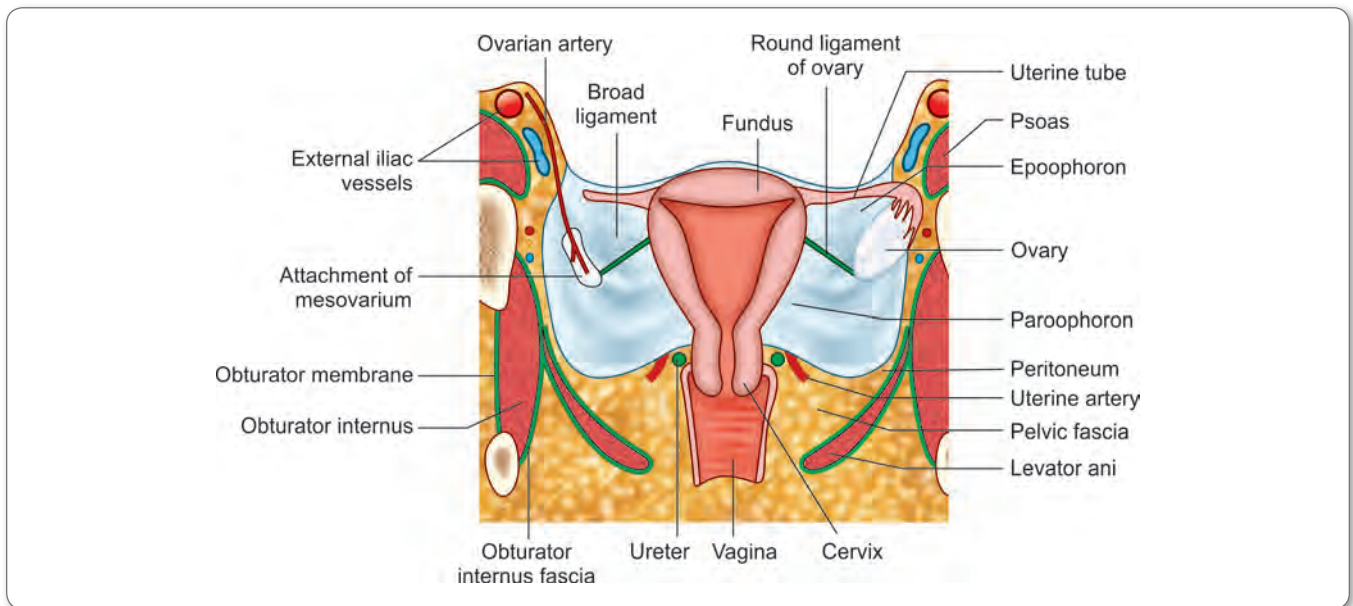


Fig. 151: Structures around uterus

Supports of Uterus

Primary Supports

Muscular

Pelvic diaphragm levator ani (consists of pubococcygeus and iliococcygeus) which forms **the pelvic floor**

- Pubococcygeus consists of pubococcygeus proper
 - Puborectalis
 - Puboanalis
 - Pubovesicalis/pubovaginalis
- Perineal body
- Urogenital diaphragm

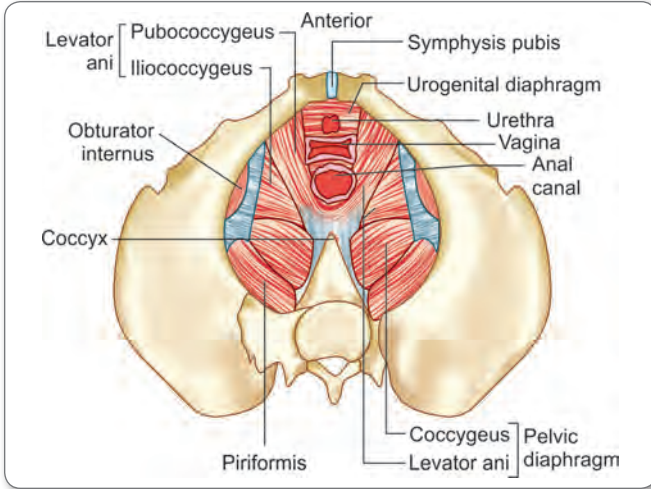


Fig. 152: Muscular supports of uterus

Ligament Support

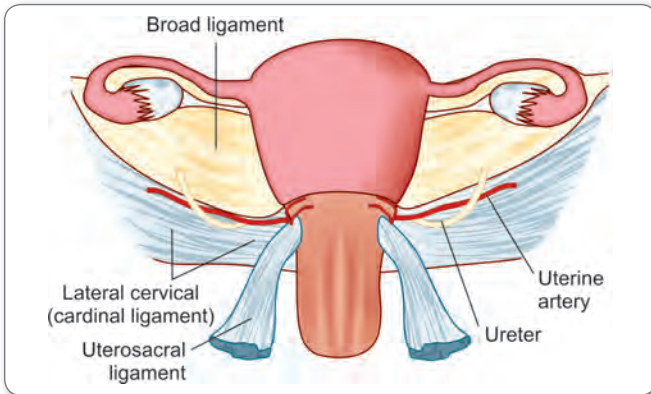


Fig. 153: Ligament support of uterus

- Transverse cervical ligament or Mackenrodt's ligament
- Uterosacral ligament

- Pubocervical ligaments
 - **Round ligament of uterus** gives **weak support** when compared to all of these
 - Secondary support by peritoneal folds like broad ligament but usually not included in the supports of uterus.
 - **Transverse cervical ligament:**
 - Ligament extending from cervicovaginal junction to lateral pelvic wall
 - Fan shaped fibromuscular strand and it is derived from condensation of parametric tissue
 - Ligament is related above with crossing of ureter and uterin artery and with lower margins of broad ligament
 - Ligament keeps cervix in median position and prevents the downward displacement of uterus
 - **Uterosacral ligaments:**
 - Ligament extending from cervix to S3
 - Ligament pull the cervix backwards and help in maintenance of anteversion and anteflexion synergistic with round ligaments
 - **Pubocervical ligaments:**
 - Thin fibrous strands which extend from cervix to pubic bones along the inferolateral surface of bladder
 - Ligament pull the cervix in front and counteract the excessive traction of uterosacral ligament
 - **Round ligament of uterus:**
 - 10–12 cm long
 - Fibromuscular band attaching proximally to lateral angle of uterus
 - From uterine angle, ligament passes through broad ligament and crosses the lateral pelvic wall and enters the deep inguinal ring and runs through inguinal canal and splits into numerous fibrous threads which are attached to labia majora
- Note:** Round ligament is remnant of distal part of gubernaculum of ovary
- **Broad ligament**
 - Fold of peritoneum extending from lateral border of uterus to lateral pelvic wall
 - Does not provide any support to uterus
 - **Parts of broad ligament**

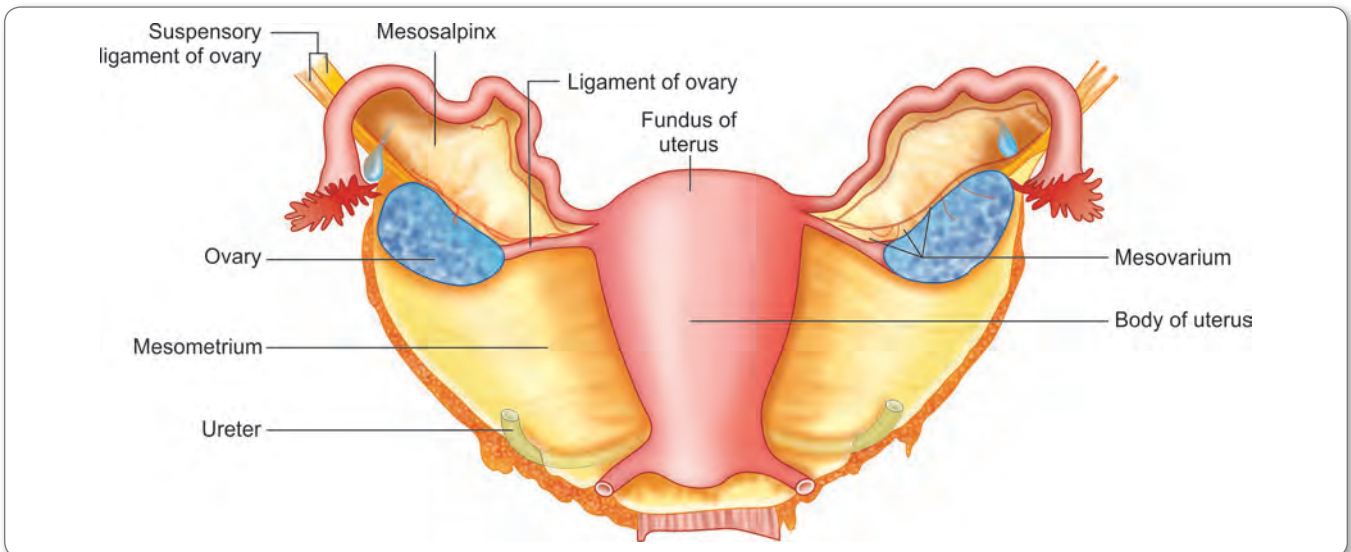


Fig. 154: Parts of broad ligament



- Mesovarium: Connects posterior layer of broad ligament with anterior surface of ovary
- Mesosalpinx: Suspends fallopian tube
- Mesometrium: Part of broad ligament below the mesosalpinx and mesovarium
- Suspensory ligament of ovary: Connects ovary and uterine tube to pelvic brim across external iliac vessels
- It transmits ovarian vessels and nerves.

HIGH YIELD POINTS

Contents of Broad Ligament

- Uterine tube
- Proximal part of the round ligament
- Ligament of ovary
- Ovarian vessels and uterine vessels
- Ureter
- Gartner's duct
- Tubules and duct of epoophoron and tubules of paroophoron
- Lymphatics, nerves and unstriated muscles of uterus

(Note: Ovaries are **not** content of broad ligament)



Clinical Aspect

- **Uterus prolapse:** Protrusion of cervix of the uterus into the lower part of vagina and cause bearing down sensation and increased frequency and burning sensation on urination. Prolapse occurs as a result of advancing age, menopause and results from weakness of muscles, ligaments and fascia of the pelvic floor.
- Natural position of uterus in the pelvis is anteversion. Normally, the **cardinal ligament** supports the uterine angle (angle of anteversion). **Round ligament** maintains the anteversion of the uterus during normal pregnancy.

Vagina

- Extension: From vestibule to vaginal part of cervix
- Measurements: Anterior wall 8 cm, posterior wall 10 cm
- Anterior wall: Nonperitoneal related to base of bladder and urethra
- Posterior wall: Upper one-fourth peritoneal related to rectouterine pouch, middle two-thirds ampulla of rectum (non peritoneal) and lower one third separated from anal canal by perineal body.
- Lateral wall: Crossing of ureter and uterine artery, Mackenrods ligament, levator ani, bulb of vestibule, greater vestibular gland.

Blood Supply

- Vaginal artery branch of internal iliac artery main supply
- Uterine artery supply the upper part
- Middle rectal artery and internal pudendal artery supply the lower part.

HIGH YIELD POINTS

Uterine artery and vaginal artery form longitudinal chain called azygous artery.

Female Urethra

- 4 cm in length
- Shorter than male urethra
- Extends from internal urethral orifice to external urethral orifice anterior to vaginal opening.

Glands around Female Urethra

- Urethral glands
- Paraurethral glands of Skene (analogous to prostate gland)
- Greater vestibular glands

REMEMBER

Most of the female urethra is lined by nonkeratinized stratified squamous epithelium. Close to internal urethral orifice is lined by transitional epithelium.

BLOOD VESSELS OF PELVIS

Internal iliac artery divided into anterior and posterior division

Anterior Division Branches

- Inferior gluteal artery
- Obliterated umbilical artery
- Obturator artery
- Superior vesicle artery
- Inferior vesicle artery
- Middle rectal artery
- Uterine artery
- Vaginal artery
- Inferior gluteal artery
- Internal pudendal artery

Posterior Division Branches

- Superior gluteal artery
- Iliolumbar artery
- Lateral sacral artery

NERVE SUPPLY OF PELVIS

- Formed by fourth and fifth lumbar ventral rami and first four sacral ventral rami
- Branches are:
 - Superior gluteal nerve L4–S1
 - Inferior gluteal nerve L5–S2
 - Sciatic nerve L4–S3
 - Nerve to obturator internus L5–S2
 - Nerve to quadratus femoris L5–S1
 - Posterior femoral cutaneous nerve S1–S3
 - Pudendal nerve S2–S4
 - Branches distributed to pelvis
 - Nerve to piriformis S1–S2
 - Nerve to levator ani and coccygeus S3–S4
 - Nerve to sphincter ani externus
 - Pelvic splanchnic nerve S2–S4



Autonomic Nerves in the Pelvis

Superior Hypogastric Plexus

- Continuation of aortic plexus below the aortic bifurcation and receives the lower two lumbar splanchnic nerves
- Lies behind the peritoneum, descends in front of fifth lumbar vertebra and ends by bifurcation into right and left hypo gastric nerves in front of sacrum
- Contains preganglionic and postganglionic sympathetic fibers and visceral afferent fibers.

Hypogastric Nerve

- Lateral extension of superior hypogastric plexus and lies in extraperitoneal connective tissue lateral to rectum
- Provides branches to sigmoid colon and descending colon
- It is joined by pelvic splanchnic nerves to form inferior hypogastric plexus.

Inferior Hypogastric Plexus

- Formed by hypogastric, pelvic splanchnic and sacral splanchnic nerve and lies against the posterolateral pelvic wall, lateral to rectum, vagina and base of bladder
- Contains pelvic ganglia in which sympathetic and parasympathetic preganglionic fibers synapse
- Gives rise to subsidiary plexus including middle rectal, utero-vaginal, vesical and prostatic plexus.

Pelvic Splanchnic Nerve

- Arises from S2, 3 and 4
- Carry parasympathetic fibers. (Other splanchnic fibers are sympathetic)
- Supplies hind gut and other viscera in the pelvis and perineum.



Chapter at a Glance

- Pain from foregut is referred to epigastric region
- Pain from midgut to umbilical regions
- Pain from hindgut to suprapubic region
- Left renal vein is anterior to aorta and below the superior mesenteric artery origin
- **Gastroduodenal artery** prone to erosion in posterior perforation of duodenal ulcer
- **Splenic artery** is prone to erosion in penetrating ulcer in the posterior wall of stomach into lesser sac
- **Left gastric artery** eroded in the penetrating ulcer on the lesser curvature of stomach
- Most dependent pouch in standing position is rectouterine pouch, in supine position hepatorenal pouch of Morrison
- Ascent of horse shoe-shaped kidney is prevented by inferior mesenteric artery
- Appendices epiploicae is more in sigmoid colon, absent in cecum, appendix and rectum
- Taenia coli is absent in appendix and rectum
- Portal vein formed by union of splenic vein and superior mesenteric vein at the level of L2 behind the neck of pancreas
- Caudate lobe drains into both left and right hepatic duct
- Calot's triangle superiorly – cystic artery not inferior surface of liver. Content cystic node of lund
- T11: Cardiac orifice of stomach
- T12: Aorta piercing diaphragm, origin of celiac trunk, tail of pancreas, epiploic foramen, upper end of kidney
- L1: Origin of superior mesenteric artery, pylorus of stomach, fundus of gallbladder, hilum of kidney, termination of spinal cord
- L2: Neck of pancreas and formation of portal vein, duodenojejunal flexure
- L3: Origin of inferior mesenteric artery, third part of duodenum, lower end of kidney
- L1 to L3: Second part of duodenum
- L3 to L4: Umbilicus level
- L4: Termination of aorta into two common iliac arteries
- L5: Formation of inferior vena cava
- S2: Subdural and subarachnoid space termination
- S3: Beginning of rectum
- Tip of coccyx: Rectosigmoid junction
- Median umbilical fold: Contains median umbilical ligament
- Pair of medial umbilical fold: Contains obliterated umbilical artery
- Pair of lateral umbilical fold: Contains inferior epigastric artery
- Falciform ligaments: Connects liver to undersurface of diaphragm and anterior abdominal wall up to umbilicus. Contents ligamentum teres, para umbilical vein and accessory portal system of Sappey.
- Coronary ligament: Connects bare area of liver with diaphragm. Contents branches of right inferior phrenic artery, communications between systemic and portal veins, upper part of right suprarenal gland and sometimes upper end of right kidney.
- Ligamentum teres hepatis: Remnant of obliterated left umbilical vein. In fetal life, left umbilical vein conveys oxygenated blood from placenta to the fetus.
- Ligamentum venosum: Remnant of obliterated ductus venosus. In fetal life it connects left branch of portal vein with inferior vena cava directly or indirectly through upper left hepatic vein
- Lienorenal ligament: Contents **splenic vessels** and sometimes **tail of pancreas**. Gastrosplenic ligament and lienorenal ligament forms the pedicle of spleen.
- Lienophrenic ligament: Suspends spleen from above so it is called as suspensory ligament of spleen.
- Phrenicocolic ligament: Extends from left colic flexure to diaphragm. Supports the spleen from below. So, it is called as sustentaculum lienis.
- True ligaments of bladder are fibrous bands with some smooth muscle, which helps in anchorage of the bladder. Totally nine in number. They are one medial umbilical ligament, four puboprostatic ligaments (medial and lateral on each side from bladder neck to symphysis pubis), a pair of lateral ligaments from inferolateral surface of the bladder to tendinous arch of pelvic fascia and pair of posterior true ligaments from base to lateral pelvic wall.
- False ligaments of bladder are peritoneal folds and seven in number. Anteriorly three folds median and pair medial umbilical ligaments, laterally pair of lateral false ligaments from bladder to lateral pelvic wall and posteriorly a pair of sacrogenital folds from base of bladder to S3.
- Mesosalpinx: Part of broad ligament, which intervenes between uterine tube and ovary with the ligament of ovary. Contains uterine tube, anastomosis of uterine and ovarian vessels, tubules and ducts of epoophoron and tubules of paroophoron.
- Mesometrium (part of broad ligament) extends from the ovary and its ligament to the base of broad ligament. Contains tortuous uterine blood vessels.
- Mesovarium: Derived from posterior layer of broad ligament. It acts as hilum of the ovary and transmits ovarian vessels and nerves.
- Levator prostate: In male formed by anterior fibers of levator ani.
- Sphincter vagina: In female formed by anterior fibers of levator ani
- Sphincter of boyden – (sphincter choledochus) around the periampullary part of bile duct.
- Sphincter pancreaticus: Around the periampullary part of pancreatic duct
- Sphincter of Oddi: Around the termination of ampulla of Vater Ampulla of Vater – Bile duct and pancreatic duct (duct of wirsung) pierce the duodenal wall separately, unite to ampulla of Vater, which opens on the summit of the major duodenal papillae.
- Ejaculatory duct: Formed by union of vas deferens and duct of seminal vesicle and opens at colliculus seminalis one on each side of prostatic utricle.
- Valves of Kerckring: These are permanent mucous folds absent in first part of duodenum.



- Major duodenal papilla: Situated in posteromedial part of second part of duodenum and 8–10 cm distal to pylorus.
- Minor duodenal papilla: Situated 2 cm above the major duodenal papilla. Accessory pancreatic duct (duct of Santorini) opens on its summit.
- Ileocecal orifice: Situated in posteromedial wall of cecum at its junction with ascending colon and with intersection between transtubercular and right lateral plane.
- Appendicular orifice: Situated about 2 cm below and behind the ileocecal orifice. Opening is guarded by **valve of gerlach**.
- **Valvule of Guerin**: Spongy urethra contains large pit known as urethral lacuna magna. Its mouth is guarded by mucous fold known as valvule of Guerin.
- Houston's valve: Horizontal permanent mucous fold in rectum. Situated in concavity of the lateral curves. 4 in number. In that 3rd is the most important and constant situated along concavity of middle lateral curve. Arises from **anterior and right wall of rectum**.
- **Spiral valve of heister**: Interior of cystic duct presents 5–12 crescentic valves.
- Nelaton's sphincter: Sometimes 3rd houston's valve encircles the rectum in such case circular muscle of valve is known as Nelaton's sphincter.
- Hartmann's pouch: From neck of bladder, small diverticulum projects downward and backward toward duodenum known as Hartmann's pouch.
- Gastric triangle
 - ✓ Right side: Lower border of liver
 - ✓ Left side: Left costal margin
 - ✓ Below: Transverse colon
 - ✓ It is the area of stomach in contact with anterior abdominal wall. **In complete esophageal obstruction, tube is introduced in the stomach through the gastric triangle**
- *Traube's space*
 - ✓ Topographic area overlying the **fundus of stomach**
 - ✓ Above: Lower border of left lung
 - ✓ Below: Left costal margin
 - ✓ Right side: Lower border of left lobe of liver
 - ✓ Left side: Lateral end of spleen
- Space of **Retzius**
 - ✓ Infront: Symphysis and body of pubis
 - ✓ Behind and on each side: Posterior true ligament of bladder
 - ✓ Above: Peritoneum of the paravesical fossa
 - ✓ Below: Pubovesical ligament
 - ✓ Medially: Inferolateral surface of bladder
 - ✓ Laterally: Fascia covering levator ani and obturator internus muscles
 - ✓ Contents: retropubic fat and vesical plexus of veins. This space act as bursa to allow the expansion of bladder
- Arrangement of structures at porta hepatis of live before backward
 - ✓ Hepatic duct
 - ✓ Hepatic artery and
 - ✓ Portal vein
- Arrangement of structures at hilum of kidney before backward
 - ✓ Renal vein
 - ✓ Renal artery
 - ✓ Pelvis of ureter
- Blood-testis barrier (BTB): Sertoli cells
- Placental barrier: Syncytiotrophoblast



Multiple Choice Questions

Embryology

1. **Also regarding umbilical cord a/e:** (Recent Question 2018)
 - a. One artery and two veins
 - b. When one vein is present, we should look for congenital anomaly
 - c. Wharton jelly is the connective tissue of the cord
 - d. Two artery and two veins
2. **Ureter develops from:** (Recent Question 2018)
 - a. Pronephros
 - b. Mesonephros
 - c. Metanephros
 - d. Mesonephric duct
3. **Which of the following structure develops from dorsal mesentery?** (Recent Question 2018)
 - a. Greater omentum
 - b. Lesser omentum
 - c. Liver
 - d. Diaphragm
4. **Epithelium of ureter develop from:** (AIIMS Nov. 2007)
 - a. Metanephric tubules
 - b. Meso nephric tubules
 - c. Pronephros
 - d. Ureteric bud
5. **Defect in any of the following result in renal agenesis except:** (AI 1997)
 - a. Nephrogenic bud
 - b. Ureteric bud
 - c. Blastema of nephrogenic tissue
 - d. Failure of descent of kidney into lumbar region
6. **Urachus fistula:** (PGI Dec. 2004)
 - a. Patent allantois
 - b. Ectopic hernia
 - c. Patent vitello intestinal duct
 - d. Meckel's diverticulum
 - e. Umbilical hernia
7. **Genital swellings in male differentiate into:** (DNB 1998)
 - a. Glans penis
 - b. Penile urethra
 - c. Ischiocavernosus of penis
 - d. Scrotum
8. **Uterus developed from:** (DNB 2004)
 - a. Müllerian duct
 - b. Wolffian duct
 - c. Both
 - d. None
9. **Regarding development of genital system what is true:** (AIIMS Nov. 2007)
 - a. Ovaries develop in the absence Y chromosomes
 - b. Genital ridge develop at 5th week
 - c. Male genitals develop earlier than female
 - d. Externally fully differentiated at 10th week
10. **Testis descends the inguinal canal during – month:**
 - a. 5th month
 - b. 6th month (DNB 2004)
 - c. 7th month
 - d. 8th month
11. **The origin of ovaries from:** (DNB 2006)
 - a. Genital ridge
 - b. Genital tubercle
 - c. Wolffian duct
 - d. Müllerian duct
12. **Gartner's duct is remnant of:** (DNB 2009)
 - a. Müllerian duct
 - b. Wolffian duct
 - c. Cloacal duct
 - d. Epooophon
13. **Epididymis is derived from:** (DNB 2010)
 - a. Paramesonephric duct
 - b. Wolffian duct
 - c. Nephric duct
 - d. None
14. **Covering of the Graafian follicle are all, except:** (DNB 2011)
 - a. Theca interna
 - b. Theca externa
 - c. Germinal cells
 - d. Granulosa cells
15. **Appendix of the testis develops from:** (DNB 2011)
 - a. Allantois
 - b. Paramesonephric duct
 - c. Mesonephric duct
 - d. Cloaca
16. **False about gastrointestinal development is:** (PGI Nov. 2009)
 - a. Lower respiratory system develops forms foregut
 - b. Stomach 90° clockwise and its posterior wall grows faster
 - c. Duodenum rotates to right and its retroperitoneal
 - d. Dorsal bud forms uncinat process
 - e. Dorsal duct forms Santorini duct
17. **Most common site of ectopic pancreatic tissue:** (AIIMS May 2007)
 - a. Stomach
 - b. Jejunum
 - c. Appendix
 - d. Hilum of spleen
18. **Ventral mesogastrium gives rise to:** (AIIMS 1991)
 - a. Lesser omentum
 - b. Greater omentum
 - c. Gastrophrenic ligament
 - d. Gastrosplenic ligament
19. **All of them develop in the mesentery of stomach, except:** (Recent Question 2013)
 - a. Liver
 - b. Spleen
 - c. Kidney
 - d. Pancreas
20. **Vaginal epithelium develops from:** (AIIMS May 2013)
 - a. Mesoderm of urogenital sinus
 - b. Mesoderm of genital ridge
 - c. Endoderm of urogenital ridge
 - d. Endoderm of genital ridge
21. **Which of the following is true about testes?**
 - a. Develop from ectoderm (AIIMS Nov. 2012)
 - b. Descends into scrotum with its inferior pole attached to gubernaculum
 - c. Reach the scrotal sac by 28th week
 - d. Covered by covering derived from peritoneum known as tunica albuginea
22. **All are derivatives of septum transversum, except:** (AI 2011)
 - a. Falciform ligament
 - b. Ligamentum teres
 - c. Coronary ligament
 - d. Mesentery of lesser sac
23. **The reduction of physiological hernia occurs at:**
 - a. 6th week
 - b. 10th week (DNB 2002)
 - c. 12th week
 - d. 20th week
24. **The cecum is found to be placed below the stomach and is midline. Which of the following abnormality must have taken place while rotation of gut?** (AIIMS Nov. 2010)
 - a. Malrotation
 - b. Nonrotation
 - c. Reverse rotation
 - d. Mixed rotation



25. Child has recurrent abdominal pain and bilious vomiting. Condition was diagnosed by barium follow through. Surgical procedures followed – ladd's band division, appendectomy and mesenteric widening, diagnosis is:

(AIIMS Nov. 2011)

- a. Duodenal web
- b. Acute appendicitis
- c. Malrotation
- d. Cecal volvulus

26. Major pancreatic duct the false statement is:

- a. Main duct lies 2 cm distal and posterior to minor duct
- b. Minor duct opens the head of pancreas only
- c. Major duct is made up of distal part of duct from dorsal bud and whole of ventral bud
- d. Minor duct is made up of only the distal part of dorsal bud

27. Which is true regarding the embryology of gut?

(JIPMER May 2015)

- a. Duodenum and jejunum are developed from foregut
- b. Ascending colon is developed from hindgut
- c. Appendix is developed from hindgut
- d. Ileum developed from midgut

28. Descending colon is supplied by:

(JIPMER May 2016)

- a. Superior mesenteric artery
- b. Inferior mesenteric artery
- c. Iliolumbar artery
- d. Lateral sacral artery

29. True statement regarding development of urinary tract is:

- a. If cloaca is not formed properly it can result in urorectal fistula
- b. Apex of bladder is formed by mesonephros
- c. Structure formed from ureteric bud is collecting ducts
- d. Mesonephric duct disappears completely

(JIPMER May 2015)

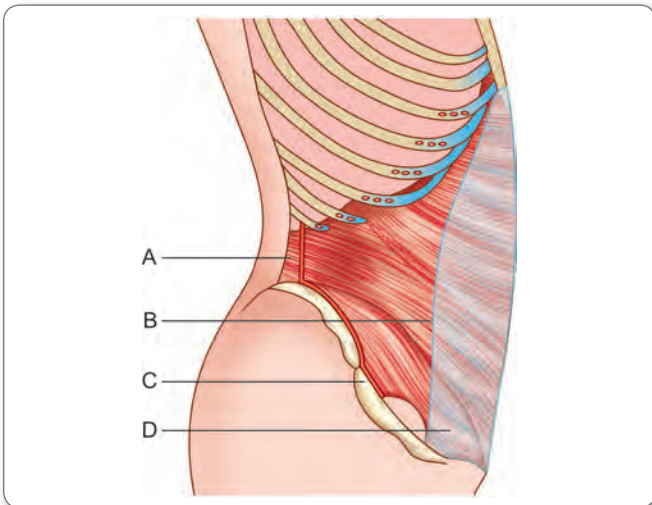
30. Differentiation of gonads in human fetus is complete by:

(JIPMER Nov 2014)

- a. 9 weeks
- b. 12 weeks
- c. 20 weeks
- d. 25 weeks

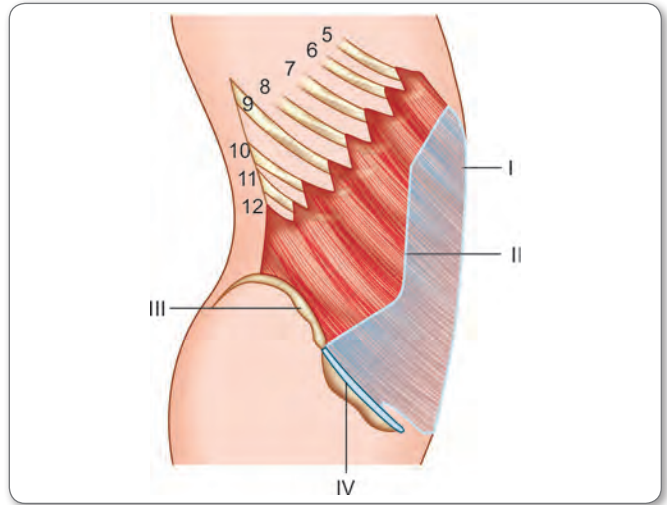
Anterior Abdominal Wall

31. In the following image of Transversus abdominals, which label denotes conjoint tendon? (AIIMS May 2017)



- a. A
- b. B
- c. C
- d. D

32. In the following image of anterior abdominal wall, the correct matching of regarding the attachment of external oblique? (AIIMS Nov 2016)



- a. 1. Linea alba, 2. Linea semilunaris, 3. Outer lip of iliac crest, 4. Inguinal ligament,
- b. 1. Linea alba, 2. Linea semilunaris, 3. Inner lip of iliac crest, 4. Outer lip of iliac crest
- c. 1. Linea semilunaris, 2. Linea alba, 3. Inner lip of iliac crest, 4. Inguinal ligament
- d. 1. Linea semilunaris, 2. Linea alba, 3. Inner lip of iliac crest, 4. Deep inguinal ring

33. Root Value of cremasteric reflex is:

(AIIMS May 2017)

- a. L1 L2
- b. S2 S3
- c. L3 L4
- d. L4 S1

34. Transpyloric plane separates:

(Recent Question 2015)

- a. Hypogastrium from lumbar region
- b. Hypochondrium from lumbar region
- c. Iliac fossa from lumbar region
- d. Umbilical region from lumbar region

35. True statement about lower 1/4th of lower abdominal wall:

- a. Lineal alba poorly developed (PGI Dec 2006, 2007)
- b. Two layers of rectus sheath present
- c. External oblique poorly formed
- d. External oblique well-formed and strong
- e. Rectus abdominis is divided

36. True about scarpa's fascia:

(Recent Question 2015)

- a. Deep fascia of anterior abdominal wall
- b. Also called as buck's fascia
- c. Attached to iliotibial tract
- d. Forms suspensory ligament of penis

37. Which of the following are associated with external oblique muscle? (PGI Nov. 2011)

- a. Poupart's ligament
- b. Lacunar ligament
- c. Superficial inguinal ring
- d. Conjoint tendon
- e. Cremasteric muscle



- 38. Which of the following structures passes behind inguinal ligament?** (PGI Nov. 2015)
- Femoral branch of genitofemoral nerve
 - Superficial epigastric artery
 - Psoas major
 - Femoral vein
 - Saphenous vein
- 39. Rectus abdominis is inserted into:** (DNB 2006)
- Xiphoid process
 - Median raphe
 - Linea alba
 - 1 – 4 ribs
- 40. Pyramidalis supplied by:** (Recent Question 2015)
- Subcostal nerve
 - Ilioinguinal nerve
 - Iliohypogastric nerve
 - Genitofemoral nerve
- 41. The efferent limb of cremaster reflex:** (Recent Question 2014)
- Femoral branch of genitofemoral nerve
 - Genital branch of genitor femoral nerve
 - Ilioinguinal nerve
 - Pudendal nerve
- 42. Lymphatic drainage of umbilicus:** (DNB 2005)
- To the axillary node only
 - To the inguinal node only
 - Both axillary and inguinal node
 - To celiac group
 - To aortic node
- 43. Neurovascular plane in anterior abdominal wall:** (AI 2012)
- Between external and internal oblique
 - Between internal oblique and transverse abdominis
 - Below the transversus abdominis
 - Above the external oblique
- 44. Conjoint tendon is formed by:** (Recent Question 2013)
- External and internal oblique
 - Internal oblique and transverse abdominis
 - External oblique and transverse abdominis
 - All three
- 45. Hypogastric sheath is a condensation of:** (AI 2010)
- Scarpa s fascia
 - Colle s fascia
 - Pelvic fascia
 - Inferior layer of urogenital diaphragm
- 46. Denonvilliers fascia is:** (DNB 2011)
- Fascia of perineum
 - Fascia of penis
 - Renal fascia
 - Rectoprostatic fascia
- 47. All are true about inguinal canal, except:** (AI 2001)
- Conjoint tendon forms the part of posterior wall
 - Superficial ring is found in external oblique aponeurosis
 - Deep ring is opening in transverse abdominis
 - Internal oblique forms both anterior and posterior wall
- 48. Which of the following is not true about inguinal canal:** (PGI 2003)
- It is an intermuscular canal
 - Superficial inguinal ring is situated superior and lateral to pubic crest
 - Deep inguinal ring is superomedial to attached to rectus abdominis
 - Internal oblique forms both anterior and posterior relations
 - Cremasteric artery is branch of external iliac artery
- 49. The inguinal canal is not bounded posteriorly by:** (DNB 2002, AI 1995)
- Transversalis fascia
 - Internal oblique tendon
 - Conjoint tendon
 - Lacunar ligament
- 50. All the following structures pass through the inguinal canal in females except:** (AI 2012)
- Ilioinguinal nerve
 - Round ligament of uterus
 - Lymphatics from uterus
 - Inferior epigastric artery
- 51. Following pass through deep inguinal, except:** (DNB 2006)
- Spermatic cord
 - Internal spermatic fascia
 - Round ligament
 - Ilioinguinal nerve
- 52. Which of following is not damaged during vasectomy:** (AIIMS Nov. 2012)
- Ilioinguinal nerve
 - Testicular nerve
 - Cremasteric artery
 - Genital branch of genitofemoral nerve
- 53. Triangle of doom is bounded by A/E:** (AIIMS Nov. 2008)
- Vas deferens
 - Gonadal vessels
 - Coopers ligament
 - Deep inguinal ring
- 54. A missile hits the body just above the pubic ramus through anterior abdominal wall, it will pierce which of the following:** (AIIMS 2000)
- Urinary bladder
 - Left renal vein
 - Spinal cord
 - Abdominal aorta
- ### Posterior Abdominal Wall
- 55. All are true about iliolumbar ligament, except:** (Recent Question 2018)
- Attached to transverse process of L4
 - Lower part attached to sacrospinous ligament
 - Attached to iliac crest
 - Upper part continuous with thoracolumbar fascia
- 56. All are true about thoracolumbar fascia, except:** (DNB 2008, AI 2000)
- Attached to spinous process of lumbar vertebra
 - Attached to transverse process of lumbar vertebra
 - The fascia lies posterior to posterior abdominal wall muscles
 - Gives attachment to transverse abdominal and internal oblique
- 57. Vein draining to IVC is:** (DNB 2002)
- Left testicular vein
 - Right suprarenal vein
 - Left ovarian vein
 - Left suprarenal vein
- 58. True about inferior vena cava:** (PGI 2003)
- Passes through diaphragm at T10
 - Right suprarenal artery directly drains into it
 - It lies anterior to renal vein
 - It forms posterior wall of epiploic foramen
 - Related to psoas muscle
- 59. Obstruction of inferior vena cava presents:** (DNB 2006, AI 1997)
- Paraumbilical dilation
 - Thoracoepigastric dilatation
 - Esophageal varices
 - Hemorrhoids



60. In case of IVC obstruction the collaterals which opens up are all, except: (AIIMS Nov. 2006)

- a. Superior and inferior epigastric vein
- b. Azygous and ascending lumbar vein
- c. Superficial epigastric and ilio lumbar vein
- d. Lateral thoracic vein and prevertebral vein

61. Which of the position best describes the location of celiac plexus? (AIIMS 2010)

- a. Anterior or anterolateral to aorta
- b. Posterolateral to aorta
- c. Anterolateral to sympathetic chain
- d. Anteromedial to sympathetic chain

62. Which nerve supplies the celiac plexus? (AI 2012)

- a. Phrenic nerve
- b. Greater splanchnic nerve
- c. Iliohypogastric nerve
- d. Inguinal nerve

GI Tract

63. Nerve of grazi branch of: (Recent Question 2014)

- a. Right vagus
- b. Left vagus
- c. Trigeminal
- d. Hypoglossal

64. Lymphatic drainage of stomach includes all, except:

- a. Right gastroepiploic
- b. Pyloric
- c. Preaortic
- d. Celiac nodes

65. Length of human intestine is about:

- a. 5 meters
- b. 8 meters
- c. 12 meters
- d. 15 meters

66. The blood vessel related to permanent fossa?

- a. Gonadal vein
- b. Inferior mesenteric vein
- c. Superior mesenteric artery
- d. Portal vein

67. Which of the following is not permanent mucous fold:

- a. Spiral valves of heister
- b. Gastric rugae
- c. Circular fold
- d. Transverse rectal fold

68. Which is related with 3rd part of duodenum? (AI 2012)

- a. Portal vein
- b. Head of pancreas
- c. Hepatic artery
- d. Superior mesenteric vein

69. Minor duodenal papilla is opening of: (AI 2012)

- a. Hepatic duct
- b. Hepatopancreatic ampulla
- c. Accessory pancreatic duct
- d. Bile duct

70. All are true about 1st part of duodenum:

- a. 5 cm long
- b. Develops from foregut
- c. Superior part
- d. Supplied by superior mesenteric artery

71. All are true regarding ileum, except: (AIIMS 1991)

- a. Lymphatic patch along the antimesenteric border
- b. 3–6 arcades in the continuation
- c. Smaller diameter than jejunum
- d. Large circular mucous folds

72. On contrast radiography which among the following is false?

- a. Ileum is featureless
- b. Colon has haustrations
- c. Jejunum is feathery
- d. Distal part of duodenum has cap

73. Valvulae conniventes are seen in: (PGI Nov. 2009)

- a. Ileum
- b. Stomach
- c. Colon
- d. Appendix

74. Which of the following about the valves of Houston is true?

- a. They disappear after mobilization of the rectum (AI 2012)
- b. The middle valve folds towards the left side
- c. The upper valve corresponds to the anterior peritoneal reflection
- d. The valve contains all layers of the muscle wall

75. False about the valves of Houston: (AI 2012)

- a. Anteriorly correlates with peritoneal reflection
- b. Are placed transversely
- c. Contain all layers of intestine
- d. Prominent on distension

76. The most common anatomical position of appendix is:

- a. Retrocecal
- b. Pelvic
- c. Paracecal
- d. Preileal

77. True statement about appendix is: (PGI June 2006)

- a. Does not have mesentery
- b. Has taenia coli
- c. Develops from midgut
- d. Supplied by appendicular branch of ileocolic

78. Not seen in large intestine:

- a. Tenia
- b. Payers patches
- c. Sacculations
- d. Appendices

79. Appendices epiploicae present in: (AIIMS May 2010)

- a. Appendix
- b. Cecum
- c. Rectum
- d. Sigmoid colon

80. Which of the following is terminal group of lymph node for colon: (AIIMS Nov. 2008)

- a. Paracolic
- b. Epicolic
- c. Preaortic
- d. Ileocolic

81. All of the following are features of large intestine, except:

- a. Large intestine secrete acid mucus which helps in formation of stools
- b. It is a site of mucocutaneous junction
- c. Its epithelium contains goblet cells in large number
- d. Absorbs salt and water

82. Which of the following is not a content of mesorectum:

- a. Inferior rectal vein
- b. Superior rectal vein
- c. Pararectal node
- d. Inferior mesenteric plexus

83. True about pectinate line:

- a. Blood supply above pectinate line is through superior rectal artery
- b. Lymphatic drainage above pectinate line is through superficial inguinal nodes
- c. Part above pectinate line develops from proctodeum
- d. Part above pectinate line is supplied by somatic nerves

84. True about upper part of anal canal: (AI 1998)

- a. Squamous epithelium lies above the dentate line
- b. Upper half of anal canal supplied by superior mesenteric artery
- c. Drained to superficial inguinal nodes
- d. Insensitive to pain



- 85. Which is false regarding dentate line?** (DNB 2002, AIIMS 1998)
- Glands of Morgagni open below the line
 - Anal glands open at the line
 - Dentate line lies 2 cm above the anal verge
 - Transitional epithelium lies above the dentate line
- 86. A patient with external hemorrhoids develop pain while passing stools. The nerve mediating this pain is:** (AI 2002)
- Hypogastric nerve
 - Pudendal nerve
 - Splanchnic visceral nerve
 - Sympathetic plexus
- 87. Internal anal sphincter is a part of:** (DNB 2002, AIIMS 1993)
- Puborectalis muscle
 - Deep perineal muscle
 - Internal longitudinal fibers
 - Internal circular fibers
- 88. True about anatomy of anal canal:** (PGI Nov. 2010)
- Puborectalis is essential to maintain continence
 - Internal sphincter is skeletal muscle
 - Internal sphincter remains in the state of tonic contraction
 - External sphincter is supplied by gluteal nerve
 - No lymphatic drainage
- 89. In an adult male, on per rectal examination, the following structures can be felt anteriorly, except:** (AI 2005)
- Internal iliac nodes
 - Bulb of penis
 - Prostate
 - Seminal vesicle when enlarged
- 90. Not felt with per rectal examination:** (DNB 2009)
- Anorectal ring
 - Prostate
 - Ureter
 - Bulb of penis
- 91. The fascia from rectum to posterior pelvic wall:** (Recent Question 2015)
- Fascia of Waldeyer
 - Fascia of denonvillier
 - Scarpa's fascia
 - Colle's fascia
- Liver**
- 92. False about hepatic duct** (AIIMS May 2009)
- Left hepatic duct formed in umbilical fissure
 - Caudate lobe drains only left hepatic duct
 - Right anterior hepatic duct formed by V and VIII segments
 - Left hepatic duct crosses IV segment
- 93. All is true about functional divisions of liver, except:**
- Based upon portal vein and hepatic vein (AIIMS 2014)
 - Divided into 8 segments
 - Three major and minor fissures
 - 4 sectors
- 94. The Couinaud's segment nomenclature is based on the position of the:** (AI 2004)
- Hepatic vein and portal vein
 - Hepatic vein and biliary ducts
 - Portal vein and biliary ducts
 - Portal vein and hepatic artery
- 95. A surgeon excises a portion of liver to the left of the attachment of the falciform ligament. The segments that have resected are:** (AI 2008)
- Segment 1a and 4
 - Segment 1 and 4b
 - Segment 2 and 3
 - Segment 1 and 3
- 96. The right lobe of liver consists of which of the following segments:** (AIIMS 2004)
- V, VI, VII and VIII
 - IV, V, VI, VII, VIII
 - I, V, VI, VII, VIII
 - I, IV, V, VI, VII, VIII
- 97. Right hepatic duct drains all, except:** (AIIMS May 2009)
- I
 - III
 - V
 - VIII
- 98. Liver segment which is physiologically independent:** (Recent Question 2015)
- Segment I
 - Segment II
 - Segment IV
 - Segment III
- 99. Blood supply of liver:** (Recent Question 2012)
- 80% hepatic artery 20% portal vein
 - 20% hepatic artery 80% portal vein
 - 50% hepatic artery 50% portal vein
 - 100% hepatic artery
- Extra Hepatic Biliary System**
- 100. True regarding common bile duct is all, except:**
- Opens 10 cm distal to the pylorus (DNB 2004, AI 2000)
 - Lies anterior to inferior vena cava
 - Portal vein lies posterior to it
 - Usually opens into duodenum separate from the main pancreatic duct
- 101. Sphincter of Oddi consists of:** (DNB 2009)
- 2 sphincters
 - 3 sphincters
 - 4 sphincters
 - 5 sphincters
- 102. False statement about common bile duct:** (PGI May 2011)
- Lies in right free margin of lesser omentum
 - Anterior to first part of duodenum
 - Right to hepatic artery
 - Anterior to portal vein
 - Opens in the second part of duodenum
- 103. Predominant blood supply to the supra duodenal bile duct is derived from:**
- Vessels that run upward along the bile duct from the duodenal end of the duct such as the retroduodenal and the gastroduodenal arteries
 - Vessels that run downward along the bile duct from the hepatic end of the duct such as the right hepatic artery
 - Vessels that arise from the hepatic artery proper as it runs up along the common bile duct and supplies it will twig in a nonaxial distribution
 - Vessels that arise from cystic artery
- 104. Which lies between cystic duct and common hepatic duct:** (AI 2012)
- Lymph node
 - Portal vein
 - Hepatic artery
 - Cystic artery
- 105. Which of the following statement about portal triad is correct?** (JIPMER May 2016)
- Hepatic artery is medial to portal vein
 - Common bile duct is medial to hepatic artery
 - Portal vein is posterior to both common bile duct and hepatic artery
 - Portal vein is anterior to common bile duct but posterior to portal vein



- 106. True statement regarding biliary apparatus are all except:** (JIPMER Nov 2014)
- Bile secretion by liver 0.5-1 liters every day and GB concentrates it by 10 folds
 - CBD diameter 6 mm
 - CBD is formed by combination of right and left hepatic duct
 - GB is mainly supplied by sympathetic innervations
- 107. Which of the following structure is related posteriorly to the first part of duodenum?** (JIPMER May 2015)
- Right psoas major
 - Superior mesenteric vessels
 - Right suprarenal gland
 - Portal vein

Pancreas

- 108. Posterior relations of head of pancreas are all, except:** (AI 2011)
- Common bile duct
 - First part of duodenum
 - Aorta
 - Inferior vena cava
- 109. Structure immediately posterior to pancreatic head:** (Recent Question 2013)
- Right renal vein
 - Splenic artery
 - Inferior mesenteric vein
 - Celiac trunk
- 110. Regarding the blood supply of pancreas, which of the following statement is correct?**
- Both superior and inferior pancreaticoduodenal artery is branch of gastroduodenal artery
 - Posterior superior pancreaticoduodenal artery is branch of superior mesenteric artery
 - Anterior inferior pancreaticoduodenal artery is branch of superior mesenteric artery
 - Posterior inferior pancreaticoduodenal artery is branch of gastroduodenal artery

Spleen

- 111. Spleen projects into the following space of peritoneal cavity?** (AIIMS May 2011, 2008, DNB 2009)
- Paracolic gutter
 - Infracolic compartment
 - Left sub hepatic space
 - Greater sac
- 112. Downward displacement of enlarged spleen is prevented by:** (DNB 2005, AI 1998)
- Lienorenal ligament
 - Phrenicocolic ligament
 - Upper pole of right kidney
 - Sigmoid colon
- 113. Regarding spleen true is:**
- Arise from ventral mesogastrium
 - Inferior border is notched
 - Axis of spleen along 9th rib
 - Lienorenal ligament contains tail of pancreas
- 114. Spleen extends from:** (AI 2012)
- 5th to 9th rib
 - 9th to 11th rib
 - 2nd to 5th rib
 - 11th to 12th rib
- 115. Anterior end of spleen is held up by:** (AI 2012)
- Lienorenal ligament
 - Phrenicocolic ligament
 - Gastrosplenic ligament
 - Gastrocolic ligament

- 116. Which of the following ligaments contain splenic artery:** (Recent Question 2014)
- Lienorenal ligament
 - Phrenicocolic ligament
 - Gastrosplenic ligament
 - Gastrocolic ligament

Blood Supply of GIT

- 117. All the following statements about splenic artery are true except:** (AIIMS 2005)
- Tortuous course
 - Branch from celiac trunk
 - Anastomose freely with spleen
 - Supplies greater curvature of stomach
- 118. All are lateral branches of aorta, except:**
- Right testicular artery
 - Left renal artery
 - Lumbar artery
 - Middle suprarenal artery
- 119. Right gastroepiploic branch of:** (AI 2010)
- Left gastric
 - Splenic
 - Celiac trunk
 - Gastroduodenal artery
- 120. Blood supply of stomach:** (PGI 2003)
- Left gastric
 - Short gastric
 - Splenic artery proper
 - Renal artery
 - Lt gastroepiploic artery
- 121. Anterior branch of internal iliac artery, except:** (Recent Question 2014)
- Inferior gluteal artery
 - Middle rectal artery
 - Superior gluteal artery
 - Inferior vesical artery
- 122. All are branches of splenic artery, except:** (AI 2009)
- Short gastric artery
 - Hilar branches
 - Right gastroepiploic artery
 - Arteria pancreatica magna
- 123. All are true about celiac trunk except:** (AI 2012)
- Ventral branch
 - Surrounded by plexus of nerves
 - Lies at lower border of pancreas
 - Left gastric artery is branch
- 124. Blood supply of sigmoid colon:** (PGI 2000)
- Middle colic artery
 - Marginal artery
 - Sigmoid artery
 - Right colic artery
 - Left colic artery
- 125. All are branches of inferior mesenteric artery:** (AI 2012)
- Left colic
 - Sigmoidal
 - Middle rectal
 - Superior rectal
- 126. Water shed area between superior and inferior mesenteric artery:** (AIIMS Nov. 2007)
- Splenic flexure
 - Hepatic flexure
 - Ilieocecal junction
 - Rectosigmoid junction
- 127. The portal vein:** (DNB 2010)
- Is formed behind the neck of pancreas by union of superior mesenteric vein and splenic vein
 - Normal pressure is 5-10 mm Hg
 - Portal venous system is valveless
 - All of the above
- 128. Portosystemic shunt is not seen in:** (AI 2007)
- Liver
 - Spleen
 - Anorectum
 - Gastroesophageal

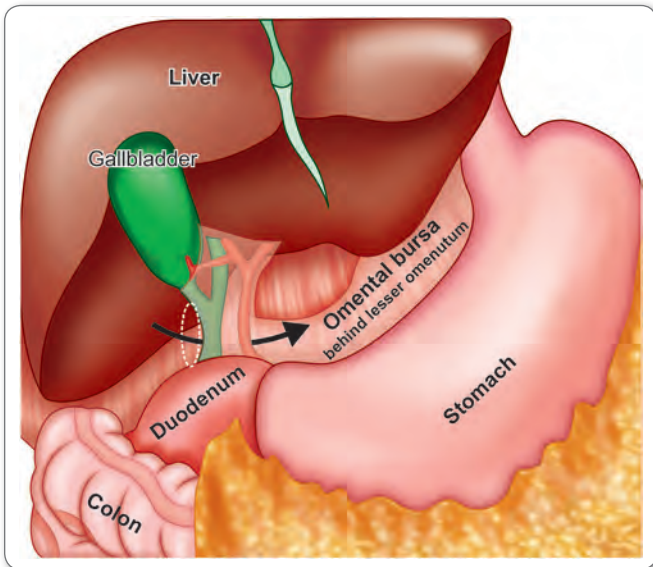


- 129. Portacaval anastomosis is seen between:** (DNB 2004, AI 1996)
- In the rectum: Superior rectal vein and inferior rectal vein
 - At the umbilicus: Portal vein and accessory hemiazygos vein
 - At the esophagus: Left gastric vein and paraumbilical vein
 - At the liver: Portal vein and renal azygos vein
- 130. Which of the following is false about portal vein?** (JIPMER 2011)
- Formed behind the neck of pancreas
 - Bile duct lies anterior and right to it
 - Gastroduodenal artery lies to left and anterior to it
 - Ascends behind 2nd part of duodenum
- 131. The most common variant in the blood supply of colon is:** (AIIMS Nov 2014)
- Absent right colic artery
 - Absent middle colic artery
 - Absent left colic artery
 - Absent superior rectal artery
- 132. A patient presented with pain in right testes. Examination reveals bag of worms suggestive of varicocele. Right testicular vein drains into** (JIPMER May 2016)
- Hemiazygos vein
 - IVC
 - Inferior mesenteric vein
 - Renal vein
- 133. A transpyloric plane of Addison is a horizontal line halfway between the jugular notch and the upper border of the pubic symphysis. It cuts through which of the following structures?** (JIPMER May 2015)
- Bifurcation of aorta
 - Inferior vena cava crossing the diaphragm
 - Ureters entering bladder
 - Origin of superior mesenteric artery from abdominal aorta

- 135. Structures injured while resecting the right free margin of lesser omentum:** (PGI May 2012)
- Portal vein
 - Hepatic artery proper
 - Hepatic vein
 - Cystic duct
 - Common bile duct
- 136. True about boundaries of epiploic foramen:** (AIIMS 1997)
- Portal vein – posteriorly
 - IVC – inferiorly
 - Hepatic artery – superiorly
 - Bile duct – anteriorly
- 137. Posteriorly perforating ulcer in the pyloric antrum of the stomach is likely to produce initial localized peritonitis in the:** (AIIMS Nov. 2004)
- Greater sac
 - Right subhepatic recess
 - Left subhepatic recess
 - Left suprahepatic recess
- 138. Most dependent space in standing posture:** (Recent Question 2014)
- Right subhepatic
 - Left sub hepatic
 - Pouch of Douglas
 - B and c
- 139. Root of the mesentery is crossed by:** (AIIMS May 2011)
- Superior mesenteric artery
 - Horizontal part of duodenum
 - Left ureter
 - Left gonadal vessels
- 140. Lesser sac is bounded by:** (PGI 2000)
- Posterior wall of stomach
 - Visceral surface of spleen
 - Under surface of liver
 - Greater omentum
- 141. Part of colon with no mesentery:** (Recent Question 2015)
- Transverse colon
 - Sigmoid colon
 - Ascending colon
 - Rectum
- 142. Morrison's pouch:** (Recent Question 2015)
- Right subphrenic space
 - Right subhepatic space
 - Left subhepatic space
 - Left subphrenic space

Peritoneum

- 134. Identify the structure marked by the arrow?** (AIIMS May 2017)



- Caudate lobe of the liver
- Foramen of Winslow
- Duodenum
- Lesser omentum

Kidney

- 143. Anterior relation of kidney are all, except:** (DNB 2003, AIIMS 1990)
- Liver
 - Hepatic flexure
 - Adrenal
 - Duodenum (4th part)
- 144. While exposing the kidney from behind, all of the following nerves are liable to injury, except:** (AI 2004)
- Lateral cutaneous nerve of thigh
 - Ilioinguinal nerve
 - Subcostal nerve
 - Iliohypogastric nerve
- 145. Left renal vein crosses aorta:** (AIIMS Nov. 2007)
- Post at level of superior mesenteric artery
 - Ant above the level of superior mesenteric artery
 - Ant below the superior mesenteric artery
 - Ant below the Inferior mesenteric artery
- 146. Initially, renal arteries are branch of:** (Recent Question 2015)
- Internal pudendal artery
 - External iliac artery
 - Common iliac artery
 - Aorta

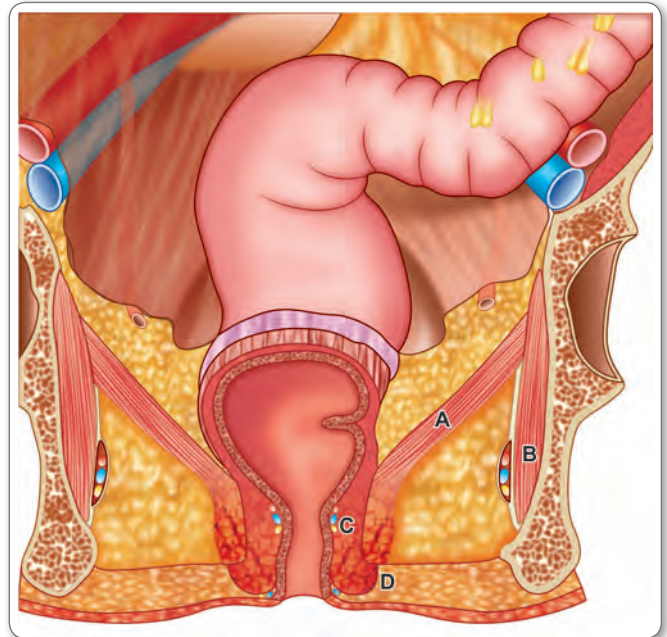


- 147. Correct sequence of structures at hilum of kidney from anterior to posterior** (AIIMS 1999)
- Renal artery, renal vein, renal pelvis
 - Renal vein, renal artery, renal pelvis
 - Renal vein, renal pelvis renal artery
 - Renal pelvis, renal artery, renal vein
- 148. All the following are true regarding blood supply to the kidney, except:** (AI 2002)
- Stellate veins drain superficial zone
 - It is a type of portal circulation
 - The renal artery divides into five segmental arteries before entering hilum
 - Its segmental arteries are end arteries
- 149. The renal angle lies between:** (DNB 2010)
- 9th rib and erector spinae
 - 10th rib and erector spinae
 - 12th rib and erector spinae
 - 11th rib and erector spinae
- 150. All are true about right kidney, except:** (AIIMS 2001)
- Right renal vein is shorter than left
 - Right related to duodenum
 - Right kidney is preferred over left for transplant
 - Right kidney is placed at the lower level than left
- 151. All the following statements about suprarenal glands are true, except:** (DNB 2007, AIIMS 2006)
- IVC and liver form the anterior relations of right supra renal gland
 - Medial border is related to inferior phrenic artery
 - Both glands drain into renal vein
 - Middle supra renal artery is branch of abdominal aorta
- 152. Suprarenal artery is derived from all, except:** (AIIMS 1999)
- Aorta
 - Renal artery
 - Inferior phrenic vein
 - Superior mesenteric artery
- 153. All of the following structures cross the right ureter anteriorly, except:** (AI 2012)
- Terminal ileum
 - Vas deferens
 - Genitofemoral nerve
 - Right colic and ileocolic vessels
- 154. The narrowest part of ureter is:** (DNB 2005)
- At pelvic brim
 - At ischial spine
 - Pelvic ureteric junction
 - At the entry of the bladder
- 155. True about ureter:** (PGI June 2006)
- Starts at hilum
 - Changes its direction at ischial spine
 - Penetrates bladder without valve
 - Enters bladder at the lateral angle of trigone
 - Enters pelvis in front of bifurcation of common iliac artery
- 156. Blood supply of ureter are:** (PGI 2003)
- Uterine artery
 - Inferior vesicle artery
 - Testicular artery
 - Common iliac artery
 - Femoral artery
- 157. True about ureter:** (AIIMS)
- Gonadal vessels lie anterior to it
 - Lies in front of great vessels
 - About 50 cm long
 - Nerve supply T8 – T10

- 158. Blood supply of ureter is/are from all, except:** (PGI Nov 2017)
- Middle rectal artery
 - Internal pudendal artery
 - Gonadal vessel
 - Common iliac artery
 - Vesical artery
- 159. Relations of left ureter are all Except:**
- Sigmoid mesentery (AIIMS Nov 2016, DNB Jun 2010)
 - Bifurcation of common iliac artery
 - Quadratus lumborum
 - Gonadal vessels
- 160. Anterior relations of right ureter are all except** (JIPMER May 2015)
- Gonadal vessels
 - Root of mesentery
 - Iliocolic vessels
 - Bifurcation of right common iliac artery

Pelvis and Perineum

- 161. Which of the following is/are true about perineal membrane of urogenital diaphragm:** (PGI Nov 2017)
- Posterior border is attached medially to perineal body
 - Triangular in shape
 - Carry pudendal nerve and internal pudendal artery
 - Perforated by ureter and vaginal
 - Supports pelvic floor
- 162. Which of the following marked structures is pelvic Diaphragm?** (AIIMS May 2017)



- A
- B
- C
- D

- 163. Urogenital diaphragm is made up of the following except:** (DNB 2011, AI 2010, 2009)
- Deep transverse perineal muscles
 - Perineal membrane
 - Colle's fascia
 - Sphincter urethrae



- 164. All are component of urogenital diaphragm, except:** (AI 2000)
a. Left transverse perineal profundus
b. Right transverse perineal profundus
c. Sphincter urethrae
d. Transverse perineal superficialis
- 165. Injury to male urethra below the perineal membrane causes urine to accumulate in:** (AI 2007)
a. Superficial perineal pouch
b. Deep perineal pouch
c. Space of Retzius
d. Pouch of Douglas
- 166. In patients with penile injury, Colles fascia prevents extravasation of urine in:** (Recent Question 2014)
a. Ischioanal fossa
b. Perineum
c. Abdomen
d. None
- 167. Contents of deep perineal pouch include all of the following except:** (AI 2009)
a. Dorsal nerve of penis
b. Bulbourethral gland
c. Root of penis
d. Sphincter urethrae
- 168. Superficial perineal space contains all, except:** (Recent Question 2014)
a. Root of penis
b. Posterior labial vessels
c. Greater vestibular glands
d. Membranous urethrae
- 169. True about ischioanal fossa:** (AIIMS 2010, 1997)
a. Apex is formed by obturator nerve
b. Levator ani forms the roof
c. Lateral wall by inferior pubic ramus
d. Communicates with other side posteriorly
- 170. During incision and drainage of ischioanal abscess, which nerve is/are affected:** (PGI May 2012)
a. Superior rectal nerve
b. Inferior rectal nerve
c. Superior gluteal nerve
d. Inferior gluteal nerve
e. Ilioinguinal nerve
- 171. The muscles attach to perineal body, except:** (AIIMS 1995)
a. Ischioavernosus
b. Bulbospongiosus
c. Superficial transverse perineal
d. Deep transverse perineal
- 172. All the following are true regarding pudendal nerve, except:** (AI 2001)
a. Sensory and motor
b. Derived from S2,3,4
c. Leaves pelvis through lesser sciatic foramen
d. Main nerve supply to perineum
- 173. Structures forming perineal body are all, except:**
a. Levator ani muscle
b. Bulbospongiosus
c. Deep transverse perineal
d. Ischiococcygeus
- 174. Pelvic diaphragm is made of all, except:**
a. Iliococcygeus
b. Ischiococcygeus
c. Pubococcygeus
d. Puborectalis
- 175. Pelvic pain is mediated by:**
a. Pudendal nerve
b. Sciatic nerve
c. Autonomic nerves
d. None of these
- 176. True about nervi erigentes are all, except:** (Recent Question 2015)
a. Autonomic nerve
b. Parasympathetic outflow
c. Arise from ventral rami
d. Joins superior hypogastric plexus
- 177. Which is not supplied by pelvic splanchnic nerve:** (AIIMS May 2010, 2009)
a. Rectum
b. Urinary bladder
c. Appendix
d. Uterus
- 178. Which of the following are true about autonomic nervous system:** (AI 2003)
a. Sympathetic outflow from CNS is through cranial nerve and sympathetic chain
b. Parasympathetic outflow from CNS is only through cranial nerve
c. Superior hypogastric plexus is located at anterior aspect of aortic bifurcation and 5th lumbar vertebra
d. Superior hypogastric plexus contains sympathetic fibers only
- 179. All are related to posterior surface of bladder, except:** (AI 2001)
a. Ureter
b. Rectum through rectovesical pouch
c. Seminal vesicles
d. Vas deferens
- 180. False regarding trigone:** (Recent Question 2015)
a. Lined by transitional epithelium
b. Mucosa is loosely associated with underlying musculature
c. Developed from mesonephric duct
d. Mucosa smooth
- 181. Nerve supply to musculature of bladder:** (Recent Question 2015)
a. Parasympathetic
b. Sympathetic
c. Both
d. None
- 182. In bladder injury, pain is referred to all except:** (AI 2012)
a. Upper part of thigh
b. Lower abdominal wall
c. Flank
d. Penis

Male Reproductive System Testes

- 183. Artery to vas arise from:** (Recent Question 2014)
a. Aorta
b. Inferior epigastric
c. Inferior vesicle
d. Internal pudendal
- 184. In fracture of penis involving rupture of tunica albuginea with intact Buck's fascia following would be noted:** (AIIMS Nov. 2007)
a. Hematoma involving shaft of penis
b. Hematoma involving scrotum and penis
c. Hematoma involving scrotum and penis and thigh
d. Hematoma involving scrotum and penis and abdominal wall
- 185. Crura of penis supplied by:** (Recent Question 2015)
a. Dorsal artery of penis
b. Deep artery of penis
c. External pudendal artery
d. Obturator artery
- 186. Helicine artery branch of:** (AI 2013)
a. Deep artery of penis
b. Femoral artery
c. External pudendal artery
d. None of the above
- 187. All the following mediate the erection of penis, except:** (AIIMS 2001)
a. Pudendal nerve
b. Sacral plexus
c. Hypogastric plexus
d. Nervi erigentes
- 188. All are component of spermatic cord, except:** (DNB 2001, AI 2000)
a. Poupart's ligament
b. Genitofemoral nerve
c. Vas deferens
d. Pampiniform plexus



- 189. The intricately and prodigiously looped system of veins and arteries that lie on the surface of epididymis is known as:** (DNB 2008, AI 2004)
- Choroid plexus
 - Tuberal plexus
 - Pampiniform plexus
 - Pectiniform septum
- 190. Which of the following is the correct order of pathway for a sperm?** (AI 2008)
- Straight tubules-rete testis-efferent tubules
 - Rete tubules-efferent tubules-straight tubules
 - Efferent tubules-rete tubules-straight tubules
 - Straight tubules-efferent tubules-rete tubules
- 191. The prostatic urethra is characterized by all of the following features, except that it:** (AI 2005)
- It is the widest and most dilatable part
 - Presents a concavity posteriorly
 - Lies closer to anterior surface of the prostate
 - Receives prostatic ductules along its posterior wall
- 192. Shortest part of male urethrae:** (DNB 2003, AI 1999)
- Prostatic
 - Membranous
 - Bulbar
 - Penile
- 193. Not true about prostatic urethra:** (DNB 2010)
- Trapezoid in cross section
 - Presence of verumontanum
 - Opening of prostatic ducts
 - Contains urethral crest
- 194. All of the following statements regarding vas deferens are true, except:** (AI 2005)
- The terminal part is dilated to form ampulla
 - It crosses ureter in the region of ischial spine
 - It passes lateral to inferior epigastric artery at deep inguinal ring
 - It is separated from the base of bladder by the peritoneum
- 195. Benign prostatic hypertrophy results in obstruction of the urinary tract. The specific condition is associated with enlargement of the:** (AI 2005)
- Entire prostate gland
 - Lateral lobes
 - Median lobes
 - Posterior lobes
- 196. Urethral crest is due to:** (AIIMS May 2013)
- Prostatic glands
 - Trigonal muscle
 - Seminal vesicle
 - Insertion of detrusor
- 197. All are true about sphincter urethrae, except:** (AIIMS Nov. 2014)
- Voluntary
 - Supplied by pudendal nerve
 - Originates from ischiopubic rami
 - Located at bladder neck
- 198. Bulbourethral glands open into:** (AI 2012)
- Membranous urethra
 - Spongy urethra
 - Prostatic urethra
 - Intra mural urethra
- 200. True about fallopian tube:** (PGI May 2012)
- Length 20 cm
 - Medial to lateral isthmus, interstitial, ampulla, fimbriae
 - Ovary attach to uterus by ovarian ligament
 - Ampulla longest
 - Uterine artery supply the medial two-thirds
- 201. Part of fallopian tube act as functional anatomical sphincter:** (AIIMS Nov. 2013)
- Intramural
 - Isthmus
 - Ampulla
 - Infundibulum
- 202. Maximum number of mucous folds are found in which part of fallopian tube:** (Recent Question 2015)
- Intramural
 - Isthmus
 - Ampulla
 - Infundibulum
- 203. Normal antelexion:** (AI 2013)
- 90
 - 100
 - 125
 - 140
- 204. Supports of the uterus are all, except:** (AI 2007, AIIMS Nov. 2006)
- Uterosacral ligament
 - Broad ligament
 - Mackenrodt's ligament
 - Levator ani
- 205. All of the following provide support to the uterus, except:** (AIIMS 1992, DNB 2003)
- Pelvic floor
 - Transcervical ligament
 - Round ligament of uterus
 - Uterosacral ligament
- 206. Not a true support of uterus is:** (DNB 2010)
- Transverse ligament
 - Round ligament
 - Utero sacral ligament
 - Broad ligament
- 207. Secondary support of uterus is:** (DNB 2011)
- Mackenrodt ligament
 - Uterosacral ligament
 - Round ligament
 - Broad ligament
- 208. All are contents of broad ligament, except:** (DNB 2004, AIIMS 1992)
- Ovary
 - Ovarian ligament
 - Round ligament
 - Fallopian tube
- 209. Ratio of connective tissue : smooth muscle in cervix:** (AI 2013)
- 2:1
 - 5:1
 - 8:1
 - None
- 210. Length of posterior vaginal wall:** (AI 2013)
- Variable
 - Same as anterior vaginal wall
 - Less than anterior vaginal wall
 - More than anterior vaginal wall
- 211. Lateral fornix is related to all except:** (AI 2012)
- Ureter
 - Uterine artery
 - Inferior vesicle artery
 - Transverse cervical ligament
- 212. All of the following are contents of vaginal sphincter except:** (DNB 2010)
- External urethral sphincter
 - Internal urethral sphincter
 - Bulbospongiosus
 - Pubovaginalis
- 213. Pain of ovarian pathology is referred to:** (AIIMS Nov. 2010)
- Back of thigh
 - Anterior thigh
 - Medial thigh
 - Gluteal region

Ovary

- 199. Order of the following structures of the tube from lateral to medial:**
- Ampulla – infundibulum – isthmus – interstitial
 - Infundibulum – ampulla – isthmus – interstitial
 - Isthmus – infundibulum – ampulla – interstitial
 - Ampulla – isthmus – infundibulum – interstitial



214. Ovarian fossa is formed by all except (Recent Question 2015)

- a. Obliterated umbilical artery
- b. Internal iliac artery
- c. Ureter
- d. Round ligament

215. The following group of lymph nodes receives lymphatics from uterus, except: (AI 2005)

- a. External iliac
- b. Internal iliac
- c. Superficial inguinal
- d. Deep inguinal

216. Lymphatic drainage of ovary: (AI 2012)

- a. Deep inguinal
- b. Superficial inguinal
- c. Obturator
- d. Para-aortic nodes

217. Lymph node drains upper part of vagina and cervix: (Recent Question 2015)

- a. Para aortic
- b. External iliac
- c. Superficial inguinal
- d. Deep inguinal

218. Lymphatic drainage of testes is to: (DNB 2006)

- a. Internal iliac
- b. Para-aortic node
- c. Sup-inguinal
- d. Deep inguinal nerve

219. Lymphatic drainage of glans penis is: (DNB 2004, AI 1995)

- a. Superficial inguinal lymph nodes
- b. Deep inguinal lymph nodes
- c. Para aortic lymph nodes
- d. Internal iliac lymph nodes

Abdomen

General

220. Plane passing midway between suprasternal notch and pubic symphysis: (Recent Question 2016-17)

- a. Transpyloric plane
- b. Transtubercular plane
- c. Subcostal plane
- d. Plane of least dimensions

221. Muscle which contributes to two triangles in the back is: (Recent Question 2015-16)

- a. Splenius Capitis
- b. Serratus Anterior
- c. Trapezius
- d. Latissimus dorsi

222. Below arcuate line, anterior wall of rectus sheath is formed by: (Recent Question 2016-17)

- a. External oblique, int. oblique and T. abdominis
- b. Int. oblique and T. abdominis
- c. Both obliques only
- d. T. abdominis and pectineus

223. Cremasteric muscle is derived from: (Recent Question 2016-17)

- a. External oblique fascia
- b. Internal oblique fascia
- c. Transversalis fascia
- d. Tunica albuginea

Peritoneal Cavity

224. Epiploic foramen connects which two important structure in body: (Recent Question 2016-17, DNB 2007)

- a. Lesser sac with greater sac
- b. Lesser sac with pouch of Morrison
- c. Greater sac with pouch of Morrison
- d. Morrison's pouch to pelvic space

225. Hepatorenal pouch also called as:

(Recent Question 2016-17)

- a. Right Anterior intraperitoneal pouch
- b. Right Posterior intraperitoneal pouch
- c. Left Anterior intraperitoneal pouch
- d. Left posterior intraperitoneal pouch

Liver

226. According to the Couinaud classification, liver is divided into how many functionally independent segments: (Recent Question 2016-17)

- a. 5
- b. 6
- c. 7
- d. 8

227. Canal of Herring is seen in: (Recent Question 2016-17)

- a. Liver
- b. Spleen
- c. Thymus
- d. Kidney

228. ITO cells of liver is function as: (Recent Question 2016-17)

- a. Vitamin A storage cells
- b. Cells of regeneration
- c. Stem cells of liver
- d. All are true

229. Structure which lies anterior to left kidney without a fold of peritoneum/membrane in between is: (Recent Question 2016-17)

- a. Spleen
- b. Transverse colon
- c. Stomach
- d. Pancreas

230. Order of structure in porta hepatis are: (Recent Question 2016-17)

- a. Right Anterior - Portal vein; posterior- Hepatic artery; left anterior - bile duct
- b. Right Anterior - bileduct; posterior- Hepatic artery; left anterior - Portal vein
- c. Right Anterior - Portal vein; posterior- bile duct; left anterior - Hepatic artery
- d. Right Anterior - Hepatic artery; posterior portal vein; left anterior - bile duct

Spleen

231. Spleen develops from: (Recent Question 2016-17)

- a. Dorsal mesogastrium
- b. Ventral mesogastrium
- c. Mesoderm of septum transversum
- d. All of above

Stomach

232. All lymph nodes draining from stomach drains into which lymph node: (Recent Question 2016-17)

- a. Celiac group of lymph nodes
- b. Mesenteric lymph nodes
- c. Pancreaticosplenic lymph nodes
- d. Inguinal lymph nodes

233. Cells of cajal is present in at: (Recent Question 2016-17)

- a. Stomach
- b. Liver
- c. Kidney
- d. Spleen

Intestine

234. Most common site of Mucosa associated lymphoid tissue (MALT) (Recent Question 2016-17; AIIMS Nov 14)

- a. Jejunum
- b. Duodenum
- c. Ileum
- d. Stomach

**Kidney****235. Which is the correct order of renal artery:***(Recent Question 2016-17)*

- a. Interlobar -> Segmental -> arcuate
- b. Segmental -> interlobar -> arcuate
- c. Arcuate -> Segmental -> interlobar
- d. Interlobar -> arcuate -> Segmental

236. The left suprarenal vein drains into:*(Recent Question 2015-16)*

- a. Internal Iliac vein
- b. Left renal vein
- c. Left suprarenal vein
- d. Inferior vena vein

237. Which of the following structure anteriorly crosses the abdominal aorta?*(Recent Question 2016-17)*

- a. Left renal vein
- b. Right renal vein
- c. Right renal artery
- d. Left renal artery

238. Duct of Bellini is present in:*(Recent Question 2016-17)*

- a. Gallbladder
- b. Kidney
- c. Anal canal
- d. Lymph nodes

Male Genitalia**239. Sperm maturation takes place at:***(Recent Question 2016-17, NBE Pattern 2012-13)*

- a. Testis
- b. Seminiferous tubules
- c. Epididymis
- d. Fallopian tube

240. Which of the following is true about nerve supply of adrenal gland?*(AIIMS May 2018)*

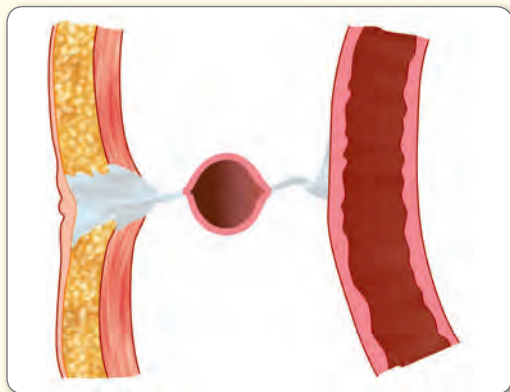
- a. Stress hormone secretion are not under nervous control
- b. Preganglionic fibres from lower thoracic and lumbar vertebra come via sympathetic chain to supply adrenal cortex
- c. Adrenal cortex devoid of nerve supply
- d. Adrenal medulla doesn't have nerve supply

241. Nervi furcalis*(JIPMER May 2018)*

- a. L3
- b. L4
- c. L5
- d. L6

242. Ejaculatory duct developed from:*(JIPMER May 2018)*

- a. Mesonephric duct
- b. Paramesonephric duct
- c. Mesonephros
- d. Genital ridge

243. Identify the anomaly in the given:*(JIPMER Dec 2019)*

- a. Vitelline cyst
- b. Meckel's diverticulum
- c. Vitelline fistula
- d. Omphalocele

244. Correct about renal arteries:*(Recent Question 2018)*

- a. They are end arteries
- b. Medulla has more supply than cortex
- c. Arcuate arteries anastomose with each other
- d. Anastomose takes place at lobar level

245. Cholecystocaval lines separates:*(Recent Question 2019)*

- a. Caudate and quadrate lobe
- b. Physiological left and right half of liver
- c. IVC and gallbladder
- d. Caudate lobe and IVC

246. Umbilicus dermatome*(Recent Question 2019)*

- a. T10
- b. T11
- c. T12
- d. L1

247. All of the following are extensions of external oblique aponeurosis except:*(Recent Question 2019)*

- a. Lacunar ligament
- b. Pectinate ligament
- c. Linea semilunaris
- d. Inguinal ligament

248. Which of the following is an end artery?*(Recent Question 2019)*

- a. Renal artery
- b. Interlobar artery
- c. Interlobular artery
- d. Arcuate artery

249. Uvula vesicae of prostate is due to:*(Recent Question 2019)*

- a. Anterior lobe
- b. Posterior
- c. Lateral
- d. Median lobe

250. Which of following statement(s) is/are false about anatomy of genitourinary region?*(PGI May 2018)*

- a. Penile skin is supplied by superficial external pudendal artery
- b. Nerve supply of penile skin is from obturator nerve
- c. There are at least 5 urethral sphincters
- d. Penis receives three venous drainage systems
- e. Dorsal artery of penis is branch of bulbourethral artery

251. Which of the following is/are true regarding anatomy of kidney?*(PGI May 2018)*

- a. Kidney extend b/w upper border of 1st lumbar vertebrae & lower border of 3rd lumbar vertebrae
- b. Long axis of the kidney is directed upward & laterally
- c. Anterior segmental artery is first & most constant branch of renal artery
- d. Supplied by preganglionic T8-T12 sympathetic fibers
- e. Papilla of renal pyramids terminates into minor calyx

252. External anal sphincter is supplied by:*(PGI May 2018)*

- a. S2, S3, S4
- b. S2, S3
- c. S1, S2
- d. L5, S1
- e. L2, L3

253. Not derived from ventral mesogastrium:*(PGI May 2018)*

- a. Falciform ligament
- b. Right coronary ligament
- c. Left coronary ligament
- d. Greater omentum
- e. Triangular ligament



Answers with Explanations

1. **Ans. c. Wharton jelly is the connective tissue of the cord**

[Ref: The Developing Human-Clinically Oriented Embryology Keith L. Moore 10th pg.no.124]

Umbilical cord contains one vein and two arteries

2. **Ans. d. Mesonephric duct**

[Ref: The Developing Human Clinically Oriented Embryology Keith L. Moore 10th pg.no.243]

Ureter – collecting part - from mesonephric duct

3. **Ans. a. Greater omentum**

Greater omentum from dorsal mesentery

4. **Ans. d. Ureteric bud**

[Ref: IB Singh, 8th ed. pg 237-241]

5. **Ans. d. Failure of descent of kidney into lumbar region**

[Ref: IB Singh, 8th ed. Pg 237-241]

Kidney ascent from sacral region to lumbar region
Excreting component derived from metanephric blastema

6. **Ans. a. Patent allantois**

[Ref: Langman's Embryology, 12th ed. Pg 72]

Allantois degenerates and form the remnant urachus.

7. **Ans. d. Scrotum**

[Ref: Gray's Anatomy 40th ed. PG 1317-1321]

8. **Ans. a. Müllerian duct**

[Ref: Langman's Medical Embryology, 12th edition 244-245]

9. **Ans. d. Externally fully differentiated at 10th week**

[Ref: Langman's Medical Embryology, 9th edition 239-253]

External genitalia differentiate at 12 week and complete by 20th week

Testis at 7th week, ovary by 10th week

Genital ridge at 5th week.

10. **Ans. c. 7th month**

[Ref: Ib Singh Embryology 8th edition Pg 237-241]

Testis Descent

4th month → iliac fossa

7th month → deep inguinal ring

7th and 8th month → Inguinal canal

11. **Ans. a. Genital ridge**

[Ref: Ib Singh Embryology 8th edition Pg 237-241]

12. **Ans. b. Wolffian duct**

[Ref: Ib Singh Embryology 8th edition Pg 237-241]

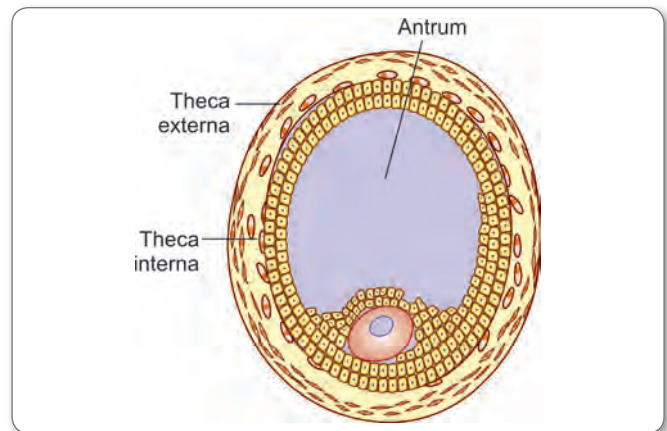
13. **Ans. b. Wolffian duct**

[Ref: Ib Singh Embryology 8th edition Pg 237-241]

14. **Ans. c. Germinal cells**

[Ref: (A.K.Datta Human Embryology 6th ed) IB Singh Embryology 8th edition Pg 237-241]

Graafian follicle Secondary oocyte and first polar body



Coverings from outside to inwards are:

- Theca externa
- Theca interna
- Membrana granulosa
- Cumulus Ovaricus
- Zona pellucida

15. **Ans. b. Paramesonephric duct**

[Ref: IB Singh Embryology 8th edition Pg 237-241]

16. **Ans. d. Dorsal bud forms uncinat process**

[Ref: Moore Persaud 8th edition Pg 213-238]

Lower Respiratory system - diverticulum from the foregut
Accessory pancreatic duct (Duct of Santorini) formed by proximal part of dorsal duct

17. **Ans. a. Stomach**

[Ref: Moore Persaud 8th edition Pg 222]

Accessory pancreatic tissue found in stomach, duodenum or Meckel's diverticulum.

18. **Ans. a. Lesser omentum**

[Ref: Moore Persaud 8th edition Pg 224-225]

**19. Ans. c. Kidney**

[Ref: Moore Persaud 8th edition Pg 224-225]

Kidney developed from metanephros and ureteric bud

20. Ans. c. Endoderm of urogenital ridge

[Ref: Langman's Embryology 12th edition Pg 250]

Vagina develops from mesoderm of paramesonephric duct.
Endoderm of urogenital ridge.

21. Ans. b. Descends into scrotum with its inferior pole attached to gubernaculum

[Ref: Gray's Anatomy 40th edition Pg 1317-1321]

Testes from genital ridge
Reach scrotal sac by 9th month
Peritoneal covering called process vaginalis

22. Ans. b. Ligamentum teres

Mesentery of lesser sac (lesser omentum), falciform ligament, coronary ligament develops from septum derivatives
Ligamentum teres is remnant of left umbilical vein

23. Ans. b. 10th week

[Ref: Gray's Anatomy 40th edition Pg 1209]

24. Ans. d. Mixed rotation

[Ref: Gray's Anatomy 40th edition Pg 1209]

Cecum – sub pyloric in mixed rotation

25. Ans. c. Malrotation

[Ref: Gray's Anatomy 40th edition Pg 1209]

Child with recurrent abdominal pain and bilious vomiting is mainly due to malrotation or rotational anomaly
Ladd's band formed
So lysis of Ladd's band, mesenteric widening to prevent volvulus

26. Ans. d. Minor duct is made up of only the distal part of dorsal bud

Minor duct is made up of proximal part of dorsal bud

Umbilicus**27. Ans. d. Ileum developed from midgut****28. Ans. b. Inferior mesenteric artery**

Descending colon – hind gut – inferior mesenteric artery

29. Ans. c. Structure formed from ureteric bud is collecting ducts

Ureteric bud forms – collecting duct

30. Ans. a. 9 weeks

Up to 6 weeks indifferent gonads.
7th week testes develop

10th week ovary develops
So best answer here 9th week

31. Ans. d. D

[Ref: Gray's 41st ed page 1071,1079,1343]

A – Thoracolumbar fascia
B – Line of demarcation between aponeurosis and muscle
C – Inguinal ligament
D – Conjoint tendon

32. Ans. b. 1. Linea alba, 2. Linea semilunaris, 3. Outer lip of iliac crest, 4. Inguinal ligament

Ref: Gray's Anatomy 41st ed page 1071,1079,1343

33. Ans. a. L1 L2

Ref: Greys anatomy 41st edition page 1045

- The cremaster is reflex is brought about by stroking the medial side of the thigh. This leads to contraction of cremaster muscle which elevates the ipsilateral testes. This reflex is mediated by genitofemoral nerve with root valu L1 and L2.
- In torsion of the testicle, this reflex is absent

34. Ans. b. Hypochondrium from lumbar region

[Ref: BDC 6th Ed Vol2 Pg 229]

Transpyloric plane separates hypochondrium from lumbar region, epigastrium from umbilical region

35. Ans. a. Lineal alba poorly developed, c. External oblique poorly formed

[Ref: Last Anatomy 12th edition Pg 220-224]

External oblique is poorly developed (only aponeurosis)
Three layers of rectus sheath present
Rectus is not divided.

36. Ans. d. Forms suspensory ligament of penis

Scarpa fascia – deep membranous layer of superficial fascia
Attach to inguinal ligament and fascia lata
Forms suspensory ligament of penis

37. Ans. a. Poupart's ligament, b. Lacunar ligament, c. Superficial inguinal ring

[Ref: Last Anatomy 12th edition Pg221-222]

External oblique aponeurosis thickens to form inguinal ligament
Superficial ring is defect in external oblique aponeurosis
Lacunar ligament is extension of inguinal ligament

38. Ans. a. Femoral branch of genitofemoral nerve, c. Psoas major, d. Femoral vein

Structures pass deep to inguinal ligament
Psoas major
Femoral nerve
Femoral vessels



Lateral femoral cutaneous nerve
Femoral branch of genitofemoral nerve

39. Ans. a. Xiphoid process

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 205]

40. Ans. a. Subcostal nerve

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 205]

Pyramidalis supplied by sub costal nerve

41. Ans. b. Genital branch of genitor femoral nerve

Afferent - Femoral branch of genitofemoral nerve and ilioinguinal nerve.

Efferent - genital branch of genitor femoral nerve

42. Ans. c. Both axillary and inguinal node

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 202]

43. Ans. b. Between internal oblique and transverse abdominis

Neurovascular plane - between internal oblique and transverse abdominis

44. Ans. b. Internal oblique and transverse abdominis

Falx inguinalis (conjoint tendon) - formed by internal oblique and transverse abdominis (2/3 by transverse abdominis and 1/3 internal oblique)

45. Ans. c. Pelvic fascia

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 423]

46. Ans. d. Rectoprostatic fascia

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 402]

47. Ans. c. Deep ring is opening in transverse abdominis

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]

Deep ring is defect in fascia transversalis

48. Ans. c. Deep inguinal ring is supero..., e. Cremasteric artery is branch of external iliac artery

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]

Deep inguinal ring is 1.25 cm above the mid inguinal point
Cremasteric artery is branch from inferior epigastric artery

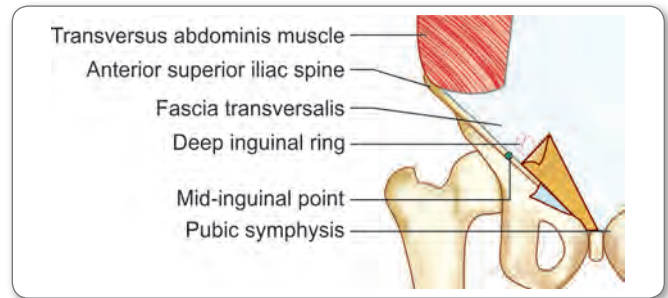
49. Ans. d. Lacunar ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]

Lacunar ligament forms the floor of inguinal canal

50. Ans. d. Inferior epigastric artery

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]



51. Ans. d. Ilioinguinal nerve

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 224]

Ilioinguinal nerve is the partial content, enters the canal by piercing the internal oblique 2.5 cm below and medial to anterior superior iliac spine.

From margins of deep ring, internal spermatic fascia extends over the spermatic cord

From the margins of superficial ring, external spermatic fascia extends over the cord

52. Ans. a. Ilioinguinal nerve

[Ref: Last Anatomy 12th edition Pg 228-229]

Inguinal nerve is not content of spermatic cord

Contents of spermatic cord

- Vas deferens
- Artery to vas, cremasteric artery, testicular artery
- Pampiniform plexus
- Genital branch of genitor femoral nerve, testicular plexus
- Lymphatics
- Accessory supra renal tissue
- Remnant of processes vaginalis

53. Ans. c. Coopers ligament

54. Ans. a. Urinary bladder

Pubic symphysis at the level of tip of coccyx, aorta terminates at the level of L4, left renal vein at L2, spinal cord at L1. So only structure might damage is bladder which may reach up to umbilicus when it is filled.

Other Vertebral Levels

T12 - aorta piercing diaphragm, origin of celiac trunk, tail of pancreas, epiploic foramen, upper end of kidney

L1 - origin of superior mesenteric artery, pylorus of stomach, fundus of gallbladder, hilum of kidney, termination of spinal cord

L2 - neck of pancreas and formation of portal vein, duodeno-jejunal flexure

L3 - origin of inferior mesenteric artery, third part of duodenum, lower end of kidney



L1 to L3 – second part of duodenum
 L3 to L4 – umbilicus level
 L4 – termination of aorta into two common iliac arteries
 L5 – formation of inferior vena cava

55. Ans. b. Lower part attached to sacrospinous ligament

[Ref: Grey's Anatomy the Anatomical Basis of Clinical Practice. 41st edition pg.no 738. Apley's & Solomon's of orthopaedics and trauma 10th ed. pg no.863]

- Iliolumbar ligament is the major ligament associated with lumbosacral junction
- It is attached to the tip of anteroinferior aspect of transverse process of fifth lumbar vertebrae and occasionally to transverse process of the fourth lumbar vertebrae
- It has two parts-upper part and lower part
- Upper part attached to iliac crest anterior to sacroiliac joint and is continuous above with anterior layer of thoracolumbar fascia
- Lower part reaches posterior part of iliac fossa and blends with anterior sacroiliac ligament
- The iliolumbar ligament contributes to the anterior stability of sacroiliac joints.

56. Ans. c. The fascia lies posterior to posterior abdominal wall muscles

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 343]

57. Ans. b. Right suprarenal vein

[Ref: BDC 6th edition Volume 2 Pg 339, 340]

58. Ans. d. It forms posterior wall of epiploic foramen, e. Related to psoas muscle

[Ref: BDC 6th edition Volume 2 PG 339, 340]

Passes Through T8
 Right supra renal vein not artery drain into it
 Related to psoas muscle posteriorly
 Epiploic foramen is situated anterior to IVC

59. Ans. b. Thoracoepigastric dilatation

60. Ans. c. Superficial epigastric and iliolumbar vein

Superficial epigastric vein tributary of great saphenous vein
 Ilio lumbar vein drains into internal iliac vein
 So both of these drain into IVC and not provide collaterals.

61. Ans. a. Anterior or anterolateral to aorta

[Ref: Gray's 40th edition pg 1044-47]

Celiac plexus situated anterolateral to aorta

62. Ans. b. Greater splanchnic nerve

Celiac plexus receives greater and lesser splanchnic nerves

63. Ans. a. Right vagus

Nerve of grazi branch of posterior (right) vagal trunk

64. Ans. c. Preaortic

Lymph from stomach drain to right and left gastroepiploic nodes, pyloric nodes, hepatic nodes and celiac nodes.

65. Ans. b. 8 meter

[Ref: Clinical Anatomy 7th/e p. 786]

Small intestine – 6–7 cm

Large intestine – 1.5 cm

66. Ans. b. Inferior mesenteric vein

[Ref: Last Anatomy 12th edition pg 254]

67. Ans. b. Gastric rugae

Gastric rugae and longitudinal folds in the upper rectum are temporary folds. Rest are permanent mucous folds

68. Ans. d. Superior mesenteric vein

[Ref: BDC 6th ed. vol. II / 261]

Third part of duodenum is crossed by superior mesenteric vessels.

69. Ans. c. Accessory pancreatic duct

Minor duodenal papilla - Accessory pancreatic duct
 Major duodenal papilla - Hepatopancreatic ampulla

70. Ans. d. Supplied by superior mesenteric artery

Duodenum – foregut – supplied by celiac trunk

71. Ans. d. Large circular mucous folds

[Ref: Last Anatomy 12th edition Pg 254]

Ileum circular folds are smaller and at the terminal part of ileum almost with no circular folds.
 Jejunum is having large mucous folds

72. Ans. d. Distal part of duodenum has cap

[Ref: Last Anatomy 12th edition Pg 253-254]

Proximal part (1st part) of duodenum has cap since circular folds are absent in first part of duodenum.

73. Ans. a. Ileum

[Ref: Last Anatomy 12th edition Pg 253-254]

Plica circularis or valves of Kerckring or valvulae conniventes or intestini tenuis features of small intestine
 Circular folds absent in first part and gradually increasing from second part up to jejunum
 From jejunum circular folds gradually decreasing and in terminal part of ileum circular folds are almost absent.

74. Ans. a. They disappear after mobilization of the rectum

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 409]

Houston valves more prominent on distension and disappear on surgical mobilization of rectum



Middle valve present on the left side and folds towards on right side

Middle fold most constant one, projecting from anterior right wall along the concavity of middle lateral curve., at the level of anterior peritoneal reflection

Contain only circular muscle not longitudinal muscle.

75. Ans. a. Anteriorly correlate with peritoneal reflection

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 409]

Placed transversely.

Valve is formed by reduplication mucous tissue containing submucous tissue and thickening of circular muscle with or without longitudinal muscle (not all layer of muscle wall). So valve contain all layer of intestine (mucous, submucous, muscular layer).

76. Ans. a. Retrocecal

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 269]

77. Ans. c. Develops from midgut, d. Supplied by appendicular branch of ileocolic

[Ref: Last Anatomy 12th edition pg 2545-256]

Appendix is devoid of mesentery, taenia and appendices epiploicae

Appendix developed from midgut

Supplied by appendicular artery which is end artery.

78. Ans. b. Payers patches

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 267]

Payers patch present in ileum

79. Ans. d. Sigmoid colon

Appendices epiploicae absent in cecum, appendix and rectum

80. Ans. c. Preaortic

Terminal node of colon superior and inferior mesenteric nodes belong to preaortic

81. Ans. a. Large intestine secrete acid mucus which helps information of stool

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 267]

Secretions of large intestine are alkali not acidic

Extends from ileocecal junction to anus (site for mucocutaneous junction)

Absorptive in function but villi are absent

82. Ans. a. Inferior rectal vein

Connective tissue and fat around the rectum is called as mesorectum

Contents

- Superior rectal vessels
- Lymphatic accompanying the vessels
- Branch from inferior mesenteric plexus to innervate rectum

83. Ans. a. Blood supply above pectinate line is through superior rectal artery

[Ref: BDC Vol-II 6th/e p. 413-416]

84. Ans. d. Insensitive to pain

Upper part of anal canal insensitive pain

Columnar epithelium over the upper part

Upper part drained to internal iliac nodes.

85. Ans. d. Transitional epithelium lies above the dentate line

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 414]

Transitional epithelium (urothelium is not mentioned here).

Epithelium is transitioned from columnar epithelium to non-keratinized stratified squamous epithelium below the dentate line. Not above.

All other statements are true.

86. Ans. b. Pudendal nerve

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 416]

External hemorrhoids are present below the dentate line

External hemorrhoids are painful since the area below the pectinate line supplied by somatic nerve (pudendal nerve)

Internal hemorrhoids are above the dentate line

It is painless since the area supplied by autonomic plexus.

87. Ans. d. Internal circular fibers

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 414]

88. Ans. a. Puborectalis is essential to maintain continence, c. Internal sphincter remains in the state tonic contraction

Internal sphincter is smooth muscle

External sphincter is supplied by pudendal nerve

Anal canal drained by internal iliac nodes and superficial inguinal nodes

89. Ans. a. Internal iliac nodes

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 412]

Internal iliac nodes are palpable only when enlarged.

90. Ans. c. Ureter

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 412]

91. Ans. a. Fascia of Waldeyer

Fascia of Waldeyer present behind the rectum.

92. Ans. b. Caudate lobe drains only left hepatic duct

[Ref: Last Anatomy 12th edition PG 259-263]

Caudate lobe drains to both right and left duct

Right inferior anterior V, right superior anterior VIII



93. Ans. c. Three major and minor fissures

[Ref: Last Anatomy 12th edition PG 259-263]

Fissures are not generally included for functional divisions.

94. Ans. a. Hepatic vein and portal vein

[Ref: Gray's Anatomy 39th edition pg 268]

95. Ans. c. Segment 2 and 3

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 306, 308]

96. Ans. a. V, VI, VII and VIII

[Ref: Last Anatomy 12th edition pg 259-263]

Caudate lobe – I

Left lobe consists of II, III, IV

Right lobe – V, VI, VII, VIII

97. Ans. b. III

[Ref: Last Anatomy 12th edition pg 259-263]

Caudate lobe – segment 1 drains to both right and left duct

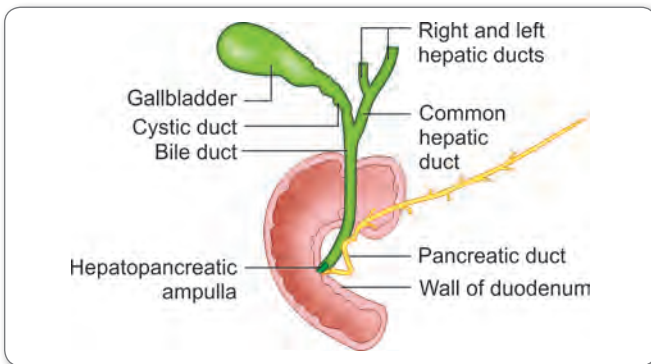
So I, V, VIII segments drains into right duct except III which is drained by left duct

98. Ans. a. Segment I

Caudate lobe is physiologically independent. Supplied by right and left hepatic arteries.

99. Ans. b. 20% hepatic artery 80% portal vein

Liver – dual blood supply 80% portal vein and 20 % hepatic artery.



100. Ans. d. Usually opens into duodenum separate from the main pancreatic duct

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 289]

Portal vein and inferior vena cava forms posterior relations.

Common bile duct and pancreatic duct pierce separately the duodenal wall not opens separate from pancreatic duct.

101. Ans. c. 4 sphincters

[Ref: Gray's Anatomy 40th edition pg 1178]

102. Ans. b. Anterior to first part of duodenum

Posterior to 1st part of duodenum (retroduodenal)

103. Ans. a. Vessels that run upward along the bile duct from the duodenal end of the duct such as the retroduodenal and the gastroduodenal arteries

Ductal Arteries–Axial Network

CBD and hepatic duct are supplied by a ascending and descending arteries (axial vessels) which run along the course of ducts. These vessels are derived from various source.

60% contribution from ascending vessels (retroduodenal branch of gastroduodenal artery) from caudal end from.

38% contribution from descending branches of right hepatic and cystic arteries as these arteries pass close to common hepatic duct.

Retroportal artery from the celiac axis, superior mesenteric artery or any of the major arteries also contributes to axial arterial network.

Nonaxial network minor contribution – derived from hepatic artery proper.

104. Ans. a. Lymph node

Cystic node of Lund present between cystic duct and hepatic duct

It is the content of Calot's triangle.

105. Ans. c. Portal vein is posterior to both common bile duct and hepatic artery

Portal vein posterior, common bile duct anterior to portal vein and right side. Proper hepatic artery anterior to portal vein and on left side.

106. Ans. c. CBD is formed by combination of right and left hepatic duct

Common bile duct is joining of cystic duct and common hepatic duct

107. Ans. d. Portal vein

Behind 1st part of duodenum – common bile duct

Portal vein posterior to common bile duct

108. Ans. b. First part of duodenum

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 300]

1st part of duodenum – forms superior border of head of pancreas

IVC and common bile duct posterior to head of pancreas

But aorta is posterior to uncinate process which is part of head so included as correct option.

**109. Ans. a. Right renal vein**

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 300]

Right and left renal vein and IVC posterior to head of pancreas. Superior mesenteric vein anterior to uncinate process. Portal vein and superior mesenteric vein posterior to neck. Splenic vein, left supra renal vein, left gonadal vein and left renal vein posterior to body.

110. Ans. c. Anterior inferior pancreaticoduodenal artery is branch of superior mesenteric artery

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 300]

111. Ans. d. Greater sac

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 295, 233]

112. Ans. b. Phrenicocolic ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 295]

113. Ans. d. Lienorenal ligament contains tail of pancreas

Developed from dorsal mesogastrium, superior border notched, axis along 10th rib.

114. Ans. b. 9th to 11th rib

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 294]

Rib 9 to 11 related to spleen
Axis is on 10th rib

115. Ans. b. Phrenicocolic ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 294, 295]

Phrenicocolic ligament not attach to spleen but supports anterior end

116. Ans. a. Lienorenal ligament

Lienorenal ligament contains splenic artery and tail of pancreas.

117. Ans. c. Anastomose freely with the spleen

[Ref: Last Anatomy 12th edition 270-271]

Tortuous arteries in the body – facial artery, posterior inferior cerebellar artery, uterine artery and splenic artery. Splenic artery is not end artery, splenic branch of splenic artery is end artery.

118. Ans. c. Lumbar artery

[Ref: Last Anatomy 12th edition 274-276]

Lumbar artery is branch from dorsal side

119. Ans. d. Gastroduodenal artery

[Ref: Last Anatomy 12th edition 249-250]

120. Ans. a. Left gastric, b. Short gastric, e. Lt gastroepiploic artery

[Ref: Last Anatomy 12th edition 249-250]

Splenic artery proper not supply the stomach

121. Ans. c. Superior gluteal artery

[Ref: Last Anatomy 12th edition 308-309]

122. Ans. c. Right gastroepiploic artery

[Ref: Last Anatomy 12th edition 270-271]

Arteria pancreatic magna – largest pancreatic branch of splenic artery
Right gastro epiploic artery is branch from gastroduodenal artery

123. Ans. c. Lies at lower border of pancreas

Celiac trunk is related to upper border of pancreas

124. Ans. b. Marginal artery, c. Sigmoid artery, e. Left colic artery

[Ref: Last Anatomy 12th edition 249-250]

Marginal artery is successive anastomosis of colic branches which extends from ileocecal junction to rectosigmoid junction. So marginal artery supply the sigmoid colon

125. Ans. c. Middle rectal

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 280, 281]

Middle rectal branch of internal iliac artery anterior division

126. Ans. a. Splenic flexure

[Ref: Last Anatomy 12th edition 244-246]

Superior mesenteric artery supplies midgut
Inferior mesenteric artery supplies hind gut
Midgut extends up to right 2/3 of transverse colon and left 1/3 of transverse colon
So, watershed line is splenic flexure.

127. Ans. d. All of the above

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 282]

128. Ans. b. Spleen

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 282]

129. Ans. a. In the rectum: superior rectal vein and inferior rectal vein

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 282]

**130. Ans. d. Ascends behind the 2nd part of duodenum**

Ascends behind the first part of duodenum

131. Ans. b. Absent middle colic artery

[Ref: Bergman's comprehensive Encyclopedia of Human Anatomic Variations ed by R. Shane Tubbs, Mohammadali M. Shoja, Marios Loukas page 647,652-656]

132. Ans. b. IVC**133. Ans. d. Origin of superior mesenteric artery from abdominal aorta**

Origin of superior mesenteric artery from abdominal aorta at L1

134. Ans. b. Foramen of Winslow

[Ref: Gray's 41st ed page 547, Grant's Atlas of Anatomy 12th ed page 672 Table 7.9]

135. Ans. a. Portal vein, b. Hepatic artery proper, e. Common bile duct

[Ref: Last Anatomy 12th edition pg 249-250]

Hepatic vein and cystic duct not present in lesser omentum right free margin

136. Ans. d. Bile duct anteriorly

[Ref: Last Anatomy 12th edition pg 235-236]

Structures present in the right free margin of lesser omentum forms anterior boundary

137. Ans. c. Left subhepatic recess

[Ref: Last Anatomy 12th edition pg 237-238]

Posteriorly perforating ulcer in the pyloric part produce abscess in the omental bursa or lesser sac or left sub hepatic recess

Gastroduodenal ulcer eroded in the posterior perforating ulcer of duodenum

Splenic artery eroded in the posterior perforating ulcer of stomach

Left gastric artery – eroded in the ulcer of lesser curvature.

138. Ans. c. Pouch of Douglas

Dependent pouch in standing position – pouch of Douglas

Dependent pouch in supine position – hepatic renal pouch of Morrison right sub hepatic recess

139. Ans. b. Horizontal part of duodenum

[Ref: Last Anatomy 12th edition pg 237-238]

140. Ans. a. Posterior wall of stomach, d. Greater omentum

[Ref: Last Anatomy 12th edition pg 234-235]

Stomach, greater omentum and lesser omentum form the anterior wall of lesser sac

141. Ans. c. Ascending colon

Transverse mesocolon, sigmoid mesocolon, mesorectum are mesentery over transverse colon, sigmoid colon, rectum.

142. Ans. b. Right subhepatic space

[Ref: BDC 6th edition volume 2 pg 243]

Right subhepatic space–Morrison's pouch

Left subhepatic space–lesser sac

143. Ans. d. Duodenum (4th part)

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 313]

144. Ans. a. Lateral cutaneous nerve of thigh

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 316]

145. Ans. c. Anterior below the superior mesenteric artery

Left renal is sandwiched between aorta and superior mesenteric artery.

146. Ans. c. Common iliac artery

Renal arteries initially come from common iliac artery.

147. Ans. b. Renal vein, renal artery, renal pelvis**148. Ans. b. It is a type of portal circulation**

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 318 to 319]

Portal circulation – blood passes two sets of capillaries before drains into heart

- Eg for portal circulation – hepatic portal circulation and in pituitary

In kidney also blood passes to capillary bed which is present between afferent and efferent arterioles and it considered as portal circulation.

But most of the authors including grays anatomy not considering renal circulation as portal circulation.

149. Ans. c. 12th rib and erector spinae

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 317]

Renal Angle

Angle between lower border of 12th rib and lateral border of erector spinae (sacrospinalis) muscle.

150. Ans. c. Right kidney is preferred over left for transplant

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 317 to 319]

Left renal vein is longer and Right renal vein is shorter (right renal vein is nearer to IVC)

So left kidney is preferred for transplant (simplifies the surgery in ligating the vessels)

Right kidney is lower than left because of liver on the right side.

**151. Ans. c. Both glands drain into renal vein**

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 328]

Right suprarenal vein drains into inferior vena cava
Left suprarenal vein drain into left renal vein

152. Ans. d. Superior mesenteric artery

Superior suprarenal artery derived from inferior phrenic artery
Middle suprarenal artery derived from abdominal aorta
Inferior suprarenal artery derived from renal artery

153. Ans. c. Genitofemoral nerve

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 321]

Genitofemoral nerve present posteriorly not anteriorly

154. Ans. d. At the entry of bladder

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 320]

At the pelvic brim—constrictions present where it crosses the common iliac vessel
At ischial spine—no constrictions here, ureter change the directions from straight to oblique course at the level of ischial spine.

155. Ans. All

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 319-322]

All are correct statement
No valve present at the point where it pierce the bladder
Enters the bladder at the lateral angle of trigone

156. Ans. a. Uterine artery, b. Inferior vesicle artery, c. Testicular artery, d. Common iliac artery

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 319-322]

Ureter is not supplied by femoral artery

157. Ans. a. Gonadal vessels lie anterior to it

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 319-322]

Ureter not lies in front of great vessels
Nerve supply by T10 to L1

158. Ans. b. Internal pudendal artery

[Ref: BDC 7th/vol.II 352; Gray's 40th/1241]

Internal pudendal artery not supply the ureter

159. Ans. c. Quadratus lumborum

[Ref: Gray's Anatomy 41st ed page 1251, Keith L, Moore 4th ed page 117]

Quadratus lumborum not related to ureter

160. Ans. d. Bifurcation of right common iliac artery

Bifurcation of common iliac situated posterior to ureter

161. Ans. a. Posterior border is attached medially to perineal body

[Ref: BDC 7th/vol. II 388-89; Snell's 9th/314-15; Gray's 40th/1094]

“Perineal membrane: a layer of tough fascia, which is perforated by the urethra (and also the vagina in the female). The role of the membrane is to provide attachment for the muscles of the external genitalia”

“Contents of the superficial perineal space: The branches of the internal pudendal vessels and the pudendal nerves”

162. Ans. a. A

[Ref: Gray's 41st ed page 1222]

A – Levator Ani
B – Obturator Internus
C – Internal Sphincter
D – External Sphincter

163. Ans. c. Colle's fascia

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 252]

164. Ans. d. Tranverse perinei superficialis

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 252]

165. Ans. a. Superficial perineal pouch

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 357]

Rupture of urethra below the perineal membrane causes urine to accumulate in
Superficial perineal pouch
Scrotum
Around penis
Lower part of anterior abdominal wall
Urine cannot escape to
Deep perineal pouch (because of perineal membrane)
Ischiorectal fossa (because of colles fascia)
Thigh (fascia lata)
Rupture of urethra above the perineal membrane causes urine to accumulate in
Deep perineal pouch
Extra peritoneal space
Space of Retzius (space around bladder and prostate)

166. Ans. a. Ischiorectal fossa

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 357]

167. Ans. c. Root of penis

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 396]

**168. Ans. d. Membranous urethrae**

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 289]

169. Ans. d. Communicates with other side posteriorly

Ischiorectal fascia – horse shoe shape
Communicates with opposite side posteriorly
Levator ani – medial relation, lateral wall – obturator internus

170. Ans. b. Inferior rectal nerve

[Ref: Last Anatomy 12th edition 316-317]

171. Ans. a. Ischiocavernosus

[Ref: Last Anatomy 12th edition 317]

172. Ans. c. Leaves pelvis through lesser sciatic foramen

[Ref: BDC 6th Ed Volume 2 Pg 363, 364]
Pudendal nerve leaves pelvis and enters gluteal region through greater sciatic foramen not lesser sciatic foramen.

173. Ans. d. Ischiococcygeus

[Ref: BDC Vol II pg 429-32]
Ischiococcygeus not attached to perineal body.

174. Ans. b. Ischiococcygeus

[Ref: IB Singh Textbook of Anatomy volume II 6th edition pg 288]
Levator ani muscle consists of iliococcygeus and pubococcygeus not ischiococcygeus.

175. Ans. c. Autonomic nerves

[Ref: Essentials of Human Anatomy by AK Dutta 8th edition volume 1 pg 392]
Visceral afferent fibers from pelvic organs travel via autonomic nerves.

176. Ans. d. Joins superior hypogastric plexus

[Ref: BDC 6th edition Vol II pg423]
Nervi erigentes is ventral rami of S2,3,4 – Sacral outflow of parasympathetic system
Join right and left hypogastric nerve to form inferior hypogastric plexus

177. Ans. c. Appendix

Pelvic splanchnic nerve supplies the pelvic viscera via inferior hypogastric plexus
Rectum supplied by middle rectal plexus
Bladder supplied by vesicle plexus
Uterus – supplied by uterovaginal plexus

178. Ans. c. Superior hypogastric plexus is located at anterior aspect of aortic bifurcation and 5th lumbar vertebra

Sympathetic – thoracolumbar flow
Parasympathetic – craniosacral flow through cranial nerves and S2, 3, 4

Superior hypogastric plexus receives parasympathetic fibers through pelvic splanchnic nerves

179. Ans. a. Ureter

[Ref: BDC 6th edition Vol II pg 372,373]

Base – upper part is peritoneal in male.
• In male - Ampulla of rectum, seminal vesicle, ampulla of vas, recto vesical fascia
• In female – upper part of anterior vaginal wall, anterior surface of supra vaginal part of cervix

180. Ans. b. Mucosa is loosely associated with underlying musculature

[Ref: BDC 6th edition Vol II pg 372,373]

Lined by transitional epithelium
Mucosa is smooth and firmly adherent
Sub mucosa absent and replaced by trigone muscle of bell
Developed from absorbed mesonephric duct

181. Ans. c. Both

[Ref: BDC 6th edition Vol II pg 375]

Parasympathetic supply the detrusor not sphincter
Sympathetic supply the sphincter not detrusor

182. Ans. c. Flank

[Ref: BDC 6th edition Vol II pg 375]

Bladder is supplied by T11 to L2, S2, 3, 4
So pain is referred to lower abdominal wall, upper part of thigh, scrotum, penis or clitoris, perineum.

183. Ans. c. Inferior vesicle

Artery to vas from superior or inferior vesical artery

184. Ans. a. Hematoma involving shaft of penis

[Ref: Schwartz 8th edition pg 1546]

Buck's fascia intact – hematoma restricted to shaft of penis only
Buck's fascia is disrupted, then hematoma extend into scrotum, perineum and suprapubic region

185. Ans. b. Deep artery of penis

Deep artery of penis supplies the crura
Dorsal artery supplies skin and fascia

186. Ans. a. Deep artery of penis

Deep artery of penis is spirally arranged called as helicine arteries of penis which fill the cavernous space

187. Ans. c. Hypogastric plexus

[Ref: Last Anatomy 12th edition PG 320-322]

Erection – parasympathetic

Afferent	Pudendal nerve and sacral plexus
Efferent	Nervi erigentes (pelvic splanchnic nerve)



Ejaculation – sympathetic

Afferent	Pudendal nerve
Efferent	Superior and inferior hypogastric plexus

188. Ans. a. Poupart's ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]

Poupart's ligament is not content of spermatic cord

189. Ans. c. Pampiniform plexus

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 212]

190. Ans. a. Straight tubules-rete testis-efferent tutatis

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 224]

191. Ans. b. Presents a concavity posteriorly

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 378]

Concave anteriorly

Descends into prostate at the junction of anterior one-third and posterior two-third

192. Ans. b. Membranous

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 378]

193. Ans. a. Trapezoid in cross section

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 378]

Prostatic urethra is crescentic in shape.

194. Ans. d. It is separated from the base of bladder by the peritoneum

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 399 to 400. 406]

Posterior surface of bladder is not covered by peritoneum, so there is no peritoneum between prostate and bladder.

195. Ans. c. Median lobes

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 404]

BPH – affects median lobe.

196. Ans. b. Trigonal muscle

Urethral crest is due to insertion of trigonal muscles of ureter.

197. Ans. d. Located at bladder neck

Sphincter urethrae surrounds the membranous urethrae not bladder neck

198. Ans. b. Spongy urethra

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 377-378]

Bulbourethral glands are found in membranous urethra
Bulbourethral glands open into spongy urethra

199. Ans. b. Infundibulum – ampulla – isthmus – interstitial

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 385, 386]

200. Ans. c. Ovary attached to uterus by ovarian ligament, d. Ampulla longest, e. Uterine artery supply the medial two-thirds

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 385, 386]

Length 10 cm

Interstitial is the most medial

201. Ans. b. Isthmus

Isthmus – 3 cm, musculature > the size of the lumen. So, act as functional/anatomical sphincter

202. Ans. c. Ampulla

Mucosa of fallopian tube folded to form longitudinal folds which project into lumen, which is maximum in ampulla.

203. Ans. c. 125

Anteflexion – 125

Anteversion – 90

204. Ans. b. Broad ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 390]

205. Ans. c. Round ligament of uterus

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 390]

206. Ans. d. Broad ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 390]

207. Ans. d. Broad ligament

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 390]

208. Ans. a. Ovary

[Ref: BD Chaurasia Human Anatomy 6th edition volume 2 pg 389]

209. Ans. c. 8:1

[Ref: Textbook of Reproductive Anatomy pg 119]

85 to 90% of cervix is made of extra cellular connective tissue matrix and remaining 10 to 15% are smooth muscle



210. Ans. d. More than anterior vaginal wall

Anterior vaginal wall – 8 cm
Posterior vaginal wall – 10 cm

211. Ans. c. Inferior vesical artery

Two lateral fornix—related to ureter, uterine artery, mackendrots ligament

212. Ans. b. Internal urethral sphincter

[Ref: Gray's Anatomy 40th edition pg 1094-1096]

Vaginal Sphincter

Four muscles surrounds vagina and act as vaginal sphincter. They are

- Bulbospongiosus
- Pubovaginalis
- External urethral sphincter
- Sphincter urethrovaginalis

In female muscles present around the internal urethral orifice is not organized into a sphincter. So **internal urethral sphincter** not contribute to vaginal sphincter.

213. Ans. c. Medial thigh

[Ref: Last Anatomy 12th edition Pg 305-306]

Lateral surface of ovarian fossa related to obturator nerve
Obturator nerve—supply the adductor compartment of thigh
So, pain radiated to medial thigh

214. Ans. d. Round ligament

Obliterated umbilical artery form anterior relation to ovarian pathology
Ureter and internal iliac artery forms posterior relations

215. Ans. d. Deep inguinal

216. Ans. d. Para-aortic nodes

217. Ans. b. External iliac

218. Ans. b. Para-aortic node

219. Ans. b. Deep inguinal lymph nodes

Organ	Draining Node
Glans penis (clitoris)	Deep inguinal nodes of Cloquet
Skin including prepuce of penis	Superficial inguinal nodes
Testis	Pre and para aortic nodes
Uterus	Preaortic and lateral aortic nodes
Fundus and upper part of	Superficial inguinal nodes (lymph vessels travel via round ligament)
Body of	
Vessels from lateral angle only	
Lower part of body of uterus	External iliac nodes

Contd...

Organ	Draining Node
Cervix	To three sources External iliac nodes Internal iliac nodes Sacral nodes
Suprarenal glands	Lateral aortic nodes
Rectum and anal canal Above pectinate line	Internal iliac nodes
Anal canal below the pectinate line	Superficial inguinal nodes
Ovary	Para aortic nodes
Upper 1/3 vagina	External iliac node
Middle 1/3 vagina	Internal iliac node
Lower 1/3 vagina	Superficial inguinal nodes.

220. Ans. a. Transpyloric plane

[Ref: BDC-II, 6th/e pg. 197]

Passing midway between supra sterna notch and pubic symphysis at L1
Transtubercular plane at L5

221. Ans. d. Latissimus dorsi

[Ref: Clemente's Anatomy Dissector 3rd/e pg. 283]

Latissimus dorsi contribute to lumbar triangle of petit and triangle of auscultation.

Triangle of Auscultation

Small triangle on the back near the inferior angle of scapula.
Boundaries

- Medially—lateral border of trapezius
- Laterally—vertebral border of scapula
- Inferiorly—upper Fibers of latissimus dorsi.
- Floor – 7th rib, 6th and 7th intercostal space and rhomboideus major
Respiratory sounds can be clearly heard and cardiac orifice lies deep to this triangle.

Lumbar Triangle of Petit

Lateral—posterior free border of external oblique
Medial—anterior border of latissimus dorsi
Base—iliac crest
Floor—internal oblique
This triangle act as site of hernia sometimes

222. Ans. a. External oblique, internal oblique and T. abdominis

[Ref: BDC-II, 6th/e pg. 209]

Above the costal margin rectus sheath formed by external oblique.
From the costal margin to arcuate line anterior wall of rectus sheath formed by external and internal oblique.
Below the arcuate line anterior wall of rectus sheath formed by external oblique, internal oblique and transverse abdominis.

**223. Ans. b. Internal oblique fascia**

[Ref: BDC-II, 6th/e pg.203]

Cremasteric muscle derived from internal oblique
Conjoint tendon derived from internal oblique and transverse abdominis periz early.

224. Ans. a. Lesser sac and greater sac

[Ref: BDC-II, 6th/e pg.233]

Epiploic foramen situated behind the stomach and communicates lesser sac and greater sac.

225. Ans. b. Right posterior intraperitoneal pouch

[Ref: BDC-II, 6th/e pg.243]

Hepatorenal pouch of Morrison–right subhepatic space– right posterior intraperitoneal pouch
Lesser sac–left sub hepatic space–left posterior intraperitoneal pouch.

226. Ans. d. 8

[Ref: BDC-II, 6th/e pg.308]

Couinaud divided liver into 8 segments based on portal vein and hepatic vein.

227. Ans. a. Liver

[Ref: BDC-II, 6th/e pg.308]

Canal of herrings–intrahepatic bile ductules

228. Ans. a. Vitamin A storage cells

[Ref: BDC-II, 6th/e pg.309]

Ito cells–present in space of disease.
Contain vitamin A in lipid droplets

229. Ans. d. Pancreas

[Ref: BDC-II, 6th/e pg. 314]

Left kidney is related to
Left supra renal gland
Spleen
Stomach
Pancreas
Splenic flexure
Jejunum
Of these spleen, stomach and jejuna surface are covered with peritoneum.

230. Ans. b. Right anterior – bile duct, posterior hepatic artery, left anterior portal vein

Arrangement of structures at porta hepatis of live before backwards –

- Hepatic duct,
- Hepatic artery and
- Portal vein

Arrangement of structures at hilum of kidney before backwards

- Renal vein
- Renal artery
- Pelvis of ureter

Arrangement of structures in intercostals space

- Intercostal vein
- Intercostal artery
- Intercostal nerve

Arrangement of structures in hiulum of right lung from above downwards

- Eparterial bronchus
- Pulmonary artery
- Hyparterial bronchus
- Lower pulmonary vein

Arrangement of structures in hilum of left lung from above downwards

- Pulmonary artery
- Hyparterial bronchus
- Lower pulmonary vein

Arrangement of structures in hilum of lung before backwards

- Upper pulmonary vein
- Pulmonary artery
- Bronchus with bronchial vessels
- Spleen

231. Ans. a. Dorsal mesogastrium

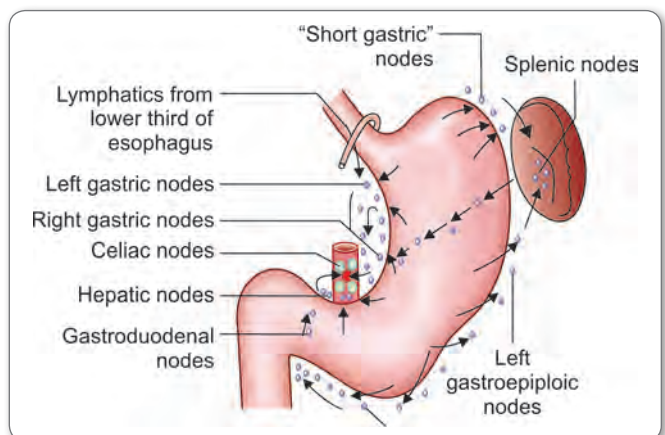
[Ref: BDC-II, 6th/e pg.233]

Spleen develops in dorsal mesogastrium
Stomach

232. Ans. a. Celiac group of lymph nodes

[Ref: BDC-II, 6th/e pg. 253]

Lymph from all areas of the stomach ultimately reaches celiac nodes

**233. Ans. a. Stomach**

[Ref: BDC-II, 6th/e pg. 317]



Cells of Cajal present in Gastrointestinal tract. These cells serve as pace maker which creates bio electric slow wave potential that leads to contraction of smooth muscle.

234. Ans. **c. Ileum**

[Ref: Gray's Anatomy 40th/e pg. 74]

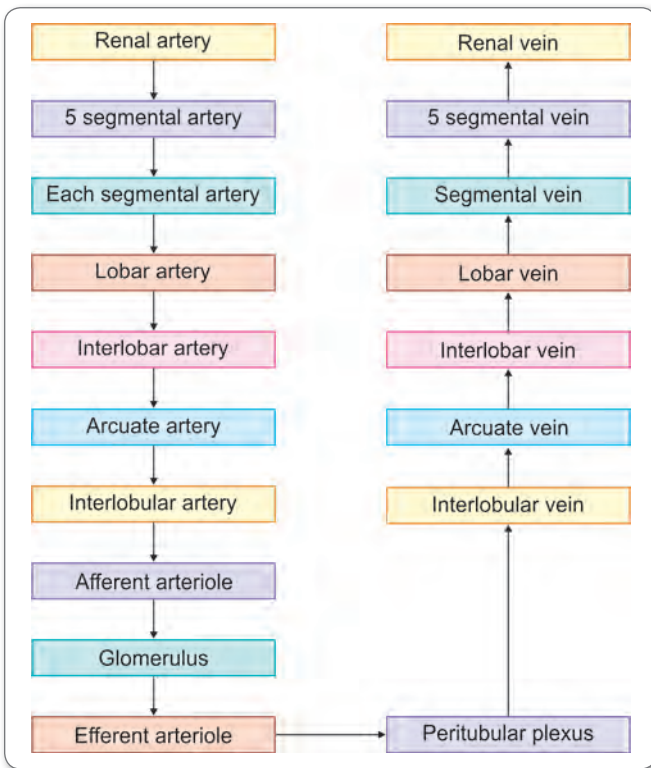
Mucosa associated lymphoid tissue - aggregations of lymphocytes in relation to respiratory tract, alimentary and urogenital tract.

MALT in alimentary system - tonsils, Peyer's patches and lymphoid nodules in vermiform appendix

235. Ans. **b. Segmental - inter lobar - arcuate**

[Ref: BDC-II, 6th/e pg. 317]

Blood Supply of Kidney



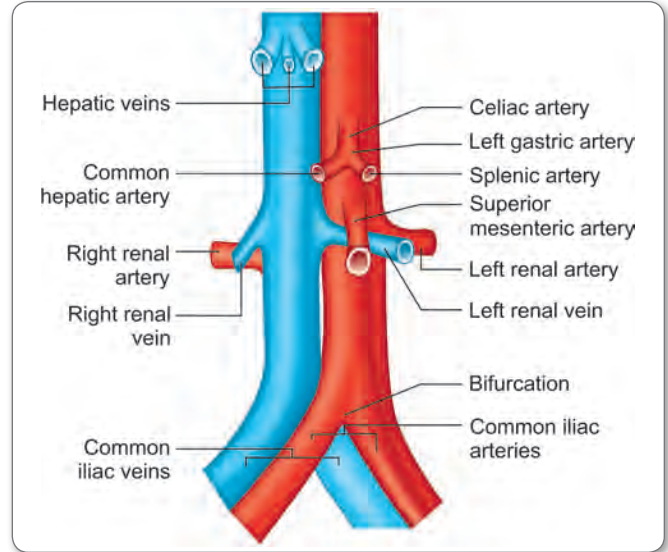
236. Ans. **b. Left renal vein**

[Ref: BDC-II, 6th/e pg.316]

Left suprarenal veins drain into left renal vein
Right suprarenal veins drain into inferior vena cava

237. Ans. **a. Left renal vein**

[Ref: BDC-II, 6th/e pg.279]



238. Ans. **b. Kidney**

[Ref: BDC-II, 6th/e pg.317]

Duct of Bellini also known as collecting duct of Bellini found in kidney.

239. Ans. **c. Epididymis**

[Ref: Essentials of Human Embryology pg. 286]

Epididymis secrete sialic acid, glyceryl phosphoryl choline that play important role in maturation of sperms.

240. Ans. **c. Adrenal cortex devoid of nerve supply**

[Ref: Gray Anatomy, 41st ed., Pg 439]

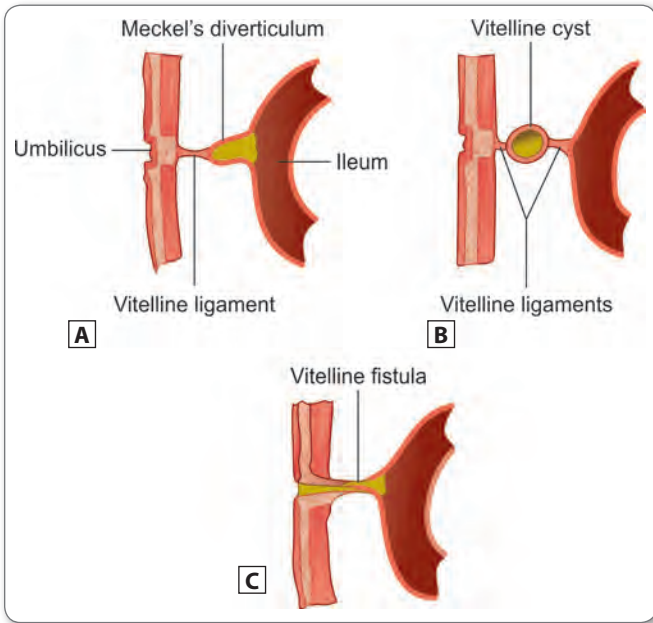
- Preganglionic sympathetic axons innervating secretory cells of adrenal medulla
- Sympathetic activity promotes the secretion of adrenaline and noradrenaline
- Suprarenal gland receives only sympathetic innervation
- Adrenal cortex is devoid of nerve supply. Stimulated by ACTH

241. Ans. **b. L4**

Lumbar plexus formed by ventral rami of L1, 2, 3 and 4.
L4 joins with L5 forms lumbosacral trunk, helps in the formation of sacral plexus
So L4 - (contribute to lumbar and sacral plexus) called as nervus furcalis

242. Ans. **a. Mesonephric duct**

243. Ans. **a. Vetelline cyst**



244. **Ans. a. They are end arteries**

- Branches of renal artery – end arteries
- Amount of blood flowing in cortex is four or five times more than medulla
- Renal artery gives segmental artery which in turn divide into lobar artery – which in turn to inter lobar artery
- Arcuate artery arises from interlobar artery which do not anastomose with each other

245. **Ans. b. Physiological left and right-half of liver**

Line drawn from IVC and gallbladder divides the liver into 2 halves – right and left lobes

246. **Ans. a. T10**

Umbilicus located l3 – l4
Supplied by T10

247. **Ans. c. Linea semilunaris**

Linea semilunaris not derived from external oblique aponeurosis

248. **Ans. d. Arcuate artery**

- Each kidney presents 5 independent vascular segments
- Renal artery divides into segmental artery. Each Segmental artery divides into lobar artery. Each lobar artery before piercing the kidney usually divides into inter lobar artery
- At the junction of cortex and medulla, interlobar artery divides dichotomously into arcuate artery. These arcuate arteries – end artery do not anastomose with one another.

249. **Ans. d. Median lobe**

Median lobe of prostate –apex directed below the colliculus seminalis and base forms uvula vesicae

250. **Ans. b. Nerve supply of penile skin is from obturator nerve; c. There are at least 5 urethral sphincters; e. Dorsal artery of penis is branch of bulbourethral artery**

Nerve supply – dorsal nerve of penis, ilioinguinal nerve
Urethral sphincters – two - external and internal
Dorsal artery of penis – from internal pudendal artery

251. **Ans. e. Papilla of renal pyramids terminates into minor calyx**

- Kidney – T12-L3
- Long axis directed infero-laterally
- First and most constant branch – posterior segmental artery
- T10-l1 segmental innervation

252. **Ans. a. S2, S3, S4**

External sphincter supplied by inferior rectal nerve – branch of pudendal nerve – root value S2, 3, 4 and perineal branch of 4th sacral nerve.

253. **Ans. d. Greater omentum**

Greater omentum from dorsal mesogastrium.

NOTES

A series of horizontal dashed lines for writing notes.

8



HEAD AND NECK



EMBRYOLOGY

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PHARYNGEAL APPARATUS

- Consists of pharyngeal arches, pharyngeal grooves, pharyngeal pouches and pharyngeal membrane
- These structures contribute to development of head and neck
- Pharyngeal apparatus is first observed in week 4 of development.

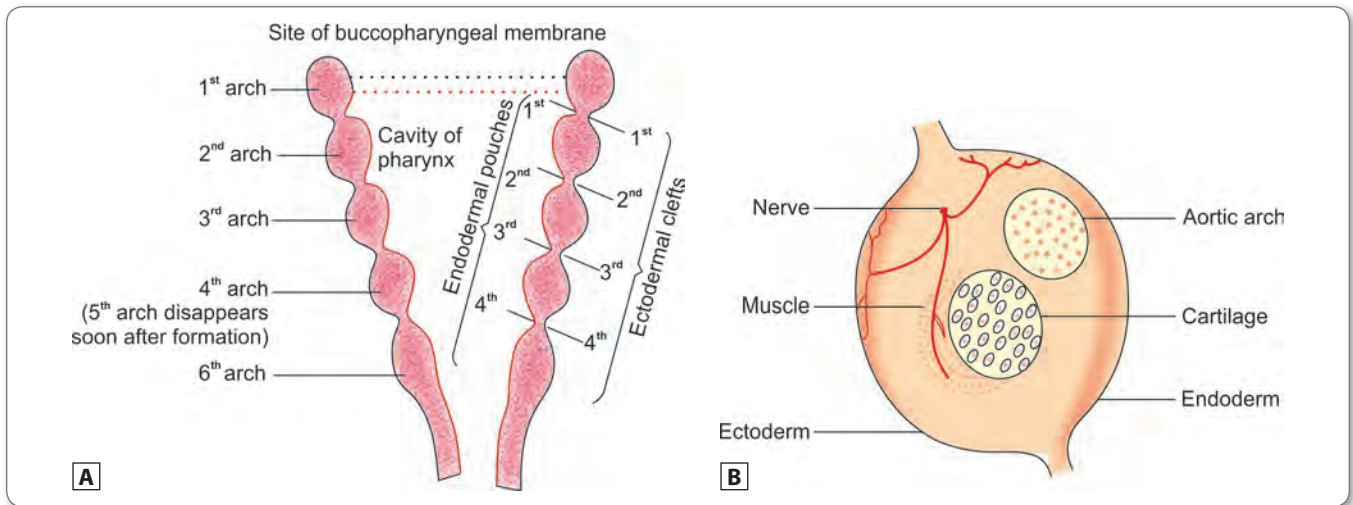
PHARYNGEAL GROOVES

- Invaginations of ectoderm are located between each pharyngeal arch

- Pharyngeal membranes
- Structures consist of ectoderm, intervening mesoderm, neural crest cells and endoderm
- Pharyngeal membranes and situated between each pharyngeal arch.

PHARYNGEAL ARCHES

- 1, 2, 3, 4, 6 (5th arch disappears)
- Each pharyngeal arch contains somatic mesoderm and neural crest cells
- Each arch contains arterial component, nerve component, cartilage component and muscle component



Figs 1A and B: Pharyngeal arches

Table 1: Derivatives from pharyngeal arches

Arch	Skeletal derivative	Muscle derivative	Nerve of the arch	Artery
First arch Meckel's cartilage Quadrate cartilage	Malleus Incus Anterior ligament of malleus Sphenomandibular ligament Maxilla Mandible Zygomatic Temporal bone Sphenoid bone Vomer	Muscles of mastication Tensor tympani Tensor veli palatini Mylohyoid Anterior belly of digastric	Mandibular nerve	Maxillary artery (transitory)
Second arch Reichert's cartilage	Stapes Styloid Stylohyoid ligament Small horn of hyoid Superior surface of hyoid	Muscles of facial expression Posterior belly of digastric Stylohyoid Stapedius	Facial nerve	Stapedial artery (transitory)
Third arch	Greater horn of hyoid Inferior surface of hyoid	Stylopharyngeus	Glossopharyngeal nerve	Common carotid artery First part of internal carotid artery

Contd...



Arch	Skeletal derivative	Muscle derivative	Nerve of the arch	Artery
Fourth arch	Thyroid cartilage Epiglottis	Muscles of pharynx Palate and cricothyroid	Vagus – superior laryngeal nerve	Right subclavian artery Part of arch of aorta between left common carotid and left subclavian
Sixth arch	Remaining cartilage of larynx	Muscles of larynx except cricothyroid	Recurrent laryngeal nerve	Pulmonary artery, ductus arteriosus

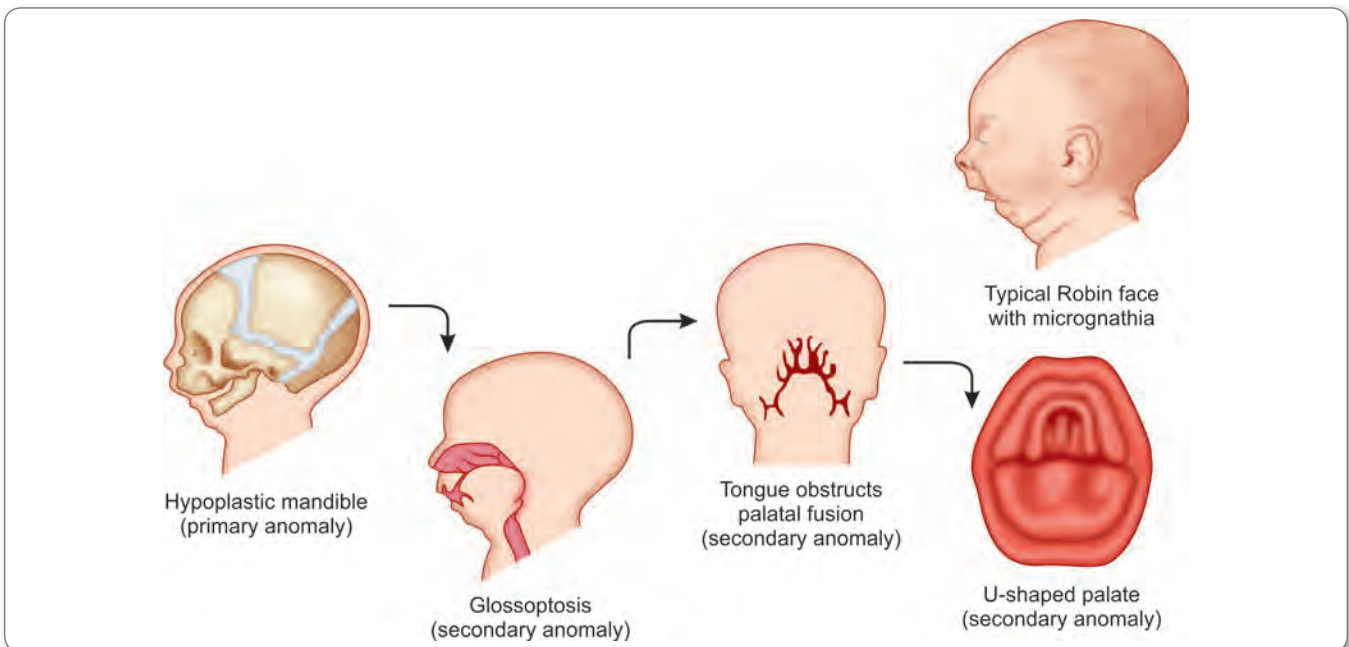
Clinical Aspect

Treacher Collins Syndrome



- First arch syndrome
- Due to lack of migration of neural crest cells into 1st arch
- Hypoplasia of zygomatic bones, mandible and midface hypoplasia, micrognathia, external ear abnormalities, lower eyelid abnormalities

PIERRE ROBINSON SEQUENCE



- Due to poorly developed mandible
- Micrognathia leads to posteriorly displaced tongue Glossoptosis
- Glossoptosis leads to failure of fusion between two palate
- So, in this syndrome, triad is seen
 - Micrognathia
 - Glossoptosis
 - Cleft palate



HIGH YIELD POINTS

- All the muscles of larynx derived from 6th arch except cricothyroid which is derived from 4th arch
- All the muscles of pharynx derived from 4th arch except stylopharyngeus which is derived from 3rd arch
- All the muscles of palate derived from 4th arch except tensor palatini which is derived from 1st arch
- Anterior belly of digastric from 1st arch & posterior belly of digastric from 2nd arch
- Middle ear muscles tensor tympani from 1st arch, stapedius from 2nd arch
- All skull bones developed from Neural crest cells (secondary mesenchyme) except parietal and occipital bones which are derived from primary mesenchyme

Pharyngeal Pouch

Pharyngeal pouches are the evaginations of endoderm that line the foregut

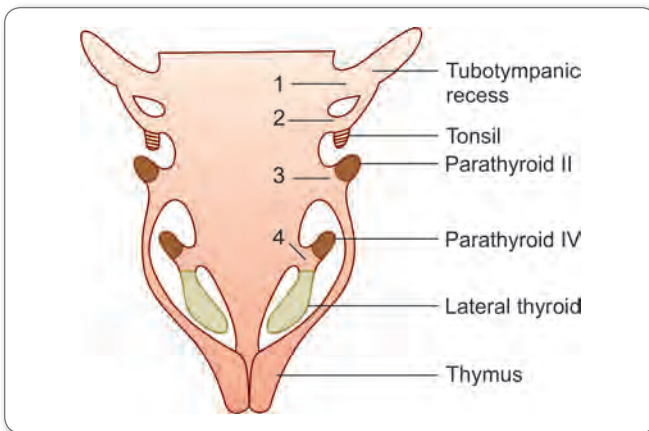


Fig. 2: Pharyngeal pouch

Four pouches between 1 and 2, 2 and 3, 3 and 4, 4 and 6

Table 2: Derivatives from pharyngeal pouches

1	Epithelial lining of auditory tube, middle ear, mastoid air cells
2	Epithelial lining of tonsillar fossa
3	Ventral components: Thymus Dorsal components: Inferior parathyroid
4	Ventral components: Ultimobranchial body which forms parafollicular cells
5	Dorsal components: Superior parathyroid

Note:

- Parafollicular cells of thyroid developed from neural crest cells > ultimobranchial body

Clinical Aspect

DiGeorge Syndrome

- Failure of pharyngeal pouches 3, 4 to differentiate into thymus and parathyroid (so called 3rd 4th pharyngeal pouch syndrome)
- This is due to microdeletion of region in **22q 11.2** that is also called as DiGeorge chromosomal region (CATCH 22 spectrum defects)
- Immunodeficiency due to absence/hypoplasia of thymus (most severe form of T-cell defect) and hypocalcemia due to absence of parathyroid gland. Neonatal tetany can be seen.

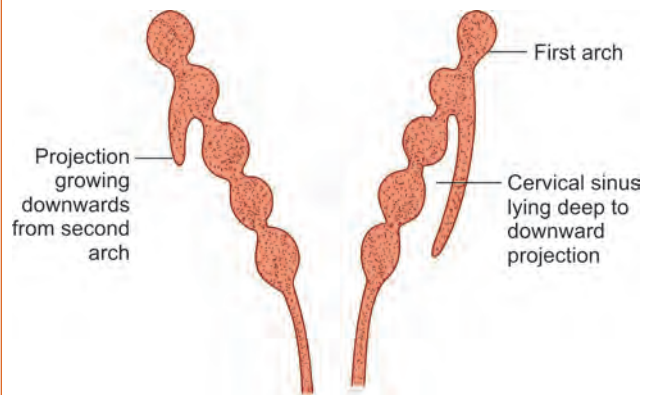
Table 3: Derivatives from pharyngeal groove

1	Epithelial lining of external auditory meatus
2, 3, 4	Obliterated

Clinical Aspect

Applied

Branchial Sinus



Failure of fusion of second arch with sixth arch and persistence of cervical sinus resulting in this condition.

Branchial Cyst

Cyst swelling arising from persistent cervical sinus

Table 4: Derivatives from pharyngeal membrane

1	Tympanic membrane
2, 3, 4	Obliterated

DEVELOPMENT OF THYROID GLAND

- In the midline of pharynx floor, endodermal lining of the foregut forms the thyroid diverticulum
- Thyroid diverticulum migrates caudally passing ventral to hyoid bone and laryngeal cartilage

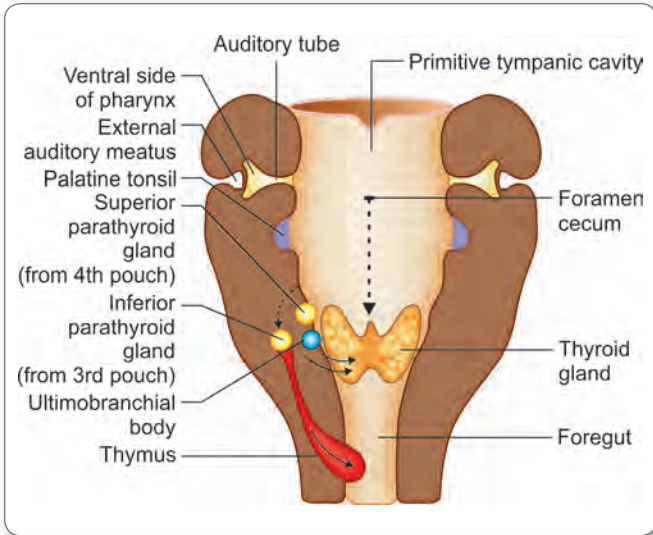


Fig. 3: Development of thyroid gland

- During the migration thyroid remains connected to tongue by thyroglossal duct, which is obliterated later
- The site of thyroglossal duct is indicated in the adult by foramen cecum.

Clinical Aspect

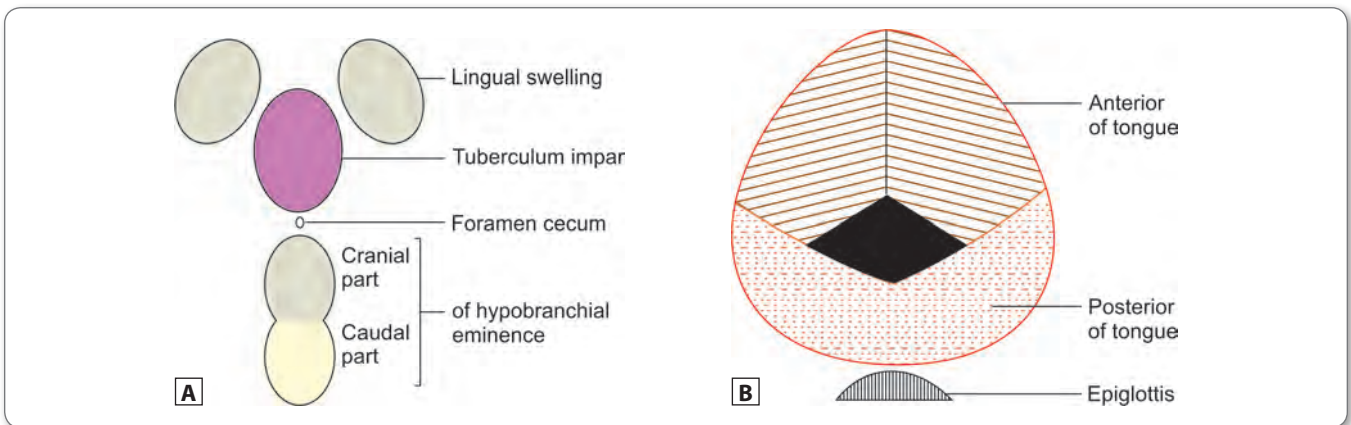
Ectopic Thymus, Parathyroid, Thyroid Tissue

- Results from abnormal migration of these glands from their embryonic position to their definite adult location
- Glandular tissue may be found anywhere along their migratory paths
- Most common site of ectopic thyroid – lingual thyroid. Other sites are esophagus, trachea, mediastinum and aortic arch

Thyroglossal Duct Cyst

- Occurs when part of thyroglossal duct persists and thereby forms cyst
- Commonly located in midline near hyoid bone

DEVELOPMENT OF TONGUE



Figs 4A and B: Development of tongue

- Muscles of tongue developed from occipital somites. (Except palatoglossus-derived from pharyngeal arches-NCC derivative).
- Epithelium of anterior 2/3 derived from surface ectoderm. Epithelium of post 1/3 derived from endoderm
- Connective tissue derived from pharyngeal arches.

Anterior Two-Thirds (Body of the Tongue)

- Develops from first pharyngeal arch—two-lateral lingual swellings and one medial swelling, the tuberculum impar.
- Lateral lingual swellings increase in size and merges with tuberculum impar, forming body of the tongue.

Posterior One-Third (Root of the Tongue)

A second median swelling, the copula of His or hypobranchial eminence is formed by mesoderm of the second, third, and part of the fourth arch.

Hypobranchial eminence over goes the second arch and fuse with first arch.

So, second arch does not contribute to tongue development.

Posterior 1/3 of tongue derived from 3rd arch and 4th arch

REMEMBER

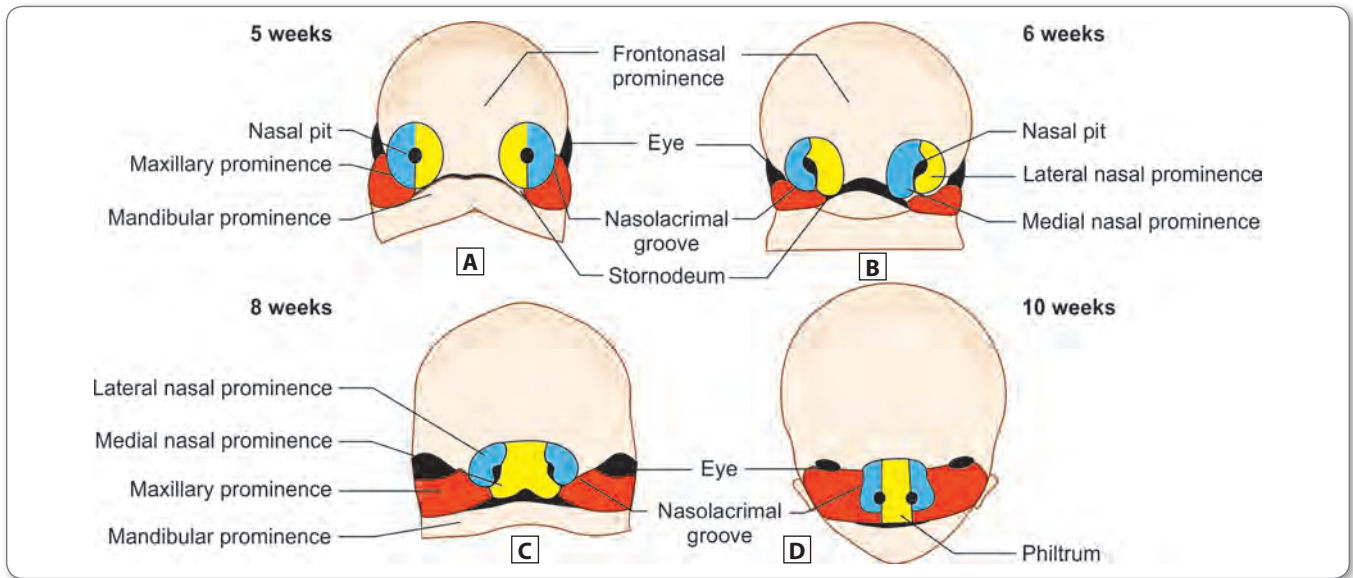
Muscles of tongue are developed from occipital somites except palatoglossus which is derived from NCC.



DEVELOPMENT OF FACE

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HEAD AND NECK



Figs 5A to D: Development of face

Developed from 5 Processes

- Frontonasal process V_1
- Medial nasal process
- Lateral nasal process
- A pair of maxillary process V_2
- A pair of Mandibular arches V_3

REMEMBER

Table 5: Structures contributing to formation of the face

Prominence	Structures formed
Frontonasal	Forehead, bridge of nose, medial and lateral nasal prominences
Maxillary	Cheeks, lateral portion of upper lip
Medial nasal	Philtrum of upper lip, crest and tip of nose
Lateral nasal	Alae of nose
Mandibular	Lower lip

Note:

- Medial nasal process of two sides fuse with each other
- Maxillary process fuse with medial and lateral nasal process
- Mandibular process of two sides fuse with each other
- Defective fusion of these process leads to anomalies in the face

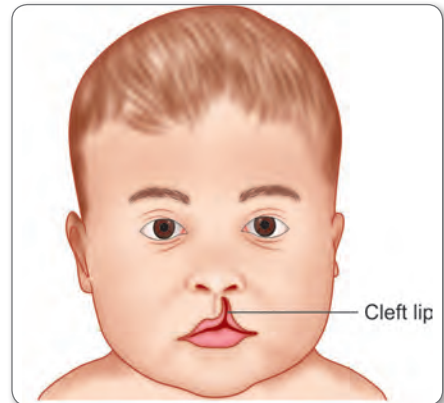
FACIAL ANOMALIES

Midline Cleft Lip



- Due to failure of fusion between 2 medial nasal process.

Cleft Upper Lip



New SARP Series Anatomy



Also called as hare lip.

Due to failure of fusion between medial nasal process and maxillary process.

Oblique Facial Cleft



Due to failure of fusion between lateral nasal process and maxillary process.

Cleft Lower Lip



Fig. 6: Median cleft of lower lip

Cleft lower lip due to failure of fusion between two mandibular process.

Development of Palate

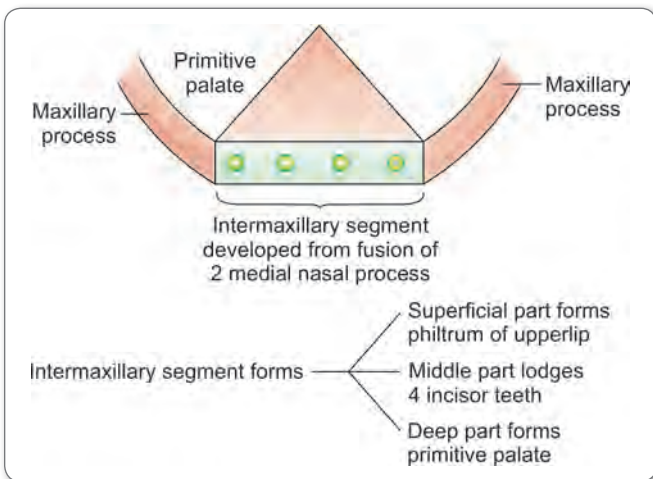
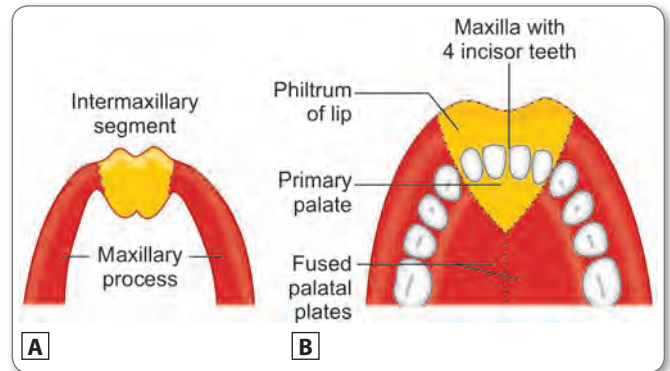


Fig. 7: Development of palate

- Secondary palate develops from palatal process of maxillary process
- Incisive fossa is formed at the meeting point of primitive palate and secondary palate

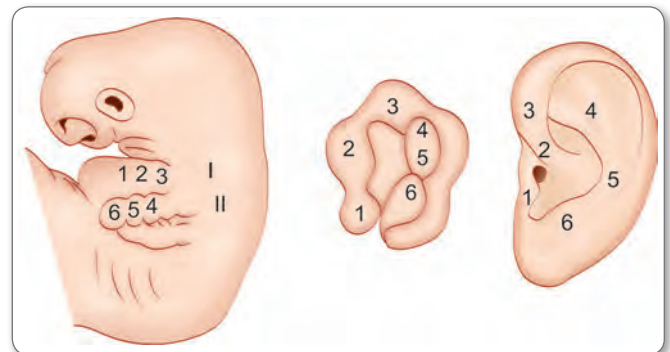


Figs 8A and B: Development of secondary palate

Development of Ear

External Ear

Auricle



- From 6 mesenchymal proliferations (auricular hillocks) at the dorsal end of 1st and 2nd arch
- These swellings three on each side of external meatus which fuse to form definitive auricle
- Tragus, helix and crus of helix derived from 1st arch
- Remaining part of pinna derived from 2nd arch

Preauricular Sinus





The failure of fusion between 1st and 2nd arch leads to formation of sinus in front of tragus.

External Auditory Canal

From the dorsal part of 1st ectodermal cleft

Tympanic Membrane

- 1st cleft (ectoderm) meets 1st pouch (endoderm) with mesoderm in between them to form tympanic membrane
- Outer epithelial layer – ectoderm
- Inner endothelial layer – endoderm
- Fibrous layer in between from mesoderm

Middle Ear

From 1st endodermal pouch

Ossicles

- Malleus, incus from 1st arch
- Stapedius – from 2nd arch

Note

Foot of stapes – dual source

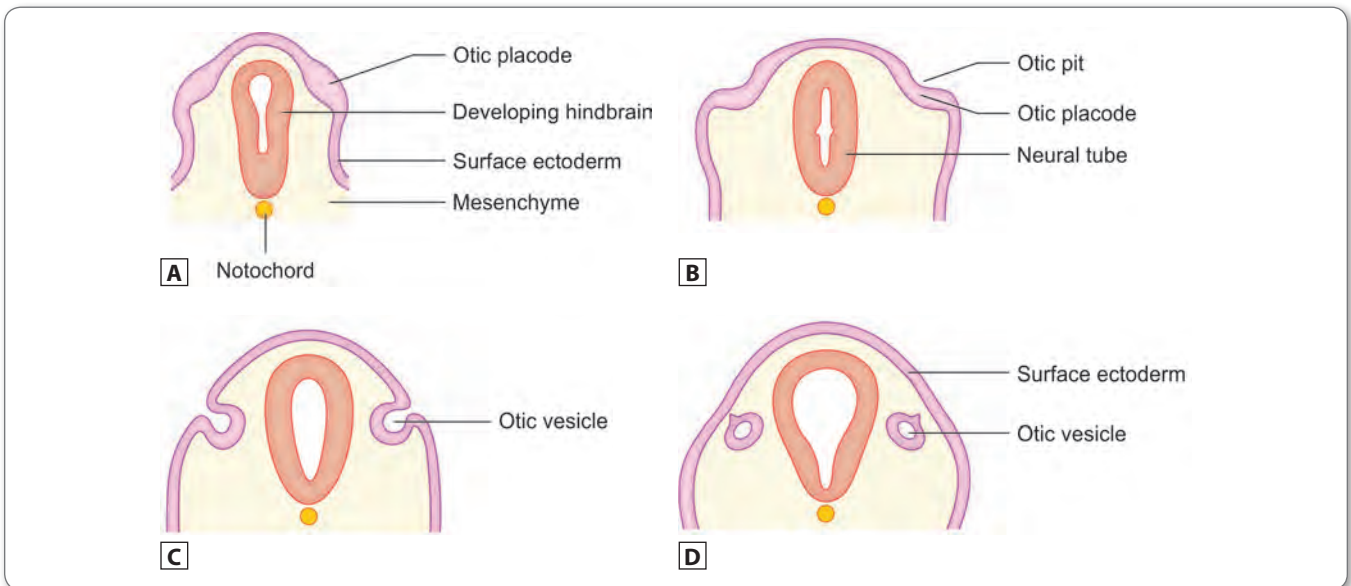
- Reichert cartilage
- Otic capsule

But best option for foot plate of stapes development **Reichert's cartilage > otic capsule.**

Middle Ear Muscles

- Tensor tympani – 1st arch derivative – supplied by mandibular nerve
- Stapedius – 2nd arch derivative – supplied by facial nerve

Development of Inner Ear



Figs 9A to D: Development of inner ear

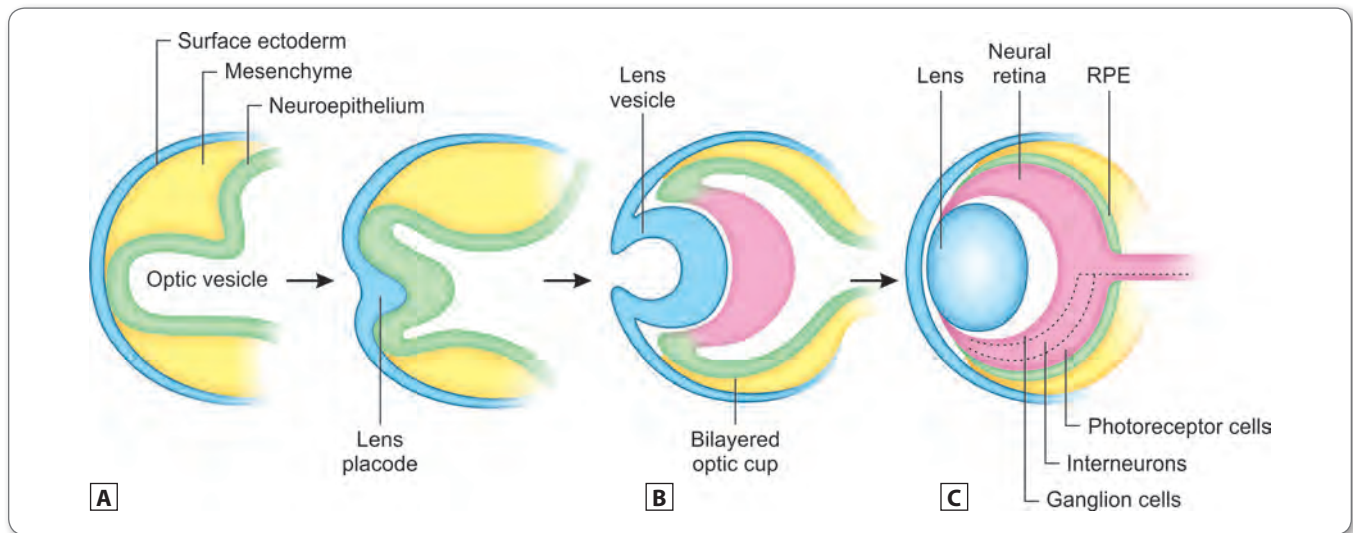
- Inner ear consists of membranous and bony labyrinth
- Membranous part derived from surface ectoderm otic placode. This becomes otic pit and then otic vesicle and forms the membranous labyrinth
- Mesenchymal tissue around the membranous labyrinth condenses to form cartilage. Later endochondral bone formation occurs in this cartilage to form bony labyrinth.

Structures which are Fully Developed at Birth

- Tympanic membrane
- Middle ear cavity with ossicles
- Mastoid antrum
- Bony and membranous labyrinth
- Only PNS visible at birth is Maxillary sinus. Maxillary sinus is the first paranasal sinus to develop.



Development of Eyeball



Figs 10A to C: Development of eyeball

- The development of the optic vesicle begins at **day 22** with the formation of optic sulcus (from diencephalon - consisting of neuroectoderm) & then optic vesicle,
- The optic vesicle invaginates and forms a double-layered optic cup and optic stalk
- PAX6 is the master homeotic gene in eye development. PAX6 is expressed predominately in the optic cup and lens placode. PAX2 is expressed predominately in the optic stalk
- The optic cup and its derivatives. The double-layered optic cup consists of an outer pigment layer and an inner neural layer
 - Retina
 - The outer pigment layer of the optic cup gives rise to the pigment layer of the retina
 - The inner neural layer of the optic cup gives rise to the neural layer of the retina (i.e., the rods and cones, bipolar cells, ganglion cells, etc.)
 - Iris
 - The epithelium of the iris develops from the anterior portions of both the outer pigment layer and inner neural layer of the optic cup - neuroectodermal derivative
 - The iris contains the dilator pupillae muscle and sphincter pupillae muscle from neuroectoderm
 - Ciliary body
 - The epithelium of the ciliary body develops from the anterior portions of both the outer pigment layer and inner neural layer of the optic cup - from neuroectoderm
 - The stroma develops from NCC > mesoderm continuous with the choroid
 - The ciliary body contains the ciliary muscle, which is formed from NCC > mesoderm within the choroid
- The optic stalk and its derivatives
 - The optic stalk contains the choroid fissure, in which the hyaloid artery and vein are found.
 - The hyaloid artery and vein later become the central artery and vein of the retina
 - The optic stalk contains axons from the ganglion cell layer of the retina
 - The choroid fissure closes during week 7, so that the optic stalk, together with the axons of the ganglion cells, forms the optic nerve (CN II), optic chiasm, and optic tract
 - The optic nerve (CN II) is a tract of the diencephalon and has the following characteristics:
 - The optic nerve is not completely myelinated until 3 months after birth; it is myelinated by oligodendrocytes
 - Optic nerve invested by meninges and surrounded by sub arachnoid space which plays role in papilledema

Development of Other Eyeball Structures

- Sclera and choroid - derived from NCC > mesoderm surrounding the optic cup.
- Sclera forms the outer fibrous layer
- Choroid forms the vascular layer
- Cornea
 - Epithelium from surface ectoderm
 - Other layers from NCC > mesoderm
- Lens from surface ectoderm
- Vitreous body from mesoderm
- Extraocular muscles - from preoccipital somites

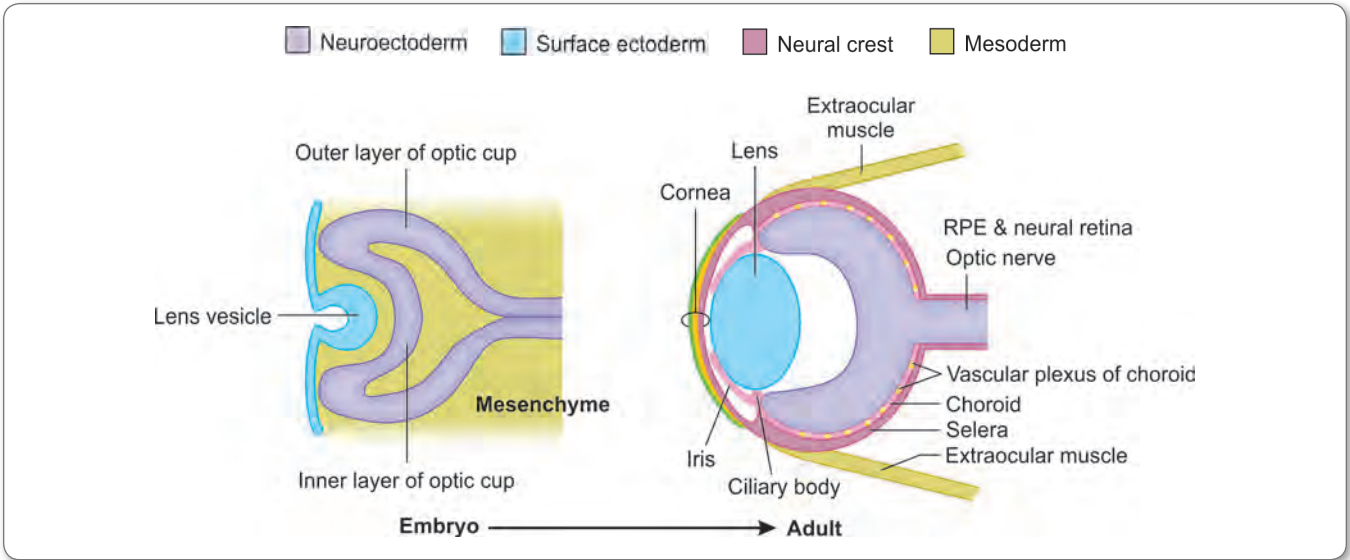
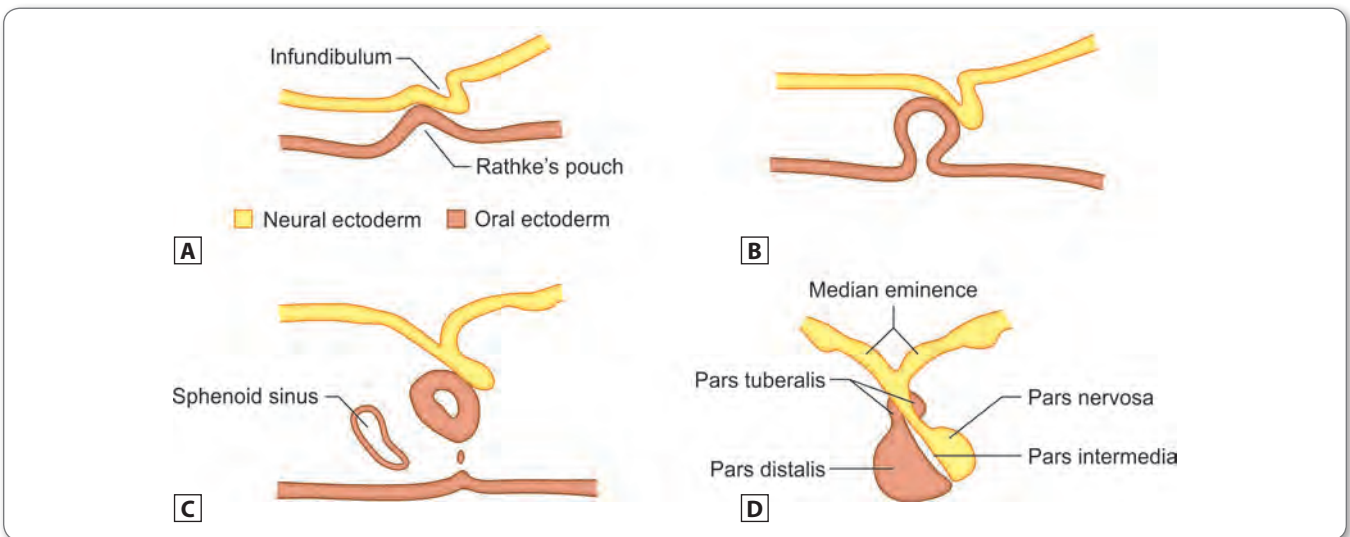


Fig. 11: Development of other eyeball structures

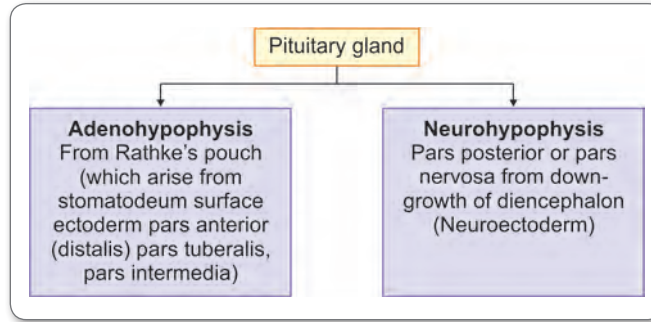
Table 6: Origin of various eye structures

Paraxial mesoderm	Surface ectoderm	Neuroectoderm	Neural crest
Primary vitreous	Lens	Optic nerve	Orbital bone/wall
	First layer of cornea (Corneal epithelium)	Retina	Corneal stroma, endothelium and keratocytes
Extraocular muscles	Conjunctival epithelium	Epithelium over iris	Trabecular meshwork, ciliary muscles, stroma of iris and choroid, sclera, ciliary body
Endothelium of blood vessels	Lacrimal gland	Epithelium over ciliary body	Uveal/conjunctival melanocytes
Blood vessel		Muscles of iris (Sphincter and dilator pupillae)	Ciliary ganglion, Schwann cells

DEVELOPMENT OF PITUITARY



Figs 12A to D: Development of pituitary



Note

All the parts of pituitary developed from surface ectoderm except pars nervosa which is derived from neuro ectoderm

OSTEOLOGY OF HEAD AND NECK

BONES OF THE SKULL

The skull consists of the 28 bones which are named as follows:

- The calvaria or brain case is composed of 14 bones including 3 paired ear ossicles.
- The facial skeleton is composed of 14 bones.

Paired	Unpaired
Parietal (2)	Frontal (1)
Temporal (2)	Occipital (1)
Malleus (2)	Sphenoid (1)
Incus (2)	Ethmoid (1)
Stapes (2)	

Paired	Unpaired
Maxilla (2)	Mandible (1)
Zygomatic (2)	Vomer (1)
Nasal (2)	
Lacrimal (2)	
Palatine (2)	
Inferior nasal concha (2)	

Bones of Cranium

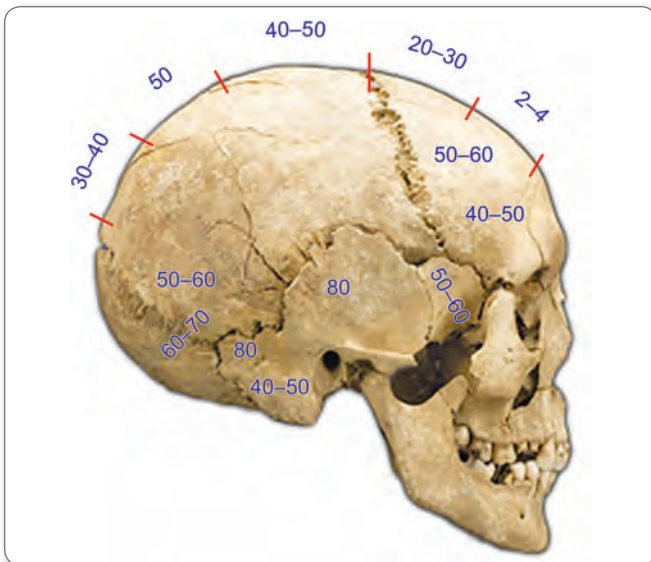


Fig. 13: Bones and sutures of cranium

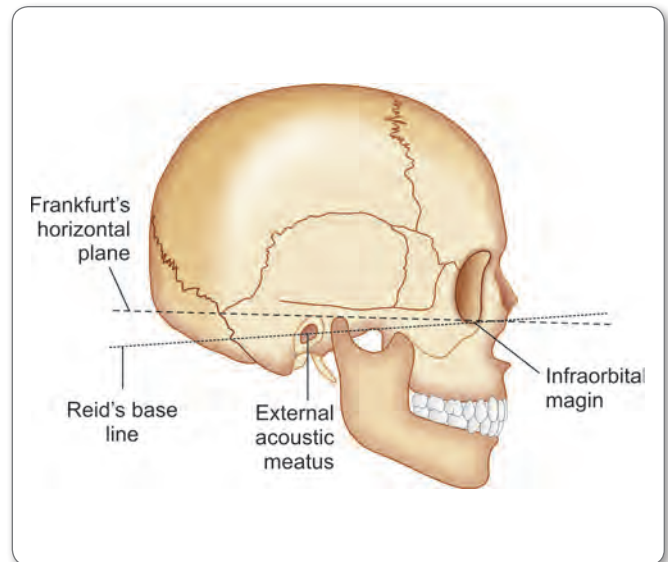


Fig. 14: Anatomical position of skull



Frontal Bone

Forms forehead and roof of orbit and smooth median prominence called glabella.

Parietal Bone

Forms superior and lateral surface of the skull.

Temporal Bone

- Consists of squamous part which is external to the lateral surface of the temporal lobe of brain.
- **Petrous part:** Encloses middle and inner ear.

Stylomastoid Part

- **Tympanic part**—encloses external auditory meatus and tympanic cavity.

Occipital Bone

Consists of squamous, basillar part and two lateral condylar parts. Contains foramen magnum.

Sphenoid Bone

Consists of body of sphenoid and two extensions lesser and greater wing and pterygoid process.

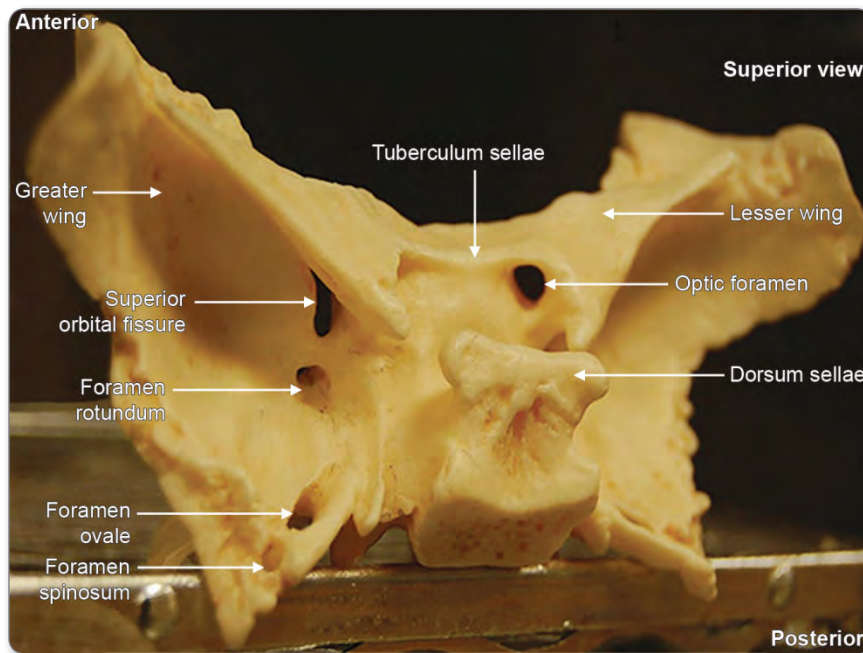


Fig. 15: Sphenoid bone

Lesser Wing of Sphenoid

Forms anterior boundary of middle cranial fossa. Superior orbital fissure situated between lesser and greater wings.

Greater Wing of Sphenoid

- Forms anterior wall and floor of middle cranial fossa. Foramen rotundum, ovale and spinosum, present in greater wing.
- **Anterior clinoid process:** Two anterior process of lesser wing of sphenoid, which provide attachment for the free border of tentorium cerebelli.
- **Posterior clinoid process:** Two tubercles from each side of dorsum sellae. Provide attachment for attached border of tentorium cerebelli.

Ethmoid Bone

- Located between orbits and consists of cribriform plate of ethmoid, perpendicular plate of ethmoid and lateral mass enclosing ethmoidal sinuses
- **Cribriform plate of ethmoid**—perforated by 15–20 foramens and transmits olfactory nerves from olfactory mucosa to olfactory bulbs.

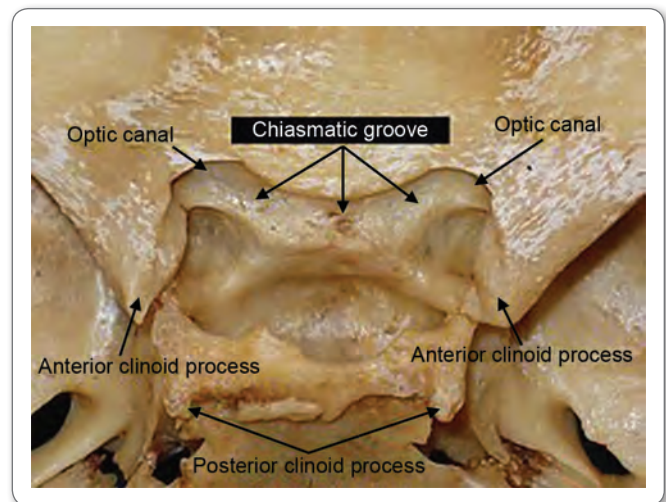


Fig. 16: Greater wing of sphenoid



HIGH YIELD POINTS

Sella Turcica

- Bounded anteriorly by tuberculum sellae and posteriorly by dorsum sellae
- It has depression called hypophyseal fossa which contains pituitary

SUTURES OF THE SKULL

- Coronal suture: Between frontal and two parietal bones.
- Sagittal suture: Between 2 parietals.
- Squamoparietal suture: Lies between squamous part of temporal bone and parietal bone.
- Lambdoid suture: Between 2 parietal and occipital bone.
- Metopic suture: Between two frontal bone extending from nasion to bregma. The metopic suture fuses at around 18 months after birth.

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THEORY

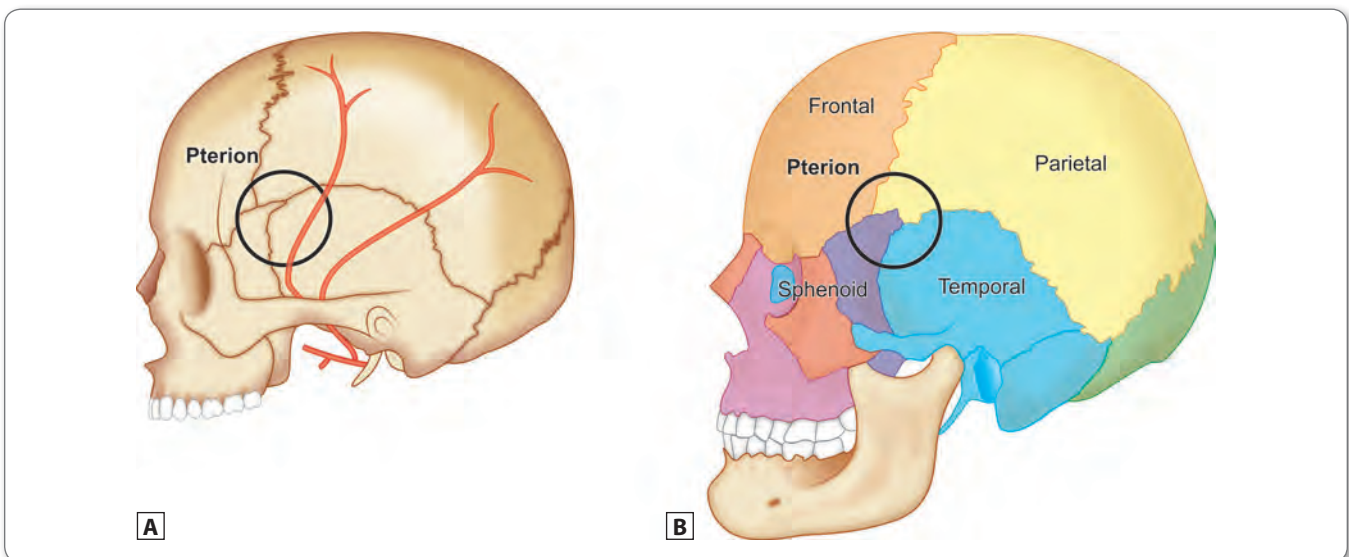
REMEMBER

Craniometric Points

Rhinion	Midline point at the inferior free end of the internasal suture
Nasion	Midline point where the two nasal bones and the frontal bone intersects
Glabella	Most anterior midline point on the frontal bone, usually above the frontonasal suture
Bregma	The ectocranial point where the coronal and sagittal sutures intersect
Apex	An instrumentally determined, ectocranial midline point placed where a paracoronal plane through the right and left poria intersects the midsagittal skull outline
Vertex	Instrumentally determined when the skull is in Frankfurt Horizontal. It is the highest ectocranial point on the skull's midline
Lambda	Ectocranial midline point where the sagittal and lambdoid sutures intersect

Inion	Ectocranial midline point at the base of the external occipital protuberance
Opisthion	Midline point at the posterior margin of the foramen magnum
Orbitale	The lowest point on the orbital margin
Pterion	<ul style="list-style-type: none"> • Region, where the frontal, temporal, parietal and sphenoid meet on the side of the vault • Centre point of pterion – sylvian point • Deep to this point – middle meningeal artery, stem of lateral sulcus present • Injury at this point – damage middle meningeal artery – results in extradural haemorrhage.
Asterion	Point where the lambdoid, parietomastoid, and occipitomastoid sutures meet

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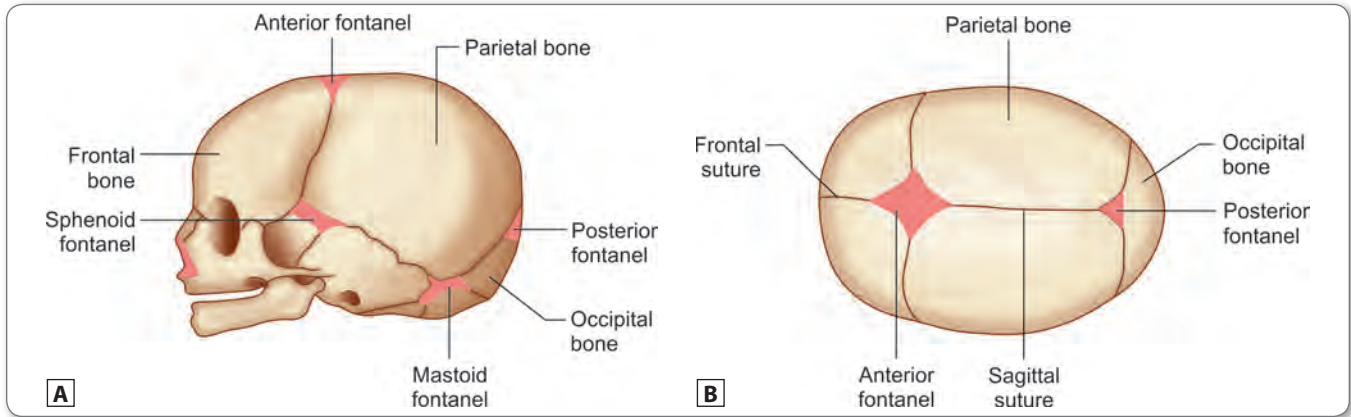
Figs 17A and B: Fracture of pterion can be especially dangerous due to potential laceration of a branch of the middle meningeal artery

New SARP Series Anatomy



Fontanelles

- Fontanelles are formed where three or four bones meet.
- **Anterior fontanelle** at the junction of the metopic and sagittal sutures. **Closes by 2 years of age.**
- **The posterior fontanelle** at the junction of the sagittal and lambdoid sutures. Closes after birth.
- Laterally, the (**sphenoidal fontanelle**) anterolateral fontanelle lies between the frontal, parietal, greater wing of the sphenoid and squamous temporal bones; its site after closure is called the pterion. Closes in few weeks of birth.
- The posterolateral fontanelle (**mastoid fontanelle**) lies between the parietal, petrous temporal, exoccipital and basioccipital bones; after closure its site is called the asterion. Closes in few weeks of birth.



Figs 18A and B: Development of fontanelles

FORAMINA OF SKULL AND STRUCTURES PASSING THROUGH IT

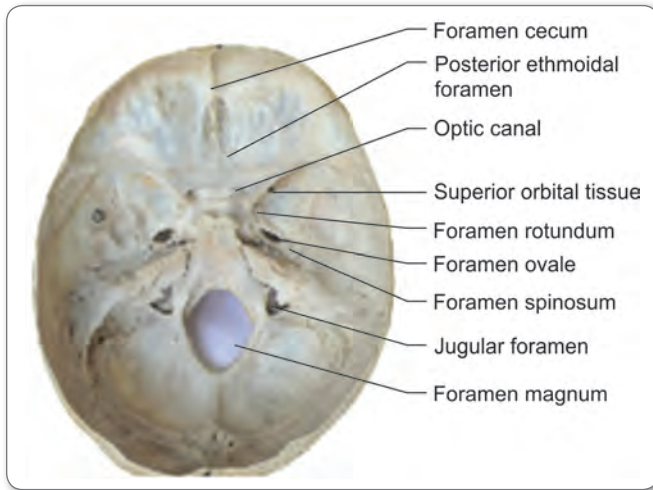


Fig. 19: Foramina of skull

Table 7: Foramina and the structures passing through them

Foramen	Structures passing through the foramen
F. ovale	Mandibular nerve Accessory meningeal artery Lesser petrosal nerve Emissary vein connecting cavernous sinus and pterygoid venous plexus
F. spinosum	Middle meningeal artery and vein Emissary vein Nervous spinosum

Contd...

Foramen	Structures passing through the foramen
F. lacerum	No structure pass through it. But the upper part is traversed by internal carotid artery, deep petrosal nerve which joins with greater petrosal nerve to form vidian nerve. (see the diagram below)
Carotid canal	Internal carotid artery and sympathetic plexus around it
F. rotundum	Maxillary nerve
Pterygoid canal	Vidian nerve (nerve of pterygoid canal) Vidian artery
Stylomastoid foramen	Facial nerve (7th nerve) Posterior Auricular artery. Mnemonic – 7 up
Petrotympenic fissure	Chorda tympani nerve
Foramen cecum	Emissary veins from nasal mucosa to superior sagittal sinus
Internal acoustic meatus	Facial nerve Nerves INtermedius Labyrinthine vessels Vestibulocochlear nerve. Mnemonic – fall in love.
Hypoglossal canal	Hypoglossal nerve Meningeal branch of ascending pharyngeal artery Emissary veins
Posterior condylar foramen	Emissary veins connecting sigmoid sinus to suboccipital venous plexus.

Contd...



Foramen	Structures passing through the foramen
Jugular foramen	Anterior part – inferior petrosal sinus (1st tributary to internal jugular vein) Intermediate part – Glossopharyngeal nerve <ul style="list-style-type: none"> • Vagus nerve • Accessory nerve • Meningeal branch of ascending pharyngeal artery Posterior part – internal jugular vein as a continuation of sigmoid sinus
Mastoid canaliculus	Auricular branch of vagus
Tympanic canaliculus	Tympanic branch of glossopharyngeal nerve
Greater palatine foramen	Greater palatine vessels and greater palatine nerves
Lesser palatine foramen	Lesser palatine vessels and nerves

Foramen	Structures passing through the foramen
Incisive foramen	Terminal branch of greater palatine vessels
Foramen magnum	Anterior part <ul style="list-style-type: none"> • Apical ligament of dens • Membrana tectoria • Vertical band of cruciate ligaments Intermediate <ul style="list-style-type: none"> • Spinal artery • Spinal part of accessory nerve • Vertebral artery and sympathetic plexus surrounding it Posterior part <ul style="list-style-type: none"> • Medulla lower part • Cerebellar tonsils • Meninges

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FORAMEN LACERUM

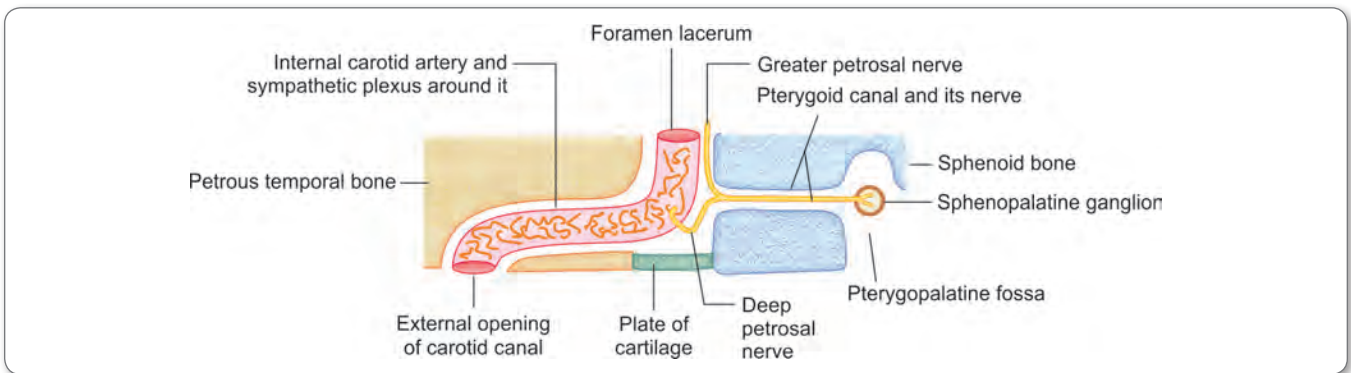
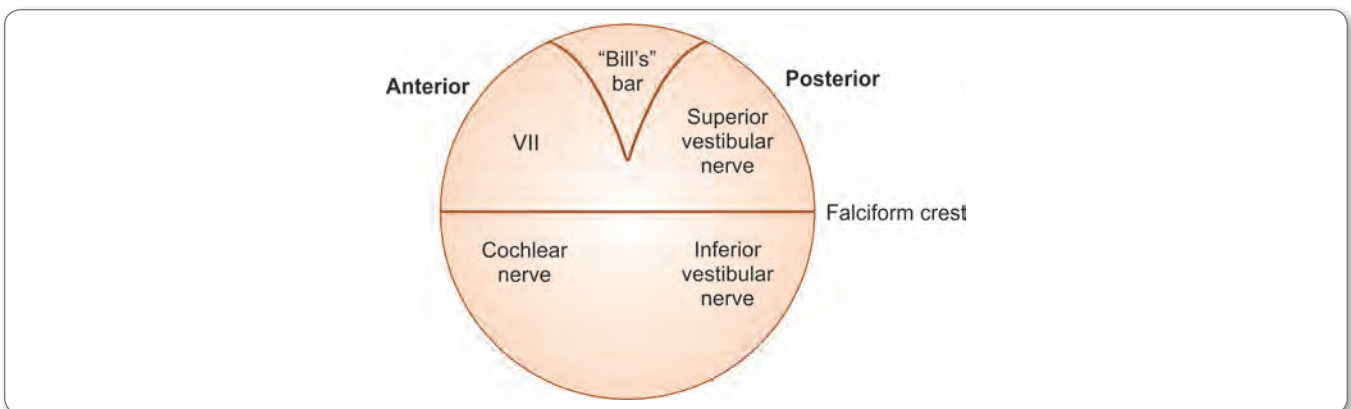


Fig. 20: Foramen lacerum

INTERNAL ACOUSTIC MEATUS



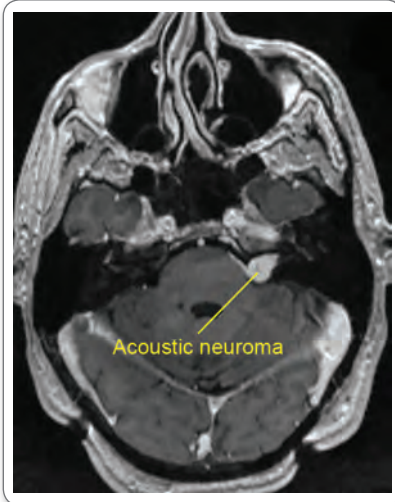
- Divided into superior and inferior part by **falciform crest**
- Superior part divided by **Bill's bar** into anterior and posterior part
- Antero superior part – **facial nerve**



- Posterior superior – superior part of **vestibular nerve**
- Inferior part – **cochlear nerve** in the anterior aspect and inferior vestibular nerve

Clinical Aspect

Acoustic Neuroma



- Cerebellopontine angle tumour
- Most commonly affected structure inferior vestibular nucleus > superior vestibular nucleus
- Rarely arise from cochlear nucleus

STERNBERG'S CANAL



Fig. 21: Three-dimensional CT imaging software (Aquarius software, TeraRecon, Inc., San Mateo, CA) reconstruction of the sphenoid bone (posterior view). The arrow points to the theoretical position of Sternberg's canal. Note how an encephalocele located in this area would need to herniate through the cavernous sinus and two layers of dura mater. (A) Superior orbital fissure; (B) Foramen rotundum.

- Sternberg's canal is a lateral craniopharyngeal canal resulting from incomplete fusion of the greater wings of the sphenoid bone with the basisphenoid
- Situated antero-medial to foramen rotundum
- Connects nasopharynx and middle cranial fossa

MANDIBLE

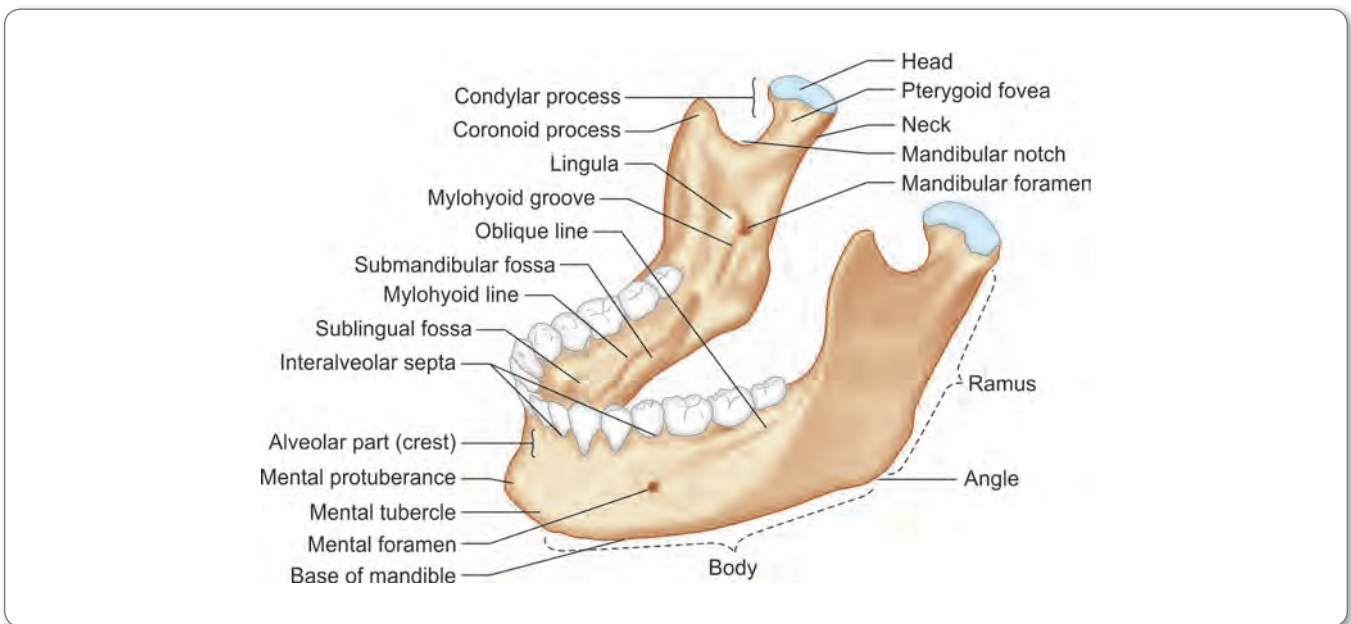


Fig. 22: Mandible of adult: anterolateral superior view



- Derived from 1st arch Meckel's cartilage
- Consists of two halves which are united in the middle by symphysis menti – secondary cartilaginous joint

Muscles Attached to Mandible

- Temporalis—attached to coronoid process
- Masseter—outer surface of ramus of mandible
- Mylohyoid muscle—mylohyoid line
- Medial pterygoid muscle—inner surface of ramus of mandible below the mylohyoid line
- Lateral pterygoid muscle—neck of the mandible

Nerves Related to Mandible

- Inferior alveolar nerve and vessel—passing through mandibular foramen
- Lingual nerve—related closely behind the mucosa of third molar tooth
- Nerve to mylohyoid—run in mylohyoid groove
- Masseteric nerve—runs in mandibular notch
- Auriculotemporal nerve—wind around the neck of the mandible
- Mental nerve—coming out through mental foramen
- Marginal mandibular nerve—across the lower border of the mandible.

HYOID BONE

U shaped bone consisting of body, pair of lesser horns – laterally and paired greater horns posteriorly

- Body
 - Provides attachments for the geniohyoid, mylohyoid, omohyoid and sternohyoid muscles
- Greater horn
 - Provides attachments for middle constrictor, hyoglossus, digastric, stylohyoid and thyrohyoid muscles
- Lesser horn
 - Provides attachments for stylohyoid ligament

STYLOID APPARATUS

- Knife like projection extending downward and forward from the temporal bone
- Gives origin to three muscles (which are innervated by three different nerves) and two ligaments (stylohyoid)
- Muscles
 - Stylohyoid supplied by facial nerve
 - Styloglossus supplied by hypoglossal nerve
 - Stylopharyngeus supplied by glossopharyngeal nerve
- Ligaments
 - Stylomandibular ligament thickening of investing layer of deep cervical fascia and separate parotid from submandibular gland.
 - Stylohyoid ligament

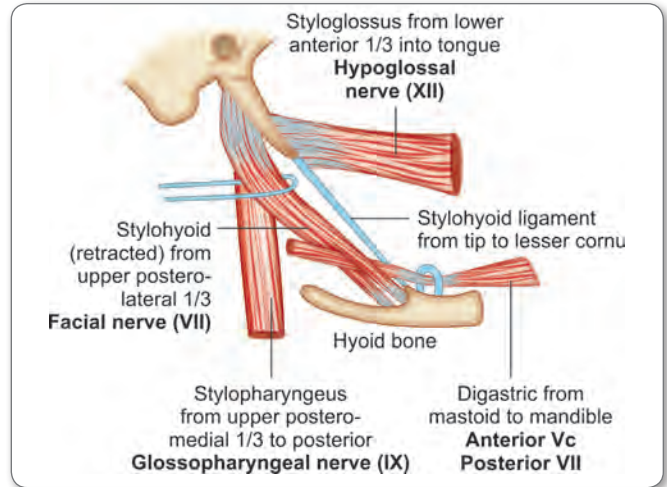


Fig. 23: Styloid apparatus

Clinical Aspect

Eagles Syndrome

- Elongation of styloid or excessive calcification of styloid process or stylohyoid ligament
- Patient complains of pain in the neck, throat, facial pain and dysphagia due to compression of glossopharyngeal nerve and facial nerve
- Sometimes it may also compress the external and internal carotid artery

PTERYGOPALATINE FOSSA

- It is a pyramidal space below the apex of orbit

Table 8: Boundaries of pterygopalatine fossa

Anterior	Posterior surface of maxilla.
Posterior	Root of the pterygoid process and adjoining greater wing of sphenoid
Above	Communicates with orbit
Below	Apex of the fossa
Medial	Perpendicular plate of palatine bone
Lateral	Communicates with infratemporal fossa

Table 9: Openings of pterygopalatine fossa

In posterior wall	Foramen rotundum transmits maxillary nerve Pterygoid canal transmits pterygoid vessels and nerves Palatinovaginal canal transmits pharyngeal vessels and nerves
In medial wall	Sphenopalatine foramen – fossa communicates with nasal cavity- transmits nasopalatine vessels and nerves
In apex of the fossa	Greater palatine canal for the passage of greater palatine vessels and nerves

- Inferior orbital fissure – communicates this fossa with orbit
- Pterygomaxillary fossa – communicates with infratemporal fossa.



INFRA TEMPORAL FOSSA

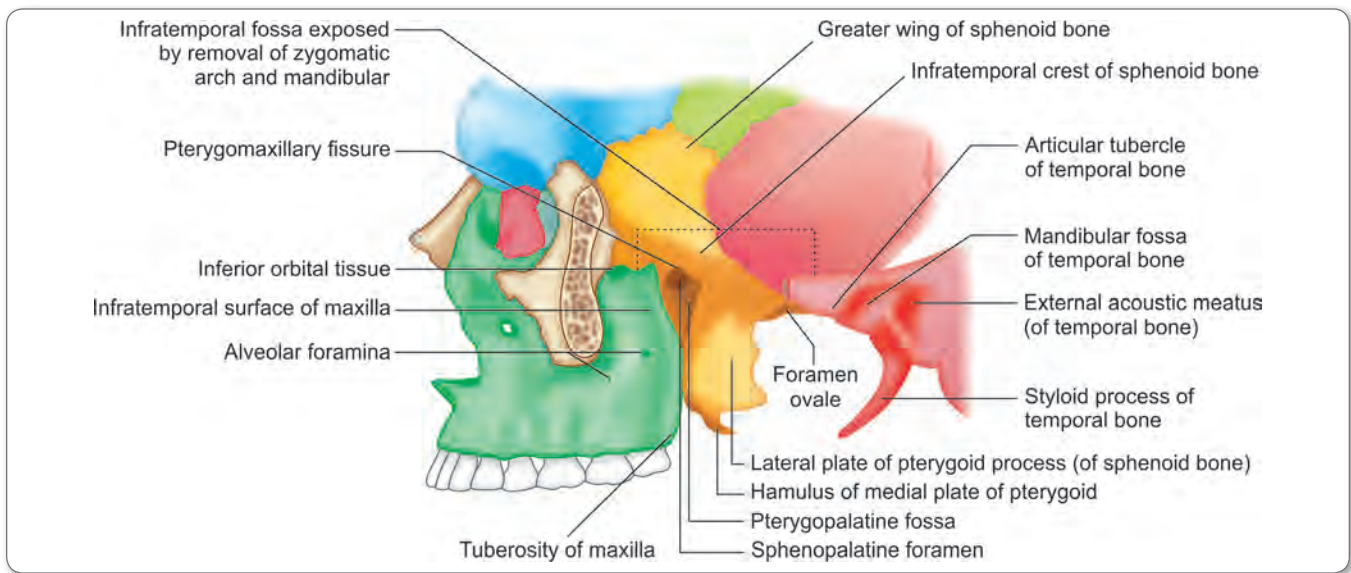


Fig. 24: Infratemporal fossa (lateral view)

Boundaries

- Anterior: Posterior surface of maxilla
- Posterior: Styloid and mastoid
- Medial: Lateral pterygoid plate
- Lateral: Ramus and coronoid process of mandible
- Roof: Greater wing of sphenoid and infra temporal crest

Contents

- Lower portion of temporalis
- Lateral and medial pterygoid
- Pterygoid venous plexus
- Mandibular nerve and its branches
- Maxillary artery
- Chorda tympani
- Otic ganglion
- Pterygoid venous plexus: Peripheral heart
 - Lies on the lateral surface of medial pterygoid muscle
 - Receives veins corresponding to branches of maxillary artery and drains into maxillary vein
 - **Communications**
 - With cavernous sinus through emissary veins
 - With facial vein through deep facial vein
 - With inferior ophthalmic vein which runs through infraorbital fissure.

TEMPORAL FOSSA

- Anterior: Zygomatic process of frontal bone and frontal process of zygomatic bone
- Superior: Temporal line
- Lateral: Zygomatic arch
- Inferior: Infra temporal crest

- Floor: Parts of frontal, parietal, temporal and greater wing of sphenoid.

Contents

- Temporalis
- Deep temporal nerve and vessels
- Auriculotemporal nerve
- Superficial temporal vessels

HEAD

SCALP

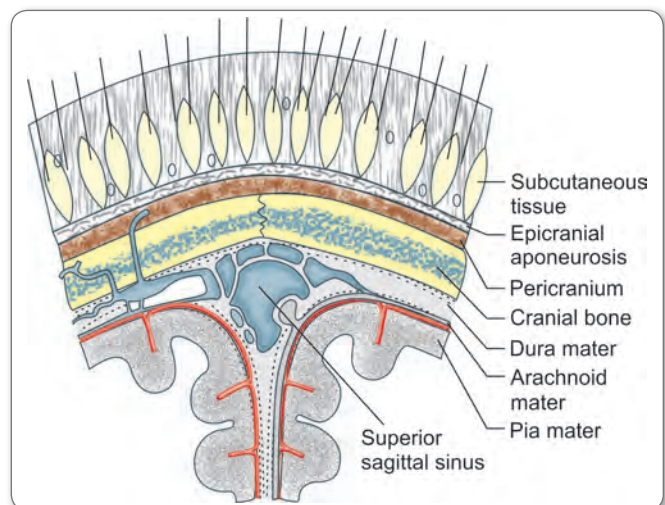


Fig. 25: Layers of scalp

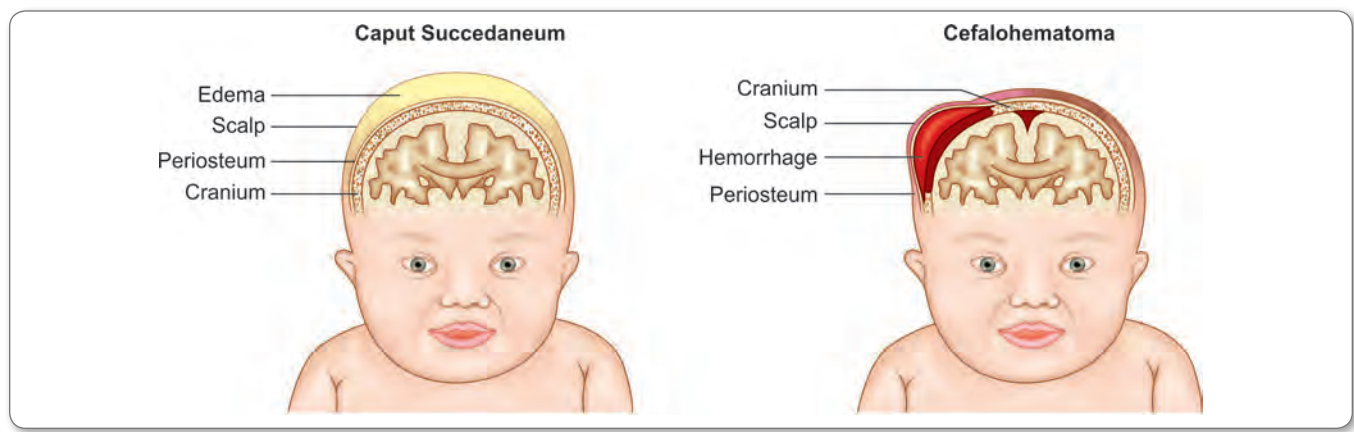


- Consists of five layers
- Skin: Contains more sebaceous glands, so sebaceous cysts are common
- Subcutaneous connective tissue: **Highly vascular layer**
- Epicranial aponeurosis—also called **galea aponeurotica**. Aponeurosis between frontalis belly (supplied by temporal branch of facial nerve) and occipital belly (supplied by posterior auricular branch of facial nerve).

Note

First three layers firmly adherent to one another and it is referred as surgical layers of the scalp.

- **Loose areolar connective tissue**—also called ‘**Danger area of scalp**’ because of presence of emissary veins in this layer. Emissary veins connected to dural venous sinus. So, any infection in this layer easily travel to dural venous sinus.
- **Pericranium**: The periosteum of the bones gets attached to sutural ligaments. Any bleeding below this layer called ‘**cephalohematoma**’. It assumes the shape of related bone.
- **Caput succedaneum** is a temporary edematous swelling seen in the newborn due to interference of venous return. Caput cross the suture lines.



Mnemonic

SCALP
 Skin
 Sub Cutaneous tissue
 Aponeurotic layer
 Loose areolar tissue and
 Pericranium.

Nerve Supply of Scalp

10 pairs, 5 pairs in front of auricle (4 sensory and 1 motor) and 5 pairs behind the auricle (4 sensory and 1 motor)

In Front of Auricle

Mnemonic

OT at Zen Temple
 Supraorbital: Branch of ophthalmic division of trigeminal nerve
 Supratrochlear: Branch of ophthalmic division of trigeminal nerve
 Zygomatico Temporal branch of maxillary division of trigeminal nerve
 Auriculotemporal nerve branch of mandibular division of trigeminal nerve
 Temporal branch of facial nerve – motor - supplies frontal belly of epicranium muscle

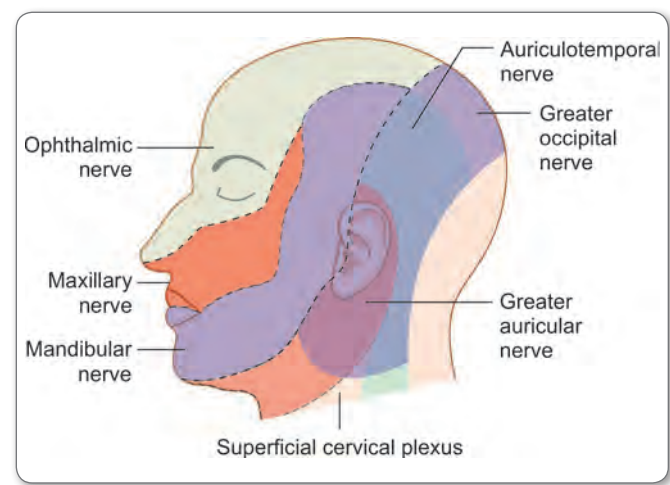


Fig. 26: Innervation of scalp

Behind the Auricle

- Great auricular nerve C2, 3 – branch of cervical plexus
- Lesser occipital nerve C2 – branch from cervical plexus
- Greater occipital nerve C2 – dorsal rami of C2
- Third occipital nerve – dorsal rami of C3
- Posterior auricular branch of facial nerve – motor – supplies occipital belly of epicranium muscle.



Arterial Supply

- In front of auricle: Supratrochlear, supraorbital artery and superficial temporal artery
- Behind the auricle: Posterior auricular artery and occipital artery.

FACE

Muscles of Face Comprise

- **Panniculus carnosus – subcutaneous muscles**
- Muscles of facial expressions
- Dartos muscle
- Platysma
- Palmaris brevis
- Corrugator cuti ani

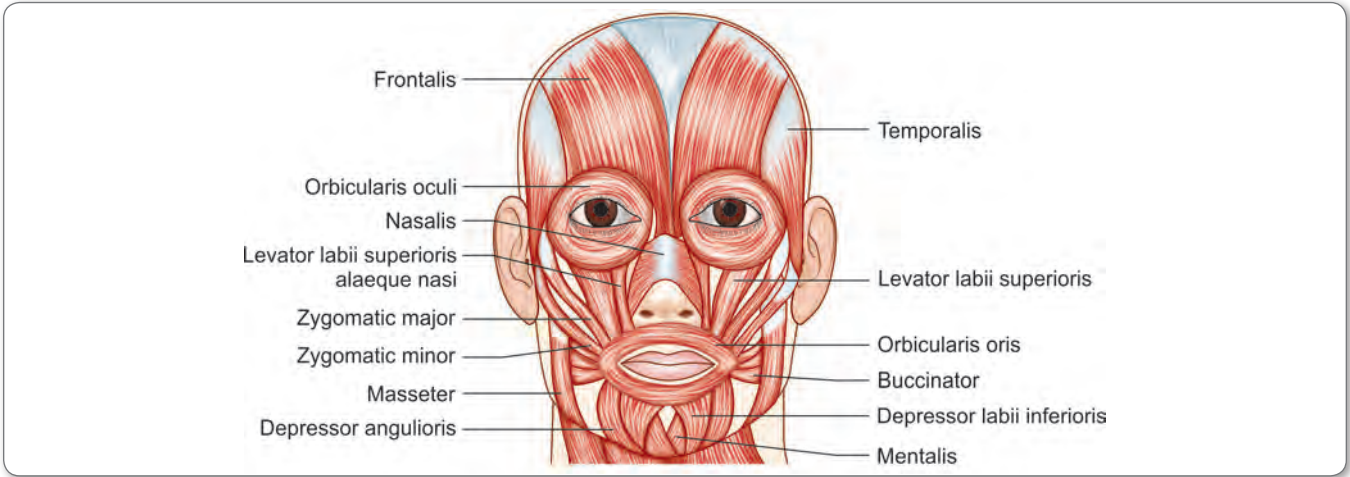


Fig. 27: Muscles of face

Muscles of Facial Expressions

- Developed from 2nd arch and are supplied by facial nerve.

Table 10: Facial expressions and muscles responsible for them

Expression	Muscle
Surprise, horror or fright	Frontalis
Smiling/Laughing	Zygomaticus major
Grinning	Risorius
Frowning	Corrugator supercillii
Doubt	Mentalis
Anger	Dilator nares and depressor septi
Irony	Depressor labii inferioris
Sadness	Levator anguli oris, levator labii superioris, zygomaticus minor and depressor anguli oris
Whistling	Buccinator

Nerve Supply of the Face

- Motor—facial nerve supplying muscles of facial expression.
- Sensory: (Skin of the face) supplied by branches of trigeminal nerve

Ophthalmic Division

- Innervates the area above the upper eyelid, tip of nose
- Supplies face as supraorbital, supratrochlear, infratrochlear and external nasal nerves

Maxillary Division

- Innervates the face below the level of eyes and above the upper lip
- Supplies face as zygomaticofacial, zygomaticotemporal and infraorbital nerve

Mandibular Division

- Innervates face below the level of lower lip
- Supplies face as auriculotemporal, buccal and mental nerves

Clinical Aspect

Corneal Blink Reflex

- Closure of eyelids in response to touching with wisp of cotton
- Due to bilateral contraction of orbicularis oculi
- **Afferent:** Nasociliary branch of ophthalmic division of trigeminal nerve
- **Efferent:** Facial nerve

Contd...

REMEMBER

Structures Piercing Buccinator

- Parotid duct
- Buccal branch of mandibular nerve
- Four or five molar mucous glands lying on buccopharyngeal fascia around the parotid duct



Trigeminal Neuralgia – Tic Douloureux

- Paroxysmal pain along the course of trigeminal nerve
 - Common causes – aberrant blood vessels, aneurysms, brain tumors compressing the trigeminal nerve at the base of the brain
- Skin over the angle of the mandible—and skin over parotid gland—by great auricular nerve.

Arterial Supply

Facial artery and transverse facial artery supply the face

Venous Drainage

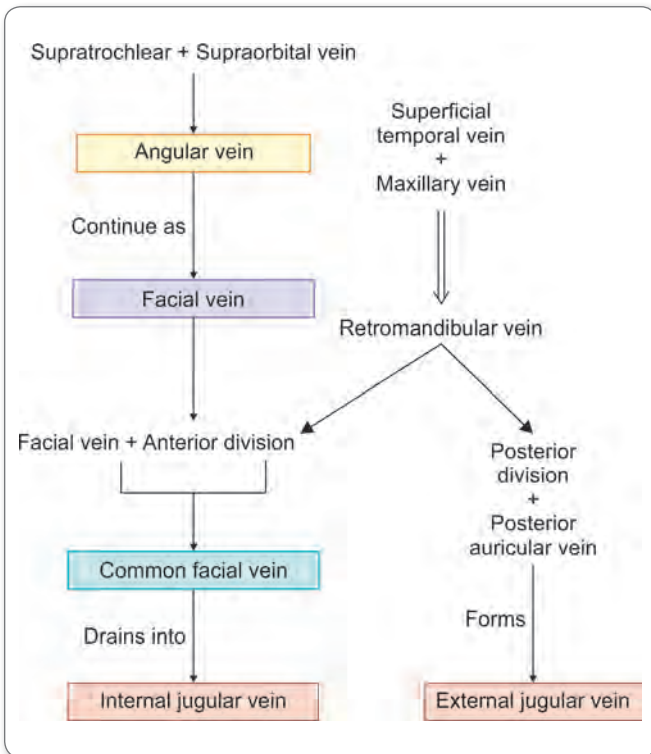


Fig. 28: Venous drainage of face

- Facial vein communicates with cavernous sinus through two routes
 - Through Superior ophthalmic vein (tributary and communicating channel of cavernous sinus)
 - Through deep facial vein - Facial vein → Deep facial vein → pterygoid venous plexus → emissary vein → cavernous sinus
- Therefore, infection from face spread to cavernous sinus
- This occurs in the presence of infection in upper lip and lower part of nose. This area is called as **dangerous area of face**.

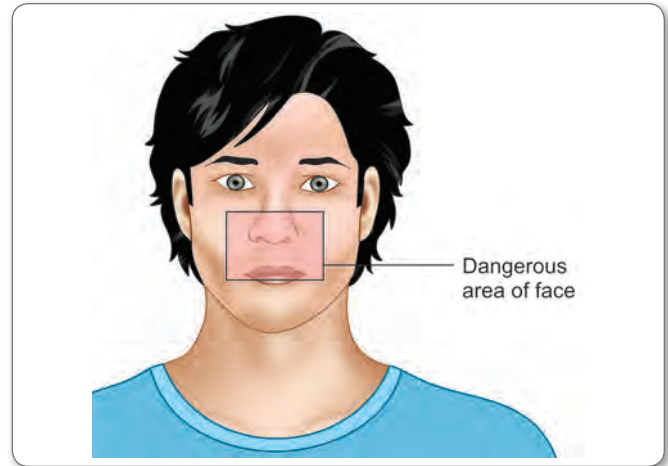


Fig. 29: Dangerous area of face

Clinical Aspect

- **Fractures of anterior cranial fossa**
These are associated with
 - Cerebrospinal fluid rhinorrhea (In fracture of Cribriform plate of ethmoid bone)
 - Subconjunctival hemorrhages (If orbital plate of frontal bone is involved)
- **Fractures of middle cranial fossa**
These are common since it is the weakest part of base of skull. They are associated with
 - Cerebrospinal fluid otorrhea (Leak from external auditory meatus)
 - Hemotympanum
 - Injury to 3rd, 4th, 6th CN if lateral wall of cavernous sinus is torn
- In fracture of posterior cranial fossa blood may accumulate in → **Posterior triangle of neck**
- Injury to scalp can cause “Black eye” because subaponeurotic layer of scalp is continuous with the subcutaneous layer.
- **Safety valve hematoma** in scalp → Collection of blood in subaponeurotic layer of scalp (dangerous area of scalp) in fracture skull
- **Bezold’s abscess** → Collection of pus into sternocleidomastoid.
- **Cephalhematoma** in scalp → Collection of blood in underneath the pericranium in fracture of vault bones. Swelling is restricted to bone and occupy the shape of related bone.
- **Cephalhydrocele** → Collection of CSF in beneath the pericranium in tear of dura/arachnoid mater.

DURAL VENOSUS SINUSES

Venous sinuses are present between the two layers of dura mater. They are paired and unpaired

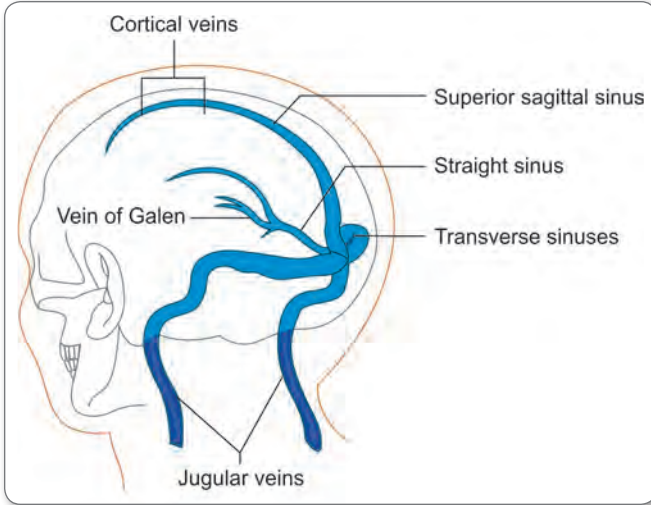


Fig. 30: Dural venous sinuses

Table 11: Paired and unpaired dural venous sinuses

Paired sinuses	Unpaired sinuses
Transverse	Superior sagittal
Sigmoid	Inferior sagittal
Cavernous	Straight
Superior petrosal	Occipital
Inferior petrosal	Anterior intercavernous
Sphenoparietal	Posterior intercavernous
Petrosquamous	Basilar venous plexus
Middle meningeal	MN – SISter At BPO

Note: Remember any one (either paired or unpaired sinus)

- Superior Sagittal sinus—continue as Right transverse sinus (**Mnemonic – SSR OLD ACTOR IN TAMIL**)
- Inferior sagittal sinus—terminates into straight sinus
- Straight sinus receives great cerebral vein of Galen – continues as left transverse sinus
- Transverse sinus—continue as sigmoid sinus.
- Sigmoid sinus—continue as internal jugular vein.

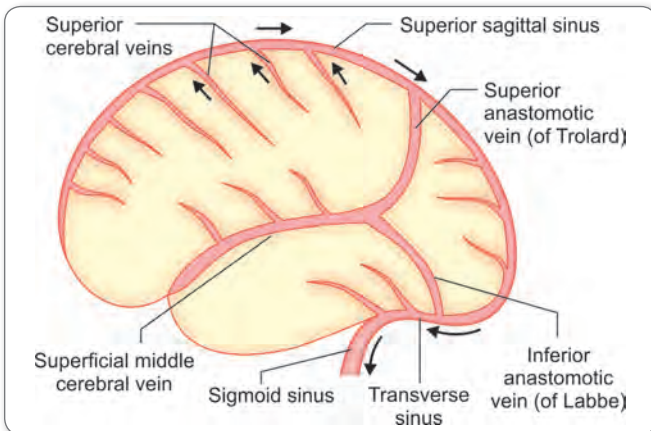


Fig. 31:

- Superior anastomosing vein – vein of Trolard – connects superior sagittal sinus to superficial middle cerebral vein
- Inferior anastomosing vein – vein of Låbbé – connects transverse sinus to superficial middle cerebral vein

Confluence of Sinus

This is meeting place of four pair of venous sinuses

Mnemonic

TOSS

- Transverse sinus
- Occipital sinus
- Straight sinus
- Superior sagittal sinus

Cavernous Sinus

- Location—on either side of body of sphenoid
- Extension—from superior orbital fissure to apex of petrous part
- Formation—separation between endosteal (forms floor and medial wall) and meningeal layer (forms roof and lateral wall) of dura mater.
- Direct content—Internal carotid artery and Abducent nerve. **Mnemonic AI (all India)**

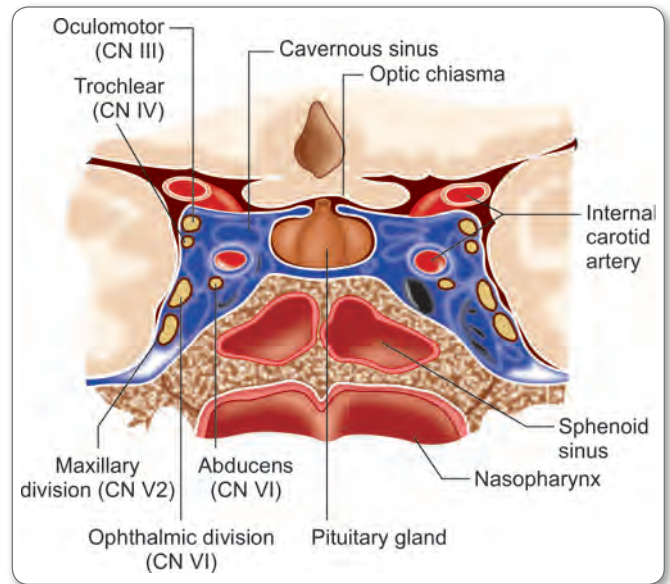


Fig. 32: Cavernous sinus

Mnemonic

Structure in Lateral wall—OTO—MAX

- Oculomotor nerve
- Trochlear nerve
- Ophthalmic nerve

Cavernous sinus lesion may be associated with paralysis of 3rd, 4th, 5th (ophthalmic division) and 6th nerve.

Note: Maxillary nerve not passing through the lateral wall according to Gray's 41th edition



Tributaries

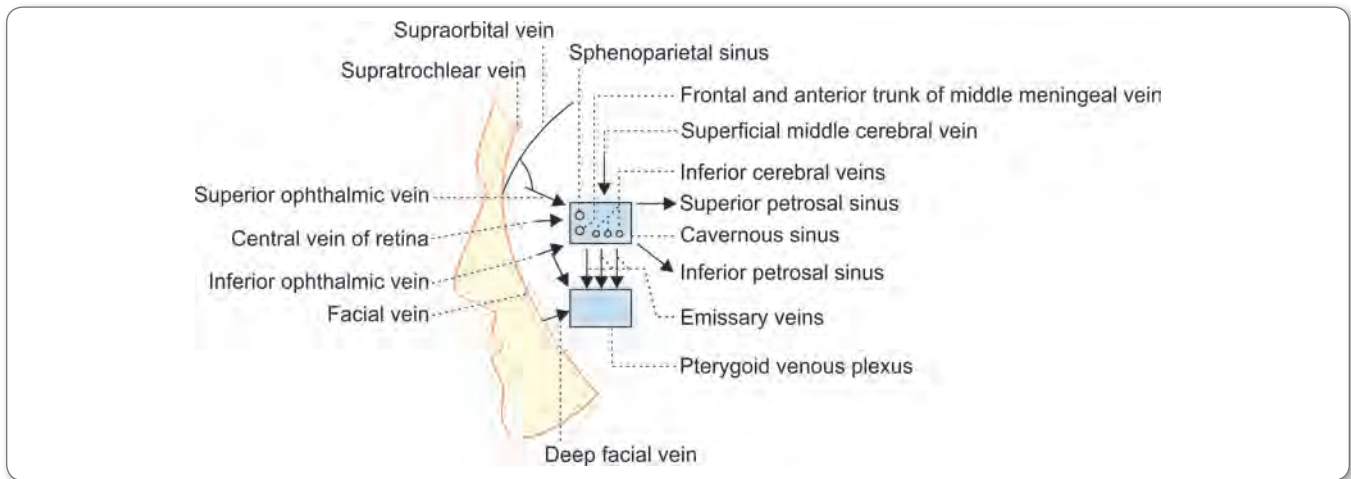


Fig. 33: Tributaries of cavernous sinus

- Superior ophthalmic vein
- A branch from inferior ophthalmic vein
- Sometimes central vein of retina
- Superficial middle cerebral vein
- Inferior cerebral veins
- Sphenoparietal sinus
- Sometimes anterior trunk of middle meningeal vein

Communications of Cavernous Sinus

- Communicates with transverse sinus via superior petrosal sinus
- Communicates with internal jugular vein via inferior petrosal sinus
- Communicates with pterygoid venous plexus via emissary veins passing through foramen ovale and spinosum
- Communicates with facial vein via 2 routes superior ophthalmic vein and angular vein and facial vein—deep facial vein—pterygoid venous plexus—emissary veins—cavernous sinus.

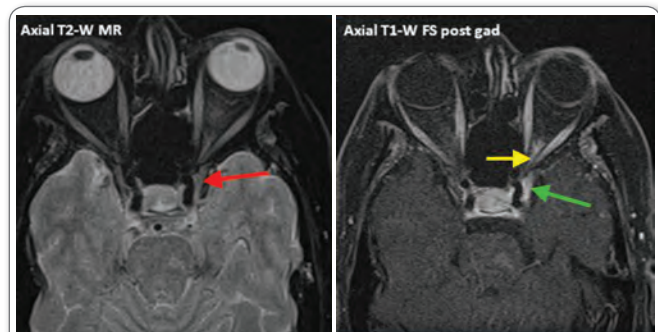


Clinical Aspect

Features of Cavernous Sinus Thrombosis

- Ophthalmoplegia—injury of 3rd, 4th, 6th cranial nerve
- **Diplopia**
- Pain over the area of distribution of ophthalmic and maxillary vein
- Swelling of eyelids and **exophthalmos**
- **Papilledema** due to raised intracranial tension
- Loss of vision due to involvement of central vein of retina

Tolosa-Hunt Syndrome



Tolosa-Hunt syndrome

T2 iso-hypointense signal in the left cavernous sinus with enhancement
Enhancement is also seen in the left superior orbital fissure

- Idiopathic inflammatory process due to lesion in cavernous sinus
- Iii, iv, vi and ophthalmic nerve are affected in this syndrome

Superior Sagittal Sinus

- Situated in the midline along the convex border of falx cerebri
- Begins at crista galli and receives cerebral veins, diploic meningeal and parietal emissary veins

Inferior Sagittal Sinus

- Lies in the free edge of the falx cerebri and joined by great cerebral vein of Galen to form straight sinus



Straight Sinus

- Situated along the line of attachment of falx cerebri to tentorium cerebelli.
- Formed by union of inferior sagittal sinus and great vein of Galen.

Transverse Sinus

- Runs laterally along the edges of tentorium cerebelli and continues as sigmoid sinus.

Sigmoid Sinus

- Continuation of transverse sinus. Arches downwards and medially in as shaped groove and continue as internal jugular vein.

Superior Petrosal Sinus

- Lies in the margin of tentorium cerebelli and running from the posterior end of cavernous sinus into transverse sinus.

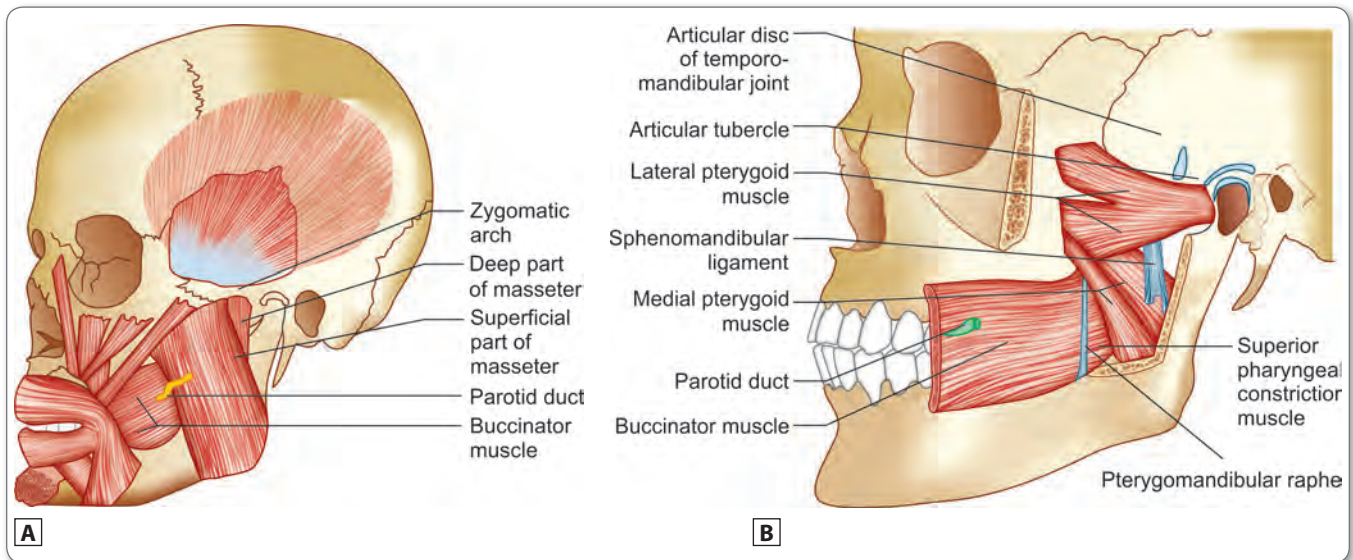
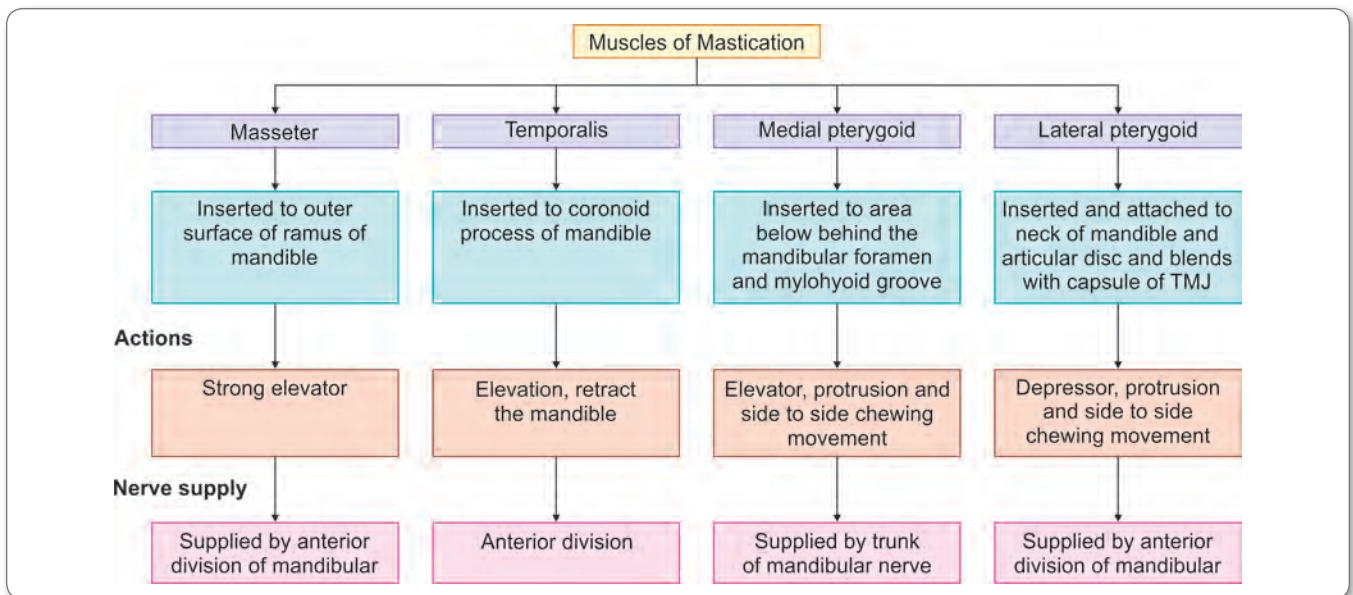
Inferior Petrosal Sinus

- Drains cavernous sinus into internal jugular vein.

Occipital Sinus

- Lies in the falx cerebelli and drains into confluence of sinus.

MUSCLES OF MASTICATION



Figs 34A and B: Muscles of mastication



Table 12: Muscles of mastication

	Masseter	Temporalis	Medial pterygoid	Lateral pterygoid
Attachments	Origin – zygomatic arch Insertion - Outer surface of ramus of mandible	Origin – temporal fossa Insertion - Coronoid process of Mandible	Origin – maxilla and medial surface of lateral pterygoid plate Insertion - Area below and behind Mandibular foramen And mylohyoid groove	Origin – undersurface of sphenoid and lateral surface of lateral pterygoid plate Insertion - Attach to neck of mandible, articular disk and blends with capsule of temporomandibular joint
Nerve supply	Anterior division of mandibular nerve	Anterior division of mandibular nerve	Directly by trunk of mandibular nerve	Anterior division of mandibular nerve
Action	Strong elevator	Elevation, retraction	Elevation, protrusion, side to side/chewing movement	Depressor, protrusion, side to side/chewing

Mnemonic

Trunk of the mandibular nerve supplies:

MTP

- Medial pterygoid
- Tensor Tympani
- Tensor veli Palatini

- Forward gliding or protrusion and backward gliding or retraction takes place in upper segment
- Elevation or closing and depression or opening of jaw takes place in lower segment

TEMPOROMANDIBULAR JOINT

- Condylar type of synovial joint
- Head of mandible and anterior part of mandibular fossa are articulating surface. Joint cavity is divided into upper and lower segments by articulating disk.

Ligaments Present in Temporomandibular Joint

- **Fibrous capsule:** Extends from articular tubercle and margins of the mandibular fossa to the neck of the mandible
- Lateral or temporomandibular ligament extends from tubercle on the zygoma to neck of the mandible
- Sphenomandibular ligament extends from spine of sphenoid to lingula of the mandible
- Stylomandibular ligament extending from styloid process to posterior border of ramus of mandible.

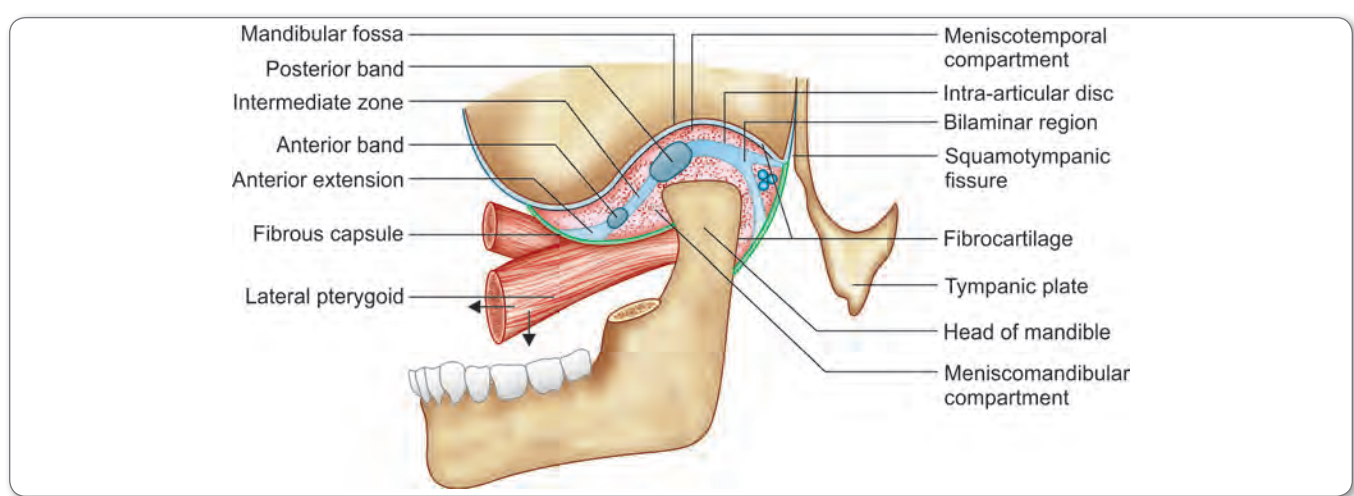


Fig. 35: Temporomandibular joint

Movements of Temporomandibular Joint

- Depression of mandible: Mandibular head rotates in horizontal axis in lower compartment. Lateral pterygoid muscle pulls neck of mandible and articular disk forward so that articular disk glides in the upper compartment.
- Elevation of mandible: Movement of depression is reversed; first head and disk move backward and then head rotates in the lower compartment.
- Protrusion of mandible: Due to contraction of two medial and lateral pterygoid muscles in the upper compartment, these two muscles pull the head and disk without depression or elevation.



- Retraction: Passive recoiling of the joint restore the normal position aided by contraction of posterior fibers of temporalis.
- Chewing or grinding movements: Alternate contraction of medial and lateral pterygoid of one side to another side.

Table 13: Movements at temporomandibular joint and muscles responsible for them

Depression of mandible	Elevation of mandible	Protrusion of mandible	Retraction of mandible	Side to side movement
<ul style="list-style-type: none"> • Gravity—(prime mover) • Lateral pterygoid Assisted by <ul style="list-style-type: none"> • Mylohyoid • Geniohyoid • Digastrics 	<ul style="list-style-type: none"> • Masseter—strong elevator • Temporalis • Medial pterygoid 	<ul style="list-style-type: none"> • Medial pterygoid • Lateral pterygoid 	<ul style="list-style-type: none"> • Posterior fibers of temporalis 	<ul style="list-style-type: none"> • Medial pterygoid • Lateral pterygoid

Note

Protuder of TMJ – lateral pterygoid > medial pterygoid

Nerve Supply

- Auriculotemporal nerve
- Masseteric nerve

Blood Supply

- Superficial temporal artery
- Maxillary artery
- Ascending pharyngeal artery

Layers of Cervical Fascia

Investing Layer of Deep Cervical Fascia

- Outermost layer which surrounds the deep part of the neck
- Splits and enclose sternocleidomastoid and trapezius
- Superiorly attach to mandible, mastoid process, external occipital protuberance and superior nuchal line of the occipital bone
- Inferiorly attach to acromion, spine of scapula, clavicle and manubrium
- Provides false capsule for parotid and sub mandibular gland.
- Forms roof of posterior triangle

Pretracheal Layer of Deep Cervical Fascia

- Middle layer
- Invests larynx, trachea and splits & enclose thyroid gland
- Posteriorly the capsule thickens and form ligament of berry which connect the thyroid gland to cricoid cartilage. So thyroid gland and its swellings move with deglutition.
- Continuous with buccopharyngeal fascia and contribute to the carotid sheath
- Superiorly attached to thyroid cartilage and cricoid cartilage and inferiorly to pericardium

Prevertebral Layer

- Deepest layer which encloses vertebral muscles and contributes to the carotid sheath
- Forms the floor of posterior triangle
- Axillary sheath derived from prevertebral layer
- Attaches to external occipital protuberance and basilar part of occipital bone and becomes continuous with endothoracic fascia and anterior longitudinal ligament of vertebra

NECK

DEEP CERVICAL FASCIA (FASCIA COLLI)

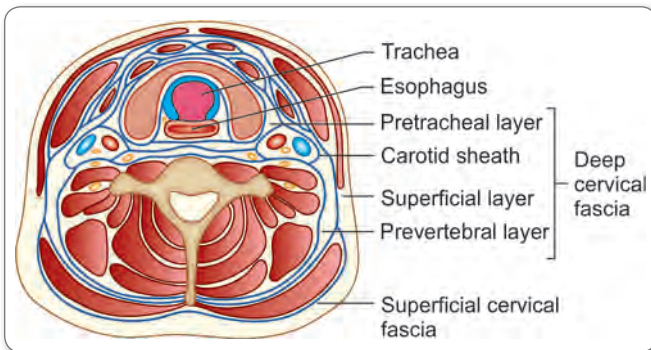


Fig. 36: Cervical fascia: Transverse section

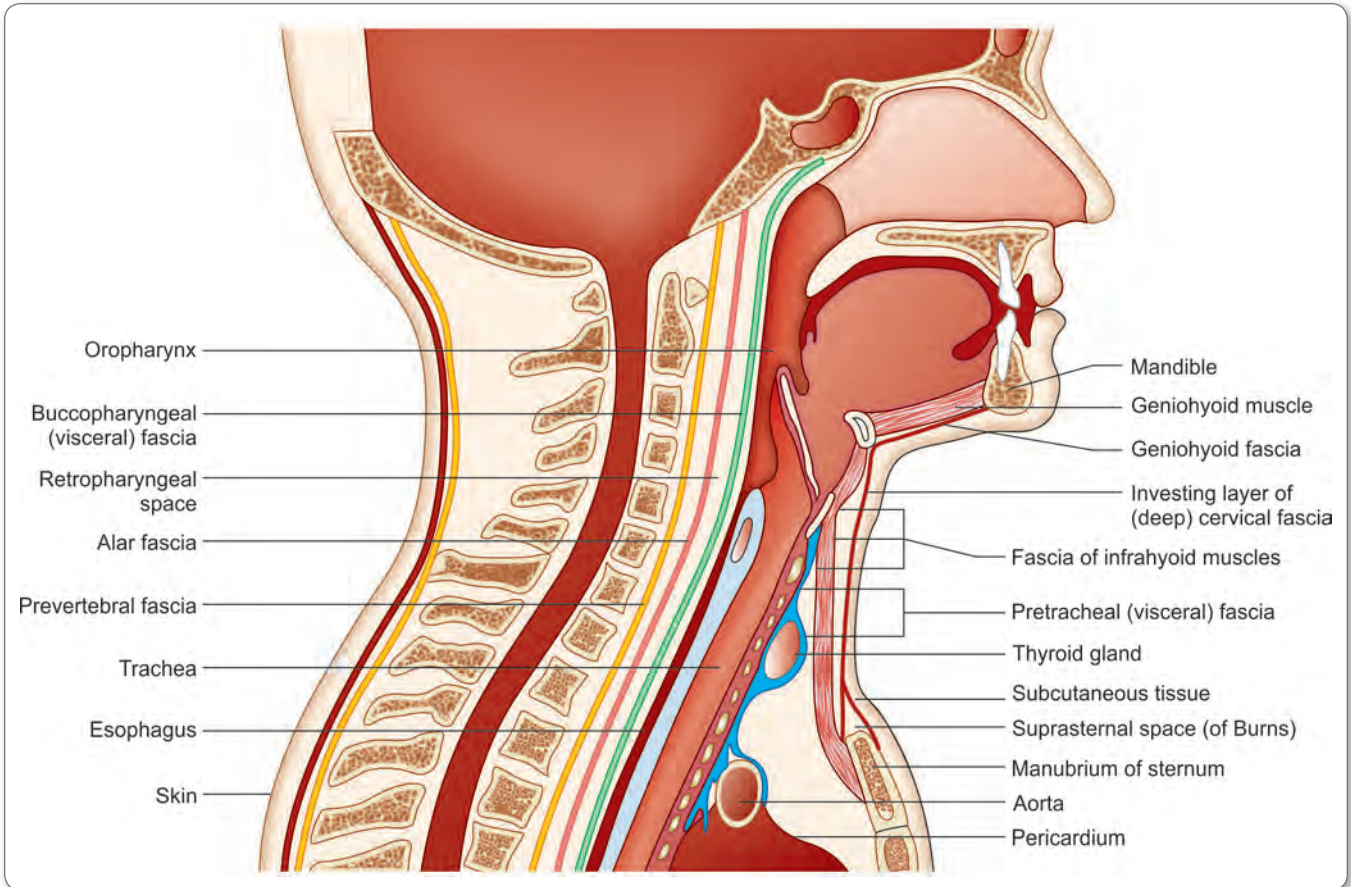
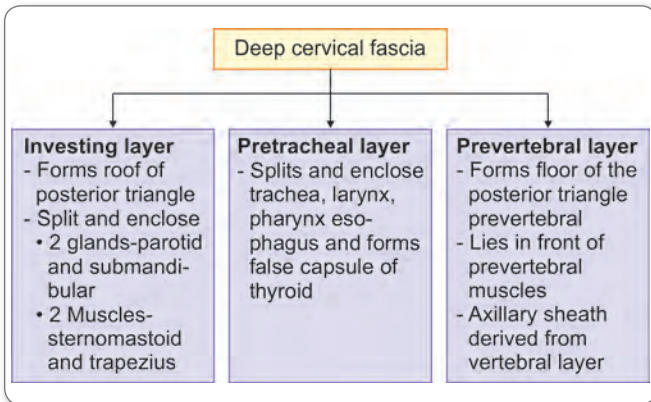


Fig. 37: Deep cervical fascia is sagittal section



RETROPHARYNGEAL SPACE

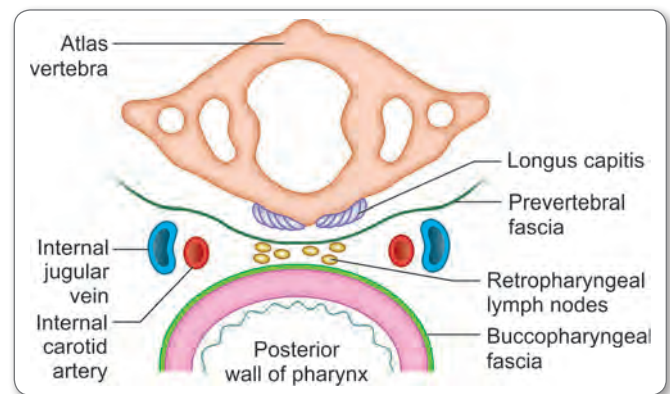


Fig. 38: Retropharyngeal space

CAROTID SHEATH

- Carotid sheath derived from all the layers of deep cervical fascia
- Contains common & internal carotid arteries, internal jugular vein and vagus nerve
- Sympathetic trunk lies behind the carotid sheath
- Ansa cervicalis embedded in the anterior layer

- Situation : Dead space behind pharynx
- Function : Acts as a bursa for expansion of pharynx during deglutition
- Boundaries : Anterior: Buccopharyngeal
Posterior: Alar fascia
Sides: Carotid sheath



- Superior : Base of skull
- Inferior : Open and continuous with superior mediastinum
- Contents : Retropharyngeal lymph nodes, pharyngeal plexus of vessels and nerves, loose areolar tissue

ALAR FASCIA

- Ancillary layer of deep cervical fascia between pretracheal and prevertebral fascia and forms subdivision of retropharyngeal space
- Extends from base of the skull to C7 where it merges with pretracheal fascia
- Right internal jugular vein is used clinically for measurement of venous pressure in right side of heart (venous manometer).
- Subclavian vein is commonly used for central venous access.
- During tracheostomy vertical incision is placed in 2-4 tracheal (preferably 3rd) rings.
- Retropharyngeal abscess can produce paramedian swelling while median swelling is seen in cold abscess.

DANGER SPACE OF NECK

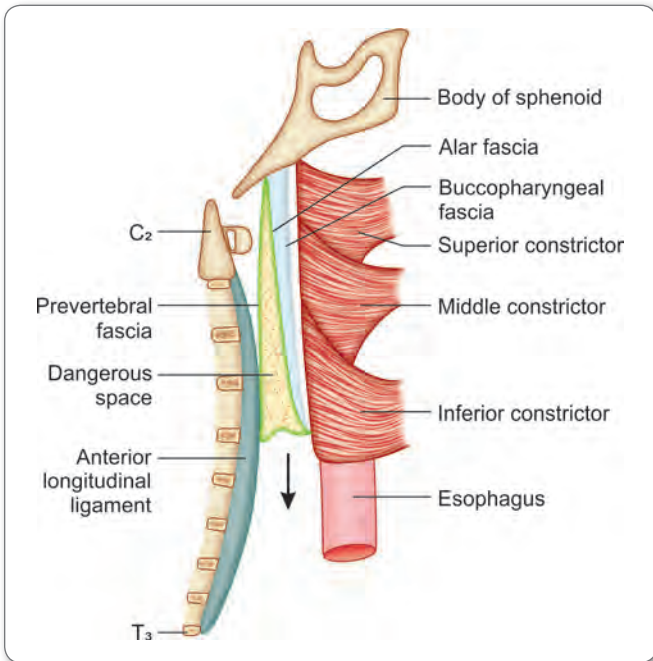


Fig. 39: Danger space of neck

- Space bounded anteriorly by alar fascia and posteriorly by prevertebral layer (Space 4 of Grodonsky and Holyoke)
- It is extending from base to skull superiorly to diaphragm inferiorly provide the route of spread of infection
- Potential space for the spread of infection from pharynx to mediastinum.

BUCCOPHARYNGEAL FASCIA

- Lines the outer surface of constrictor muscles
- Covers buccinator muscle and pharynx and blends with pretracheal fascia
- Attached to pharyngeal tubercle and pterygomandibular raphae
- Behind buccopharyngeal fascia – alar fascia
- Behind alar fascia – prevertebral fascia
- Behind the prevertebral fascia – vertebra.

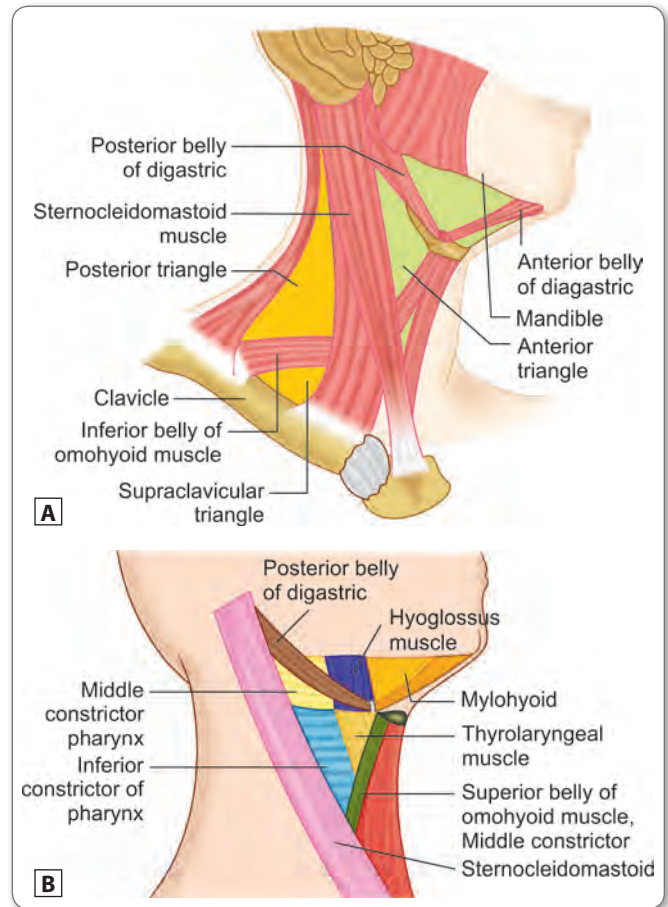
Note

- Space between buccopharyngeal fascia anteriorly and alar fascia posteriorly – retropharyngeal space
- Space between alar fascia anteriorly and prevertebral fascia posteriorly – dangerous area of neck
- Space between prevertebral fascia anteriorly and vertebra posteriorly – prevertebral space.

PHARYNGOBASILAR FASCIA

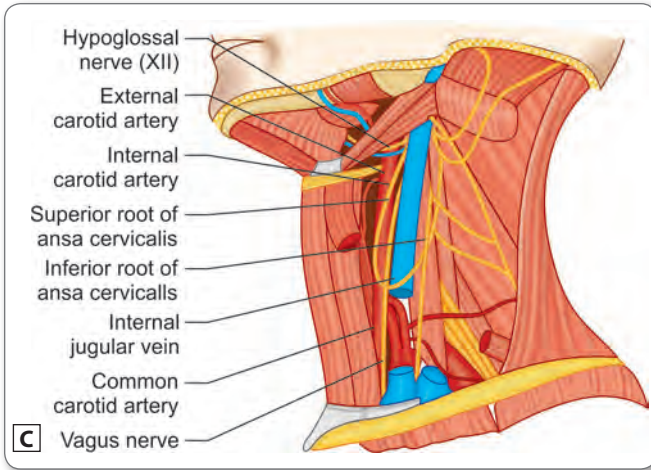
- Fibrous coat in the wall of pharynx
- Situated between mucous membrane and constrictor of muscles.

ANTERIOR AND POSTERIOR TRIANGLES OF NECK



Figs 40A to B:

Contd...



Figs 40A to C: Anterior and posterior triangles of neck

Posterior Triangle

- Bounded by posterior border of sternocleidomastoid muscle, anterior border of trapezius and superior border of clavicle
- Roof: Platysma and investing layer of deep cervical fascia
- Floor: Splenius capitis, levator scapulae, scalenus medius and scalenus posterior

Note: Inferior belly of omohyoid divides posterior triangle into occipital triangle and subclavian triangle.

Anterior Triangle

- Bounded by anterior border of sternomastoid, anterior midline of neck and inferior border of mandible
- Roof: Platysma and investing layer of deep cervical fascia
- Anterior and posterior belly of digastric, anterior belly of omohyoid divide the anterior triangle into muscular triangle, submental triangle, digastric triangle and carotid triangle.

Table 14: Anterior triangle of neck

Triangles	Boundaries	Floors	Contents
Submental – anterior Triangle	Apex: Symphysis menti lower border Base: Body of hyoid bone Sides: Anterior belly of digastric muscles of both sides	Mylohyoid muscles and the median fibrous raphe formed by it	<ul style="list-style-type: none"> • 3 to 4 Submental lymph nodes • Starting of anterior jugular vein
Carotid–Anterior triangle	In front and above: Stylohyoid muscle and posterior belly of digastric In front and below: Superior belly of omohyoid. Behind: Sternocleidomastoid anterior border	Hyoglossus, middle constrictor, inferior constrictor and Thyrohyoid	<ul style="list-style-type: none"> • Carotid sheath and ansa cervicalis embedded in its anterior layer • Common carotid artery • External carotid and first five branches and internal carotid artery • Internal jugular vein • Loop of hypoglossal nerve • Vagus nerve, external and internal laryngeal nerve and • Spinal accessory • Sympathetic trunk (posterior to carotid sheath) • Parotid gland apex • More posteriorly – carotid sheath and its contents and external carotid artery.
Digastric–Anterior triangle	Above: Body of mandible lower border Below and behind: Digastric posterior belly and stylohyoid Below and in front: Digastric anterior belly	Hyoglossus, middle constrictor and Mylohyoid	<ul style="list-style-type: none"> • Superficial part of submandibular gland • Submandibular lymph nodes • Facial vein and facial artery • Mylohyoid vessels and nerve • Hypoglossal nerve
Muscular–Anterior triangle	Front: Anterior median line of the neck Behind and above: Superior belly of omohyoid. Behind and below: Anterior border of sternocleidomastoid	Sternohyoid and sternothyroid	Infrahyoid muscles, trachea and esophagus

Contd...



Triangles	Boundaries	Floors	Contents
Occipital triangle – Posterior triangle	In front: Posterior border of sternocleidomastoid Behind: Anterior border of trapezius Below: Inferior belly of digastric	Splenius capitis, levator scapulae, scalenus medius and scalenus posterior	<ul style="list-style-type: none"> • Spinal accessory nerve, • Upper part of brachial plexus • Lesser occipital • Great auricular • Dorsal scapular nerve • Muscular branch to levator scapulae, rhomboids and trapezius • Occipital artery, transverse cervical artery • External jugular vein
Subclavian triangle – Posterior triangle	In front: Sternomastoid posterior border Behind: Trapezius anterior border Above: Inferior belly of omohyoid Below: Middle-third of clavicle	Outer border of first rib, scalenus medius and serratus anterior first digitations	<ul style="list-style-type: none"> • Brachial plexus trunk • Suprascapular nerve • Nerve to subclavius • Long thoracic nerve • 3rd part of subclavian artery and subclavian vein • Transverse cervical artery • Suprascapular artery • Dorsal scapular artery • External jugular vein

LYMPHNODES IN NECK CAN BE PLACED INTO SIX GROUPS

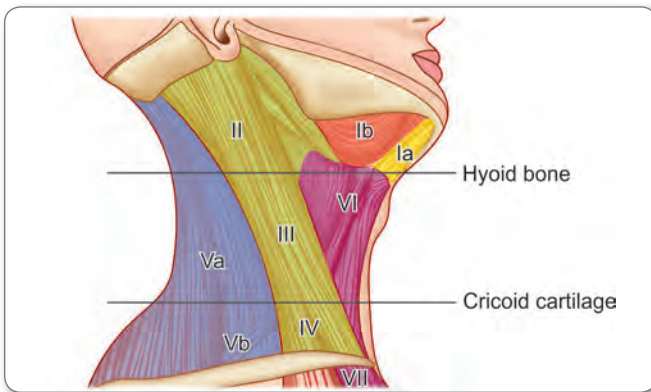


Fig. 41: Lymph node levels

- Level I – submental and submandibular
- Level II – upper deep cervical
- Level III – middle deep cervical
- Level IV – lower deep cervical
- Level V – posterior triangle
- Level VI – anterior compartment from hyoid to clavicle

INFRAHYOID MUSCLES–STRAP MUSCLES–RIBBON MUSCLES – RECTUS CERVICES

Table 15: Infrahyoid muscles

Muscle	Origin	Insertion	Nerve supply	Action
Sternohyoid	Manubrium sternum and medial end of clavicle	Body of hyoid	Ansa cervicalis	Depressors of larynx and hyoid bone and stabilizes the hyoid bone during depression of mandible
Sternothyroid	Manubrium sternum and first costal cartilage	Oblique of thyroid cartilage	Ansa cervicalis	Depressors of larynx and hyoid bone and stabilize the hyoid bone during depression of mandible
Thyrohyoid	Oblique of thyroid cartilage	Body and greater horn of hyoid	C1 fibers via hypoglossal nerve	Depresses the hyoid and elevates the larynx
Omohyoid	Inferior belly–medial lip of the suprascapular notch Superior belly–from intermediate tendon	Inferior belly–intermediate tendon Superior belly– body of hyoid	Ansa cervicalis	Depresses the hyoid and retracts the larynx



Mnemonic

- **Mnemonic GT**
Muscles supplied by C1 through hypoglossal nerve – Geniohyoid, thyrohyoid
- Muscles supplied by superior root of ANSA – superior belly of omohyoid
- Muscles supplied by Ansa cervicalis
 - Inferior belly omohyoid
 - Sternohyoid
 - Sternothyroid

SUPRAHYOID MUSCLES

Suspends the hyoid bone from the skull.

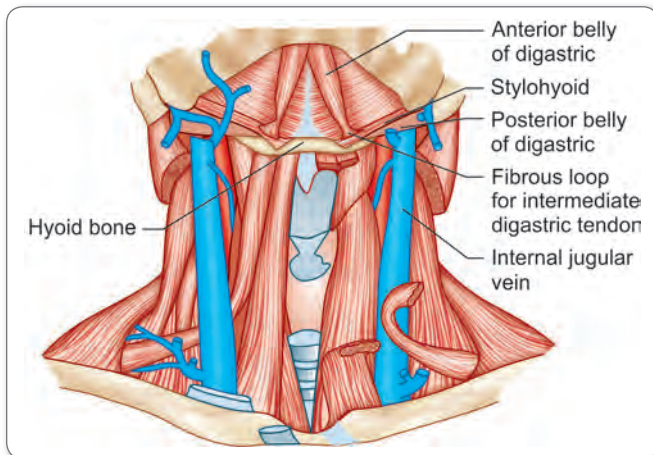


Fig. 42: Suprahyoid muscles

Hyoglossus and genioglossus are also suprahyoid in position, but they belong to extrinsic muscle of tongue.

Table 16: Suprahyoid muscles

Muscles	Nerve supply	Actions
Digastric	Anterior belly: Nerve to mylohyoid (mandibular nerve branch) (since muscle is first arch derivative) Posterior belly: Facial nerve (second arch derivative)	Depression of mandible - assist the lateral pterygoid
Stylohyoid	Facial nerve (second arch derivative)	Pulls the hyoid bone upward and backward and elongates the floor of the mouth
Mylohyoid	Nerve to mylohyoid branch from mandibular nerve (since it is first arch derivative)	Elevates the floor of the mouth and helps in deglutition
Geniohyoid	C1 Fibers conveyed by hypoglossal nerve	Pulls the hyoid bone upward and forward and shortens the floor of the mouth

CERVICAL PLEXUS

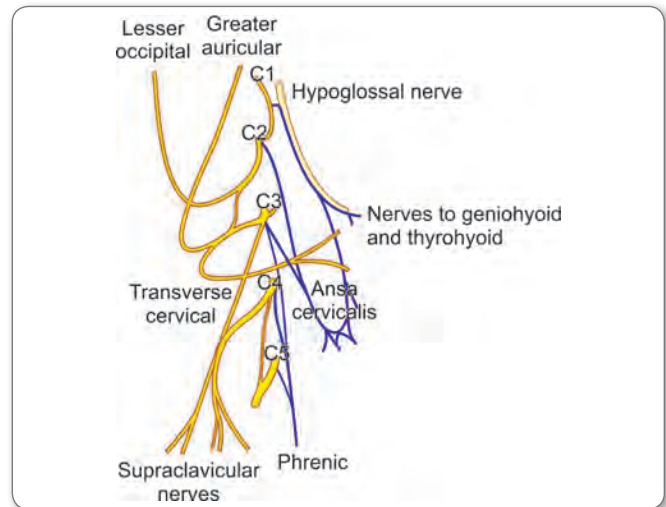


Fig. 43: Cervical plexus

- Formed by ventral primary rami of C1-4
- **Cutaneous branches**
 - Lesser occipital nerve – C2
 - Great auricular nerve – C2-3
 - Transverse cervical nerve – C2-3
 - Supraclavicular nerve – C3-C4
- **Motor branches**
 - Ansa cervicalis
 - Nerve root formed by the union superior root C1 – Descendens hypoglossi and inferior root – C2, 3 – descendens cervicalis.
 - Blends with anterior layer of carotid sheath.
 - Innervates sternothyroid, sternohyoid, omohyoid.
 - Thyrohyoid is supplied by C1 fibers through hypoglossal nerve
- **Phrenic nerve (C3–C5):** Explained in thorax
- **Accessory phrenic nerve:** C5
- **Twig from plexus:** Supplies the longus capitis, cervicis or coli, sternocleidomastoid, trapezius, levator scapulae and scalene muscles.

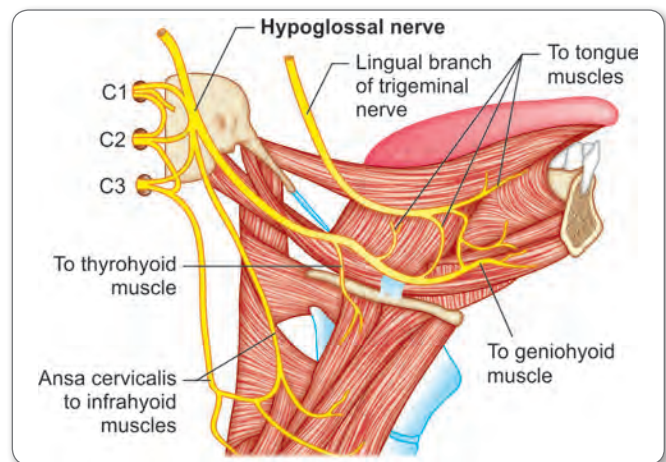


Fig. 44: Motor branches of cervical plexus



PLATYSMA

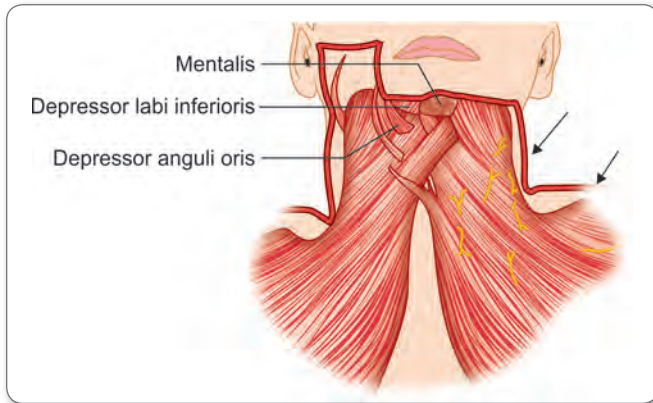


Fig. 45: Platysma

- **Subcutaneous** muscle extends from clavicle to mandible
- Origin: Superficial fascia over the upper part of deltoid and pectoralis major
- Insertion: Mandible, skin and muscles over the mandible and angle of mouth
- Nerve: Facial nerve
- Action: Assists in depression of the mandible, angle of mouth and its contraction produces wrinkles of neck.

STERNOCLEIDOMASTOID

- Origin from sternum and clavicle
- Insertions to mastoid process and superior nuchal line

- Actions: It turns head and face to opposite side during unilateral contractions, protracts the head to peep forward in the crowd when they act bilaterally
- Innervated by spinal part of accessory nerve
- Receives blood supply from occipital, posterior auricular artery, superior thyroid artery and suprascapular artery

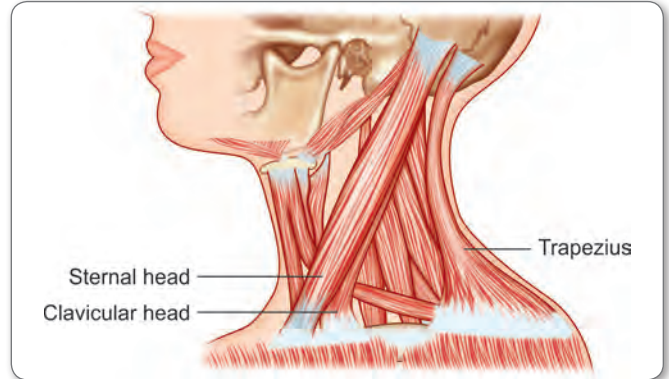


Fig. 46: Sternal and clavicular heads of sternocleidomastoid muscle

Clinical Aspect

Torticollis (Wry Neck)

- Spasmodic contractions or shortening of the neck due to injury of sternocleidomastoid or avulsion of accessory nerve at the time of birth
- In congenital torticollis: Muscle cannot lengthen with the growing neck

Table 17: Anterior vertebral muscles

Muscles	Origin	Insertion	Nerve supply	Action
Longus colli	From body of C5–T3 and transverse process of C3–C5	To transverse process of C5, C6. Front of bodies of C2–C4	Ventral rami of C2–C6	Bend the neck forwards
Longus capitis	Transverse process of C3–C5	Basilar part of occipital bone	Ventral rami of C1–C3	Flexes the head
Rectus capitis anterior	From atlas	Basilar part of occipital bone	Ventral rami of C1–C2	Flexes the head
Rectus capitis lateralis	Transverse process of atlas	Jugular process of occipital bone.	Ventral rami of C1–C2	Flexes the head

Table 18: Lateral vertebral muscles

Muscles	Origin	Insertion	Nerve supply	Action
Scalenus anterior	Transverse process of C3–C6	Scalene tubercle on 1 st rib	Ventral rami of C4–C6	Bends cervical vertebral column and elevates 1 st rib
Scalenus medius	From transverse process of C2 to C7	First rib behind sub-clavian groove	Ventral rami C3–C8	Bends cervical vertebral column elevates 1 st rib
Scalenus posterior	From transverse process of C4 to C6	2 nd rib	Ventral rami of C6–C8	Bends the neck and elevates 2 nd rib



PHARYNX

- Extension from base of skull to C6
- Length: 12–14 cm
- Sub divisions nasopharynx, oropharynx and laryngopharynx

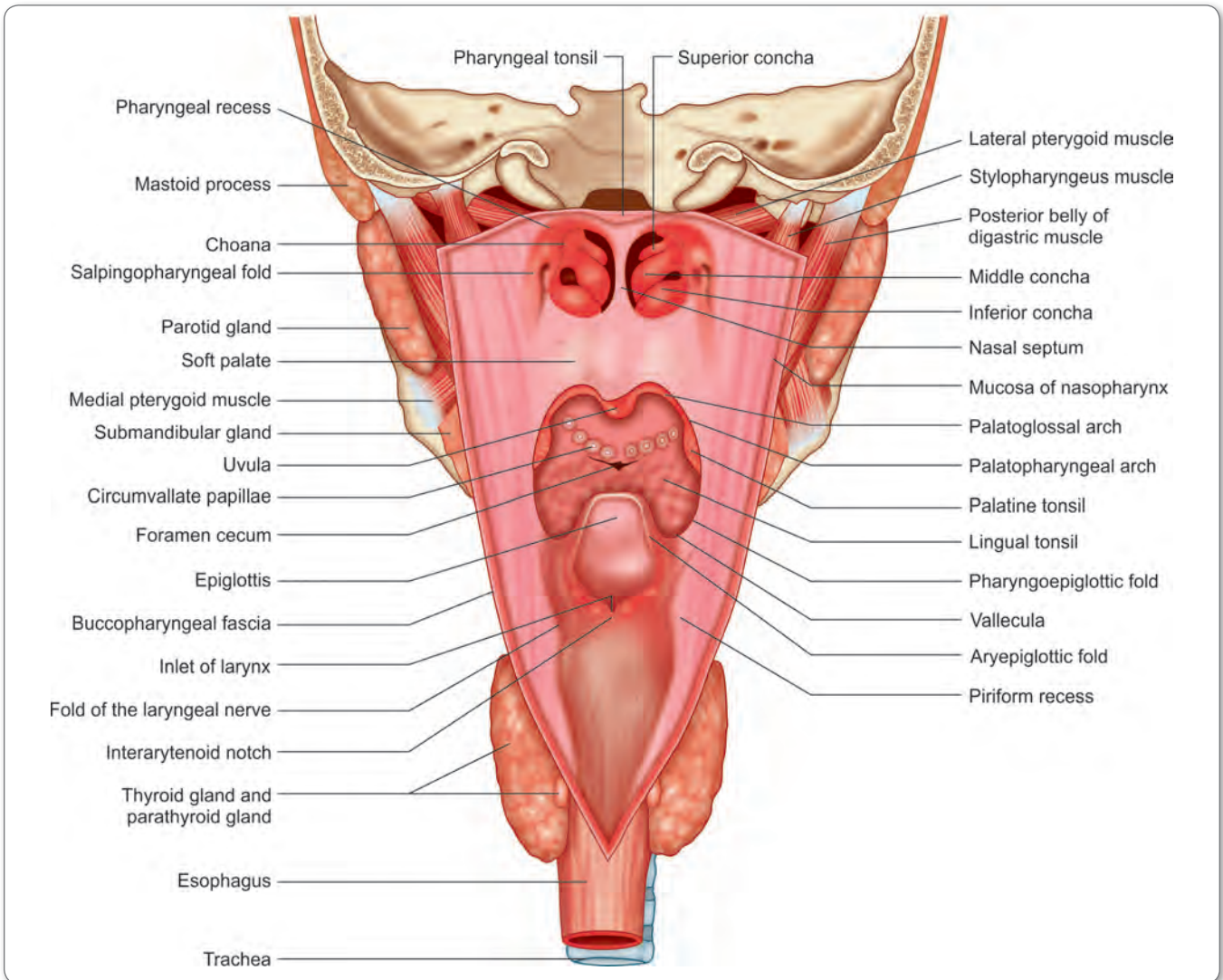


Fig. 47: Structure of pharynx

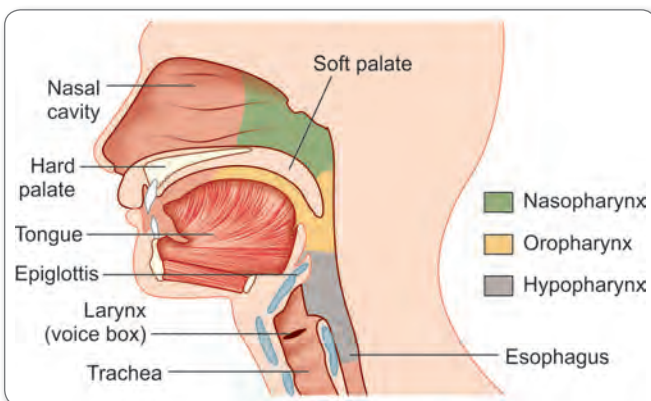


Fig. 48: Divisions of pharynx

Nasopharynx

- Situated behind the nasal cavity above the soft palate and communicates with nasal cavities through nasal choanae

Anterior Wall

- Deficient

Roof and Posterior Wall

- Slopes downward and backward and supported by body of sphenoid and basilar part of occiput. This surface present with following features
- Nasopharyngeal tonsil (adenoid) aggregation of lymphoid tissue.



- Pharyngeal bursa (**pouch of Luschka**) mucous diverticulum extending upward into substance of nasopharyngeal tonsil from apex
- Pharyngeal hypophysis: Glandular tissue similar to adenohypophysis.

Floor

- Nasopharynx communicates with oropharynx through pharyngeal isthmus
- Pharyngeal isthmus boundaries
 - In front: Posterior part of soft palate
 - Behind: Passavant's ridge (formed by palatopharyngeal sphincter)
- Each side: Palatopharyngeal arch containing muscle of same.

Lateral Wall

- Pharyngeal opening of auditory tube which equalize the pressure on both sides of tympanic membrane
- Tubal elevation: Guards upper and posterior margins of auditory opening
- Pharyngeal recess: Mucous covered deep depression behind tubal elevation.

Oropharynx

Lies behind the oral cavity at the level of **C2, 3**

- In front: Communicates with oropharyngeal isthmus
- Above: Soft palate
- Below: Posterior-third of tongue
- Each side: Posterior-third of tongue
- Below: Communicates with laryngopharynx
- Lateral wall: Tonsillar fossa. Boundaries of tonsillar fossa are:
 - In front: Palatoglossal arch
 - Behind: Palatopharyngeal arch
 - Apex: Soft palate
 - Base: Posterior 1/3 tongue.

Laryngopharynx

- Extends from upper part of epiglottis to lower border of cricoid cartilage
- Situated at the level of **C4 to C6**
- On each side of laryngeal inlet, pyriform sinus present (fish bone area)
- **Boundaries of piriform fossa**
 - Medially: Aryepiglottic fold
 - Laterally: Mucous membrane covering the medial surface of the lamina of thyroid cartilage
 - Above: It is separated from epiglottic vallecula by pharyngoepiglottic fold
- Pyriform fossa supplied by internal laryngeal nerve.

Note

Internal laryngeal nerve supply hypopharynx and larynx above the level of vocal cord.

REMEMBER

Waldeyer's Ring

- Circular group of lymph nodes around oropharynx and nasopharynx
- Prevent the entry of microorganisms from external environment
- Components
 - Dorsally – Adenoids (Luschka tonsil or nasopharyngeal tonsil)
 - Ventrally – Lingual tonsils
 - Laterally – Palatine tonsils (faucial tonsil) and tubal tonsils (Gerlach's tonsil)

In relation to the naso-oropharyngeal isthmus, there are several aggregations of lymphoid tissue that constitute Waldeyer's lymphatic ring. The most important aggregations are the right and left palatine tonsils usually referred to simply as the tonsils. Posteriorly and above, there is the nasopharyngeal tonsil; laterally and above, there are the tubal tonsils, and inferiorly, there is the lingual tonsil over the posterior part of the dorsum of the tongue.

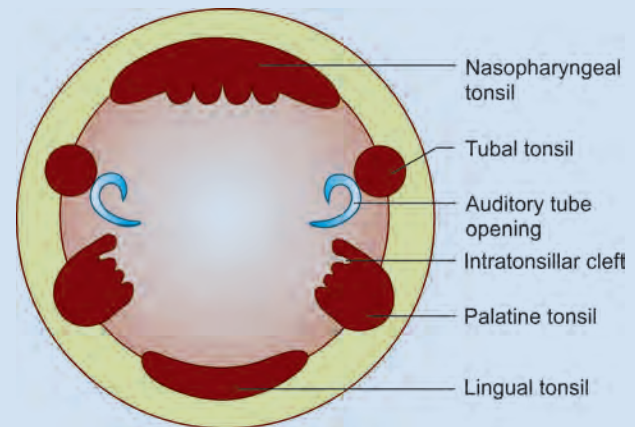


Fig. 49: Waldeyer's ring

Muscles of Pharynx

- Pterygomandibular raphae
 - Extends from pterygoid hamulus to mylohyoid line
 - Fibrous band between buccinator and superior pharyngeal constrictor
- **Circular muscles:** Superior constrictor, middle constrictor and inferior constrictor.
- Inferior constrictor consists of two parts thyropharyngeus and cricopharyngeus.
 - Gap between these two parts is called as Killian's dehiscence
 - Pharynx may pull down and forms the pouch called Zenker's diverticulum.

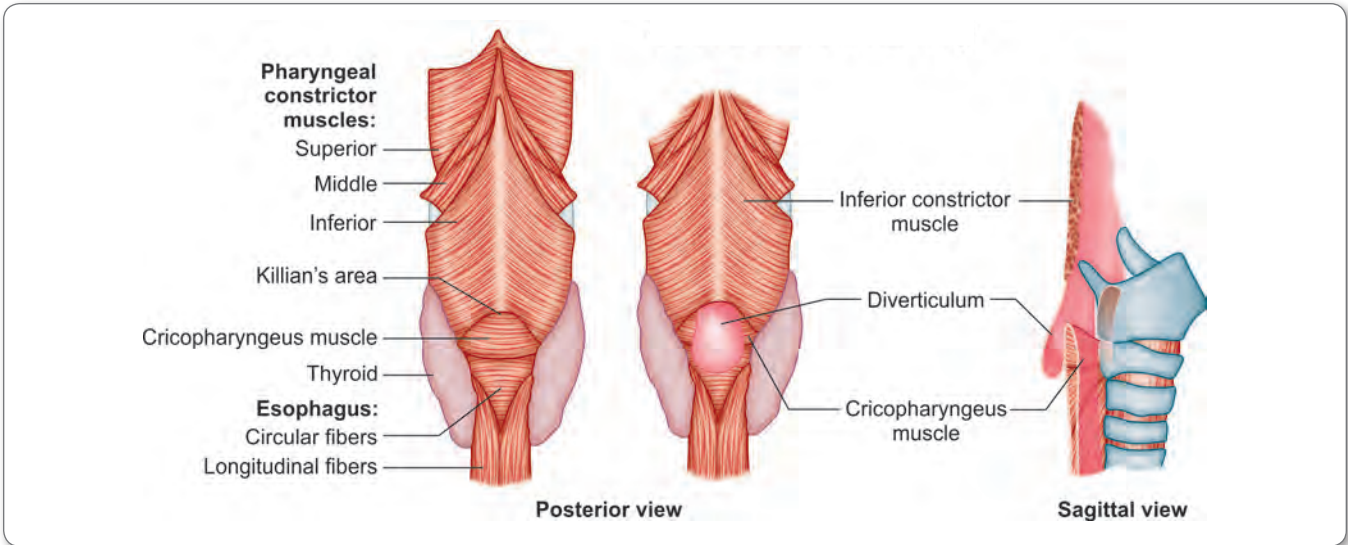
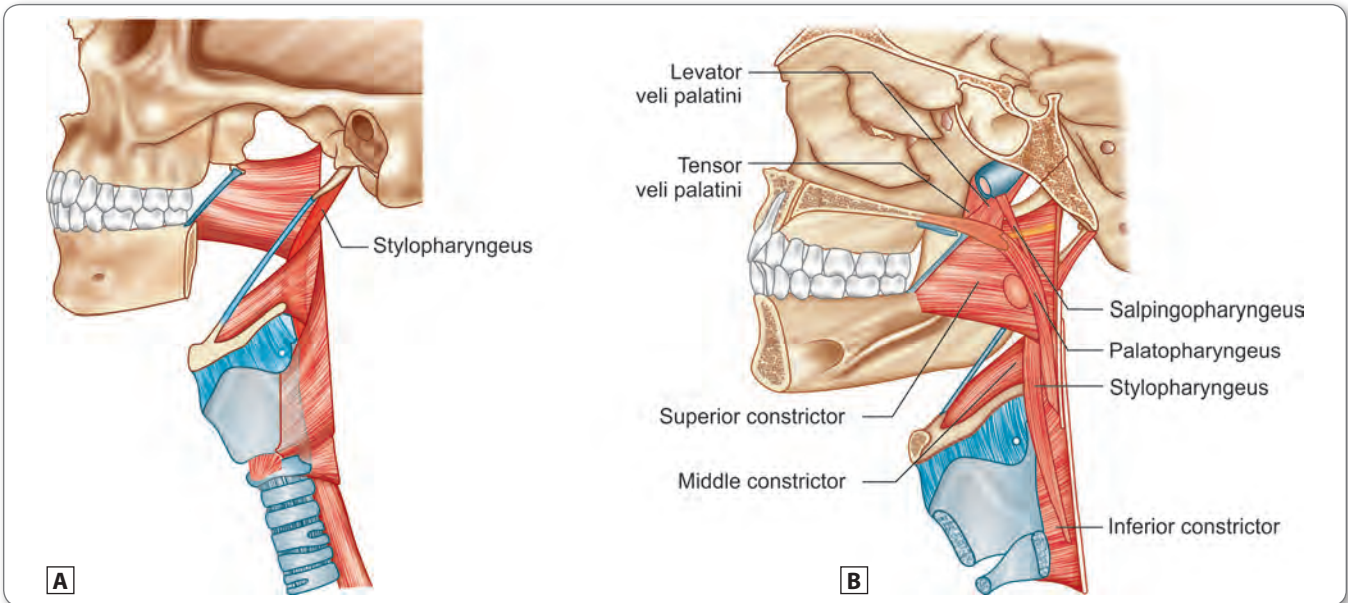


Fig. 50: Zenker's diverticulum anatomy

- Gap between base of skull and superior constrictor (sinus of Morgagni)—levator veli palatini, auditory tube, palatine branch of ascending pharyngeal artery and ascending palatine artery.
- Gap between superior and middle constrictor—stylopharyngeus and glossopharyngeal nerve
- Gap between middle and inferior: Superior laryngeal vessels and internal laryngeal nerve.



Figs 51A and B: Muscles of pharynx

- Below inferior constrictor: Recurrent laryngeal nerve and inferior laryngeal vessels. Longitudinal muscles: Stylopharyngeus, salpingopharyngeus and Palatopharyngeus.
- All the muscles are supplied by pharyngeal plexus except stylopharyngeus, which is supplied by glossopharyngeal nerve.



Table 19: Muscles of pharynx

Muscle	Origin	Insertion	Nerve supply	Action
Superior constrictor	Medial pterygoid plate, Pterygoid hamulus Pterygomandibular raphae Mylohyoid line of mandible	Pharyngeal tubercle of the skull and median raphe	Pharyngeal plexus	Constricts the upper pharynx
Middle constrictor	Greater and lesser horn of hyoid and stylohyoid ligament	Median raphae	Pharyngeal plexus	Constricts the middle pharynx
Inferior constrictor	Cricoid arch and oblique line of thyroid cartilage	Median raphae	Pharyngeal plexus	Constricts the lower pharynx
Stylopharyngeus	Styloid process	Form conjoint tendon along with palatopharyngeus and salpingopharyngeus and inserted on the posterior border of lamina of thyroid cartilage	Glossopharyngeal nerve	Elevates larynx and pharynx
Palatopharyngeus	Hard palate and palatine aponeurosis	Form conjoint tendon inserted on the posterior border of lamina of thyroid cartilage	Pharyngeal plexus	Elevates pharynx and larynx and closes nasopharynx
Salpingopharyngeus	Cartilage of auditory tube	Form conjoint tendon inserted on the posterior border of lamina of thyroid cartilage	Pharyngeal plexus	Elevates pharynx and opens the auditory tube

Nerve Supply

- By pharyngeal plexus
- Formed by pharyngeal branch of vagus, which carries fibers from cranial part accessory, pharyngeal branch of glossopharyngeal nerve and sympathetic fibers from superior cervical ganglion.

Blood Supply

Ascending pharyngeal artery, ascending palatine branch of facial artery, descending palatine artery, pharyngeal branch of maxillary artery and branches of superior and inferior thyroid artery.



Clinical Aspect

Pharyngeal tumors may irritate the glossopharyngeal and vagus nerve. Pain that occurs while swallowing is referred to the ear because these nerves contribute sensory innervation to the external ear.

HIGH YIELD POINTS

Swallowing (Deglutition)

Act of transferring a food from mouth through pharynx and esophagus into stomach. Consists of three phases.

Oral Phase

Food bolus is pushed backward by elevating the tongue by styloglossus and palatoglossus into oropharynx.

Pharyngeal Phase

- The tensor veli palatini and levator veli palatini muscles elevate the soft palate and uvula to close the entrance into nasopharynx
- The walls of pharynx are raised by three longitudinal muscles to receive the bolus of food
- Suprahyoid muscles elevate the hyoid and larynx to close the opening into larynx thus preventing the bolus entering into larynx.

Esophageal Phase

Contraction of three pharyngeal constrictors propel the food into esophagus and then into stomach.

LARYNX

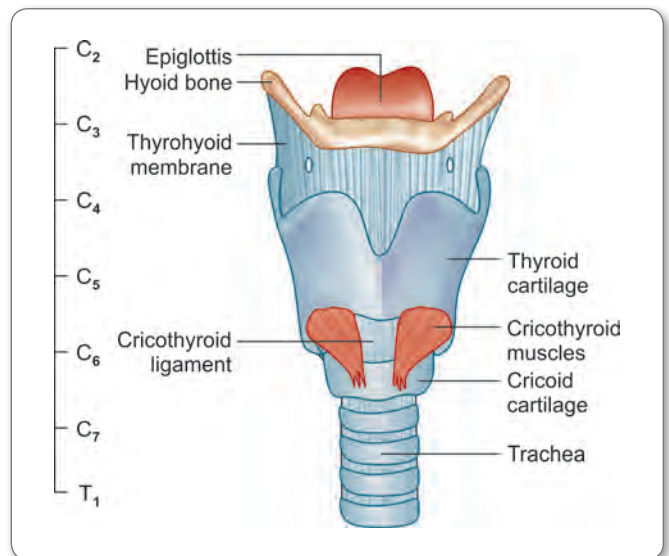


Fig. 52: Larynx

- In adults extends from C3 – C6, in children C1 to C4.
- Laryngeal skeleton consists of paired and unpaired cartilage.



Unpaired Cartilage

- Thyroid cartilage (hyaline) consists of two laminae which meets in the thyroid angle. Has an oblique line on the lateral surface of lamina that gives attachment for inferior constrictor, sternothyroid and thyrohyoid.
- Cricoids (hyaline) **signet ring shape** - consists of anterior arch and posterior lamina. **Only cartilage which forms complete ring.** Its lower border marks the end of pharynx and larynx.
- Epiglottis (elastic cartilage) leaf shape – lingual surface is lined by nonkeratinized stratified squamous epithelium, respiratory surface is lined by ciliated columnar epithelium with small mucous glands.

Paired Cartilage

- Arytenoids: Hyaline (except the apex of arytenoids, elastic cartilage), pyramidal shape, sits on the top of cricoid cartilage and rotates to change the opening of vocal cord. Corniculate cartilage presents in apex of arytenoids, base is having two process, vocal process (which gives attachment to vocal ligament) and muscular process (which gives attachment to lateral and posterior cricoarytenoid).
- Corniculate: Elastic cartilage, conical, lies in the aryepiglottic fold.
- Cuneiform (cartilage of Wrisberg): Elastic cartilage: lies in the aryepiglottic fold in front of corniculate cartilage.
- Triarte cartilage: Elastic cartilage, small nodules in thyrohyoid membrane.

Membranes of Larynx

Intrinsic and extrinsic membranes.

Extrinsic Membrane

Connects larynx with surrounding structure

- Thyrohyoid membrane: Extends from thyroid cartilage to hyoid. Lateral part of the membrane is pierced by internal laryngeal nerve and superior laryngeal vessels
- Hyoepiglottic membrane
- Cricotracheal membrane

Intrinsic Membrane

Connects the structures within the larynx

- Cricovocal membrane: Upper part of this membrane thickens to form vocal ligament
- Quadrate membrane: Lower part of this membrane thickens to form vestibular ligament
 - Vocal ligament: Extends from posterior surface of thyroid cartilage to vocal process of arytenoid
 - Vestibular ligament: Extends from thyroid cartilage to anterolateral surface of arytenoid cartilage.

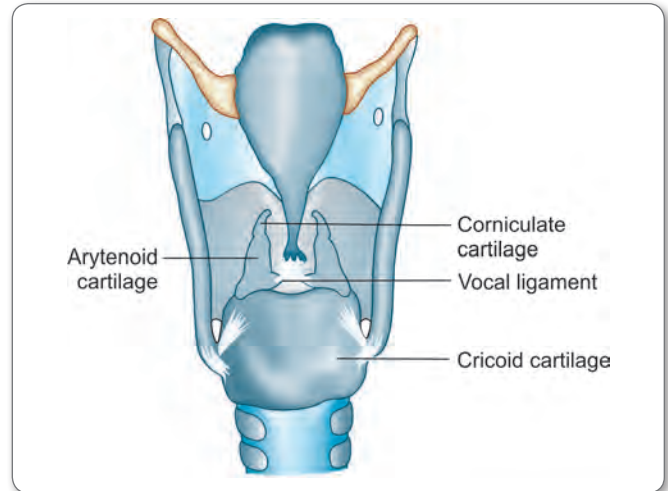


Fig. 53: Cartilages of larynx

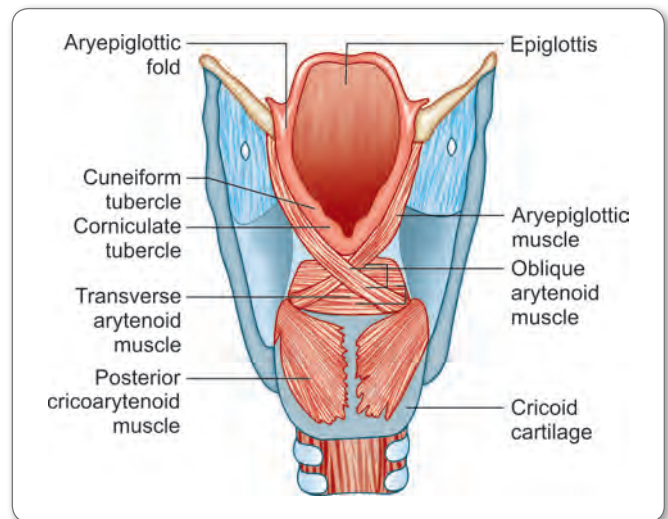


Fig. 54: Muscles of larynx

Cavities and Folds

- Laryngeal cavity is divided into three portions by vestibular and vocal folds
- They are vestibule, ventricle and infraglottic cavity:
 - **Vestibule:**
 - Extends from laryngeal inlet to vestibular folds
 - **Ventricle:**
 - Extends between vestibular fold to vocal fold
 - **Infra glottic cavity:**
 - Extends from rima glottidis to lower border of cricoid cartilage
- **True vocal cords:**
 - Contains vocal ligament and vocalis muscle
 - Extends from angle of thyroid cartilage to vocal process of arytenoid
 - Alter the shape of size of rima glottidis by movements of arytenoids to facilitate respiration and phonation.



Spaces of Larynx

Preglottis space – space of Boyer

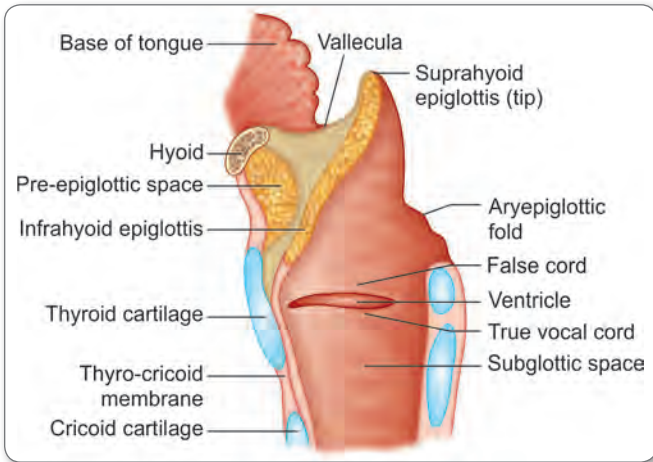


Fig. 55: Spaces of larynx

- Space present between thyroid and thyrohyoid membrane anteriorly and epiglottis posteriorly
- Laterally communicates with paraepiglottic space.

- Medially – quadrangular membrane, ventricle and conus elasticus
- Posteriorly – pyriform fossa.

Reinke's Space

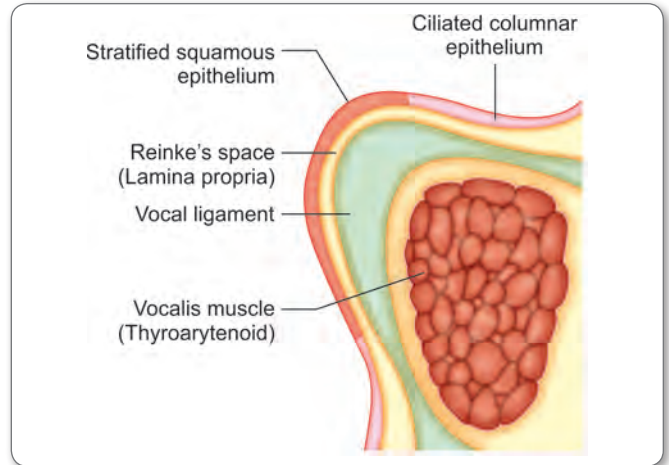


Fig. 57: Structure of Vocal fold, Cross-section

- Subepithelial space
- Present between epithelium of vocal cord and vocal ligament

Paraglottic Space – Space of Tucker

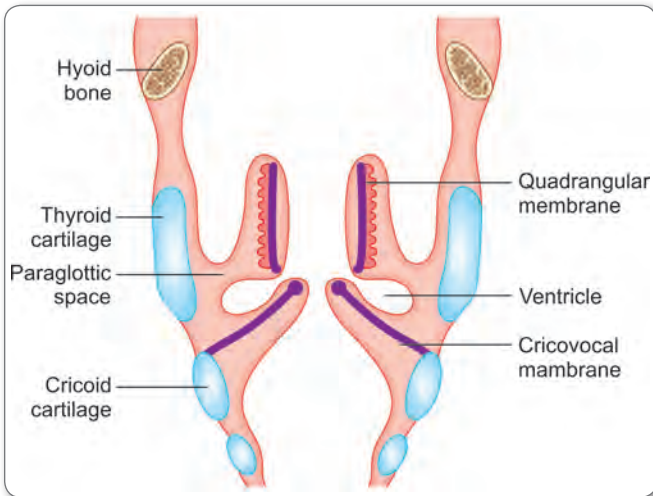


Fig. 56: Para glottic space

- Space present lateral to larynx
- Laterally – thyroid ala

Clinical Aspect



Reinke's Edema

- Edema of Reinke's space
- Due to chronic irritation of larynx mainly due to smoking

Table 20: Muscles of larynx

Muscle	Origin	Insertion	Action	Nerve supply
Cricothyroid	Arch of cricoid cartilage	Inferior horn and lower lamina of thyroid cartilage	Tensor	External laryngeal nerve
Posterior cricoarytenoid	Posterior surface of lamina of cricoid cartilage	Muscular process of arytenoid cartilage	Abducts the vocal cord	

Contd...



Muscle	Origin	Insertion	Action	Nerve supply
Lateral cricoarytenoid	Arch of cricoid cartilage	Muscular process of arytenoid cartilage	Adducts the vocal cord	Recurrent laryngeal nerve
Transverse arytenoids	Posterior surface of arytenoids	Opposite arytenoid cartilage	Adducts the vocal cord	
Oblique arytenoids	Muscular process of arytenoid cartilage	Apex of the opposite arytenoid cartilage	Closes rima glottidis	
Aryepiglottic	Apex of the arytenoid cartilage	Inserted to side of epiglottis	Closes the laryngeal inlet	
Thyroepiglottis	Lamina of thyroid cartilage	Lateral margins of epiglottic cartilage	Opens the laryngeal inlet	
Thyroarytenoid	Inner surface of thyroid lamina	Anterolateral surface of arytenoid cartilage	Relax the vocal cord	
Vocalis	Angle between 2 laminae of thyroid cartilage	Vocal process of arytenoid	Controls pitch	

Table 21: Movements of larynx caused by different laryngeal muscles

Tensor	Relaxor	Abductor	Adductor	Inlet - Larynx
Cricothyroid	Thyroarytenoid vocalis	Posterior cricoarytenoid	<ul style="list-style-type: none"> Lateral cricoarytenoid Oblique arytenoids Transverse arytenoid 	<ul style="list-style-type: none"> Aryepiglotticus (closes the laryngeal inlet) Thyroepiglotticus (opener)

Nerve Supply

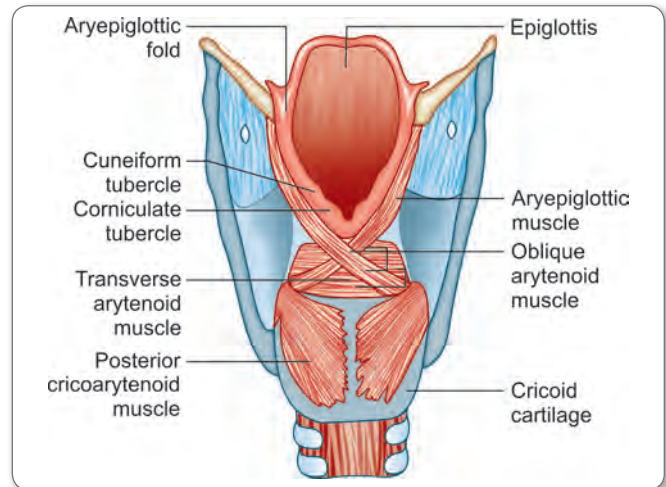
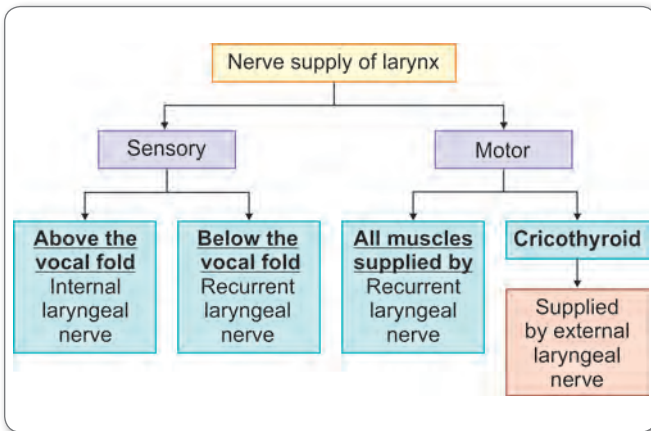


Fig. 58: Nervous supply of larynx



Clinical Aspect

Lesion of internal laryngeal nerve	Results in loss of sensation above the vocal cord and loss of taste sensation on epiglottis
Lesion of external laryngeal nerve	Results in inability to tense vocal cords- paralysis of cricothyroid muscle
Lesion of recurrent laryngeal nerve	Results in hoarseness of voice (paralysis of all muscles of larynx except cricothyroid) and loss of sensation below the vocal cord



GLANDS

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THYROID GLAND

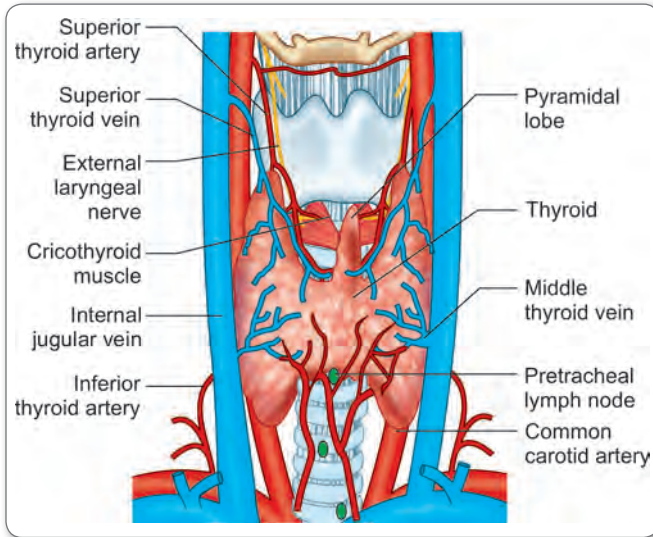


Fig. 59: Thyroid gland

- Covered by true capsule and false capsule, **false capsule is derived from pretracheal layer**
- False capsule is thickened to form ligament of Berry, which connects the gland to cricoid cartilage.

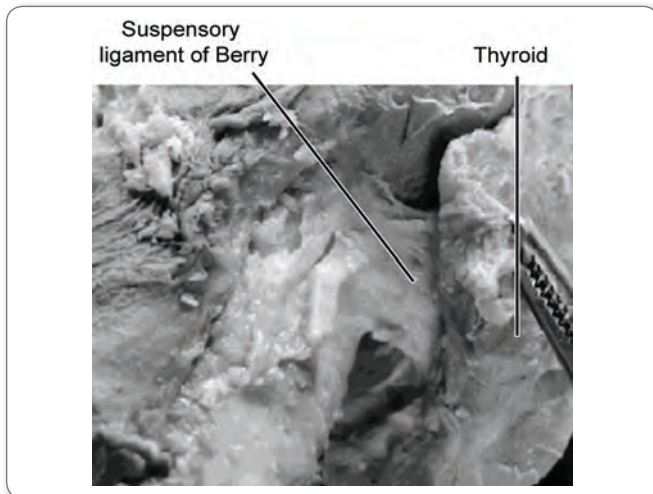


Fig. 60: Ligament of Berry

- Space between true and false capsule is occupied by venous plexus, whereas in prostate, venous plexus lies deep to true capsule
- Gland consists of two lateral lobe and isthmus
 - **Pyramidal lobe:**
 - Remnant of thyroglossal duct extends from isthmus and attach to hyoid bone by levator glandular thyroideae

- **Lateral lobe:**

- Apex: Directed upward and laterally and directed toward oblique line of thyroid cartilage. Related to superior thyroid artery and external laryngeal nerve.

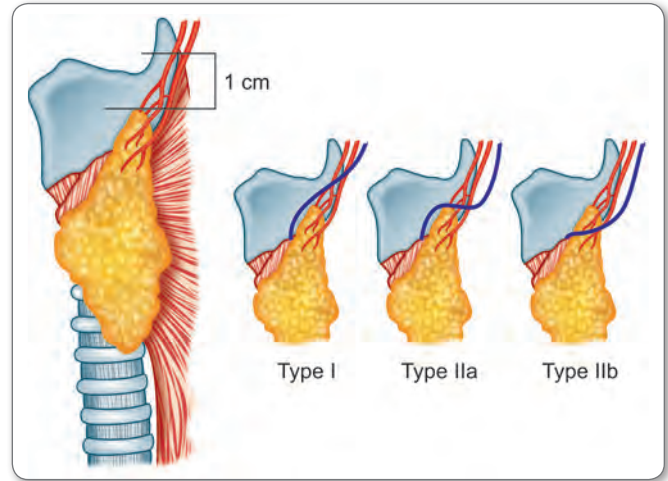


Fig. 61: Cerena classification for relationship between superior thyroid artery and ELN

- Type I – nerve crosses artery 1 cm above the gland
- Type II – nerve crosses artery less than 1 cm
 - II a – above the thyroid pole
 - II b – below the thyroid pole

Note

II b – high risk of damage during thyroid surgery

- **Base:** Extends up to 5th or 6th ring. related to inferior thyroid artery and recurrent laryngeal nerve.

Note

According to Schwartz 10th edition – both superior and inferior thyroid artery ligated close to the gland. If inferior thyroid artery ligated away from the gland – blood supply to parathyroid gets lost

- Anterolateral surface related to sternohyoid, sternothyroid and superior belly of omohyoid
- Medial surface related to 2 tubes (larynx and pharynx), 2 muscles (inferior constrictor and cricopharyngeus), 2 nerves (external laryngeal and recurrent laryngeal nerve)
- Posterolateral surface related to carotid sheath and contents.

- **Isthmus**

- Lies in front of 2, 3, 4 tracheal rings
- Upper border of isthmus related to arterial anastomosis between two superior thyroid arteries and pyramidal lobe
- Lower border of isthmus related to inferior thyroid vein and arteria thyroid ima, if present.

Blood Supply—Arterial Supply

- Superior thyroid artery: Branch of external carotid artery.
- Inferior thyroid artery: Branch of thyrocervical trunk.
- Arteria thyroid ima: Branch from arch of aorta.



Venous Drainage

- Superior thyroid vein: Drains into internal jugular vein
- Middle thyroid vein: Drains into internal jugular vein
- Inferior thyroid vein: Drains into brachiocephalic vein

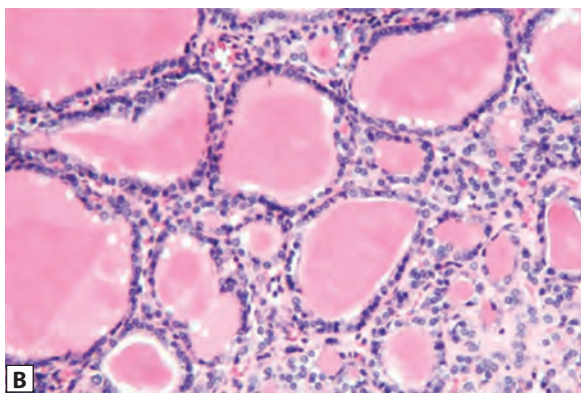
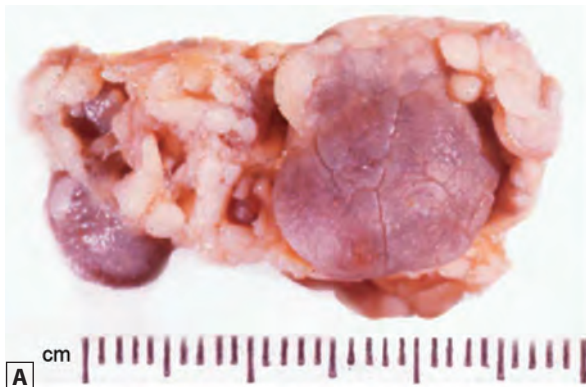
REMEMBER

Kocher vein – 4th thyroid vein – emerges from lower pole of thyroid and drains into internal jugular vein.



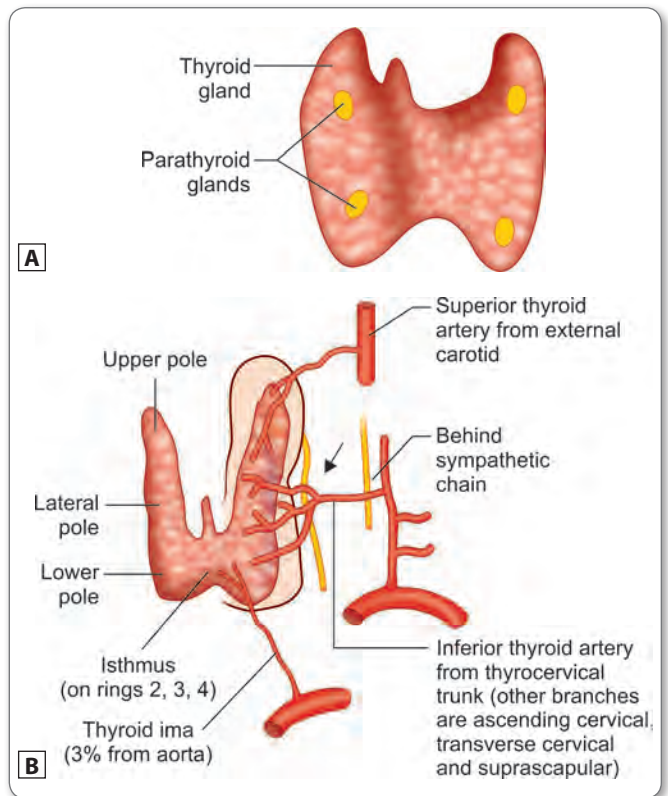
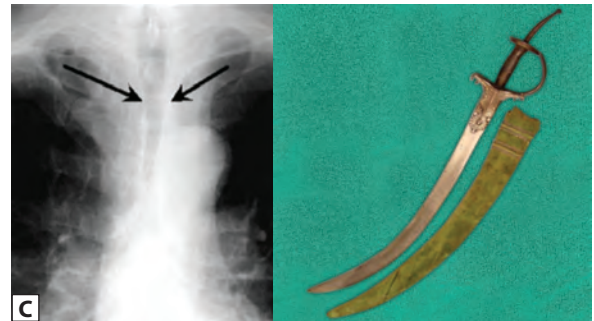
Clinical Aspect

- **Goiter:** Enlargement of thyroid gland due to iodine deficiency, hyperthyroidism and hypothyroidism
- Enlarged gland compresses trachea, esophagus, recurrent laryngeal nerve and causing compression symptoms
- **Grave's disease** (autoimmune disease) causing hyperthyroidism
- **Hashimoto's disease** – autoimmune disease – causing hypothyroidism
- **Papillary carcinoma:** Most common malignancy of thyroid gland, more common in female, symptoms lump in the neck, hoarseness of voice, difficulty in swallowing
 - **Tracheostomy** – incision made on 2nd & 3rd tracheal rings or 3rd & 4th tracheal rings
 - When incision on 1st tracheal ring or below the 4th ring is called high and low tracheostomy respectively.
 - **Struma ovarii** – benign ovary tumor (teratoma) containing the thyroid elements



Contd...

- **Scabbard trachea** – lateral compression of trachea due to long standing goiters or malignancy



Figs 62A and B: Blood supply of thyroid and parathyroid glands

PARATHYROID GLAND

- Brownish yellow in color, which distinguishes it from deep-red thyroid glands
- Four glands two on each side, vary from 2 to 6

Superior Parathyroid

- Developed from 4th endodermal pharyngeal pouch called as **Parathyroid IV**
- Superior parathyroid is constant in position and it **lies at the level of lower border of cricoid cartilage**



Inferior Parathyroid

- Developed from 3rd endodermal pharyngeal pouch so called as **Parathyroid III**
- Inferior parathyroid is variably situated, usually within thyroid fascia below the inferior thyroid artery.

Blood Supply

Blood supply derived from inferior thyroid arteries. Parathyroid veins drain into thyroid plexus of veins.

Clinical Aspect

Inadvertent Parathyroidectomy

- Occur during thyroidectomy, result in decreased production of parathormone – so level of calcium resulting in muscle spasm, as well as high phosphorous and low level of vitamin D.

SALIVARY GLANDS

Table 22: Development of salivary glands

Parotid gland	Ectodermal in origin. Appears at 6th week
Submandibular gland	Endodermal in origin. Appears at late 6th week
Sublingual gland	Endodermal in origin. Appears at 8th week

Parotid Gland

- Accessory gland present between zygomatic arch and parotid duct.
- Covered by true capsule and false capsule
- False capsule: Derived from Investing layer of deep cervical fascia. Thickens to form stylomandibular ligament (separates parotid from sub mandibular gland).

Surfaces of Parotid Gland

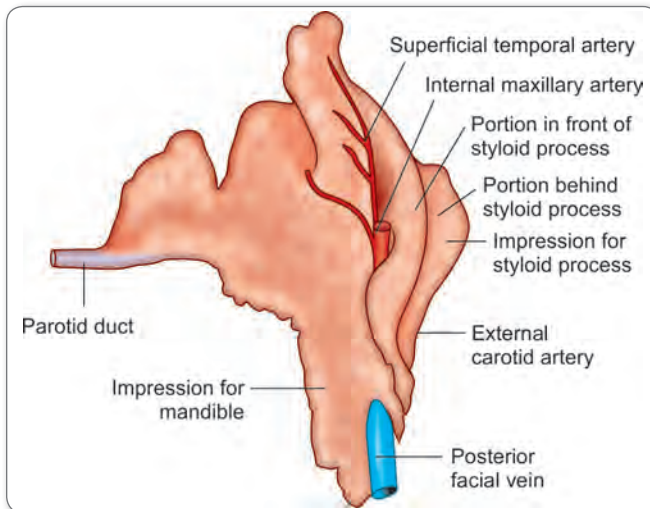


Fig. 63: Surfaces of parotid gland

Table 23: Relations of various surfaces of parotid

Surface	Relations
Superficial surface or lateral surface	Skin, superficial fascia, deep fascia, parotid group of nodes
Anteromedial surface	Grooved by mandibular ramus Masseter, medial pterygoid muscle
Posteromedial surface	<ul style="list-style-type: none"> • Mastoid process with sternocleidomastoid and posterior belly of digastric • Styloid process with its attached muscles • Internal carotid artery and internal jugular vein covered in carotid sheath

- Stenson’s duct (parotid duct) **pierces** the buccal pad of fat, buccopharyngeal fascia and **buccinator muscle** and opens in to the mucous membrane of cheek opposite to crown of upper **second molar tooth**.
- Structures present in the gland (from superficial to deep): facial nerve, retromandibular vein and external carotid artery.

Nerve Supply

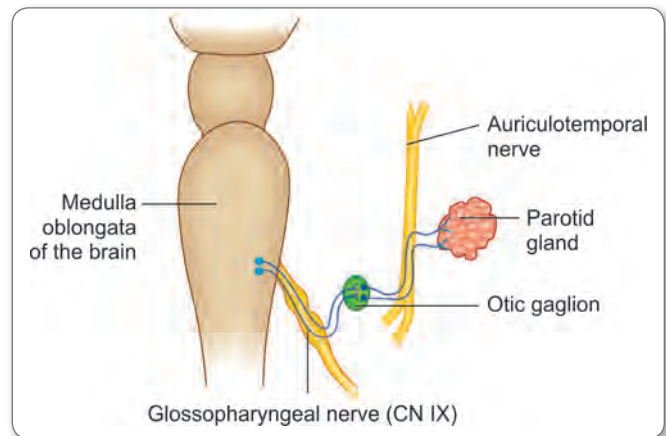


Fig. 64: Nerve supply of the parotid gland

Table 24: Nerve supply of the parotid gland

Parasympathetic	Sympathetic	Sensory
<ul style="list-style-type: none"> • Stimulates watery secretion • Pathway—inferior salivatory nucleus-Glossopharyngeal nerve-tympanic plexus—lesser petrosal nerve—otic ganglion—auriculotemporal nerve—parotid gland 	<ul style="list-style-type: none"> • Stimulates thick secretion • Postganglionic fibers from superior cervical ganglion to gland via plexus on middle meningeal arteries 	<ul style="list-style-type: none"> • Great auricular nerve innervates parotid gland and skin overlying skin



Submandibular Gland

Parts

- Superficial part
- Deep part
- Submandibular duct

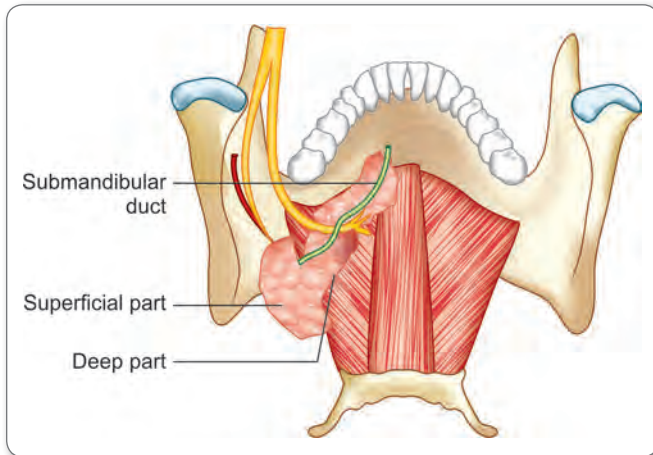


Fig. 65: Submandibular gland parts

- Situated in the submandibular fossa of mandible
- Gland consists of superficial and deep, both parts continuous around posterior border of mylohyoid
- Deep part of the gland is situated between the mylohyoid and hyoglossus
- Wharton's duct (submandibular duct—5 cm in intimate relation with lingual nerve and opens into floor of mouth in the sublingual papillae.
- Gland is supplied by both sympathetic and parasympathetic
 - Parasympathetic: Secretomotor in function (watery secretion)

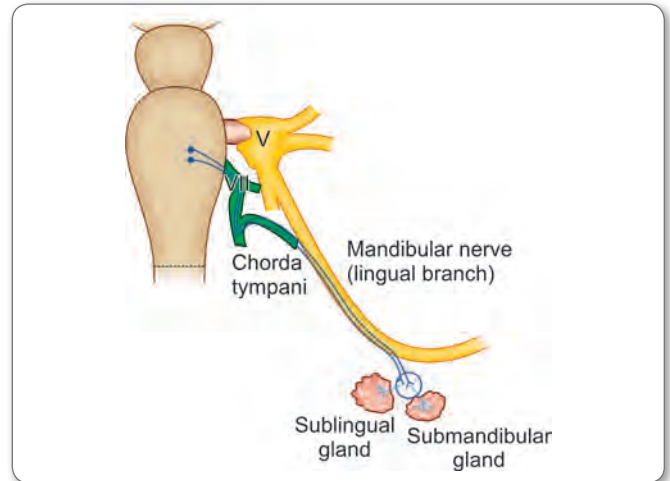


Fig. 66: Nerve supply of submandibular gland

- Fibers arise from superior salivatory nucleus, facial nerve, chorda tympani, lingual nerve and terminate in submandibular ganglion. Postganglionic fibers from the ganglion directly supply the gland.
- Sympathetic—secretomotor—mucus like secretion—postganglionic fibers arise from superior cervical ganglion and reach the gland through **plexus around the facial artery**.

Sublingual Gland

- Smallest of salivary gland situated between the floor of the mouth and mylohyoid muscle
- Ducts of sublingual gland—8 to 20—duct of Rivinus—open separately into the floor of mouth
- Duct of Bartholin: Some sublingual ducts open into submandibular duct.

Parasympathetic Pathway for Salivary Glands

Parotid gland	Submandibular gland sublingual	Lacrimal gland	Nasal/palatal glands
From inferior salivatory nucleus	Superior salivatory nucleus	Lacrimal nucleus	Superior salivatory nucleus
↓	↓	↓	↓
Tympanic branch of glossopharyngeal	Facial nerve	Nervus intermedius	Facial nerve
↓	↓	↓	↓
Tympanic plexus	Chorda tympani	Trunk of facial nerve	Greater petrosal nerve
↓	↓	↓	↓
Lesser petrosal nerve	Lingual nerve	Genicular ganglion	Pterygoid canal
↓	↓	↓	↓
Otic ganglion	Submandibular ganglion	Greater petrosal nerve	Pterygopalatine ganglion
↓	↓ Direct branch from ganglion	↓	↓
Auriculotemporal nerve	Submandibular gland	Nerve of pterygoid canal	Nasal glands
↓		↓	Greater palatine nerve
Parotid gland		Pterygopalatine ganglion	↓
		↓	Lesser palatine nerve
		Maxillary nerve	↓
		↓	Palatal glands
		Zygomatic nerve	
		↓	
		Lacrimal nerve	
		↓	
		Lacrimal gland	



Clinical Aspect

Most common site of stone formation in salivary gland is submandibular gland.
Nerve injured in Frey's syndrome—auriculotemporal nerve.

- Inferiorly: Sphenoid sinus
- Consists anterior lobe and posterior lobe
 - Anterior lobe: Pars distalis (pars anterior), pars intermedia and pars tuberalis
 - Posterior lobe: Pars nervosa.

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PITUITARY GLAND

- Situation: In sella turcica roofed by diaphragm sellae.

Relations

- Anterosuperiorly: Optic chiasma
- Laterally: Cavernous sinus

Blood Supply

- Arterial supply: Hypophyseal branches from internal carotid artery.
- Venous drainage: Hypothalamo—hypophyseal portal venous system connecting hypothalamus and pituitary gland.

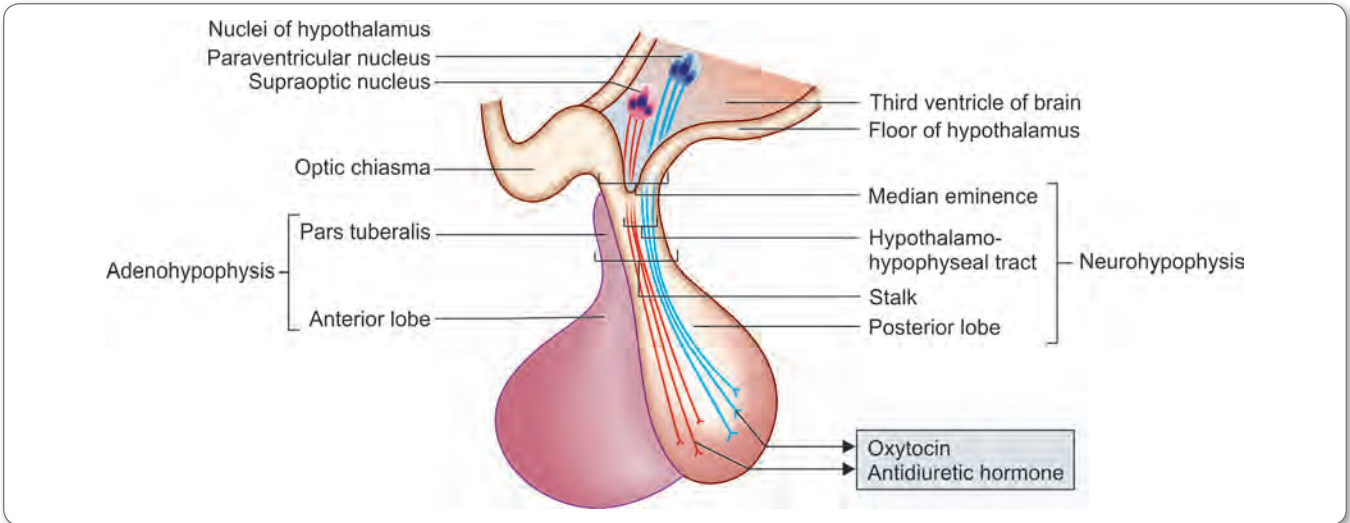


Fig. 67: Pituitary gland

ORBIT AND EYEBALL

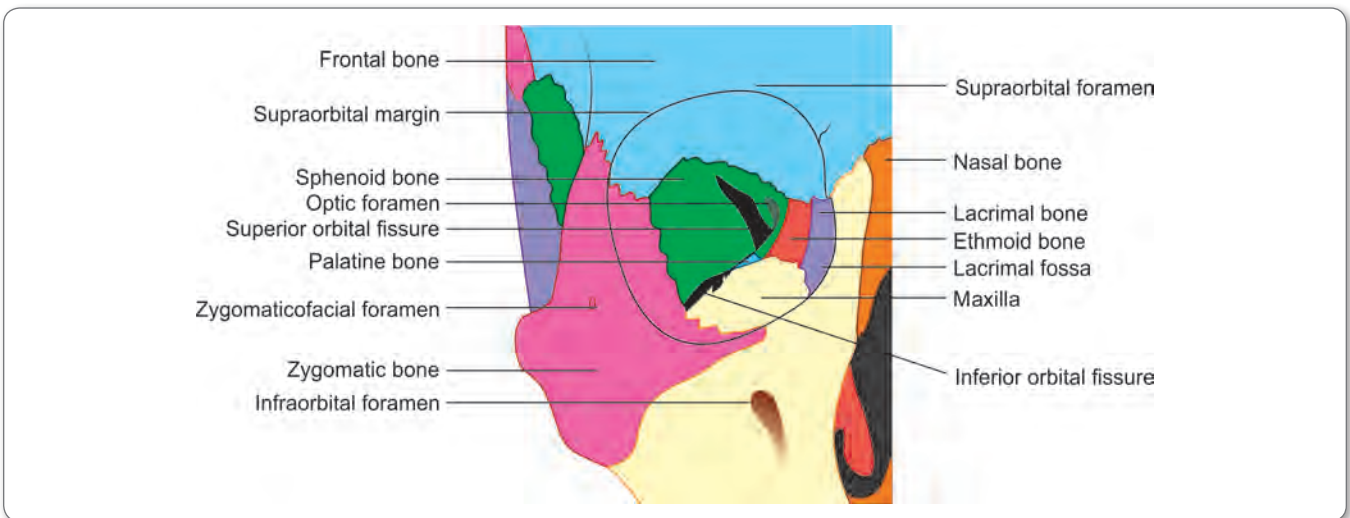


Fig. 68: Bony orbit



BOUNDARIES OF BONY ORBIT

Table 25: Boundaries of bony orbit

Roof	Orbital plate of frontal bone and lesser wing of sphenoid bone
Floor	Orbital surface of body of maxilla , zygomatic bone and palatine bone (Mnemonic – max-zip)
Medial wall	Frontal process of maxilla , lacrimal, body of sphenoid and orbital plate of ethmoid (Mnemonic – usmle)
Lateral wall	Zygomatic bone and orbital surface of the greater wing of sphenoid (Mnemonic – zig)

Clinical Aspect

- Blow out fracture of orbit most commonly involves floor of orbit > medial wall
- Weakest wall of orbit—medial wall
- Onodi cells are posterior ethmoidal cells related to optic nerve
- Haller cells are infraorbital extension of ethmoidal cells situated in the orbital floor and medial roof of maxillary sinus.

- At the junction of roof and lateral wall lies the superior orbital fissure. The fissure is bounded:
 - Above by the lesser wing,
 - Below by the greater wing and
 - Medially by body of sphenoid.

Superior orbital fissure is divided into three compartments by common tendinous ring.

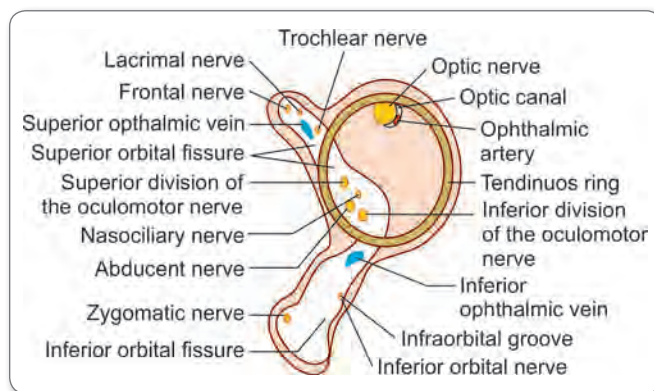


Fig. 69: Structures in compartments of superior orbital fissure

Superolateral compartment	Lacrimal, frontal and trochlear nerve (LFT). Superior ophthalmic vein, recurrent meningeal branch of the lacrimal artery.
Intermediate compartment	Superior and inferior division of oculomotor, nasociliary nerve, abducent nerve (SONIA)
Inferomedial compartment	Inferior ophthalmic vein

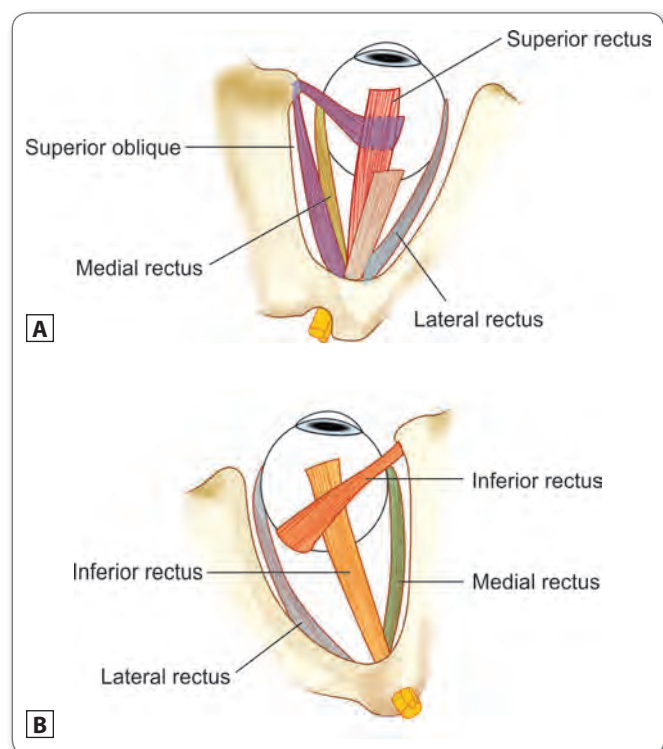
- At the junction of floor and lateral wall – inferior orbital fissure. The fissure is bounded
 - Below and medially by the maxilla and
 - Above and laterally by greater wing of sphenoid.
- Inferior orbital fissure transmits
 - Infraorbital vessels and nerves
 - Zygomatic nerve
 - Orbital branch of pterygopalatine ganglion and
 - Communications between the inferior ophthalmic vein and pterygoid venous plexus.

OPTIC CANAL

Boundaries

- Laterally: Lesser wing of sphenoid
- Medially: Body of sphenoid
- Behind and in front: Two roots of sphenoid
- Transmits: Ophthalmic artery and optic nerve with all layer of meninges.

EXTRAOCULAR MUSCLES



Figs 70A and B: Extraocular muscles



Table 26: Extraocular muscles

Muscles	Origin	Insertion	Innervation
Superior rectus	From common tendinous ring	Inserted in front of the equator and 7.7 mm behind the sclerocorneal junction	Oculomotor (SO4, LR6, remaining 3-mnemonic)
Inferior rectus	From common tendinous ring	Inserted in front of the equator and 6.5 mm behind the sclerocorneal junction	Oculomotor
Medial rectus	From common tendinous ring	Inserted in front of the equator and 5.5 mm behind the sclerocorneal junction	Oculomotor
Lateral rectus	From common tendinous ring	Inserted into in front of the equator and 6.9 mm behind the sclerocorneal junction	Abducent nerve
Superior oblique	From undersurface of lesser wing of sphenoid	Inserted into sclera behind the equator	Trochlear nerve
Inferior oblique	From orbital surface of maxilla	Inserted into sclera behind the equator in line with superior oblique	Oculomotor nerve
Levator palpebrae superioris	From lesser wing of sphenoid	Tarsal plate and to the skin of upper eyelid	Oculomotor

Table 27: Actions of extraocular muscles

Muscle	Action in primary position	Action in abducted eye	Action in adducted eye	Yolk muscles
Superior oblique	<ul style="list-style-type: none"> • Depression • Abduction • Intorsion 	Only intorsion	Only depression	Inferior rectus of opposite eye
Inferior oblique	<ul style="list-style-type: none"> • Elevation • Abduction • Extorsion 	Only extorsion	Only elevation	Superior rectus of opposite eye
Superior rectus	<ul style="list-style-type: none"> • Elevation • Adduction • Intorsion 	Only elevation	Only intorsion	Inferior oblique of opposite eye
Inferior rectus	<ul style="list-style-type: none"> • Depression • Adduction • Extorsion 	Only depression	Only extorsion	Superior oblique of opposite eye
Lateral rectus	Only abduction	No action	No action	Medial rectus of opposite eye
Medial rectus	Only adduction	No action	No action	Lateral rectus of opposite eye

- Superior and inferior recti directed 25° away from the optical axis (optical axis is the anteroposterior line extending from anterior pole to posterior pole). So, in the abducted eye optical axis coincides with superior and inferior recti. Therefore, contraction of superior and inferior recti produce **adduction**.
- **Oblique** muscles make an angle 51° medial to optic axis. So, in adducted eye, optical axis coincides with oblique muscles. Therefore, contraction of oblique muscles produce **abduction**.

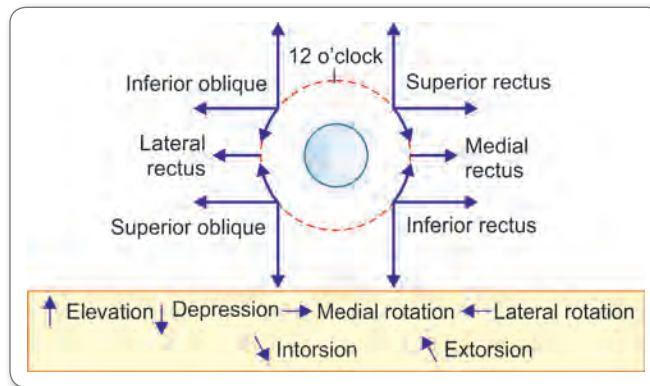


Fig. 71: Movements caused by extraocular muscles



- All the superior muscles are intortors: 12 o'clock position of cornea rotates medially.
- All the inferior muscles are extortors: Cornea rotates laterally

HIGH YIELD POINTS

Ciliary Ganglion

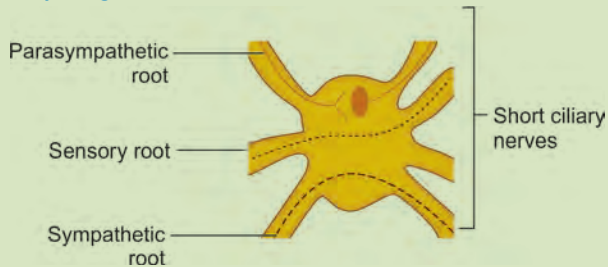


Fig. 72: Ciliary ganglion

- Topographically connected to nasociliary nerve, functionally to oculomotor nerve
- Situated in the apex of orbit between optic nerve and the origin of lateral rectus.

Connections of the Ganglion

- **Parasympathetic root:** Derived from nerve to inferior oblique, carrying the preganglionic fibers from Etinger Westphal nucleus and postganglionic fibers supply the ciliaris muscle and sphincter pupillae
- Sensory root is derived from nasociliary nerve. Carries pain, touch and thermal sensations from the eyeball
- Sympathetic root derived from **internal carotid plexus** which carries post ganglionic sympathetic fibers from superior cervical ganglion and supplies dilator pupillae and blood vessels of eyeball.

BLOOD VESSELS

Ophthalmic Artery

- Branch of internal carotid artery.
- Enters the orbit through optic canal beneath optic nerve

Branches

- Central artery of retina—end artery—so its occlusion results in blindness
- Long and short posterior ciliary arteries
- Lacrimal artery
- Medial palpebral artery
- Muscular branches
- Supraorbital branches
- Posterior ethmoidal artery
- Anterior ethmoidal artery
- Supratrochlear artery
- Dorsal nasal artery.

Ophthalmic Veins

Superior Ophthalmic Veins

- Receives tributaries that corresponds with accompanying ophthalmic artery
- Passes through superior orbital fissure and end in cavernous sinus
- Communicates with facial vein through angular vein.

Inferior Ophthalmic Veins

- Begins by union of small veins in the floor of the orbit
- Terminates directly or indirectly to cavernous sinus
- Communicates with pterygoid venous plexus through inferior orbital fissure.

EYEBALL

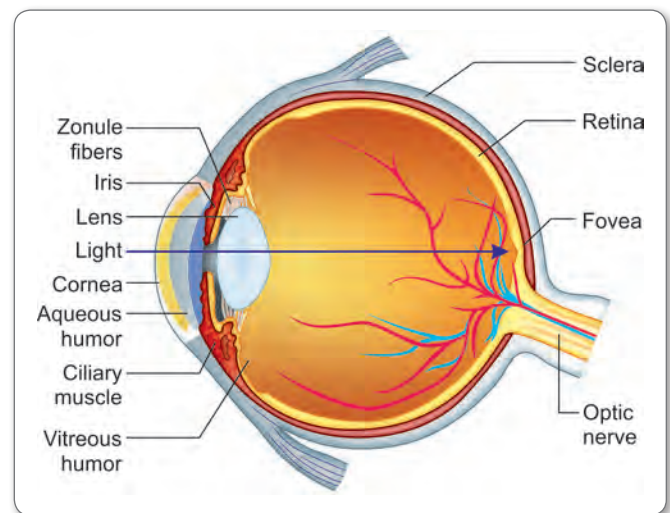


Fig. 73: Eyeball

Consists of Three Layers

- **Outermost layer:** Consists of sclera and cornea
 - **Cornea:** Transparent layer forming anterior 1/6th of the eyeball
 - **Sclera:** Tough white fibrous enveloping posterior 5/6th of the eyeball
- **Middle layer:** It is vascular and consists of iris, ciliary body and choroid
 - **Choroid**
 - Consists of outer pigmented layer and inner highly vascular layer
 - Nourishes the retina and darkens the eye
 - **Ciliary body**
 - Thickened portion of vascular coat between choroid and iris and consists of ciliary muscle and ciliary processes
 - ◆ **Ciliary processes** – radiating pigmented ridges that encircle the margins of lens
 - ◆ **Ciliary muscle** – smooth muscle innervated by parasympathetic fibers. It relaxes the suspensory ligament of lens and allowing it to increase the convexity



- **Iris**
 - Thin, contractile, circular pigmented diaphragm with central aperture called pupil
 - Contains circular muscle—sphincter pupillae—innervated by parasympathetic fibers
 - Contains radial fibers—dilator pupillae—innervated by sympathetic fibers
- **Inner layer: Nerve layer—retina**
 - Consists of outer pigmented layer and inner nervous layer
 - Optic disc: Consists of optic nerve fibers formed by axons of the ganglion cells. They are connected to rods and cones by bipolar neurons
 - Physiological cup is the depression in the center of optic disk.

Aqueous Humor

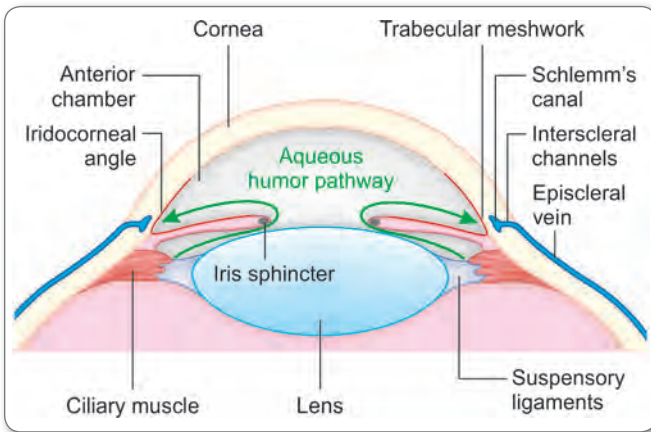


Fig. 74: Aqueous Humor

- Formed by ciliary process and provides nutrition for avascular cornea and lens
- Pass from posterior chamber through pupil to anterior chamber
- Drained into scleral venous plexus through Schlemm canal at the iridocorneal angle
- Impaired drainage leads to raised intra ocular pressure.

HIGH YIELD POINTS

Macula

- Yellowish area in the center of retina, which is situated on the temporal side of the optic disk
- Fovea centralis—depression in the macula. Has only cones and no rods
- Cones: For color vision and visual acuity. Around 7 million cells are present. And most numerous in foveal region
- Rods: Specialized for dim light. Contain rhodopsin pigment. 120 million cells are there. Situated 0.5 cm away from fovea centralis



Clinical Aspect

- Retinitis pigmentosa: Inherited disorder causes degeneration of photoreceptor cells in the retina and it is characterized by tunnel vision.
- Retinal detachment: Separation of sensory layer from the pigment layer of the retina. Mainly due to trauma.

Fascial Covering of Eyeball

Fascia Bulbi – Tenon’s Capsule

- Thin membrane which envelops eyeball from optic nerve to the limbus
- Separates eyeball from orbital pad of fat.

Suspensory Ligament of Lockwood

- Lower thickening of fascia bulbi is Lockwood’s ligament
- Expanded in the centre enclosing inferior rectus and inferior oblique and narrowed in the extremities and attached to lacrimal bone and zygomatic bone.

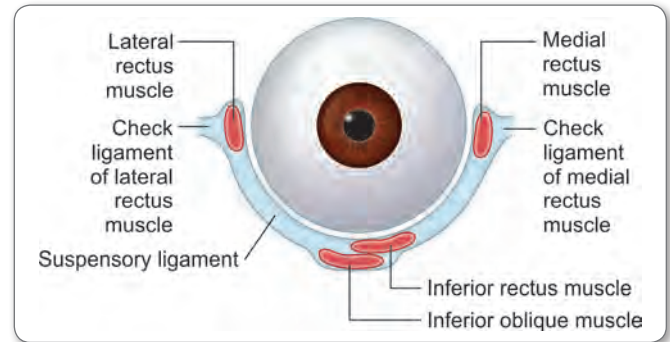


Fig. 75: Suspensory ligament of lockwood

Derivatives

- Tubular sheath: To each muscle.
- Lateral check ligaments: Triangular expansion from the sheath of lateral rectus.
- Medial check ligament: Triangular expansion from the sheath of medial rectus.
- Suspensory ligament of Lockwood: Both check ligaments are connected below by this Lockwood ligament.

NOSE

NASAL CAVITY

Opens to the exterior by anterior nasal aperture and communicates with the nasopharynx through posterior opening called choanae.

Lining Membrane

- Olfactory epithelium—lines the upper 1/3rd of the nasal cavity
- Pseudo stratified ciliated columnar—lines the rest of the nose. This is also known as Schneiderian membrane
- Vestibule—line by stratified squamous epithelium contains sweat glands and sebaceous glands

Boundaries

Roof

Nasal bone, frontal bone, cribriform plate of ethmoid and sphenoid bone. The cribriform plate of ethmoid is pierced by olfactory nerves.

Floor

Formed by palatine process of maxilla and horizontal plate of palatine bone.



NASAL SEPTUM OR MEDIAL WALL

- Nasal septum or medial wall formed by bony septum and cartilage septum.
- Nasal septum develops from fusion of maxillary + frontonasal process at 6 weeks of gestation
- Alar cartilage forms tip of external nose.

Mnemonic

Bony Septum

Main Structure (Mn – VP)	Accessory Structures (Mn – MP, RSs – FN)
<ul style="list-style-type: none"> • Vomer • Perpendicular plate of ethmoid 	<ul style="list-style-type: none"> • Nasal spine of frontal bone • Nasal crest of nasal bone, maxilla, palatine bone • Sphenoidal crest and rostrum

Cartilaginous Septum Formed by – Mn – sin

- Septal cartilage (quadrate cartilage)
- **I**nferior nasal cartilage

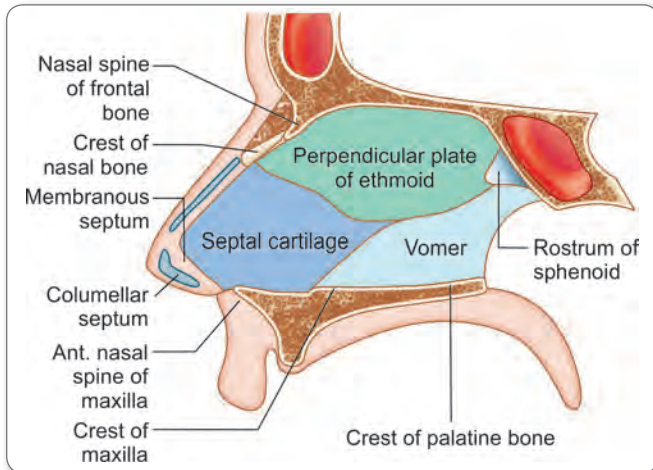


Fig. 76: Nasal cavity

Note

Joint between rostrum of sphenoid and vomer—Schindylesis joint.

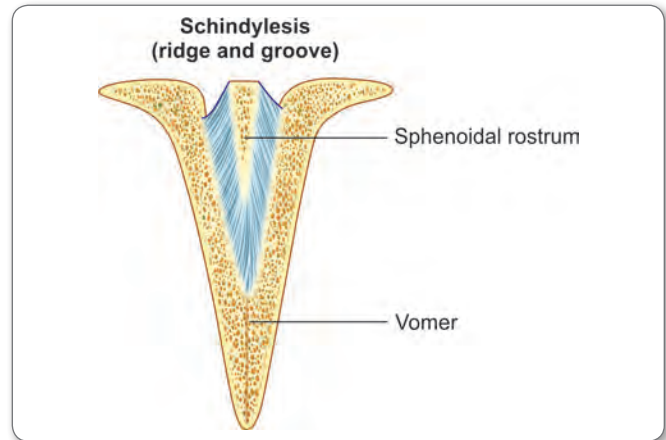


Fig. 77: Schindylesis joint

Blood Supply

Little's Area

Anteroinferior part of nasal septum is highly vascular and it is called Little's area or Kiesselbach's area. Arteries converge in the little area:

- Septal branch of sphenopalatine artery (branch of maxillary artery—branch of external carotid)
- Greater palatine artery (branch of maxillary artery—branch of external carotid)
- Anterior ethmoidal artery (branch of ophthalmic artery—branch of internal carotid artery)
- Superior labial artery (branch of facial artery—branch of external carotid)

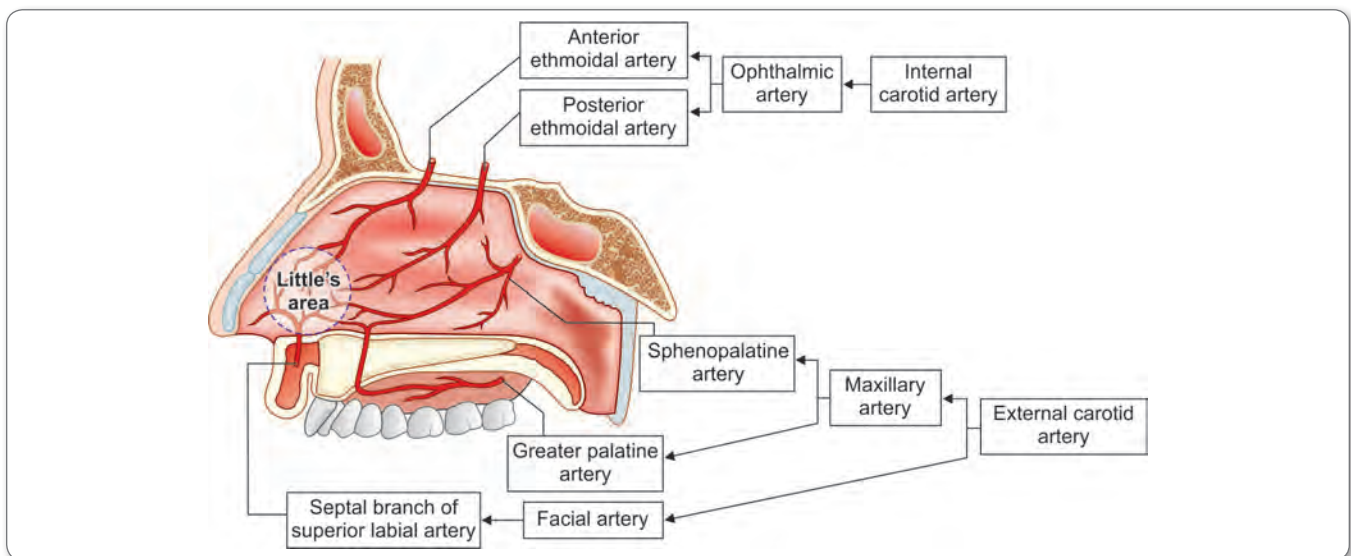


Fig. 78: Blood supply of the nasal region



LATERAL WALL

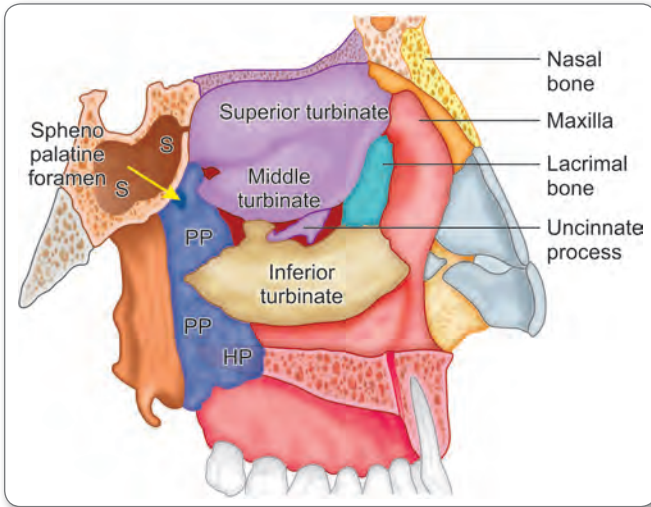


Fig. 79: Lateral wall of nasal cavity

- Nasal bones
- Frontal process of maxilla

- Lacrimal bone
- Superior, middle and inferior nasal concha
- Perpendicular plate of ethmoid
- Medial pterygoid plate of sphenoid
- Uncinate process extends from middle turbinate articulates with lacrimal bone and posteriorly with inferior turbinate.

Important Structures in Relation to Lateral Wall

- Eustachian tube—behind (1.25 M) and below the inferior turbinate is the opening of eustachian tube
- Sphenopalatine foramen—behind (1 cm) and below the middle turbinate—sphenopalatine foramen

Sphenopalatine Foramen

Transmits sphenopalatine vessel—**artery of epistaxis**
 Sphenopalatine foramen—**most common site of angiofibroma**

HIGH YIELD POINTS

- Superior and middle turbinate are projections from medial surface of ethmoid labyrinth
- Inferior turbinate—**independent bone—largest turbinate**

MEATUS

Meatus is the space present below the concha

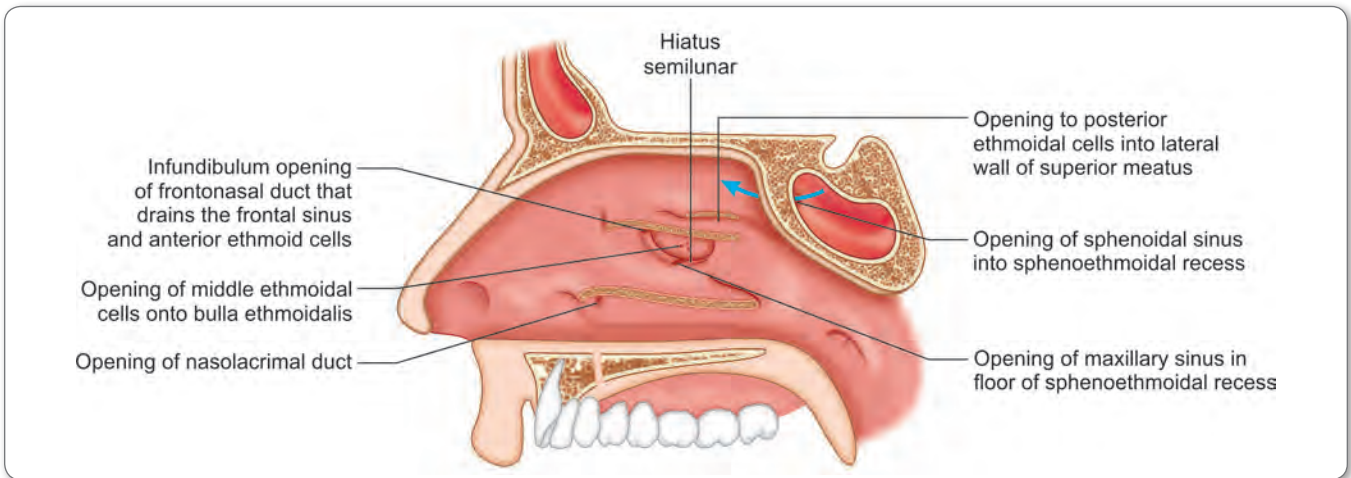


Fig. 80: Lateral wall of nose

Table 28: Meatus and structures opening into the meatus

Meatus	Structures opening
Inferior meatus	Nasolacrimal duct
Middle meatus	Maxillary sinus Frontal sinus Middle ethmoidal sinus Anterior ethmoidal sinus
Superior meatus	Posterior ethmoidal sinus
Sphenothmoidal recess	Sphenoidal sinus



Note

Valve of Hasner—seen in nasolacrimal duct
 Direction of duct—**downwards, backwards and laterally**
 (Mn - DouBLE)

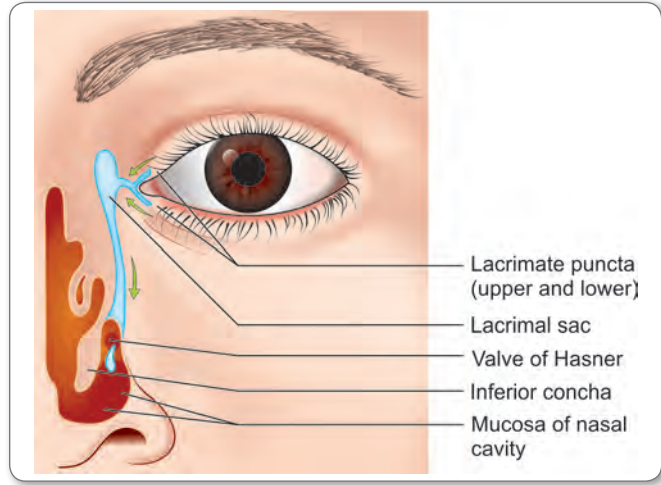


Fig. 81: Nasolacrimal duct

Olfactory Region

- Contains superior concha and upper 1/3rd of nasal septum
- Innervated by olfactory nerves which carry the sense from olfactory cells and pierce the cribriform plate of ethmoid to end in olfactory bulb.

Nerve Supply

- SVA—SMELL—Supplied by olfactory nerves for olfactory area
- GSA—supplied by anterior ethmoidal nerve, nasopalatine nerve, lateral nasal branch of maxillary nerve and anterior superior alveolar nerve.

HIGH YIELD POINTS

Sneeze Reflex

- Involuntary and sudden expulsion of air through mouth and nose
- Afferent – maxillary nerve branch (which convey general sensation from nasal cavity and palate)
- Efferent—vagus nerve.

HIGH YIELD POINTS

Ostiomeatal Complex

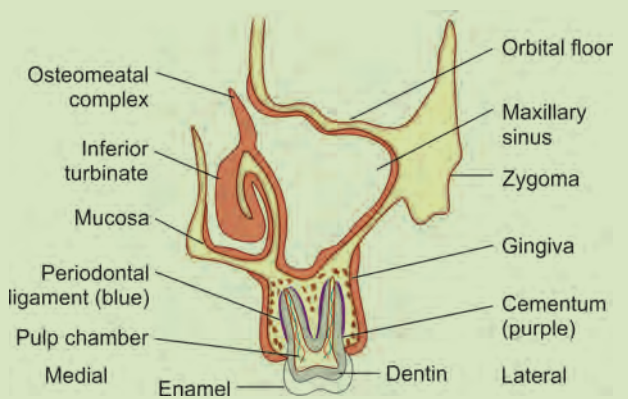


Fig. 82: Ostiomeatal Complex

Common channel links frontal sinus, anterior and middle ethmoidal sinus and maxillary sinus to middle ear for easy mucous drainage and air flow.

Boundaries

- Medially—middle turbinate
- Laterally—lamina papyracea
- Superiorly and posteriorly—basal lamella
- Inferiorly and anteriorly—open

SUBDIVISIONS OF NASAL CAVITY

Respiratory Region

- Lower 2/3rd of nasal cavity
- Warms, moistens and cleans incoming air

CSF RHINORRHOEA

Leak of CSF from sub arachnoid space to nose is called CSF rhinorrhoea

3 three routes for the CSF rhinorrhoea

- Through cribriform plate (most common)
- Through ethmoid, frontal and sphenoid sinuses
- From middle ear through eustachian tube

PARANASAL SINUSES

Ethmoidal Sinuses

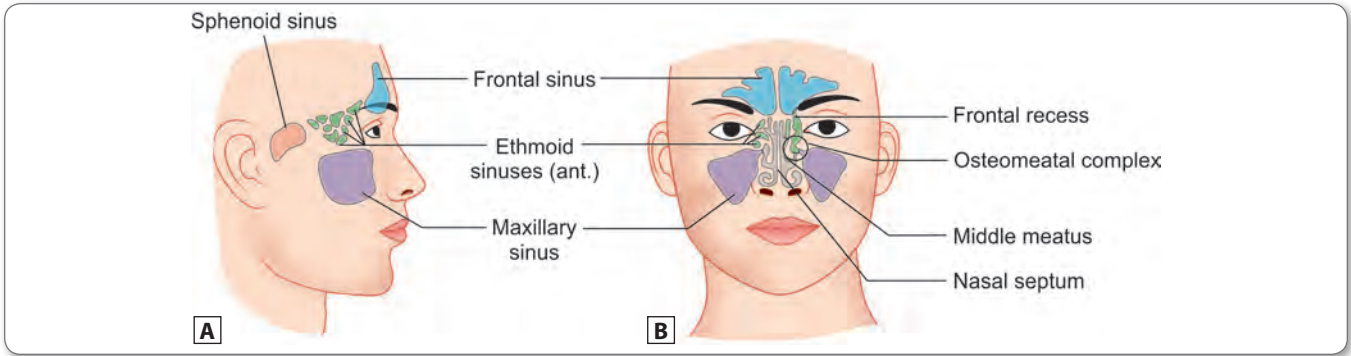
- Numerous small cavities within the ethmoidal labyrinth between orbit and nasal cavity
- Nerve supply—nasociliary nerve branch of ophthalmic nerve

Table 29: Ethmoidal sinuses

Anterior ethmoidal sinus	Drain into anterior aspect of hiatus semilunaris in the middle meatus
Middle ethmoidal sinus	Drain into summit of ethmoidal bulla of middle meatus
Posterior ethmoidal sinus	Drain into superior meatus

Clinical Aspect

- Ethmoidal sinusitis—inflammation of ethmoidal sinuses that may erode medial wall of orbit causing orbital cellulitis that may spread to cranial cavity
- Most common sinusitis in infants and young children



Figs 83A and B: Paranasal sinuses

Frontal Sinus

- Situated in the frontal bone
- Not present at birth and grows till late teenage. last sinus to develop
- Nerve supply—supra orbital (frontal nerve) from ophthalmic nerve
- Opens into hiatus semilunaris of middle meatus by way of frontonasal infundibulum
- Innervated by supraorbital branch of ophthalmic nerve.



Clinical Aspect

Frontal Sinusitis

Inflammation of frontal sinus that may erode the bone of anterior cranial fossa producing meningitis.

Maxillary Sinus

- Largest paranasal sinuses
- Only paranasal sinus present at birth
- Lies in the maxilla on each side lateral to lateral wall of nasal cavity and inferior to floor of orbit
- Drains into posterior aspect of hiatus semilunaris in the middle meatus
- Nerve supply – posterosuperior alveolar, middle superior alveolar, anterior superior alveolar nerve.



Clinical Aspect

Maxillary Sinusitis

- Infection may spread from maxillary sinus to upper teeth and irritate the nerves to these teeth causing toothache
 - It may be confused with toothache because thin layer of bone separates the roots of maxillary teeth from sinus cavity
- Most common sinusitis in adults.

Sphenoidal Sinus

- Contained within the sphenoid bone
- Drained into sphenothmoidal recess of nasal cavity
- Innervated by maxillary nerve and posterior ethmoidal branch of nasociliary nerve
- High opening so least commonly affected.



Clinical Aspect

Pituitary gland lies above the sinus and that can be reached by transsphenoidal approach. Care must be taken not to damage cavernous sinus and internal carotid artery.

So, in sphenoidal sinusitis—infection may spread to pituitary gland, internal carotid artery and cavernous sinus.

Table 30: Development of the sinuses

Sinus	Gestational month when development starts	Present in clinically significant size	Fully developed
Maxillary	2	Birth	12 years
Ethmoid	3	Birth	12 years
Frontal	4	3 years	18–20 years
Sphenoid	3	8 years	12–15 years

EAR

EXTERNAL EAR

- Pinna—made up of elastic cartilage
- Nerves supplying pinna:
 - Great auricular nerve
 - Lesser occipital nerve
 - Auriculotemporal nerve
 - Auricular branch of vagus (Arnolds nerve)



External Acoustic Meatus

Table 31: Cartilaginous and bony parts of external acoustic meatus

Cartilaginous parts	Bony parts
<ul style="list-style-type: none"> Outer and lateral part 	<ul style="list-style-type: none"> Inner and medial
<ul style="list-style-type: none"> 8 mm in length 	<ul style="list-style-type: none"> 16 mm
<ul style="list-style-type: none"> Contains hair and ceruminous glands 	<ul style="list-style-type: none"> Hair and ceruminous glands are absent
<ul style="list-style-type: none"> Deficiency is called fissure of Santorini through which parotid infection spreads or vice versa 	<ul style="list-style-type: none"> Deficiency in the anterior part – foramen of Luschka spreads infection from parotid

Tympanic Membrane

- Ear drum:** Semitransparent, pearly white and trilaminar membrane.
- Makes an angle at 55° with external acoustic meatus.

Subdivisions

- Pars flaccida (Shrapnell's membrane):** Small triangular area above the malleolar folds.
- Pars tensa:** Occupies rest of the membrane.

Recess

- Anterior recess—between handle of malleus and anterior fold
- Posterior recess—between handle of malleus and posterior fold.
- Prussak's space—**recess above the lateral process of malleus** and intervening between neck of malleus and pars flaccida.

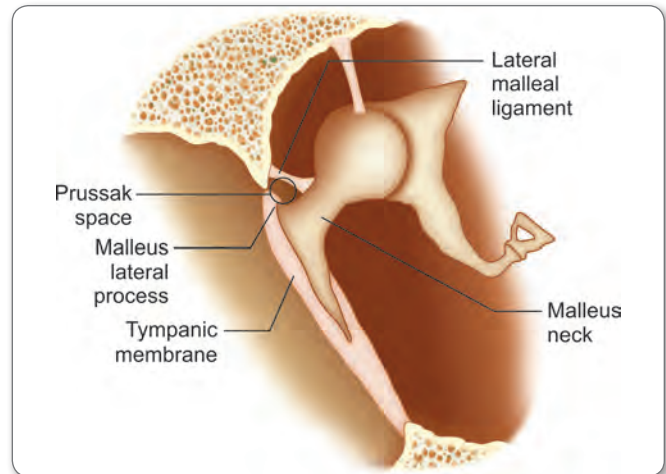


Fig. 84: Prussak's space

Nerve Supply

- Auriculotemporal nerve: Supplies anterior part of membrane.
- Auricular branch of vagus: Supplies lower and posterior part.
- Glossopharyngeal nerve: Supplies mucous layer.

MIDDLE EAR

Enclosed in petrous part of temporal bone communicates anteriorly with nasopharynx via auditory tube and posteriorly with mastoid air cells through antrum traversed by chorda tympani nerve and lesser petrosal nerve.

Subdivisions

- Epitympanum:** Situated above the tympanic membrane. Contains head of malleus, body and short process of incus.
- Mesotympanum:** Opposite to membrane. Contains handle of malleus, long process of incus and stapes.
- Hypotympanum:** Below the tympanic membrane.

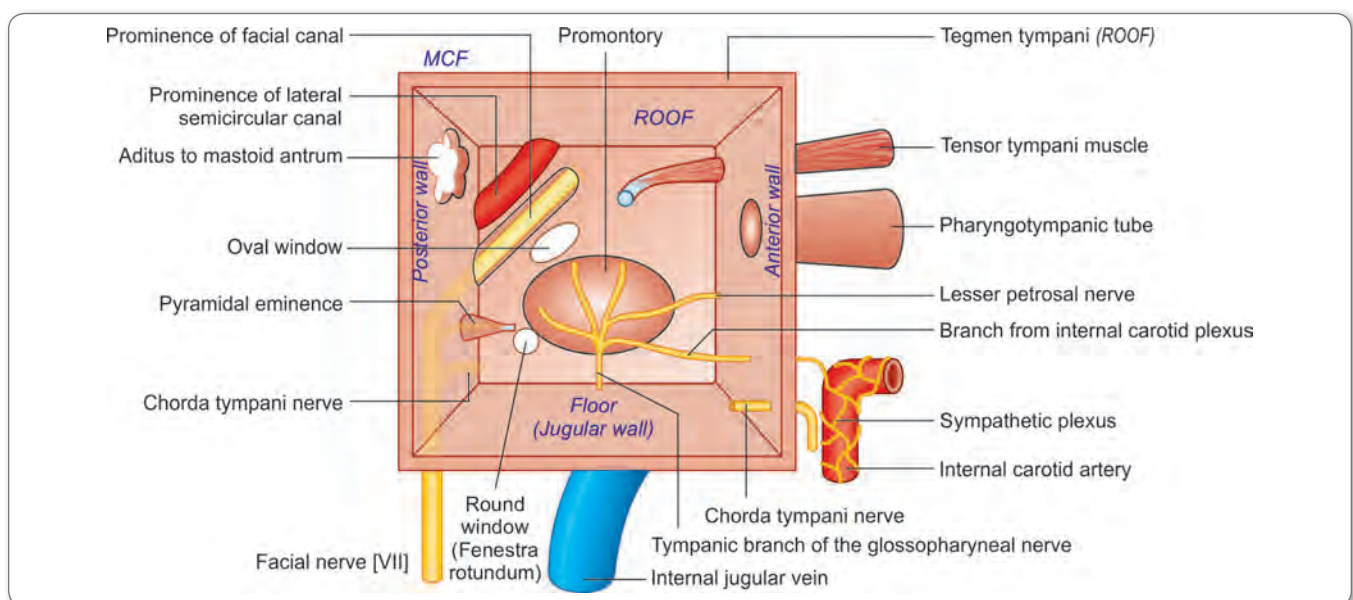


Fig. 85: Middle ear compartment



Table 32: Boundaries of middle ear

Roof	Tegmen tympani—thin plate of petrous bone, which separates middle ear from middle cranial fossa
Floor	Internal jugular vein
Anterior wall	Upper bony canal for tensor tympani muscle Lower bony canal for auditory tube Internal carotid artery presents in the lower part
Posterior wall	Aditus to mastoid antrum Bony canal for facial nerve Pyramidal eminence: Contains stapedius muscle
Medial wall	Promontory: Round elevation produced by basal turn of cochlea Oval window: Closed by stapes Round window: Closed by secondary tympanic membrane Oblique canal for facial nerve
Lateral wall	Tympanic membrane

- Oval window: Closed by foot plate of stapes and transmits vibrations from ossicles to perilymph of scala vestibuli in the inner ear.
- Round window: Closed by secondary tympanic membrane and accommodate pressure waves transmitted to the perilymph of scala vestibuli.

Contents

- Muscles
- Ossicles
- Tympanic plexus

Muscles of Middle Ear

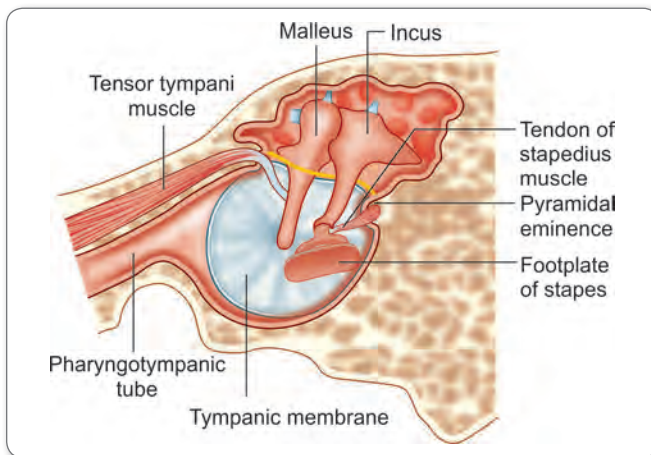


Fig. 86: Muscles of middle ear

Table 33: Muscles of middle ear

	Tensor tympani	Stapedius
Origin	Auditory tube and from sulcus tubae	Pyramidal eminence
Insertion	Handle of malleus	Neck of stapes
Nerve supply	From the trunk of the mandibular nerve	Facial nerve
Action	Dampens the vibration	Dampens the vibration

Note:

- Tensor tympani draws the tympanic membrane medially and tightens it and reduce the vibration of tympanic membrane
- Stapedius muscle—pulls the head of stapes posteriorly and prevent the vibration of stapes.

Ossicles

These ossicles transmit sound from external ear (tympanic membrane) to inner ear (oval window).

Malleus

- Consists of head, neck, handle and anterior and lateral process
- Head articulates with incus in the epitympanic recess
- Handle fused to medial surface of tympanic membrane and provides attachment to tensor tympani.

Incus

- Consists of body, short process and long process
- Long process articulates with stapes
- Short process provides attachment to posterior ligament of the incus.

Stapes

- Consists of head, neck, 2 crura and foot plate
- Neck provides insertion of stapedius muscle
- Foot plate closes oval window.

REMEMBER

Malleus and incus	Derived from 1st arch
Stapes	Derived from 2nd arch

- Joint between malleus and incus: Saddle type of synovial joint
- Joint between incus and stapes: Ball and socket.
- Ossify from one center in the fourth month of intrauterine life
- All ossicles assume adult size at birth.

Note

- Tulio phenomenon—excessive movements of stapes on loud sounds now causes stimulation of utricle and saccule leading to imbalance
- Vertigo on external pressure changes is known as Hennebert’s sign.



Clinical Aspect

Abnormal ossification between foot plate and stapes—otosclerosis that results in conductive hearing loss

Conductive hearing loss	<ul style="list-style-type: none"> Defect in sound transmission pathways Lesion may be in auditory meatus, ear drum or ossicles
Sensorineural hearing loss	<ul style="list-style-type: none"> Due to lesion of auditory nerve or central neural hearing pathway

Tympanic Plexus

- Tympanic branch of **glossopharyngeal nerve** and branch from plexus over the internal carotid artery joins to form tympanic plexus.
- This tympanic plexus ramifies over the promontory (which is in the medial wall of the middle ear cavity).

Eustachian Tube (Pharyngotympanic Tube)

- Extends from anterior wall of middle ear to lateral wall of nasopharynx to equalize the pressure on both sides of tympanic membrane.
- Direction: Downward, forward and medially from tympanic cavity to nasopharynx and making an angle about 45 with sagittal plane and 30 with horizontal plane
- Length 3.6 cm made up of two components bony (1.2 cm) and cartilage (2.4 cm)
- Isthmus—narrowest part, slightly bent, junction between bony and cartilaginous parts
- Cartilaginous (elastic) portion remains close except during swallowing or yawning
- Opened by simultaneous contraction of tensor veli palatini (dilator tubae) assisted by salpingopharyngeus

- Lined by **ciliated columnar epithelium**
- Nerve supply by tympanic plexus (tympanic branch of glossopharyngeal nerve and caroticotympanic nerve)
- Arterial supply: Ascending pharyngeal branch of external carotid artery, middle meningeal artery and artery of pterygoid canal.

Mastoid Antrum

Backward extension of tympanic cavity.

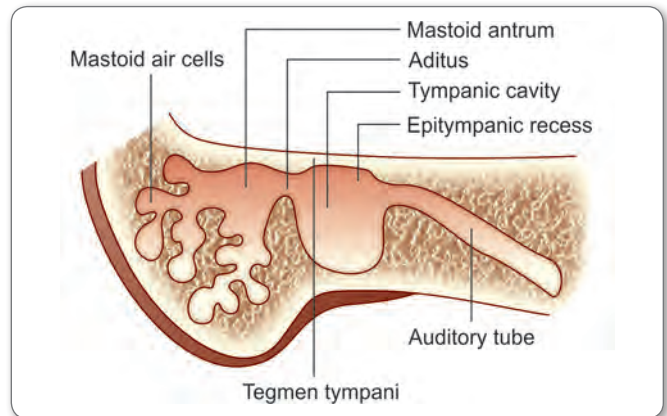
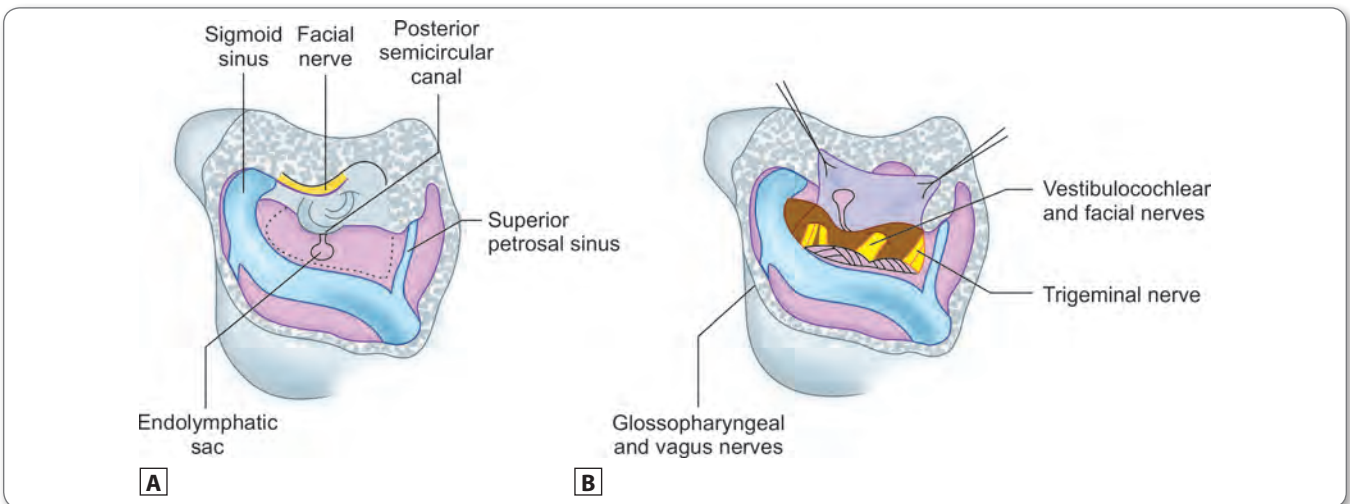


Fig. 87: Mastoid antrum

Boundaries

- Roof: Tegmen tympani and related to middle cranial fossa.
- Floor: Communicate with mastoid.
- Anterior wall: Opening called **aditus** present, which communicates with epitympanic part.
- Posterior wall: Related to sigmoid sinus.
- Medial wall: Bulge of posterior semicircular canal.



Figs 88A and B: Trautmann's triangle



Triangular area on the medial wall of mastoid antrum—**Trautmann's triangle.**

This triangle used as easy approach to posterior cranial fossa

Superiorly—superior petrosal sinus

Posteriorly—sigmoid sinus

Anteriorly—bony labyrinth

- Lateral wall: **Suprameatal triangle—MacEwen's triangle**

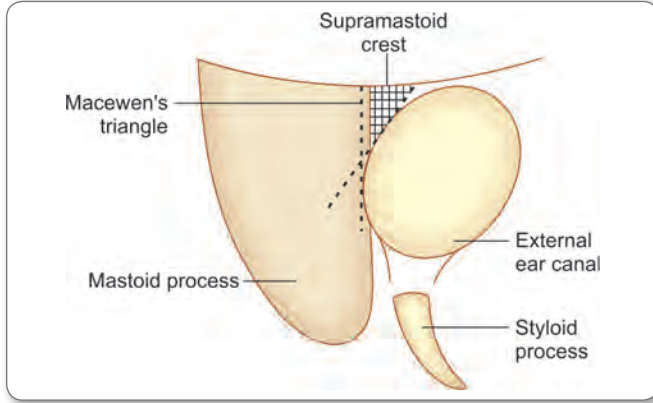


Fig. 89: MacEwen's triangle

Boundaries

- Upper part of triangle: Supramastoid crest
 - Anteroinferiorly: External ear canal
 - Posteriorly: Tangent line to meatal opening.
- 12–15 mm deep to this triangle is the mastoid antrum.

INNER EAR

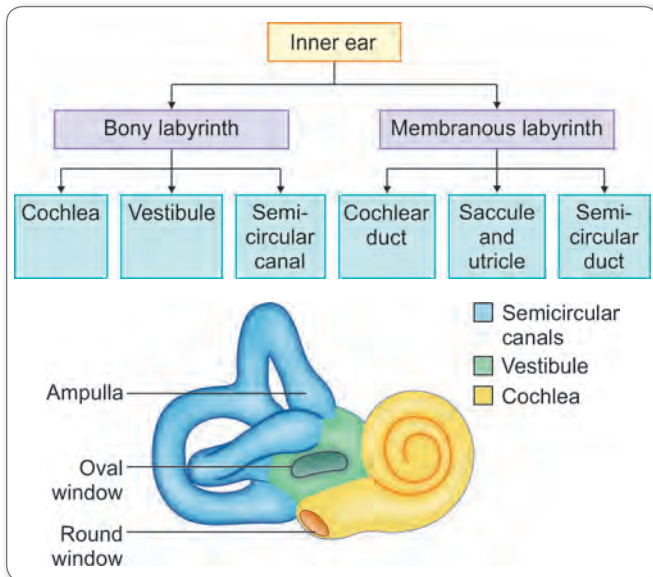


Fig. 90: Inner ear

Bony Labyrinth

Consists of vestibule, semicircular canal and cochlea all of which contain perilymph in which membranous labyrinth is suspended.

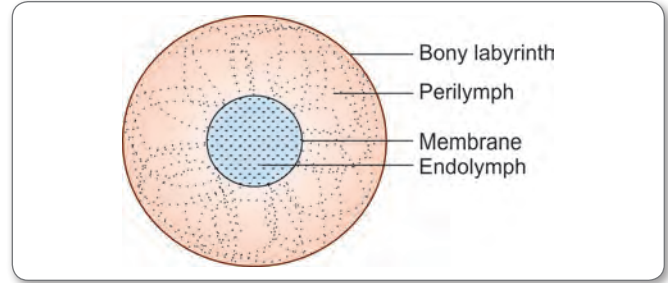


Fig. 91: Structure of inner ear

Cochlea

- Shape: Conical which resembles shell of snail.
- **Modiolus is the central pillar** from that bony cochlear canal makes two and half turns and subdivided into two passages scala vestibuli and scala tympani
- Each next turn is of decreasing size
- Apex of the modiolus directed anterolaterally and inferiorly and base faces posteromedially.
- Screw shaped modiolus transmits cochlear nerve and transmits spiral ganglion.

Semicircular Canals

- Three in numbers. Anterior (superior), posterior and lateral.
- Each canal has two ends but medial end of anterior canal and upper end of posterior canal unites to form crus commune. So semicircular canals open by 5 openings not by 6 openings.
- Each semicircular canal is at right angles to each other.
- The plane of anterior canal is right angle to long axis of petrous bone
- The plane of posterior canal-parallel to the posterior surface of petrous bone
- The plane of lateral canal becomes horizontal.

Vestibule

Occupies central position between cochlea in front and the three semicircular canals behind.

Lateral wall of the vestibule presents oval and round window.

Membranous Labyrinth

Filled with endolymph

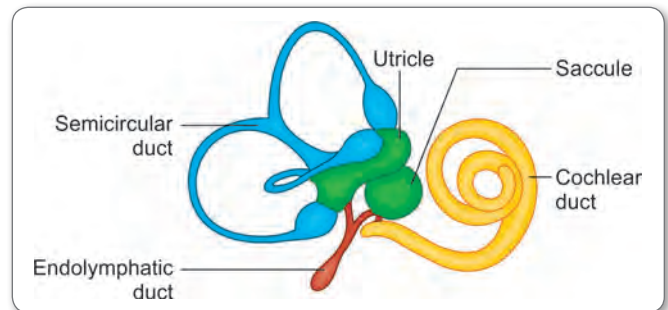


Fig. 92: Membranous labyrinth



Utricle and Sacculle

- Dilated membranous sac of the vestibule and contains sense organ called maculae. Maculae of utricle detects horizontal orientation and maculae of sacculle detects vertical orientation.

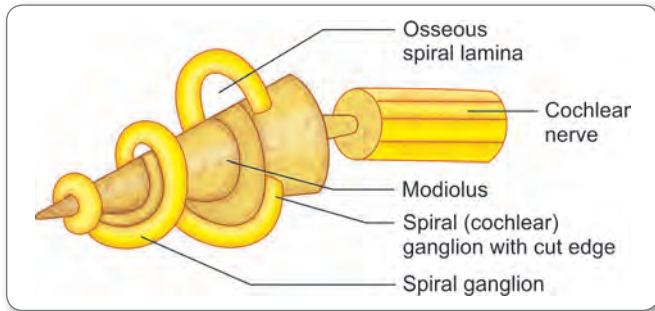


Fig. 93: Structure of cochlea

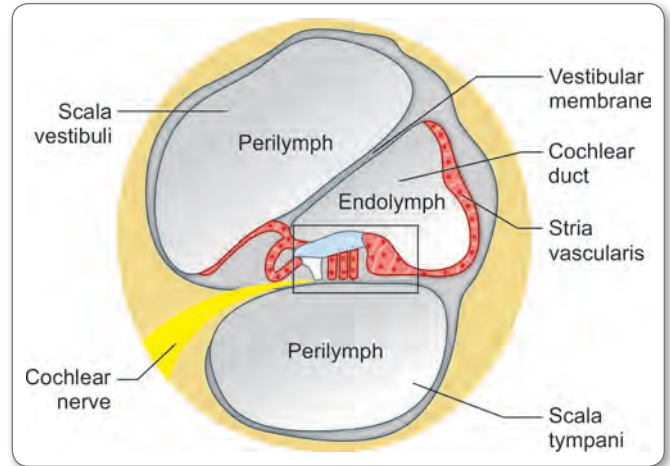


Fig. 94: Cross-section of cochlea

Osseous Spiral Lamina

- Bony canal running spirally around the modiolus
- Inside this lamina is the Rosenthal canal contains spiral ganglion
- This lamina is attached to basilar membrane which divide the cochlea into scala vestibuli, scala tympani and scala media (membranous cochlea)

Cochlear Duct—Scala Media

Cochlear duct is triangular in cross section. Bounded by basilar membrane—separates scala media from scala tympani. Organ of corti presents in basilar membrane Reissner’s membrane—separates scala media from scala vestibuli stria vascularis—site of production of endolymph structure of organ of Corti.

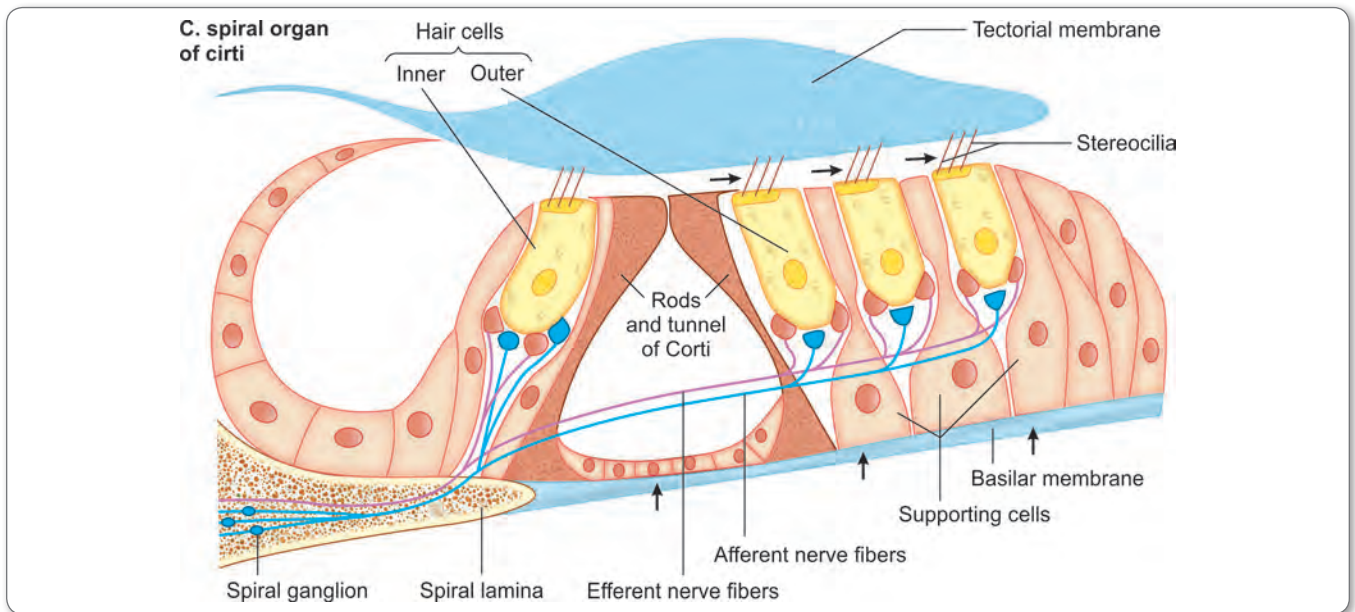


Fig. 95: Cochlea and spiral organ

Hair cells—inner and outer hair cells. These hair cells project into tectorial membrane
Supporting cells—support the outer hair cells

Spiral Ganglion

- Bipolar
- Peripheral process innervates the organ of Corti (Most of them innervate inner hair cells very few to outer hair cells)
- Central process forms cochlear nerve.

Semicircular Duct

Consists of anterior, lateral and posterior duct. Contains sense organ called crista ampullaris which detect angular acceleration of head.

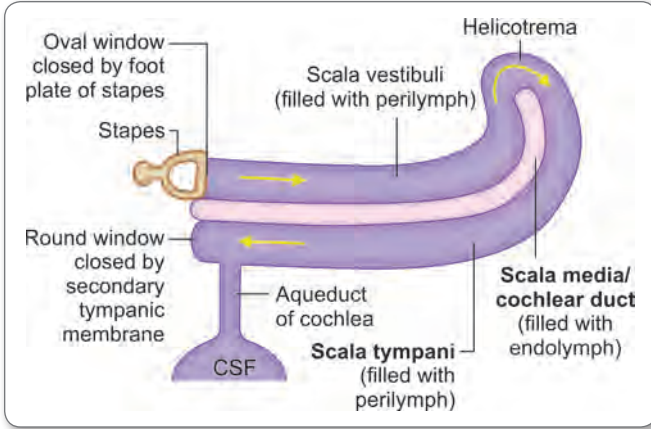


Fig. 96: Semicircular duct



Clinical Aspect

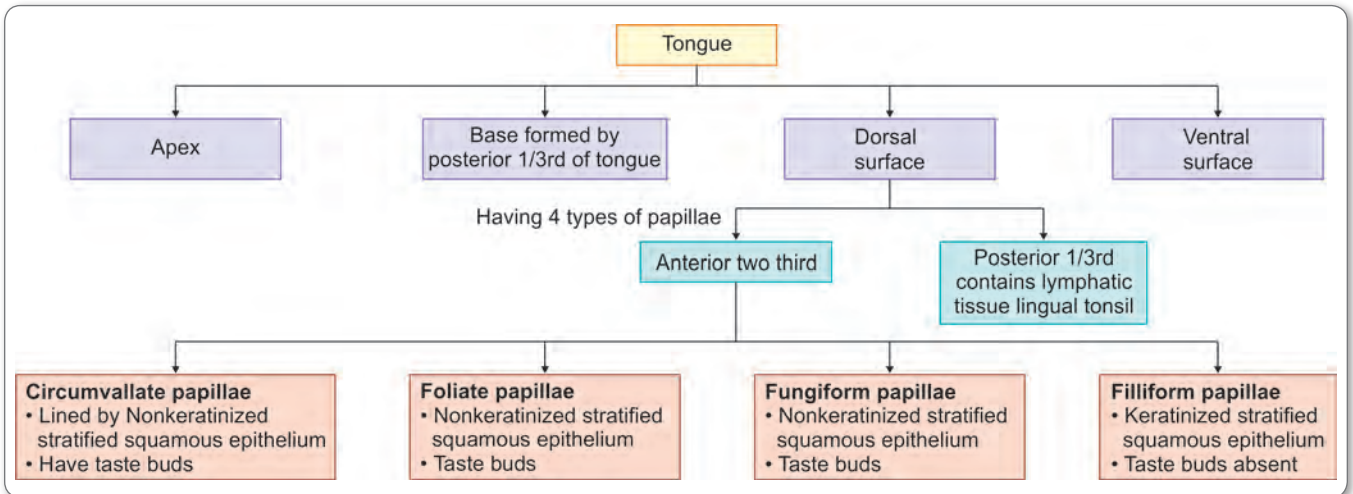
Meniere's Disease

Loss of balance, tinnitus, progressive hearing loss resulting from hydrops of the endolymphatic duct.

Table 34: Comparison between endolymph and perilymph

Endolymph	Perilymph
<ul style="list-style-type: none"> • Membranous labyrinth filled with endolymph 	<ul style="list-style-type: none"> • Bony labyrinth filled with perilymph
<ul style="list-style-type: none"> • Present in the membranous labyrinth 	<ul style="list-style-type: none"> • Present between bony and membranous labyrinth
<ul style="list-style-type: none"> • Resembles intracellular fluid because rich in K⁺ ions 	<ul style="list-style-type: none"> • Resembles extracellular fluid because rich in Na⁺ ions
<ul style="list-style-type: none"> • Circulation of endolymph 	<ul style="list-style-type: none"> • Circulation of perilymph: Perilymph communicates with CSF through aqueduct of cochlea which opens into the scala tympani near round window.
<ul style="list-style-type: none"> • Cochlea—sacculle—utricle—endolymphatic duct, then reaches endolymphatic sac in subdural space to get absorbed 	

TONGUE



- Dorsal surface of tongue is divided into anterior 2/3rd and posterior 1/3rd by V shaped sulcus terminalis.
- Foramen cecum is situated at the junction and indicates sites of origin of the thyroglossal duct.
- All papillae supplied by chorda tympani nerve except circumvallate papillae which is supplied by glossopharyngeal nerve.

MUSCLES OF TONGUE

Mnemonic

- **Extrinsic:** Alter the Position of tongue
 - **Intrinsic:** Alter the Shape of the tongue
- Mnemonic - PEpSI



Extrinsic Muscles

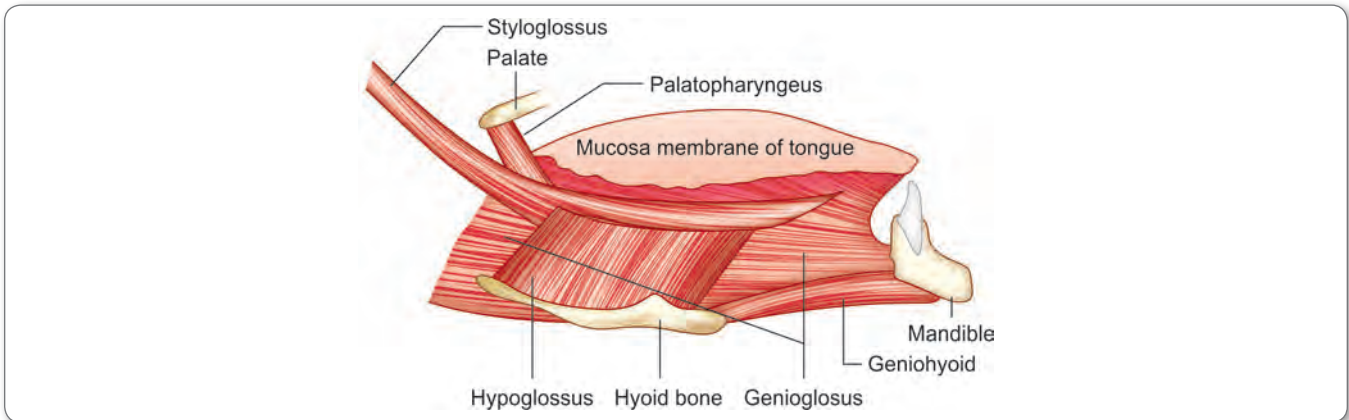


Fig. 97: Extrinsic muscles of the tongue

Table 35: Muscles of tongue—origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Genioglossus	Superior genial tubercles of symphysis menti	<ul style="list-style-type: none"> Lowest fibers-hyoid bone Intermediate-continuous with middle constrictor Upper fibers-tongue from root to apex 	Hypoglossal nerve	<ul style="list-style-type: none"> Depress and Protrudes the tongue. Prevents fall back of tongue which result in choking (safety muscle of tongue)
Hyoglossus	Hyoid bone	Side of tongue	Hypoglossal nerve	Depress the side of tongue make its dorsal surface convex and retracts the tongue
Chondroglossus (detached part of hyoglossus)	Hyoid bone	Side of tongue	Hypoglossal nerve	Depress the side of tongue
Styloglossus	Styloid process	Side of tongue	Hypoglossal nerve	Retracts the tongue and elevates the tongue
Palatoglossus	Palatine aponeurosis	Side of tongue in front	Cranial accessory through pharyngeal plexus	Elevates the base of tongue

Intrinsic Muscles and their Actions

- Superior longitudinal muscles-turns apex and sides upward to make dorsum concave
- Inferior longitudinal muscles-pull apex down to make dorsum convex (contraction of these two muscles, shorten the tongue)
- Transversus linguae-narrows and elongates the tongue
- Verticalis- makes tongue flatter and wider.

NERVE SUPPLY OF TONGUE

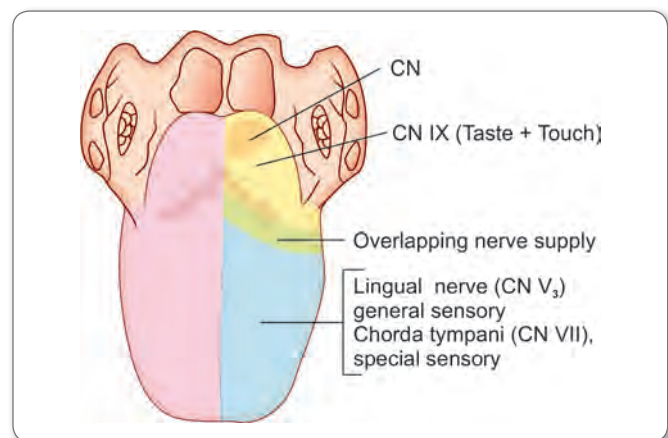


Fig. 98: Nerve supply of tongue



Sensory Supply

Table 36: Sensory supply of tongue

	Anterior two-thirds of tongue- derived from 1st arch	Posterior one-third of tongue- from 3rd arch	From the epiglottis- from 4th arch
General sensory	Lingual nerve	Glossopharyngeal nerve	Internal laryngeal branch of superior laryngeal nerve (vagus)
Special sensory	Except circumvallate papillae by chorda tympani (facial nerve)	Including circumvallate papillae by glossopharyngeal nerve	Internal laryngeal branch of superior laryngeal nerve (vagus)

Mnemonic

Taste sensation from palate is supplied by facial nerve through its greater petrosal nerve which send fibers into palatine nerves

Motor Supply

All the muscles of tongue (four pairs of genioglossus, hyoglossus, chondroglossus and styloglossus) and intrinsic (superior and inferior longitudinal muscles, transverses and verticalis) supplied by hypoglossal nerve, except palatoglossus (extrinsic) supplied by cranial accessory through pharyngeal plexus.



Clinical Aspect

Features of Hypoglossal Nerve Injury

- Unilateral hemiatrophy of muscles on the affected side
- The protruded tongue deviates on the same side of lesion, whereas larynx deviates on the active side (due to paralysis of hyoid depressors which is innervated by C1 fibers which run along the hypoglossal nerve)
- Paralysis of geniohyoid and thyrohyoid muscles.
- On retraction, paralyzed side rises higher than normal side

LYMPHATIC DRAINAGE

Table 37: Lymphatic drainage of various parts of tongue

Part	Lymph Nodes
Tip of tongue	Submental nodes
Anterior 2/3rd except Circumvallate papillae	Unilateral submandibular nodes Bilateral deep cervical nodes Jugulodigastric/jugulo-omohyoid
Posterior 1/3rd including Circumvallate papillae	Jugulodigastric and jugulo-omohyoid

Note

- Hypoglossal nerve injury causes tongue deviation on same side of lesion and larynx deviation to active side of lesion.

PALATE

Separates oral and nasal cavities

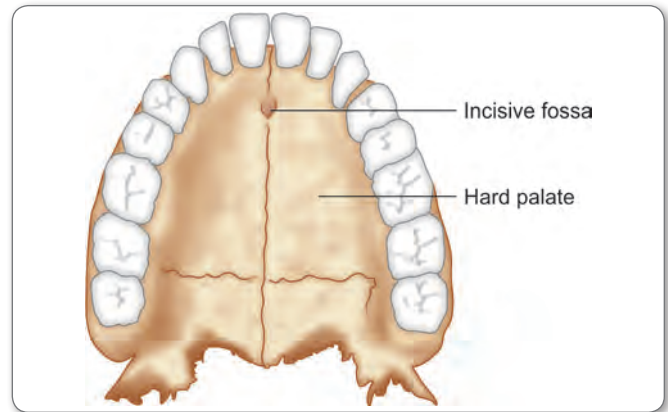


Fig. 99: Hard palate

HARD PALATE

- Forms anterior 4/5th of the palate and forms bony framework covered with mucous membrane between nasal and oral cavities.
- Contains incisive foramen in its median plane anteriorly and greater and lesser palatine foramina posteriorly.
- Formed between palatine process of maxilla and horizontal plates of palatine bones.

SOFT PALATE

- Fibromusculoglandular organ
- Separates oropharynx from nasopharynx
- Anterior surface lined by stratified non-keratinized squamous epithelium
- Posterior surface: Respiratory epithelium.
- Tensor veli palatini: Supplied by branch from the trunk of the mandibular nerve.
- Levator veli palatini: Supplied by pharyngeal plexus.
- Palatopharyngeus: Supplied by pharyngeal plexus.
- Palatoglossus: Supplied by pharyngeal plexus.

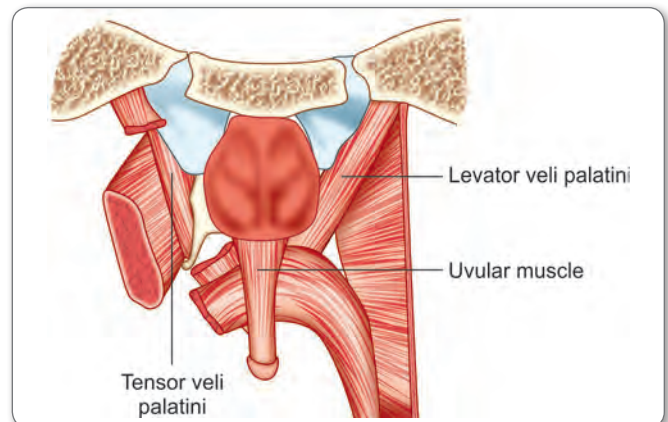


Fig. 100: Components of soft plate



Table 38: Muscles of palate

Muscles	Origin	Insertion	Nerve supply	Action
Tensor veli palatini	<ul style="list-style-type: none"> Scaphoid fossa Spine of sphenoid Cartilage of auditory tube 	Insert into palatine aponeurosis	Mandibular trunk	Tenses the soft palate
Levator veli palatini	<ul style="list-style-type: none"> Petrous part of temporal bone Cartilage of auditory tube 	Aponeurosis of soft palate	Pharyngeal plexus	Elevates soft palate
Palatoglossus	Aponeurosis of soft palate	Dorsolateral part of tongue	Pharyngeal plexus	Elevates tongue
Palatopharyngeus	Aponeurosis of soft palate	Thyroid cartilage and side of pharynx	Pharyngeal plexus	Elevates pharynx closes nasopharynx
Musculus uvulae	Posterior nasal spine of palatine bone, palatine aponeurosis	Mucous membrane of uvula	Pharyngeal plexus	Elevates uvula

HIGH YIELD POINTS

- Passavant ridge is formed by **palatopharyngeus**.
- Pharyngeal plexus is formed by cranial part of accessory nerve which carries fibers from vagus and also receives contribution from glossopharyngeal nerve and superior cervical ganglion.

SENSORY SUPPLY OF PALATE

General sensation	Greater palatine nerve, lesser palatine nerve and long sphenopalatine nerve and glossopharyngeal nerve.
Special sensation	Taste sensation from palate is supplied by facial nerve through its greater petrosal nerve which send fibers into palatine nerves.

- Postganglionic parasympathetic pathway—from pterygopalatine ganglion through lesser palatine nerve.
- Postganglionic sympathetic fibers run along the arteries, which supplying the palate.

PALATINE TONSIL

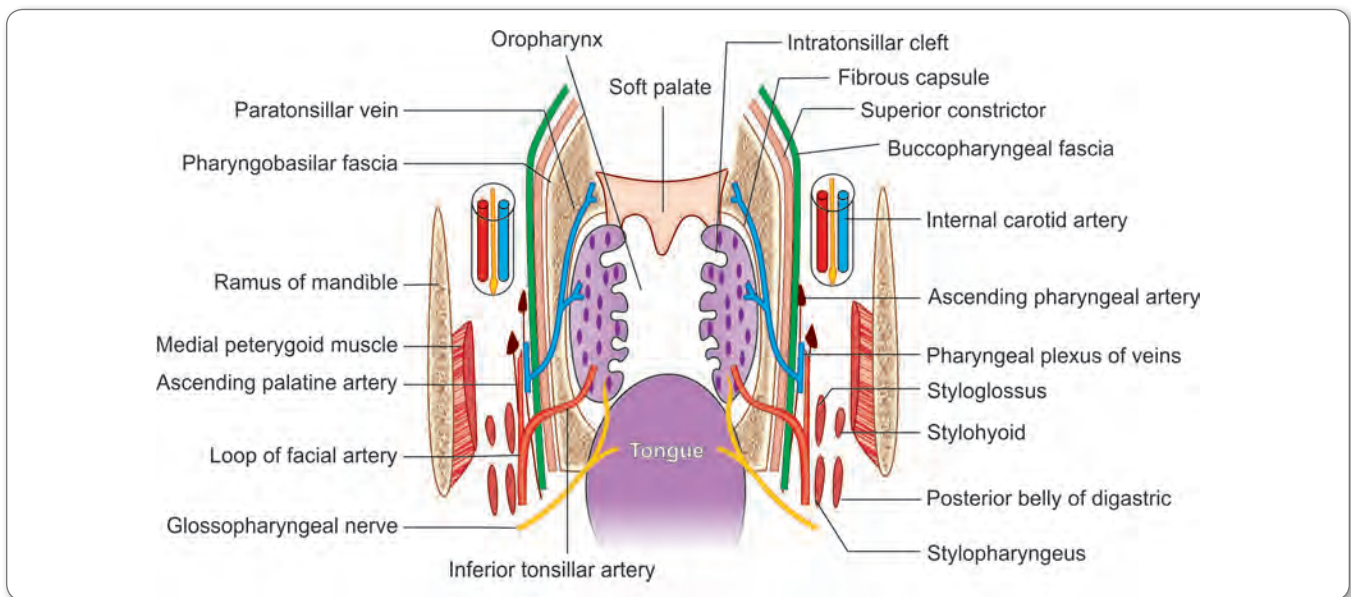


Fig. 101: Relations of palatine tonsil



- Axis of tonsil: Directed above downward and laterally
 - Development—2nd endodermal pouch—ventral component forms tonsillar fossa, whereas tonsil which is collection of lymphocyte—is mesoderm developed from neural crest cells.
 - Situated in oropharynx in an internal between palatoglossus and palatopharyngeal fold
 - Medial surface: Lined by **nonkeratinized stratified squamous epithelium**—provided with 12-15 crypts
 - Lateral surface: Covered with fibrous capsule. And the *structures forming tonsillar bed* are:
 - Pharyngobasilar fascia
 - Superior constrictor
 - Buccopharyngeal fascia
 - Styloglossus
 - Glossopharyngeal nerve
- Between capsule and circular muscles—peritonsillar space contains para tonsillar vein.
Infection of peritonsillar space is known as quinsy.

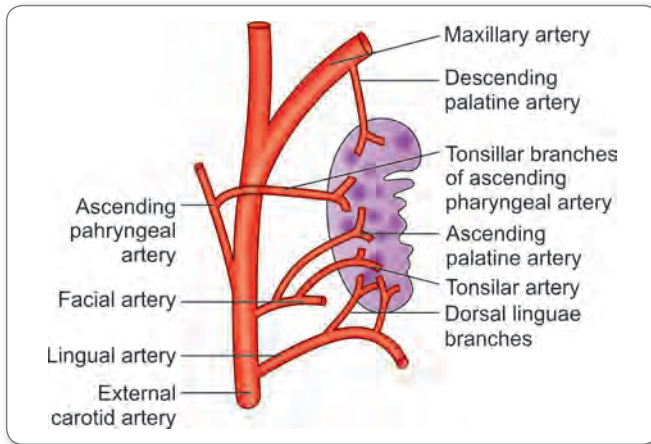


Fig. 102: Blood supply of tonsil

Glossopharyngeal nerve and lesser palatine nerves are nerve supply to the gland.

BLOOD SUPPLY TO TONSIL

- Tonsillar branch of facial artery is the main supply
- Dorsal lingual artery
- Greater palatine artery
- Ascending palatine artery
- Palatine branch of ascending pharyngeal artery.

Lymphatics from palatine tonsil drain into **jugulodigastric node** (**Jugulo-omohyoid** is principal node of tongue).



Clinical Aspect

During tonsillectomy procedures glossopharyngeal nerve is damaged results in loss of general sensation and taste sensation in posterior one-third of tongue, difficulty in swallowing.

Severe hemorrhages may occur due to the injury of para tonsillar veins or branches of facial artery, ascending pharyngeal artery or lingual artery.

NERVES OF HEAD AND NECK

CRANIAL NERVES

I. Olfactory Nerve

Functional Components

- Special somatic afferent

Features

- Consists of approximately 20 unmyelinated fibers which arise from neurons in the upper one-third of nasal mucosa and mediate sense of smell
- Pass through the foramina in the cribriform plate of ethmoid and end in olfactory bulb
- Project into cortex without relay into thalamus
- Project directly to forebrain (Only CN to enter cerebrum directly)
- Olfactory neurons are only neurons, which are continuously replaced from stem cell.
- Olfactory path is unique as they have ipsilateral projection to cortex.



Clinical Aspect

Ethmoidal bone fracture results in lesion of olfactory nerve and causes anosmia and also CSF rhinorrhea.

II. Optic Nerve

Functional Components

- Special somatic afferent for vision
- Afferents for papillary light reflex and accommodation reflex.

Peculiarities

- Covered by three meninges
- Devoid of neurolemma sheath and endoneurium
- Optic nerve cannot regenerate if damaged
- It is not peripheral nerve because, nerve is developed from stalk of optic vesicle; prolongation of white matter.

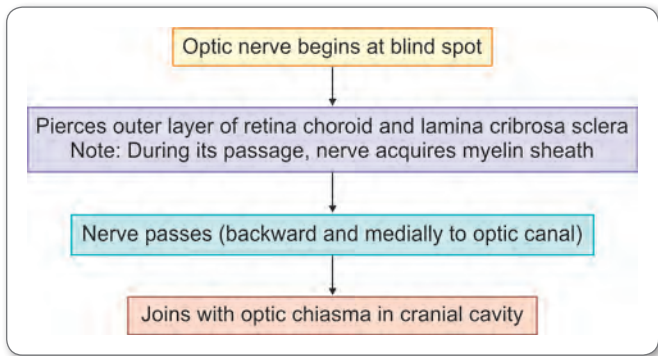
Measurements 3-5 cm

It can be divided into four parts:

- Intraocular part—1 mm
- Intraorbital part—2 to 3 mm
- Intracanalicular part—4 to 10 mm
- Intracranial part—1 cm



Course



Clinical Aspect

- Lesion of optic nerve as seen in optic neuritis result in blindness and no pupillary light reflex in the affected eye.
- Lesion of optic chiasma occur in pituitary tumor results in bitemporal hemianopia.
- Lesion of optic tract produces contralateral homonymous hemianopia.

III. Oculomotor Nerve

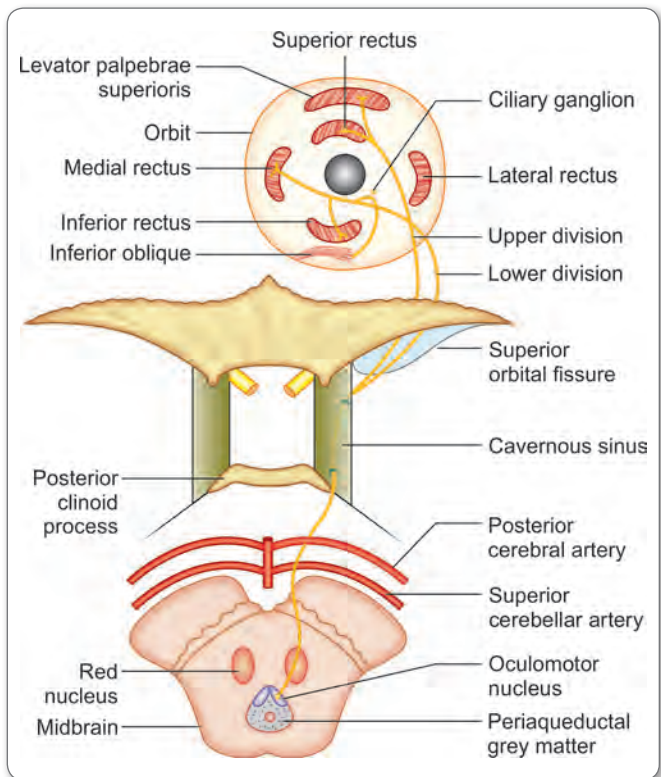


Fig. 103: Oculomotor Nerve

Functional Components

- General somatic efferent: Supplies extraocular muscles
- General visceral efferent—preganglionic visceral efferent—preganglionic parasympathetic fibers located in Edinger Westphal nucleus that supply the ciliary ganglion for constriction of pupil and accommodation.

Course

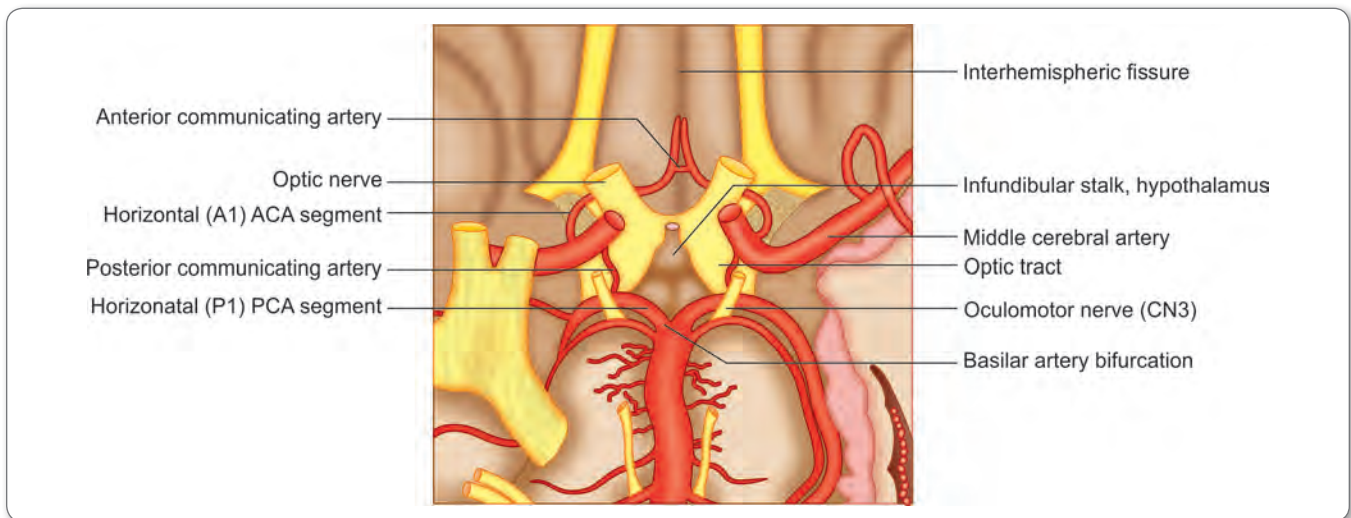
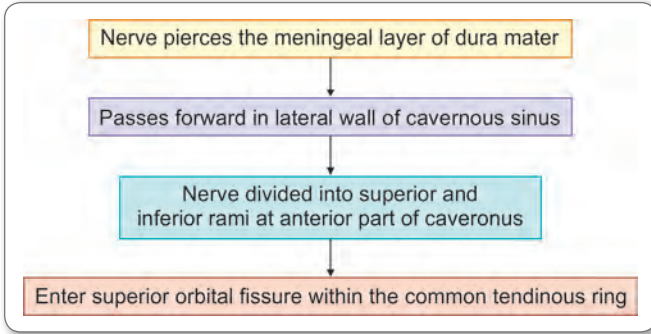


Fig. 104: Infundibular stalk hypothalamus



- Oculomotor nerve arise from midbrain at the level of superior colliculi
- Pass between posterior cerebral artery and superior cerebellar artery
- So, aneurysms of these arteries involve oculomotor nerve
- Runs on the lateral side of posterior communicating artery and reach the cavernous sinus.

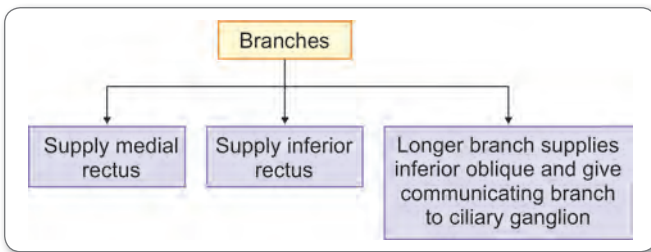


Branches

- Superior ramus supplies the superior rectus and levator palpebrae superioris
- Inferior ramus divides into three branches.

Superior Rectus

- Supplied by contralateral oculomotor nerve
- Right oculomotor nucleus gives fibres which cross midline and join the left oculomotor nerve and supplies left superior rectus muscle
- Left oculomotor nucleus gives fibres which cross midline and join the right oculomotor nerve and supplies right superior rectus muscle.



IV. Trochlear Nerve

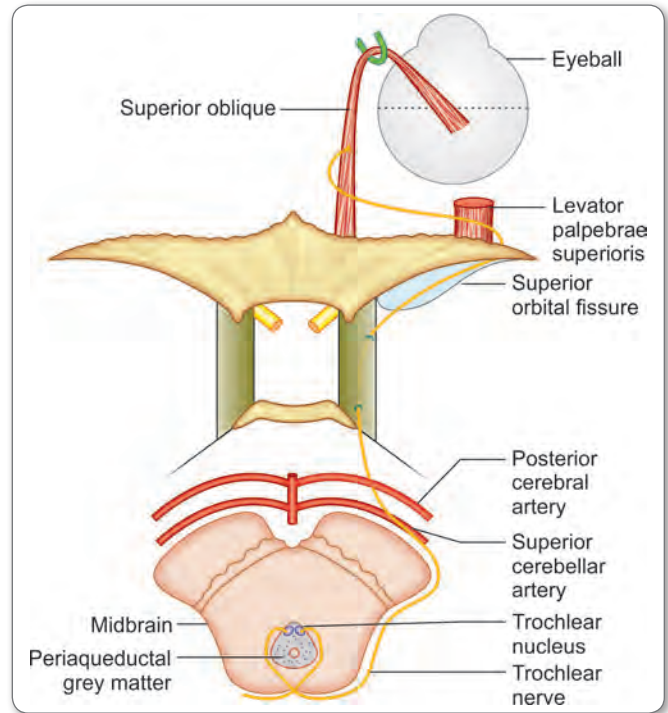


Fig. 105: Trochlear nerve

Functional Components

- General somatic efferent: Supplies superior oblique
 - General somatic afferent: Proprioceptive fibers from superior oblique to mesencephalic nucleus of trigeminal.
 - Left trochlear nucleus arise from mid brain at the level of inferior colliculus and gives axons which decussate within the brain stem and became the right trochlear nerve and exit from dorsal side.
 - Passes through lateral wall of cavernous sinus and enters orbit through superior orbital fissure
 - Motor fibers supply the superior oblique
- Features—(listed in cranial nerve facts tabular column)
- Lesion of left trochlear nucleus results in paralysis of right superior oblique muscle.

HIGH YIELD POINTS

Cranial Nerve Facts

Facts	Cranial nerves
Cranial nerve which enters the cerebrum directly	Olfactory nerve
Cranial nerve with longest intracranial (sub arachnoid) course	Trochlear nerve
Smallest nerve in terms of axons it contains	Trochlear nerve
Cranial nerve which emerges from posterior aspect	Trochlear nerve
Cranial nerve with dorsal exit	Trochlear nerve
Only nerve decussate before innervating the target	Trochlear nerve
Cranial nerve which is largest	Trigeminal nerve



Cranial nerve with longest extracranial course	Vagus nerve
Cranial nerve with longest interosseous course	Facial nerve
Cranial nerve with longest intradural course	Abducent nerve
Cranial nerve involved in raised intracranial pressure	Abducent nerve
Cranial nerve passing through cavernous sinus	Abducent nerve
Cranial nerve related to lateral wall of cavernous sinus	III, IV, and ophthalmic nerve

V. Abducent Nerve

Functional Components

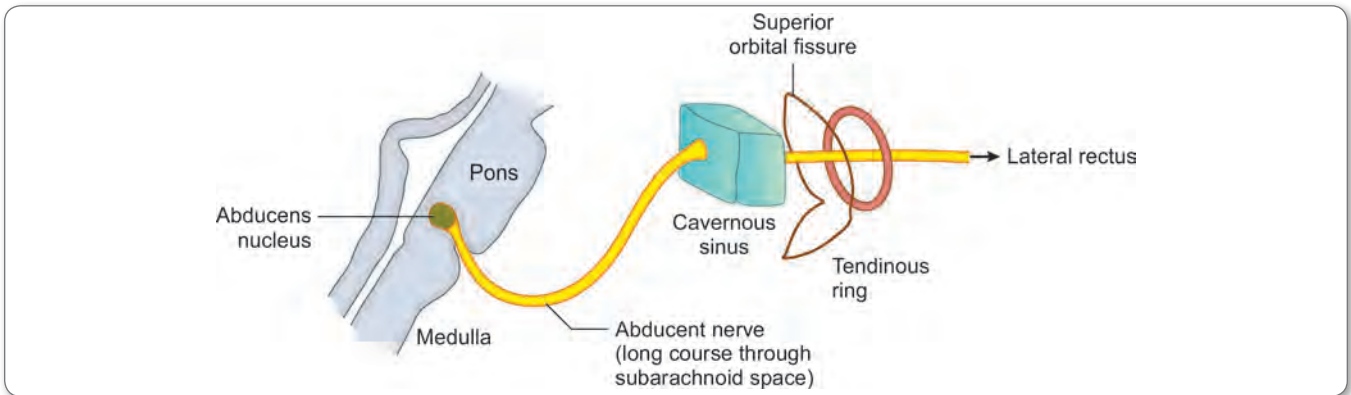


Fig. 106: Abducent Nerve

- General somatic efferent: Supplies lateral rectus.
- General somatic afferent: Proprioceptive impulse to mesencephalic nucleus of trigeminal nerve.
- Arises from abducens nucleus of caudal pons leave the brain at pontomedullary junction.
- Exists from brain stem from inferior pontine sulcus
- Passes through Dorello's canal and cavernous sinus inferolateral to internal carotid artery to enter the orbit via superior orbital fissure.
- Pierce the dura relatively early in the intra cranial course because of this abducent is having longest intradural course.

HIGH YIELD POINTS

Dorello's canal

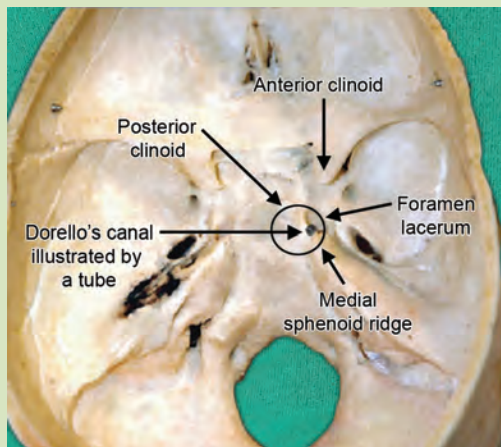


Fig. 107: Dorello's canal

- Found close to petrous apex, below the Gruber's ligament (petrosphenoidal) between petrous apex and clivus
- Contents—6th cranial nerve and inferior petrosal sinus.

Clinical Aspect

Features of Nerve Injuries

3rd nerve injury features	4th nerve injury features	6th nerve injury features
<ul style="list-style-type: none"> • Loss of pupillary reflex • Loss of light reflex • Dilatation of pupil (mydriasis) • Loss of accommodation • Ptosis due to levator palpebrae superioris paralysis • Eye—down and out (due to unopposed action of superior oblique and lateral rectus) • Upward gaze and adduction not possible 	<ul style="list-style-type: none"> • Vertical Diplopia on looking down (vertical on looking down) • Contralateral Head tilting to compensate for extorsion 	<ul style="list-style-type: none"> • Eye—full adducted • Due to unopposed action of medial rectus • Lateral gaze not possible



3rd Nerve Injury Image

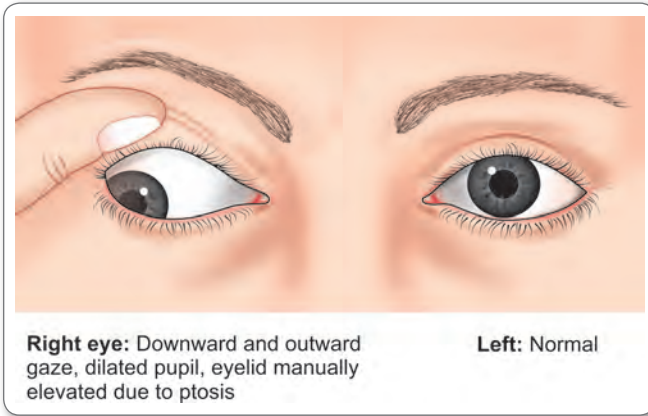


Fig. 108: Illrd nerve injury

4th Nerve Injury Image



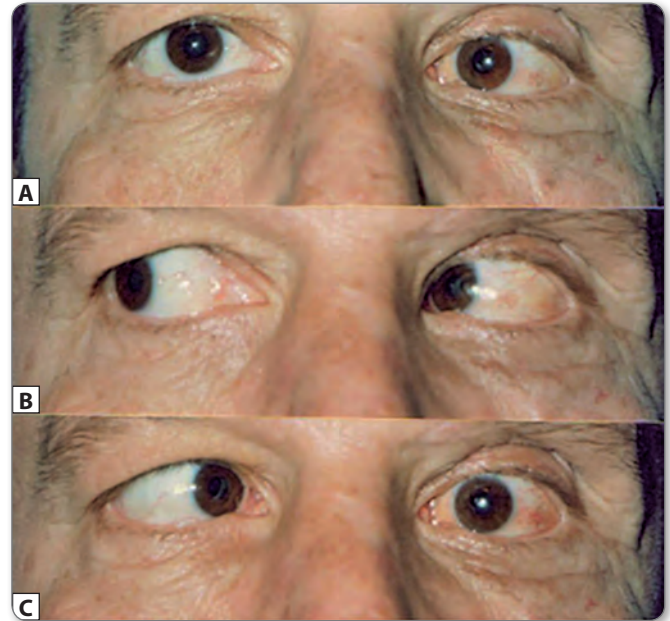
Fig. 109: IV nerve injury

Compensatory Contralateral Head Tilt—for Extorsion in Superior Oblique Palsy



Fig. 110: Compensatory contralateral head tilt

6th Nerve Injury



Figs 111A to C: Nerve injury

VI. Trigeminal Nerve

Functional Components

- Sensory root conveys exteroceptive and proprioceptive sensation.
- Motor root conveys supply 1st arch derivative muscles
- So, trigeminal is a mixed nerve

Nucleus

Three sensory and motor

- Chief sensory nucleus in pons
- Mesencephalic nucleus in mid brain
- Spinal nucleus of trigeminal nerve—in medulla
- 1 motor nucleus of trigeminal nerve—in pons.

Trigeminal Ganglion

- Semilunar ganglion
- Gasserian ganglion
- Corresponds with dorsal root ganglion of spinal nerve
- Contains cells bodies pseudounipolar neurons
- Located in Meckel's cave: Cavum trigeminale
- Mandibular nerve is a mixed nerve containing sensory root from ganglion and motor root from pons.

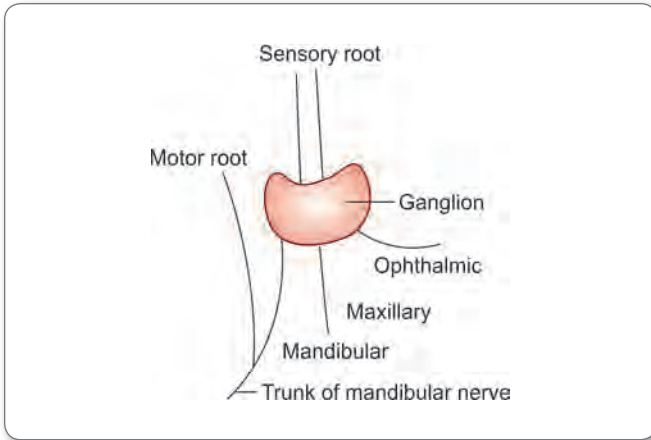
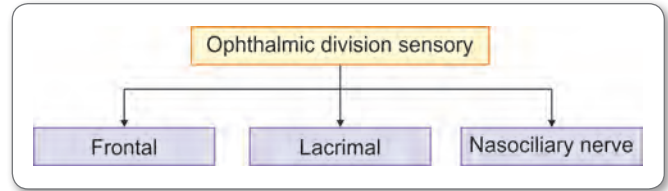


Fig. 112: Trigeminal ganglion



Lacrimal

- Enters the orbit through superior orbital fissure
- Carries postganglionic, parasympathetic secretomotor fibers to lacrimal gland.

Frontal

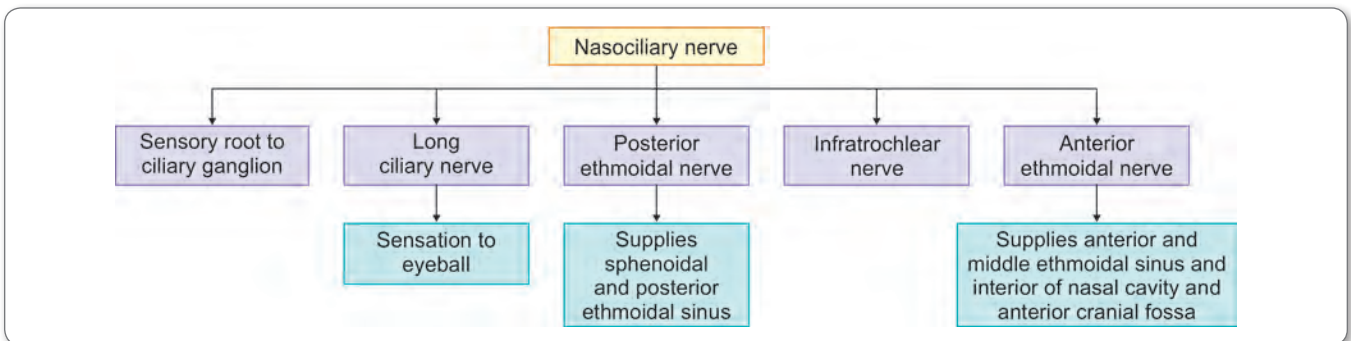
- Enters the orbit through superior orbital fissure
- Runs superior to levator palpebrae superioris
- Divides into Supratrochlear and Supraorbital

Nasociliary Nerve

- Sensory nerve and enters the orbit through superior orbital fissure within the common tendinous ring
- Give rise to the following 5 branches

Ophthalmic Nerve

Enters the orbit through superior orbital fissure and divides into three branches.



Maxillary Nerve–Sensory Nerve

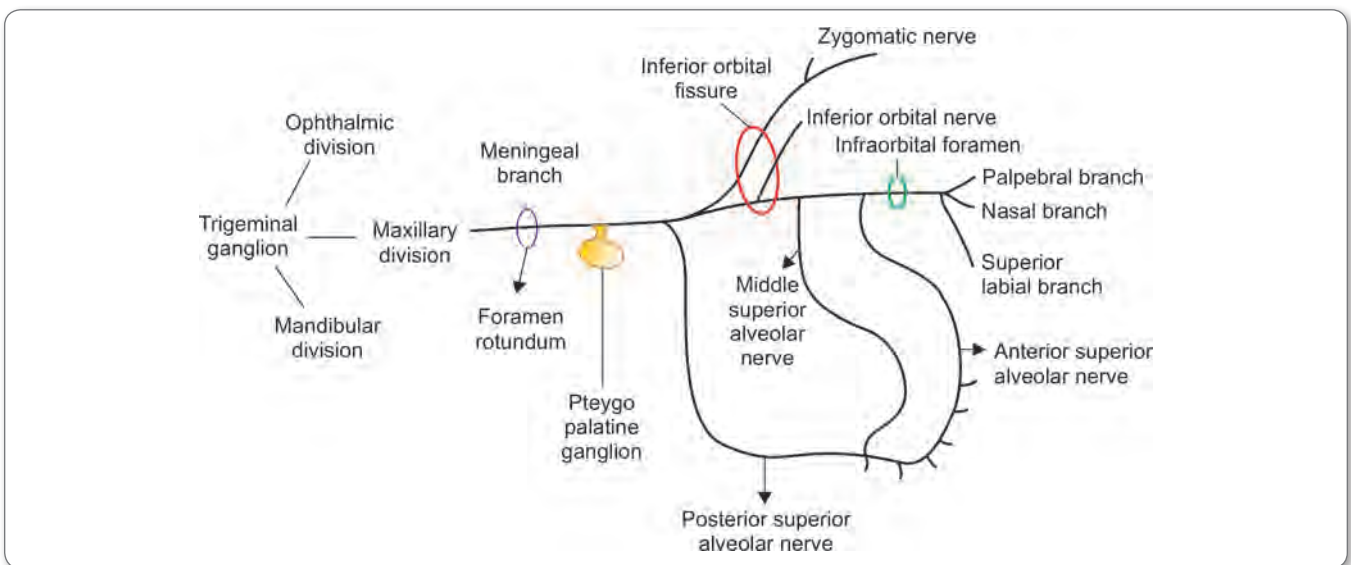


Fig. 113: Maxillary nerve



- Passes through the lateral wall of cavernous sinus and enters pterygopalatine fossa
- Then it leaves the cranial cavity through foramen rotundum.

Branches

- Meningeal branch: Innervates middle cranial fossa.
- Communicating branch to pterygopalatine ganglion.
- **Posterior superior alveolar nerve** supplies upper molar tooth and maxillary sinus.
- Zygomatic nerve enters the orbit through inferior orbital fissure and divides into zygomaticotemporal and zygomaticofacial nerve and supplies the skin over the temple region and zygomatic region. Conveys postganglionic parasympathetic fibers to lacrimal gland.
- Infraorbital nerve enters the orbit through inferior orbital fissure and runs through infraorbital groove and canal. It gives **middle superior alveolar** (supplies upper premolar and maxillary

sinus) and **anterior superior alveolar** (supplies **upper incisor and canine** teeth and maxillary sinus).

- Infraorbital nerves emerge through infraorbital foramen and divides into **palpebral, nasal and labial branch**.
- Branches via pterygopalatine ganglion
 - Orbital branch
- Pharyngeal branch
 - Posterior superior lateral nasal branch
 - Greater palatine nerve
 - Lesser palatine nerve
 - Nasopalatine nerve

Mandibular Nerve

- Mandibular nerve is formed by sensory root and motor root
- Motor root derived from pons
- Sensory root derived from trigeminal ganglion
- Both roots pass through foramen ovale and join together to form trunk of the mandibular nerve.

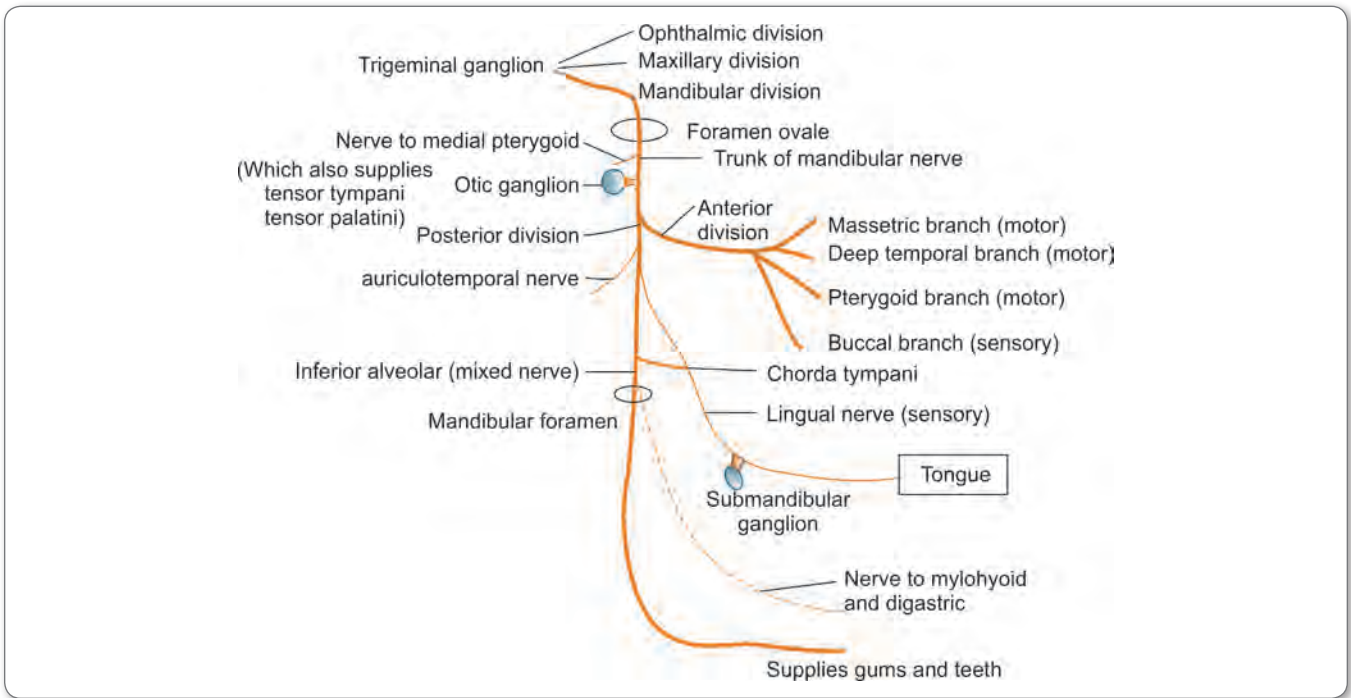


Fig. 114: Branches of mandibular nerve

Branches

- **Branches from the trunk**
 - Meningeal branch: (Nervi spinosum) passes through foramen spinosum
 - Nerve to medial pterygoid supplies medial pterygoid and also tensor veli palatine and tensor tympani
- Trunk is divided into anterior and posterior division
- **Branches from anterior trunk**
 - Muscular branch to temporalis, masseter and lateral pterygoid and
 - One sensory branch buccal nerve pierces the buccinator (but does not supply the muscle) and supplies the skin and fascia on the buccinator

- **Branches from the posterior division**
 - **Lingual nerve:** Sensory nerve receives chorda tympani nerve, carries taste sensation from anterior two-thirds of tongue (facial nerve branch – carries preganglionic parasympathetic fibers to submandibular gland and sublingual gland), lingual nerve carries general sensation from anterior two-thirds of tongue crosses lateral to styloglossus and hyoglossus and pass deep to mylohyoid muscle and descends lateral to loop of submandibular duct [Remember: **T**ympani for **T**aste and (lin) **G**ual for **G**eneral sensation]
 - Auriculotemporal nerve: Sensory branch to skin of the scalp and auricle and carries postganglionic parasympathetic fibers to parotid gland.



- Inferior alveolar nerve – **mixed nerve**
 - Passes through **mandibular foramen**
 - Sensory supply to the **lower jaw**
 - Gives nerve to **mylohyoid (motor branch)** pierces the sphenomandibular ligament and supplies mylohyoid and anterior belly of digastric.



Clinical Aspect

JAW JERK – MASSETER REFLEX

Afferent—mandibular (trigeminal nerve) to mesencephalic nucleus of trigeminal then reach motor nucleus of trigeminal in pons.

Efferent—motor fibers carried by trigeminal mandibular nerve – innervates masseter which elevates mandible.

Frey's Syndrome

- Some penetrating wound of parotid gland damages auriculo-temporal nerve and great auricular nerve.
- During the process of regeneration, auriculotemporal nerve joins with great auricular nerve
- So, when the patient eats, beads of perspiration appear on the skin covering the parotid

Lesions of Nerve

- Lesion of trigeminal nerve causes sensory loss on the face and weakness of muscles of mastication
- Lesions of lingual nerve results in loss of general sensation in anterior two-thirds of tongue and loss of secretion from submandibular and sub lingual salivary gland
- Lesion of ophthalmic nerve cannot mediate the afferent limb of corneal reflex
- Lesion of maxillary nerve cannot mediate the afferent limb of sneeze reflex
- Lesion of mandibular nerve associated with loss of both afferent and efferent limb for jaw jerk.

List of functional components in facial nerve:

- **Special visceral efferent** supplies muscles of second pharyngeal arch
- **General visceral efferent**—secretomotor to submandibular gland, sublingual gland, lacrimal gland, palatal glands and nasal glands.
- **General somatic afferent**: Sensory supply to external ear
- **Special visceral afferent**: Taste sensation to anterior 2/3rd of tongue.
- Facial nerve consists of **large motor root** which carries SVE fibers to supply the muscles of facial expression and **nerve intermedius** which carries sensory, secretory and parasympathetic fibres (contain SVA fibers for taste sensation and GVE fibers for lacrimal, submandibular, sublingual, nasal and palatal glands).

Note

Hitzelberger's sign—involvement of sensory component of facial nerve leads to anaesthesia over the posterosuperior part of external meatus/canal

- Both roots joined together and form the trunk of facial nerve in the internal acoustic meatus and forms geniculate ganglion.
- Make a course in the middle ear
- And then emerges through stylomastoid foramen
- Enters the parotid and divided into two terminal branches temporo-facial and cervicofacial branches
- Temporo-facial divided into temporal and zygomatic branches
- Cervicofacial divided into buccal, marginal mandibular and cervical branches.

Branches

- Greater petrosal nerve arise from geniculate ganglion
- Contains preganglionic parasympathetic fibers destined to pterygopalatine ganglion
- Joins with deep petrosal nerve and forms nerve to pterygoid canal
- Stapedial nerve: Supplies stapedius muscle
- Chorda tympani nerve
 - Exists the skull through petrotympanic fissure and joins with lingual nerve in the infratemporal fossa
 - Carries preganglionic parasympathetic fibers destined to submandibular ganglion
 - Conveys taste sensation to anterior two-thirds of tongue
- Muscular branches to posterior belly of digastric and stylohyoid
- Communicating branch joins the auricular branch of vagus and glossopharyngeal nerve to supply the GSA fibers to external ear
- Posterior auricular nerve supplies occipitalis muscle
- Terminal branches supply the muscles of facial expressions

VII. Facial Nerve

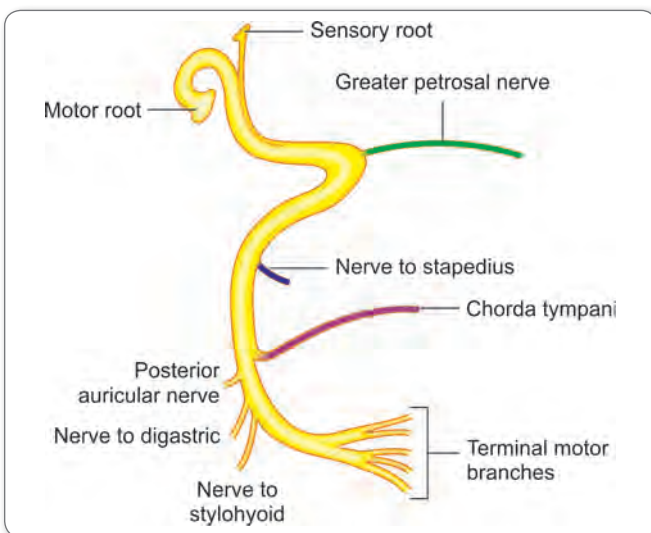


Fig. 115: Facial nerve

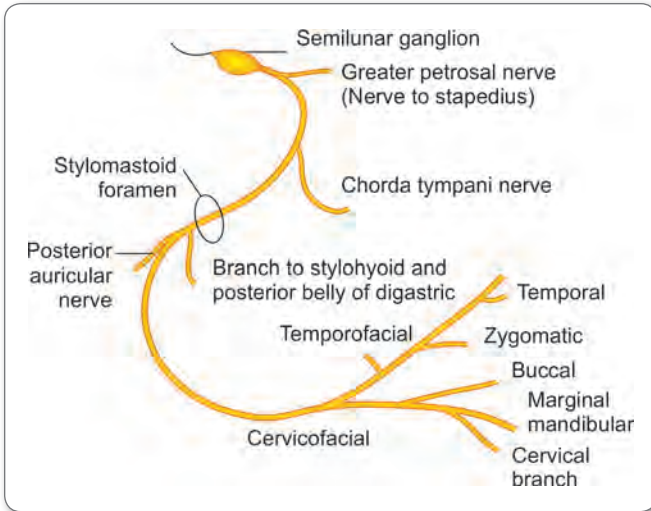


Fig. 116: Branches of facial nerve

- Greater petrosal nerve + Deep petrosal nerve ↓ Nerve of pterygoid canal—carries secretomotor fibers to lacrimal, nasal, palatal and pharyngeal gland. If this is damaged, loss of lacrimation occurs.
- Nerve to stapedius supplies stapedius muscle if this nerve is damaged, loss of stapedial reflex occurs.
- Chorda tympani is responsible for taste sensation from anterior two-thirds tongue and preganglionic parasympathetic fibers to submandibular ganglion. Nerve paralysis—loss of salivation and loss of taste sensation from anterior two-thirds.
- Terminal branch—supplies muscles of facial expression. Nerve paralysis: Paralysis of muscles of facial expression.

Clinical Aspect

<p>Lesion at geniculate ganglion</p> <ul style="list-style-type: none"> Loss of lacrimation (Schirmer's test – positive) Loss of stapedial reflex Loss of salivation and taste sensation from anterior 2/3rd tongue Paralysis of facial muscles 	<p>Lesion proximal to chorda tympani</p> <ul style="list-style-type: none"> Loss of salivation and anterior 2/3rd tongue taste sensation. Paralysis of facial muscles.
<p>Lesion distal to geniculate ganglion</p> <ul style="list-style-type: none"> Loss of stapedial reflex Loss of salivation and taste sensation from anterior 2/3rd Paralysis of facial muscles 	<p>Lesion distal to chorda tympani</p> <ul style="list-style-type: none"> Paralysis of facial muscles

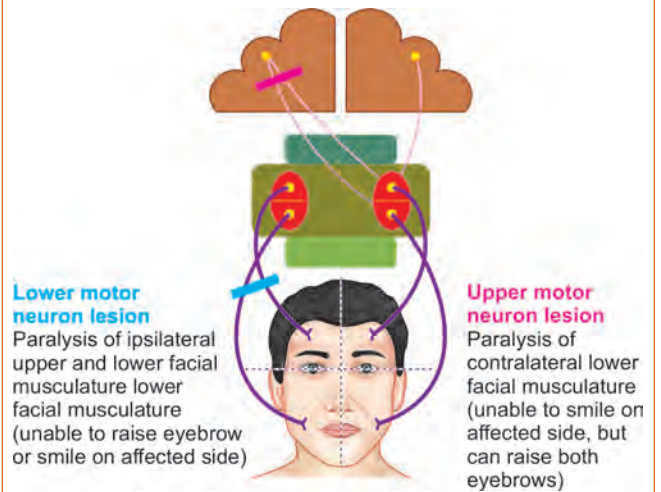
HIGH YIELD POINTS

Petrosal Nerves

- Lesser petrosal nerve branch of glossopharyngeal nerve
- Greater petrosal nerve branch of facial nerve
- Deep petrosal nerve branch of plexus around internal carotid artery.
- Deep petrosal nerve joins with greater petrosal nerve forms **nerve to pterygoid canal**, which passes through pterygoid canal and joins with pterygopalatine ganglion.

Clinical Aspect

- In UMN type of facial nerve palsy—contralateral lower-half of face affected (because ipsilateral cortex supplies the upper part of nucleus, so upper part of face is not affected)
- In LMN type of facial nerve palsy—ipsilateral half of the face affected



Bell palsy—lower motor neuron palsy of facial nerve—ipsilateral half of the face affected

- Paralysis of facial muscles on the affected side due to lesion of facial nerve
- Palsy manifests as:
 - Inability to wrinkle the forehead
 - Drooping of the eyebrow
 - Inability to close eyelids
 - Inability to smile, laugh
 - Palsy causes decreased lacrimation
 - Painful sensitivity to sounds
 - Loss of taste sensation in the anterior two-thirds of tongue.

Crocodile Tears

Gustatory lacrimation

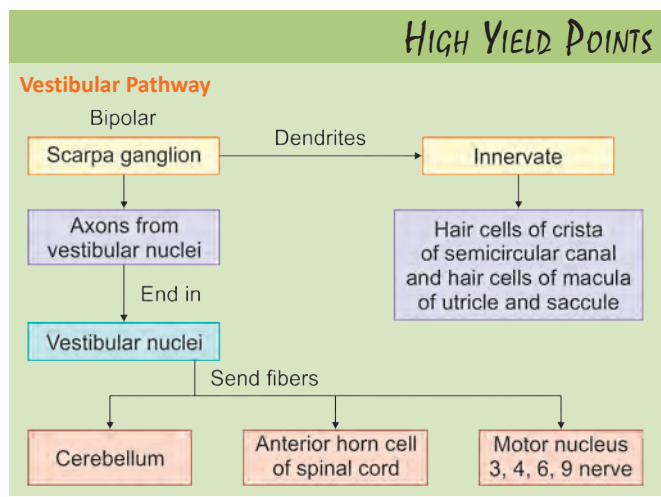
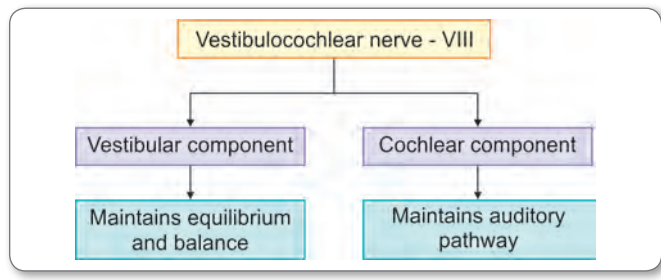
When the facial nerve gets injured before geniculate ganglion, during the regeneration fibres which destined to go chorda tympani interconnect with greater petrosal nerve. So patient have lacrimation along with salivation while eating.

VIII. Vestibulocochlear Nerve

- Functional component—special somatic afferent
- Pure sensory nerve



- Passes through internal acoustic meatus
- Auditory pathway (explained in neuroanatomy)



Branches

- Tympanic branch—Jacobson’s nerve, which supplies sensory fibers via tympanic tube.
- Its secretomotor fibers run through lesser petrosal nerve to otic ganglion
- The postganglionic fibers from ganglion supplies parotid gland via auriculotemporal nerve
- Carotid branch (**nerve of Herring**) branch to carotid sinus and body
- Stylopharyngeus branch
- Pharyngeal branch—form pharyngeal plexus
- Tonsillar branch supplies the mucous membrane of tonsil, fauces and palate
- Lingual branch supplies post one-third tongue and also carries taste sensation.

Gag reflex

- Afferent—touch posterior 1/3rd of tongue—glossopharyngeal nerve
- Efferent—reflex contraction of pharyngeal constrictors and palate—vagus.

Clinical Aspect

- Loss of general sensations in pharynx, tonsils, fauces and posterior one-third of tongue.
- Loss of taste sensation in posterior one-third of tongue.
- Loss of gag reflex.
- Hypersensitivity of carotid sinus and carotid body.
- Difficulty in swallowing.

IX. Glossopharyngeal Nerve

Clinical Aspect

Lesion of glossopharyngeal nerve leads to decreased secretion from parotid gland.

Functional Components

- **Special visceral efferent** forms nucleus ambiguus with X, XI nerve (Branchial arch)—to supply **stylopharyngeus**.
- **General visceral efferent** inferior salivatory: Parasympathetic secretomotor to parotid.
- **Special visceral afferent**: Nucleus tractus solitarius taste pathway—taste from posterior 1/3rd of tongue.
- **General visceral afferent**: Lower part of nucleus tractus solitarius—sensory from carotid sinus and carotid body.
- **General somatic afferent**: Spinal nucleus of trigeminal—general sensation from posterior 1/3rd of tongue, oropharynx, middle ear.

Course and Distribution

- Arises from medulla posterior to olive as three – four rootlets
- The rootlets fuse to form trunk and leaves the cranial cavity through jugular foramen
- Nerve passes downward and forwards between internal carotid artery and internal jugular vein
- Runs inferolaterally looping around the lateral aspect of stylopharyngeus which it supplies
- Runs deep to hyoglossus to terminate into lingual branches.

X. Vagus Nerve

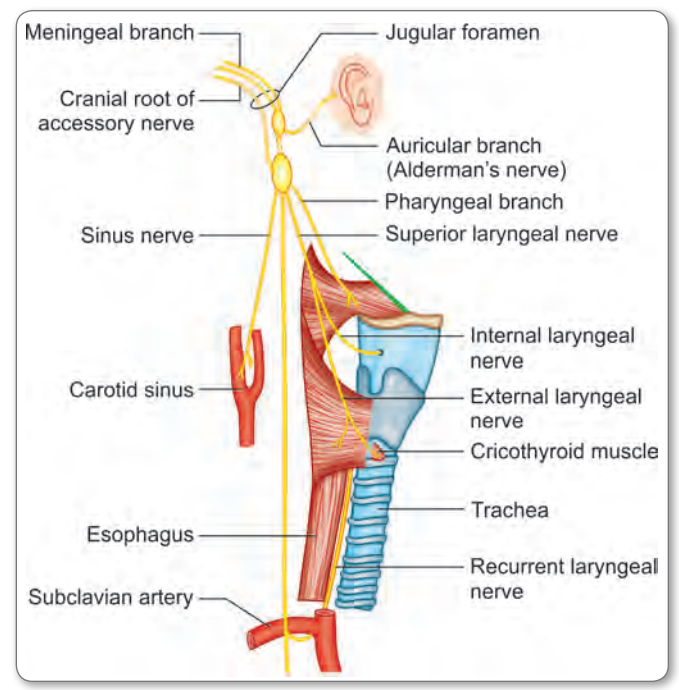
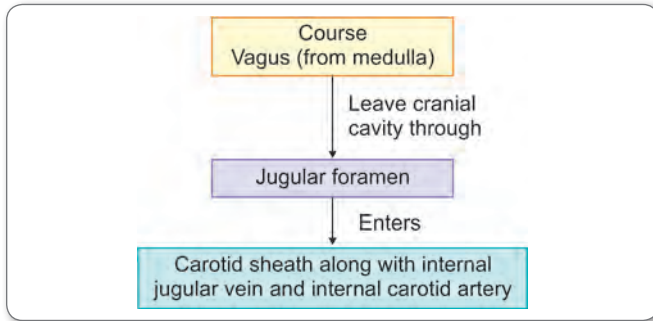


Fig. 117: Vagus nerve



Functional Component

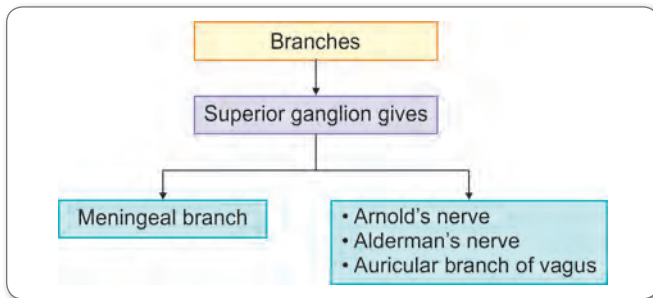
- Special visceral efferent—nucleus ambiguus—motor to muscles of palate, pharynx, esophagus striated muscle and larynx
- General visceral efferent dorsal nucleus of vagus preganglionic parasympathetic fibers to glands, smooth muscle in pharynx, larynx, thoracic and abdominal viscera
- General visceral afferent nucleus tractus solitarius (lower part)—sensory from thoracic, abdominal viscera, baroreceptor and chemo receptor
- Special visceral afferent nucleus tractus solitarius (upper part)—Taste
- General somatic afferent—to trigeminal sensory nucleus – general sensation from pharynx, larynx, trachea, esophagus, part of auricle, external auditory meatus.



Course and Distribution

- Vagus nerve arises from medulla posterior to olive
- Leaves the cranial cavity through jugular foramen
- Cranial root of accessory joins with vagus just below jugular foramen
- Nerve passes vertically downward in the carotid sheath lying between internal carotid artery and internal jugular vein
- At the root of neck on the right side it enters the thorax by crossing in front of right subclavian artery and on the left side by passing between left common carotid and left subclavian artery.

Branches



Inferior Ganglion Branch

- Pharyngeal branch forms pharyngeal plexus
- Carotid branch for carotid body
- Superior laryngeal nerve divides into external and internal laryngeal nerve

External laryngeal	Internal laryngeal
Supplies cricothyroid	Sensory supply to larynx above vocal fold

External laryngeal nerve closely related to superior thyroid artery and supplies cricothyroid muscle

Internal laryngeal nerve pierces the thyrohyoid membrane along with superior laryngeal artery and provide sensory supply of larynx above the vocal cord internal laryngeal nerve anastomoses with ascending branch from recurrent laryngeal nerve called Galen's anastomosis.

Recurrent Laryngeal Nerve

Inferior branch of vagus is recurrent laryngeal nerve
Course is different in right and left side.

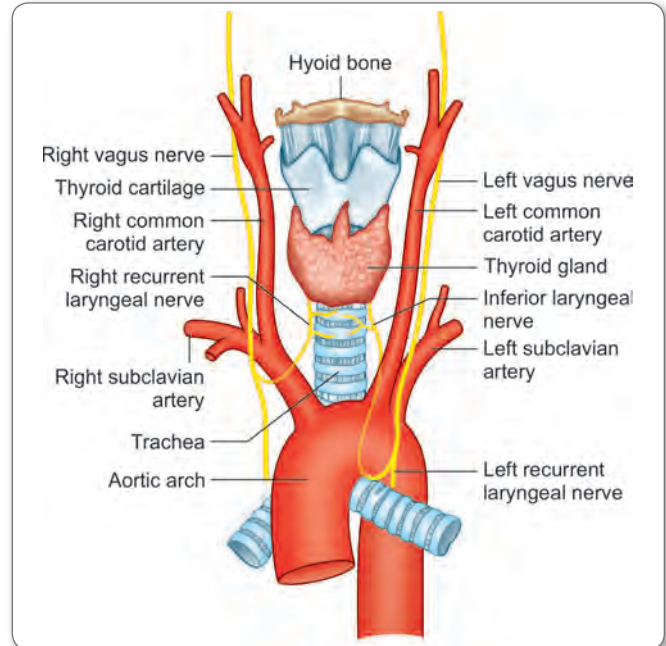


Fig. 118: Recurrent Laryngeal Nerve

Right recurrent laryngeal nerve	Left recurrent laryngeal nerve
Wind around 1st part subclavian artery	Wind around arch of aorta

- Right recurrent laryngeal nerve lies between the branches of inferior thyroid either anterior or posterior to inferior thyroid artery.
- Left recurrent laryngeal nerve loops around the arch of aorta and ascends in the tracheoesophageal groove lies posterior to inferior thyroid artery
- Left recurrent laryngeal nerve has longer course in the neck and more prone to injury as compared to right side.

Note

- So, in **thyroid surgeries** most prone to injure is **right recurrent laryngeal nerve** than left
- **Mediastinal pathologies** affect only the **left recurrent laryngeal nerve not right** (left-wind around the arch of aorta —arch of aorta presents in superior mediastinum)



- **Ortner's syndrome**—mitral stenosis leads to **left atrial enlargement** which compress left recurrent laryngeal nerve

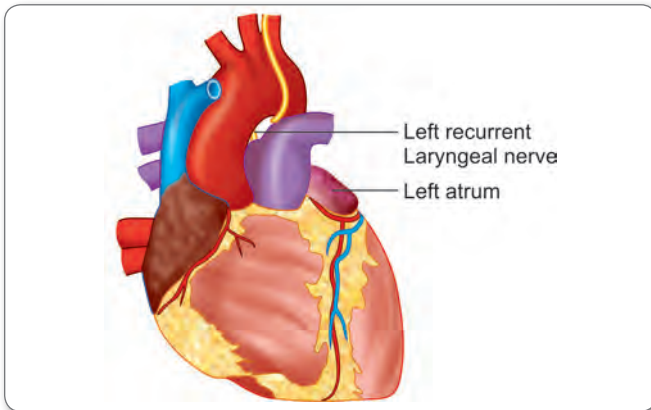


Fig. 119: Ortner's syndrome—recurrent laryngeal nerve

- Recurrent laryngeal: Supplies all intrinsic muscles except cricothyroid and sensory supply to larynx below vocal fold.

Cardiac Branches

- Human communicating nerve: Between recurrent and external laryngeal nerve.



Clinical Aspect

- Injury of external laryngeal nerve while ligating superior thyroid artery leads to paralysis of cricothyroid—so patient not able to tense the vocal cords
- Injury of internal laryngeal nerve (sensory nerve)—leads to paroxysmal nocturnal cough and in turn leads to aspiration

Internal Laryngeal Nerve—Rare to Get Injured of all Nerves

- Injury of recurrent laryngeal nerve while ligating the inferior thyroid artery leads to hoarseness of voice (unilateral lesion) stridor and dyspnea (due to bilateral lesion)

Lesion of vagus produce the following:

- Ipsilateral paralysis of soft palate leading to sagging of palatal arch. The uvula deviates towards the opposite side healthy side
- Ipsilateral paralysis of soft palate, pharynx and larynx leading to dysphonia (hoarseness), dyspnea, dysarthria and dysphagia
- Loss of gag reflex
- Anesthesia of pharynx, larynx leading to loss of cough reflex
- Injury to vagus nerve results in loss of palate elevation and uvula deviates to intact side.

XI. Accessory Nerve

Functional Components

- Cranial root—special visceral efferent—nucleus ambiguus—to muscles of palate, pharynx and cricothyroid
- Spinal root—special visceral root—spinal segments C1 to C5—to sternocleidomastoid, trapezius
- Cranial part arises from medulla and leaves the cranial cavity through jugular foramen

- Spinal part arises from spinal cord and enters the cranial cavity through foramen magnum. And then it joins with cranial part inside the jugular foramen and forms the trunk of accessory nerve

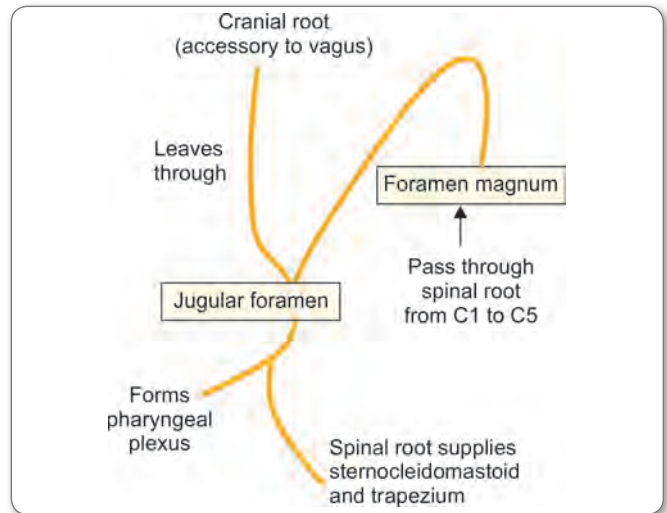


Fig. 120: Accessory nerve

- Then nerve divides into cranial part and spinal part
 - Cranial component joins with vagus ganglion to supply the muscles of pharynx, palate, cricothyroid
 - Spinal component supplies sternocleidomastoid, trapezius.



Clinical Aspect

Lesion of accessory nerve results in:

- Paralysis of muscles of pharynx and palate
- Not able to turn the head to opposite side
- Not able to retract the scapula, not to able to do over head abduction of shoulder joint, not able to elevate the shoulder.

XII. Hypoglossal Nerve (Motor)

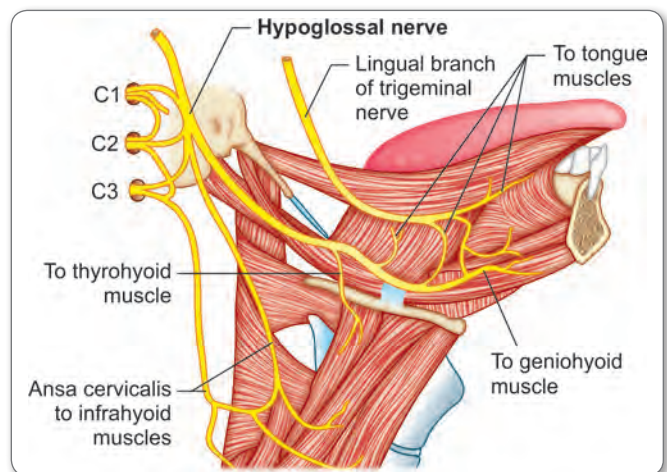


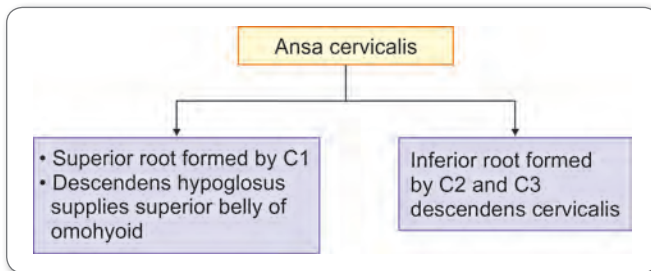
Fig. 121: Hypoglossal nerve



- General somatic efferent hypoglossal nucleus supplies tongue muscles.
- General somatic afferent:
 - Arises from medulla between pyramid and olive
 - Leaves cranial cavity through hypoglossal canal
 - Descends vertically downward between internal carotid and internal jugular vein
 - Finally, it runs forward superficial to internal and external carotid and loop of lingual artery to reach above the hyoid bone
 - Supplies all muscles of extrinsic and intrinsic muscles of tongue.

Ansa Cervicalis

- C1 fibers join with hypoglossal nerve and gives meningeal branch, muscular branch to geniohyoid, thyrohyoid and descendens hypoglossi—superior root ansa cervicalis
- C2, 3 join together and forms inferior root of ansa cervicalis or descendens cervicalis
- Superior and inferior root join together to form ansa cervicalis
- Ansa cervicalis supplies all muscles of infrahyoid muscles



- C₁ fibers supply 2 muscles Geniohyoid and Thyrohyoid (Mn-GT naidu) through hypoglossal nerve
- Ansa cervicalis loop supplies sternohyoid, sternothyroid, omohyoid.



Clinical Aspect

- Hypoglossal nerve injury causes tongue deviation on same side of lesion and larynx deviation to active side of lesion.

SYMPATHETIC TRUNK

- Covered by prevertebral fascia
- Situated behind the carotid sheath
- Contains preganglionic and postganglionic sympathetic fibers, cell bodies of postganglionic sympathetic fibers and visceral afferent fibers with cell bodies in the upper thoracic dorsal root ganglia
- Emits gray rami communicantes but receives no white rami communicantes in the cervical region.

Cervical Sympathetic Ganglia

Three in numbers—superior, middle and inferior.

Superior Ganglia

- Largest ganglia
- Formed by fusion of upper 4 ganglia
- Situated at C2, 3

Branches

- Gray rami communicantes to C1 to C4 and last four cranial nerves
- Plexus around internal and external carotid artery
- Contribution to **pharyngeal plexus**
- Deep petrosal nerve—at foramen lacerum it joins with greater petrosal nerve and form nerve of pterygoid canal
- Contribution to superior cardiac plexus through left superior cardiac plexus
- Contribution to deep cardiac plexus through right superior cervical cardiac branch.

Middle Cervical Ganglia

- Formed by fusion of C5, 6
- Situated opposite to C6
- Middle ganglion connected to inferior by 2 cords, anterior cord forms ansa subclavia around first part of subclavian artery, posterior cord splits to enclose vertebral artery.

Branches

- Gray rami communicantes to C5, 6
- Thyroid branch accompany inferior thyroid artery to supply the gland
- Cardiac branches to deep cardiac plexus.

Inferior Cervical Ganglion

- Formed by fusion of C7, 8
- Joins with T1 ganglion and form stellate ganglion
- Situated between C7 transverse process and first rib neck.

Branches

- Gray rami communicantes to C7, 8
- Cardiac branches to deep cardiac branch
- Vascular branches to subclavian artery
- Vertebral branches form plexus around vertebral artery

Ansa Subclavia

Loop connecting middle and inferior cervical sympathetic ganglia, forming loop around the first part of subclavian artery.



Clinical Aspect

- Stellate ganglion block
- Performed under fluoroscopy by inserting the needle at the level of C6 to avoid injury to pleura although ganglion lies at the level of C7
- Needle is inserted between trachea and carotid sheath through the skin over the anterior tubercle of the transverse process of C6 and then directed medially and inferiorly
- Once needle position close to ganglion is confirmed, local anesthetic is injected.



PARASYMPATHETIC GANGLIA IN HEAD AND NECK

Table 39: Various parasympathetic ganglia

Name of the ganglia	Topographically related	Functionally related	Supplies
Otic	Mandibular nerve	Glossopharyngeal nerve	Parotid gland
Pterygopalatine ganglion	Maxillary nerve	Facial nerve (Greater petrosal nerve)	Lacrimal gland, Nasal, Palatine and Pharyngeal glands.
Submandibular ganglion	Mandibular nerve (Lingual nerve)	Facial (chorda tympani nerve)	Submandibular and sublingual gland
Ciliary ganglion	Ophthalmic division of trigeminal (nasociliary nerve)	Oculomotor nerve	Ciliaris and Sphincter pupillae through parasympathetic root and dilator pupillae through sympathetic root.

BLOOD VESSELS OF HEAD AND NECK

COMMON CAROTID ARTERY

- Right common carotid branch from brachiocephalic trunk and left from arch of aorta
- It terminates into external and internal carotid artery at the upper border of lamina of thyroid or at C3, 4
- Common carotid **enclosed in carotid sheath along with vagus nerve and internal jugular vein**
- Artery is **palpated against the Chassaignac tubercle of C6.**

- Innervated by carotid body branch from glossopharyngeal nerve and vagus nerve.

Carotid Sinus

- Spindle shaped dilatation at the origin of internal carotid artery
- Act as baroreceptor
- Stimulated by change in pressure
- Innervated by carotid sinus branch from glossopharyngeal nerve and vagus nerve.

Receptors

Carotid Body

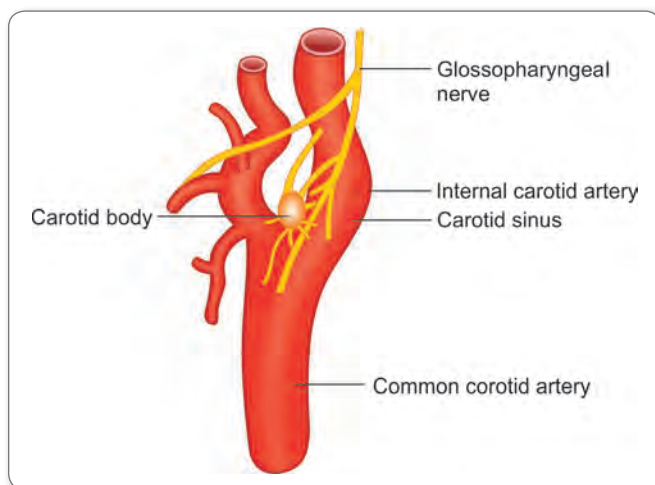


Fig. 122: Common carotid artery

- Oval shaped structure lies at the bifurcation of common carotid artery.
- Act as chemoreceptor.
- Stimulated by chemical changes—lack of oxygen concentration, excess of CO₂, etc.

Clinical Aspect

Carotid Sinus Syncope

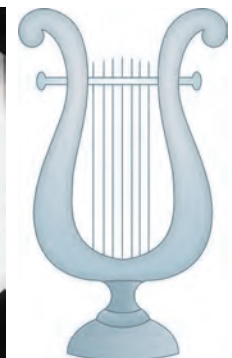
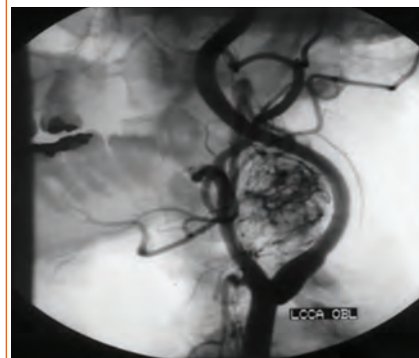
Sudden attacks of syncope and slowing of heart beat observed in hypersensitive sinus called Carotid sinus syncope.

Carotid Body Tumors

Arise from chemoreceptor cells of carotid body and are stimulated by decreased arterial oxygen tension

In the angiogram, showing carotid body tumor between internal and external carotid artery and splaying of internal and external carotid vessel due to tumor in between – lyre sign

Arteriogram showing vascular carotid body tumour between internal and external carotid arteries



INTERNAL CAROTID ARTERY

Explained in neuroanatomy chapter.



EXTERNAL CAROTID ARTERY

- External carotid extends from upper border of lamina of thyroid to neck of mandible
- Branches from the front side
 - Superior thyroid
 - Lingual
 - Facial artery
- Branches from posterior side
 - Occipital artery
 - Posterior auricular artery
- Branches from medial side
 - Ascending pharyngeal artery
- Terminal branches
 - Superficial temporal
 - Maxillary artery

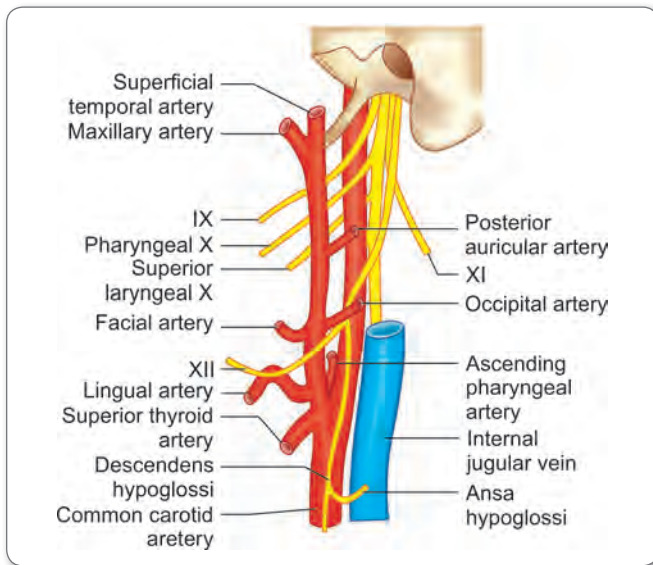
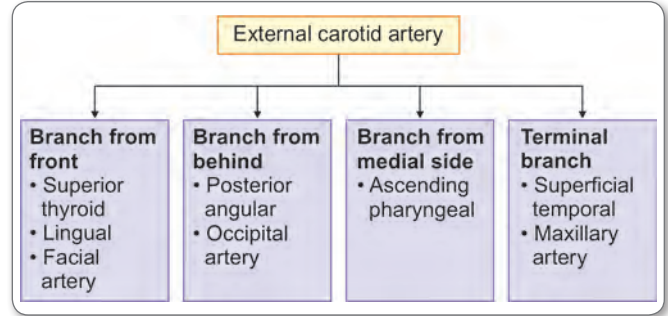


Fig. 123: External carotid artery and its branches

MAXILLARY ARTERY

- Terminal branch of external carotid artery
- Runs deep to neck of mandible and enters the infratemporal fossa
- Divided into three parts by **lateral pterygoid** muscle
 - 1st and 2nd branch accompany mandibular nerve branches
 - 3rd part accompanies maxillary nerve branch
 - 1st and 3rd part branches require bony foramen and 2nd part branches are muscular branches.

Branches from the First Part

- Deep auricular artery
- Anterior tympanic artery
- Middle meningeal artery
- Accessory middle meningeal artery
- Inferior alveolar artery.

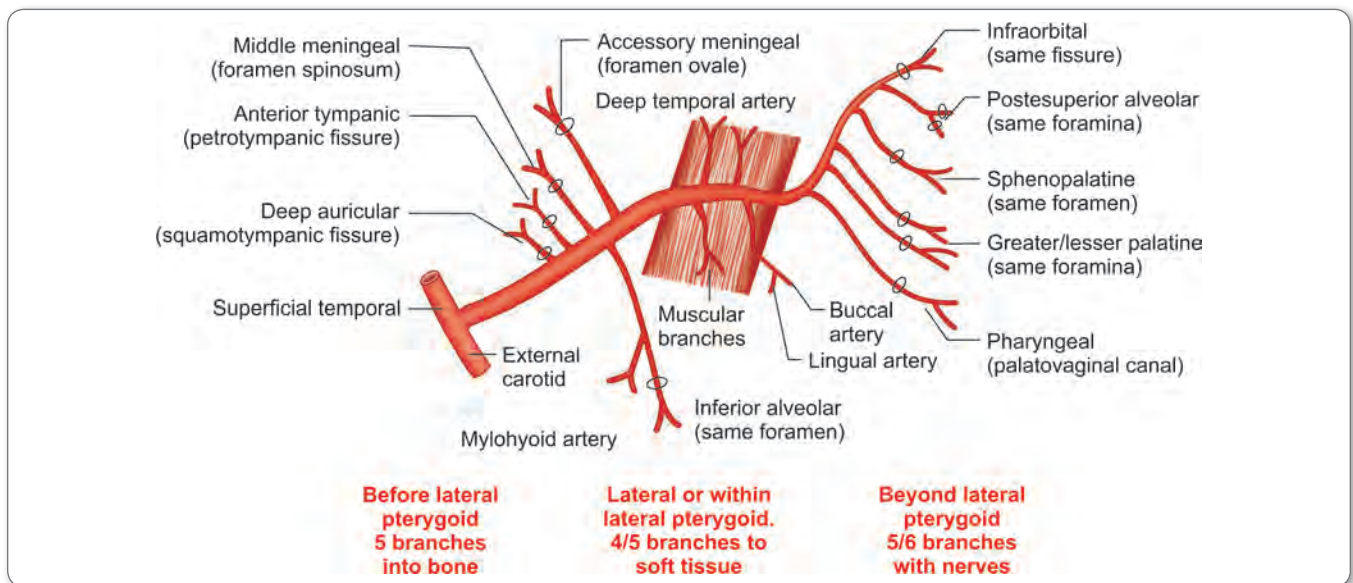


Fig. 124: Branches of maxillary artery



MIDDLE MENINGEAL ARTERY

- Passes through foramen spinosum and runs deep to inner surface of temporal bone
- So fracture of squamous part of temporal bone results in rupture of middle meningeal artery and results in epidural hematoma.

Branches from the Second Part

- Deep temporal artery
- Pterygoid branches
- Masseteric branch
- Buccal branch

Branches from Third Part

- Posterior superior alveolar artery
- Infraorbital artery
- Greater palatine artery
- Pharyngeal artery
- Artery to pterygoid canal
- Sphenopalatine artery

SUBCLAVIAN ARTERY AND ITS BRANCHES

- Branch of brachiocephalic trunk on the right and arch of aorta on the left side
- Divide into three parts by scalene anterior muscle. First part—medial to muscle, second part—lies behind the muscle and third part—passes from lateral margin of the muscle to the outer border of first rib.

Branches from the First Part

- Vertebral artery
 - First part in the neck—passes between scalene anterior and longus colli muscle
 - Second part—passes through foramen transversarium of C6 and ascends up to C1
 - Third part—passes through suboccipital triangle
 - Fourth part—enters the cranial cavity through foramen magnum and joins with the opposite side and form basilar artery
 - Branches: Muscular branches, anterior spinal artery, posterior spinal artery and posterior inferior cerebellar artery
- Thyrocervical trunk: Short trunk from the first part and divides into:
 - Inferior thyroid artery: Supplies thyroid gland and parathyroid gland
 - Transverse cervical artery: Divides into superficial branch and deep branch, dorsal scapular artery, which takes part in scapular anastomosis
 - Suprascapular artery—passes above the suprascapular foramen and takes part in scapular anastomosis (Internal thoracic artery—already explained in thorax chapter)

Branches from Second Part

- Costocervical trunk—divided into following branches:
 - Deep cervical artery
 - Superior intercostal artery—gives first two posterior intercostal arteries

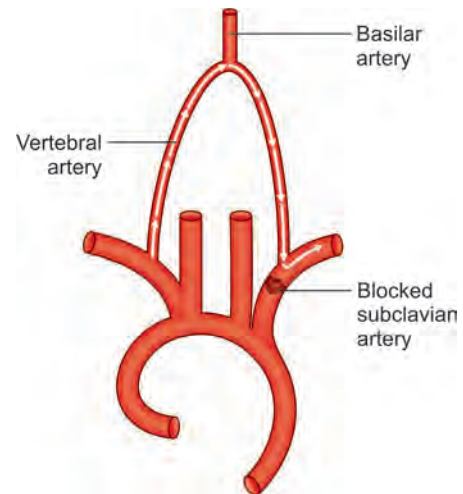
Branches from Third Part

Dorsal scapular arises from third part of subclavian or deep branch of transverse cervical artery takes part in scapular anastomosis.



Clinical Aspect

Subclavian Steel Syndrome



- Embolus in the subclavian artery proximal to the origin of vertebral artery
- Reversal of blood flow from basilar artery and then ipsilateral vertebral artery and then flows in the subclavian artery
- Subclavian artery is stealing the blood from circle of willis, basilar circulation causing vertebro basilar insufficiency
- Symptoms are dizziness, ataxia, vertigo, visual disturbance, motor deficit, confusion, syncope.

VEINS

Internal Jugular Vein

- Sigmoid sinus pass through posterior compartment of jugular foramen and continue as internal jugular vein
- Passes through along with carotid vessels and vagus nerve which are enclosed in carotid sheath.

Tributaries (and figure Refer the Chart, Veins)

- Inferior petrosal sinus—1st tributary
- Common facial vein
- Lingual vein
- Pharyngeal vein



- Superior thyroid vein
- Middle thyroid vein
- Thoracic duct—last tributary on left side
- Right lymphatic duct—last tributary on right side.

External Jugular Vein

Formed by union of posterior auricular vein and posterior division of retromandibular vein and drains into subclavian vein.

Tributaries

- Anterior jugular vein
- Posterior external jugular vein
- Suprascapular vein
- Transverse cervical vein

LYMPHATICS OF HEAD AND NECK

- 450 lymph nodes are present in the body, out of which 60–70 nodes are present in head and neck
- All lymphatics from head and neck drain directly or indirectly to **deep cervical nodes**.
- Deep cervical nodes
- Arranged along internal jugular vein under the cover of sternocleidomastoid
- Deep nodes divided into upper and lower group by intermediate tendon of omohyoid.

UPPER GROUP–JUGULODIGASTRIC

- Situated in the triangular area between digastric, facial vein and internal jugular vein

- Principal node of **palatine tonsil**
- Efferent drain into lower deep cervical nodes.

LOWER GROUP–JUGULO-OMOHYOID

- Lies on internal jugular vein above the intermediate tendon of omohyoid
- Principal node of **tongue**
- Lower group extend into supra clavicular triangle as supraclavicular lymph nodes.

Superficial Group

Lies superficial to sternocleidomastoid.

Submental Nodes

- 3 or 4 situated on mylohyoid muscles
- Afferent: From tip of tongue, floor of mouth, central part of lower lip
- Efferent: Submandibular nodes or jugulo-omohyoid.

Submandibular Nodes

- Situated in **digastric triangle** in contact with submandibular gland.
- Afferent: Center of forehead, medial angle of eye, side of nose, cheek and upper lip, angle of mouth, lateral part of lower lip, anterior two-third of tongue, frontal, maxillary and ethmoidal sinus.
- Efferent: Jugulo-omohyoid or jugulodigastric nodes.



Chapter at a Glance

- All the muscles of palate are supplied by pharyngeal plexus except tensor veli palatini (supplied by direct branch from mandibular trunk)
- All the muscles of tongue are supplied by hypoglossal nerve except palatoglossus which is supplied by pharyngeal plexus
- All the muscles of pharynx are supplied by pharyngeal plexus except stylopharyngeus which is supplied by glossopharyngeal nerve
- All the muscles of larynx are supplied by recurrent laryngeal nerve except cricothyroid which is supplied by external laryngeal nerve
- All the muscles of mastication are supplied by anterior branch of mandibular nerve except medial pterygoid which is supplied by direct branch from the trunk of the mandibular nerve
- Muscles of facial expression supplied by facial nerve
- Cervical plexus formed by C1,2,3. Superficial branches include great auricular, transverse cervical, supraclavicular and lesser occipital. Deep branches phrenic nerve and ansa cervicalis
- **Lesser petrosal nerve** branch of glossopharyngeal nerve
- **Greater petrosal nerve** branch of facial nerve
- **Deep petrosal nerve** branch of plexus around internal carotid artery
- Deep petrosal nerve joins with greater petrosal nerve forms **nerve to pterygoid canal** which passes through pterygoid canal and joins with pterygopalatine ganglion
- Vidian nerve passes through pterygoid canal
- Safety muscle of larynx: Posterior cricoarytenoid
- Safety muscle of tongue: Genioglossus
- Depression of mandible by lateral pterygoid and elevation by temporalis, masseter and medial pterygoid
- C3 – Hyoid bone
- C4 – bifurcation of common carotid artery
- C4-5 – Thyroid cartilage
- C6 –
 - ✓ Cricoid cartilage,
 - ✓ Junction between larynx and trachea
 - ✓ Pharynx and esophagus,
 - ✓ Anterior tubercle of the transverse process of C6 vertebra against which carotid artery is compressed,
 - ✓ Location of superior parathyroid
 - ✓ Location of ansa cervicalis
 - ✓ Middle cervical ganglion of sympathetic trunk located
- Carotid sheath—anterior wall—pretracheal fascia, posterior layer—prevertebral fascia
- False capsule of parotid gland—derived from investing layer of deep cervical fascia
- Stylomandibular ligament which extends angle of mandible and separates parotid gland from submandibular gland—modification of deep lamella of false capsule of parotid.
- False capsule of thyroid gland—derived from pretracheal fascia
- False capsule of thyroid thickened on posterior side to form ligament of berry
- Valve of Hasner—present in lower opening of nasolacrimal duct
- Submandibular duct—**Wharton's duct**—opens in the floor of mouth on a sublingual papilla
- Sublingual duct—duct of **Rivinus** opens separately in the floor of mouth on the sublingual fold
- Duct of Bartholin—some part of sublingual duct joins with submandibular duct and forms Bartholin duct
- **Stensen's duct**—**parotid duct**—opens in the upper second molar teeth.
- Suboccipital triangle
 - ✓ Superomedially—rectus capitis posterior major
 - ✓ Superolaterally: Oblique capitis superior
 - ✓ Inferiorly: Oblique capitis inferior
 - ✓ Roof: Greater occipital nerve and occipital artery
 - ✓ Floor: Posterior arch of atlas and posterior atlanto occipital membrane
 - ✓ Contents—third part of vertebral artery, suboccipital nerve (first cervical nerve) and suboccipital plexus of veins
- Scaleno—vertebral triangle
 - ✓ Medially—oblique part of longus colli
 - ✓ Laterally—scalenus anterior muscle
 - ✓ Apex—transverse process of C6 vertebra
 - ✓ Base—first part of subclavian artery
 - ✓ Posterior wall—transverse process of C7, ventral rami of C8, neck of first rib, cupola of pleura
 - ✓ Contents—first part of vertebral artery, cervical part of sympathetic trunk,
- Structures passing through sinus of Morgagni
 - ✓ Auditory tube
 - ✓ Levator veli palatini
 - ✓ Ascending palatine artery
 - ✓ Palatine branch of ascending pharyngeal artery
- Structures passing between superior and middle constrictor
 - ✓ Glossopharyngeal nerve
 - ✓ Stylopharyngeus muscle
- Structures pass between middle and inferior constrictor
 - ✓ Internal laryngeal nerve
 - ✓ Superior laryngeal vessels



- Structures pass below inferior constrictor
 - ✓ Recurrent laryngeal nerve
 - ✓ Inferior laryngeal vessels
- Scalenus anterior divides the subclavian artery into three parts
- Lateral pterygoid divides the maxillary artery into three parts
- Hyoglossus separates lingual artery into three parts
- Joint between malleus and incus—saddle
- Joint between incus and stapes—ball and socket
- All the ossicles formed at birth

Hybrid Muscles in the Head and Neck

- Digastric
 - ✓ Posterior belly—facial nerve
 - ✓ Anterior belly nerve to mylohyoid

- Sternocleidomastoid
 - ✓ Spinal root of accessory nerve
 - ✓ Ventral rami of C2 and C3
- Inferior constrictor of the pharynx
 - ✓ External laryngeal nerve
 - ✓ Recurrent laryngeal nerve
 - ✓ Pharyngeal plexus.
- Trapezius
 - ✓ Spinal root of accessory nerve
 - ✓ Ventral rami of C2 and C3
- Transverse arytenoids
 - ✓ Recurrent laryngeal nerve
 - ✓ Internal laryngeal nerve



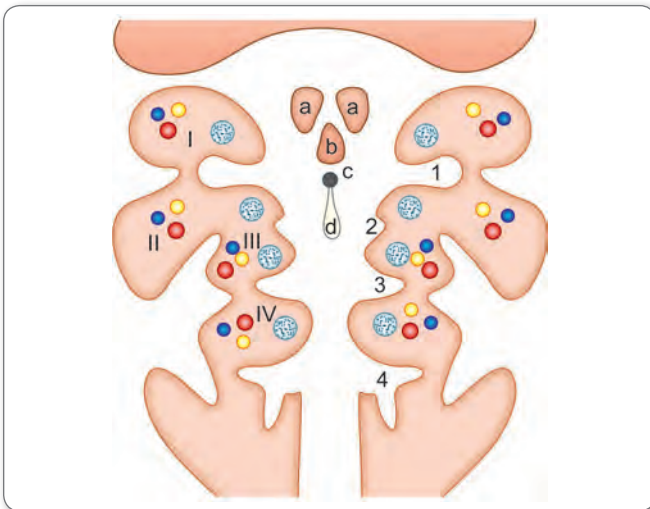
Multiple Choice Questions

1. Development of heart is formed from which of the following marked area
(AIIMS Nov 2017)



- a. a
- b. b
- c. c
- d. d

2. Different endodermal pouches are marked as 1,2,3,4. Identify the pouches involved in DiGeorge syndrome
(AIIMS May 2017)

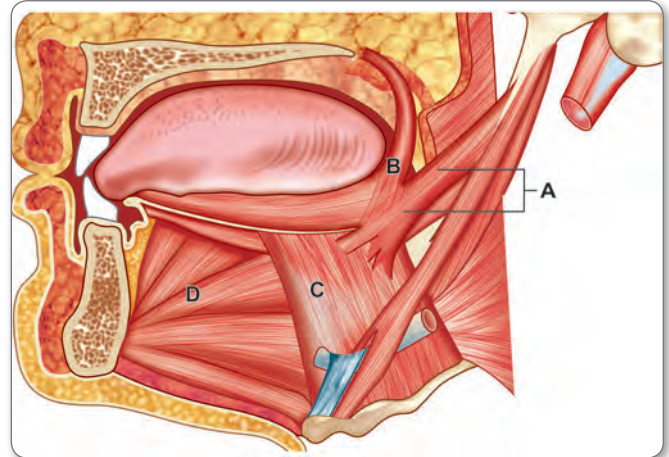


- a. 1
- b. 2
- c. 3
- d. 4

3. True regarding thymus is
(JIPMER May 2015)

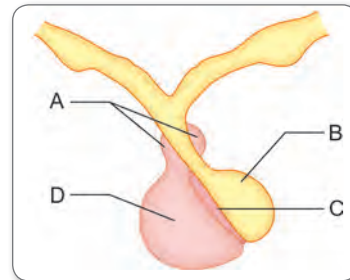
- a. Develops from fourth pharyngeal pouch
- b. Increase in size with increasing age
- c. It's ectodermal in origin
- d. Descends anterior to brachiocephalic vein

4. Identify the tongue muscle not develop from somites



- a. A
- b. B
- c. C
- d. D

5. Structure develops from neuro ectoderm



- a. A
- b. B
- c. C
- d. D

6. Maxillary prominence develops in:
(DNB 2002)

- a. 1st Pharyngeal arch
- b. 1st pharyngeal groove
- c. 1st pharyngeal pouch
- d. 1st Pharyngeal membrane

7. Which of the following muscles supplied by mandibular nerve?
(AI 2002)

- a. Levator veli palatini
- b. Buccinator
- c. Tensor veli palate
- d. Posterior belly of digastric

8. Thymus is developed from:
(DNB 2009)

- a. 4th pouch
- b. 2nd pouch
- c. 3rd pouch
- d. 6th pouch

9. Which of the following is derived from the cartilage of third arch?
(DNB 2008)

- a. Styloid process
- b. Malleus
- c. Incus
- d. Greater cornu of hyoid bone

10. Bone not present at birth:
(AI 2005)

- a. Malleus
- b. Stapes
- c. Incus
- d. Petrous temporal



11. All the muscles are derived from the pharyngeal arches except: (AI 2012)
- Tensor tympani
 - Levator palpebrae superioris
 - Palatine tensor
 - Orbicularis oculi
12. All the following are derived from the pharyngeal arches, except: (AI 2012)
- Tensor tympani
 - Palatine tonsils
 - Mylohyoid
 - Tensor veli palatini
13. Parafollicular cells develop from: (AIIMS 1996)
- Ultimo – brachial body
 - Pharyngeal pouch 4
 - Pharyngeal pouch 3
 - Neural crest cells
14. Which is correct about the development of tonsil: (Recent Question 2013)
- Derivative of 1st pharyngeal pouch
 - Develops from second pharyngeal pouch
 - Develops from 3rd pharyngeal pouch
 - Derivative of neural crest
15. Tongue develops from all, except: (AIIMS 1998)
- Tuberculum impar
 - Hypo branchial eminence
 - Second arch
 - Lingual swellings
16. External ear canal developed from:
- First branchial pouch
 - Second branchial pouch
 - First ectodermal cleft
 - Second ectodermal cleft
17. Midline cleft upper lip due to failure of fusion between:
- Maxillary process
 - Medial nasal process
 - Medial and lateral nasal process
 - Medial nasal process and maxillary process

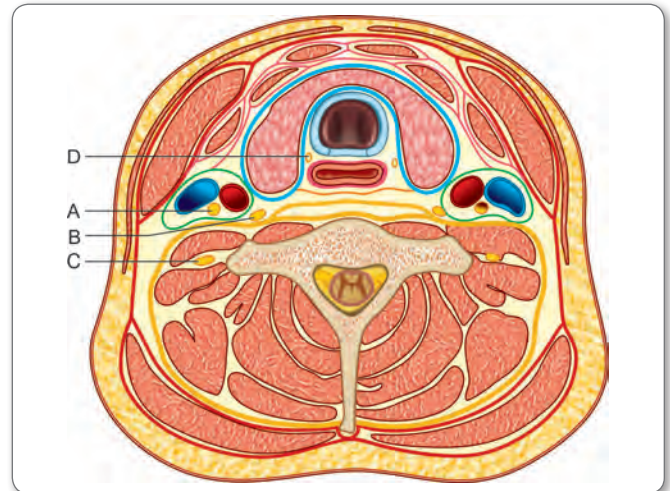
Scalp and Face

18. The layer of scalp which is vascular: (DNB 2009)
- Skin
 - Pericranium
 - Aponeurosis
 - Subcutaneous tissue
19. All the following are true about diploic veins, except: (DNB 2011)
- Present in cranial bones
 - Lined by single layer of endothelium supported by elastic tissue
 - Valveless/thin walled
 - Develop by 8th week IUL
20. Tissue expander in scalp is placed between: (DNB 2016)
- Skin and galea
 - Subcutaneous tissue and loose areolar layer
 - Aponeurotic and periosteum
 - Areolar tissue and bone
21. Nerve supply of scalp: (PGI 2004, 2007)
- Auriculotemporal nerve
 - Zygomatic nerve
 - Occipital nerve
 - Infra trochlear nerve
 - Frontal nerve
22. Buccinator muscle is pierced by: (DNB 2008)
- Facial nerve
 - Wharton s duct
 - Parotid duct
 - Trigeminal nerve
23. Structure which is a close relation to the lower third molar is: (DNB 2009)
- Lingual nerve
 - Inferior alveolar nerve
 - Facial nerve
 - Alveolar vein

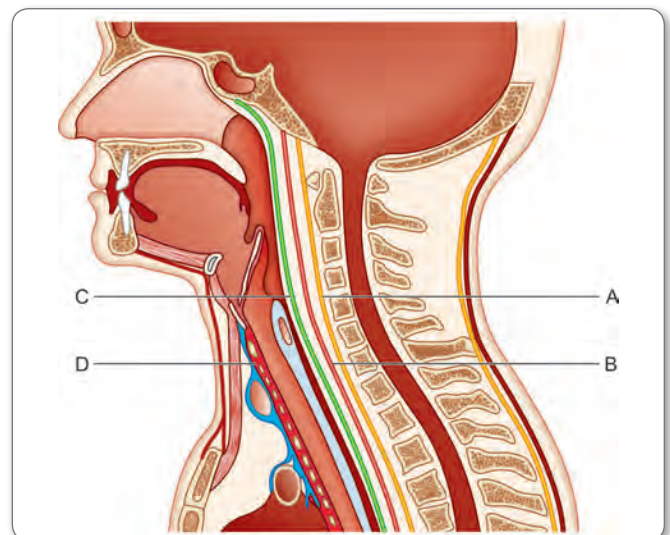
24. The subcutaneous muscle extending from clavicle to mandible: (DNB 2006)
- Platysma
 - Sternocleidomastoid
 - Omohyoid
 - Sternohyoid

Neck

25. Identify the vagus nerve in the following diagram (AIIMS 2015)



- A
 - B
 - C
 - D
26. All are true about cervical fascia except
- Prevertebral fascia contributes to axillary sheath and carotid sheath
 - Ligament of berry derived from pretracheal layer
 - Prevertebral fascia forms the roof of posterior triangle
 - Ansa cervicalis embedded in the anterior wall of carotid sheath
27. Below is the pictorial representation of spaces of neck enclosed by cervical fascia. The spaces are marked as A, B, C, D. dangerous area of neck is marked by (AIIMS Nov 2016)



- A
- B
- C
- D



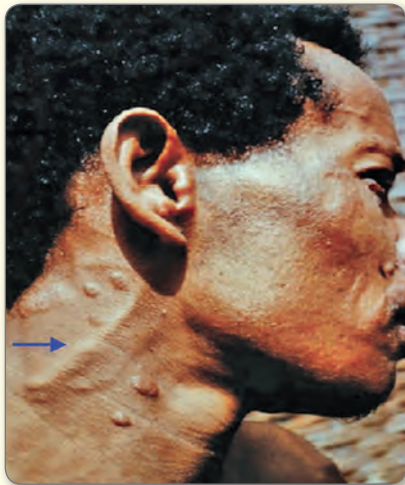
28. On both sides submental triangle is bounded by: (DNB 2003)

- a. Hyoid bone
- b. Anterior digastric
- c. Posterior digastric
- d. Mylohyoid

29. Floor of digastric is formed by: (DNB 2003)

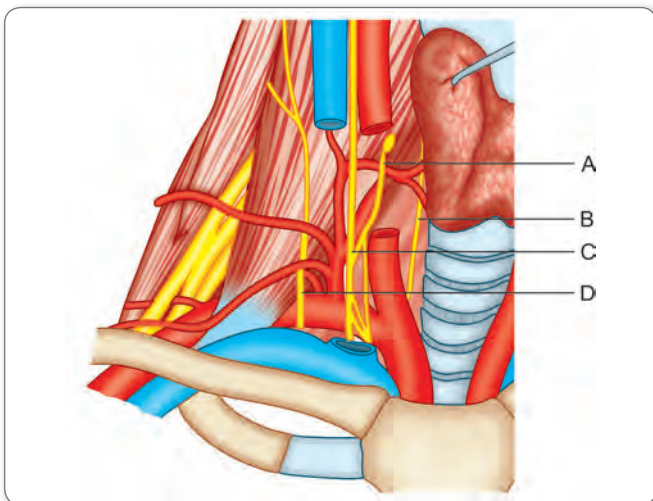
- a. Digastric anterior belly
- b. Digastric posterior belly
- c. Mylohyoid
- d. Stylohyoid

30. Which nerve is thickened in the following image of patient with Hansen's disease (Recent Question 2018)



- a. Supra trochlear
- b. Transverse cervical
- c. Supra clavicular
- d. Great auricular nerve

31. In the figure below, different nerves are marked by labelled arrows. Paralysis of thoracoabdominal diaphragm results due to injury to nerve marked (AIIMS May 2016)



- a. A
- b. B
- c. C
- d. D

32. Structure superficial to mylohyoid in anterior digastric triangle: (DNB 1999)

- a. Deep part of submandibular gland
- b. Hypoglossal nerve
- c. Part of parotid gland
- d. Mylohyoid artery and nerve

33. Hypoglossal nerve is related to: (PGI 1999)

- a. Digastric triangle
- b. Carotid triangle
- c. Both
- d. None

34. Posterior boundary of carotid triangle: (DNB 1999)

- a. Superior belly of omohyoid
- b. Posterior belly of digastric
- c. Sternohyoid
- d. Sternocleidomastoid

35. All are suprahyoid muscles, except: (DNB 1998)

- a. Mylohyoid
- b. Geniohyoid
- c. Omohyoid
- d. Digastric

36. Which of the supra hyoid muscle is supplied by both facial and mandibular nerve: (Recent Question 2014)

- a. Stylohyoid
- b. Mylohyoid
- c. Digastrics
- d. Hyoglossus

37. Fascia around nerve bundle of brachial plexus is derived from: (AIIMS Nov. 2008, May 2001)

- a. Prevertebral fascia
- b. Pretracheal fascia
- c. Investing layer
- d. Superficial cervical fascia

38. True about sternocleidomastoid: (PGI Dec. 2007)

- a. Arises from sternum and clavicle
- b. Turns face to opposite side
- c. Shortened in congenital torticollis
- d. Supplied by cranial part of accessory
- e. Supplied by occipital artery

39. Sternocleidomastoid is supplied by all, except: (AIIMS Nov. 2012)

- a. Occipital
- b. Posterior auricular artery
- c. Superior thyroid artery
- d. Thyrocervical trunk

40. After surgery on right side of neck, a person cannot raise his arm above the head and also not able to shrug the shoulder, what are the possible causes: (PGI May 2013)

- a. Damage to spinal accessory nerve
- b. Paralysis of trapezius muscle
- c. Injury to axillary nerve
- d. Paralysis of latissimus dorsi
- e. Paralysis of deltoid muscle

Dural Venous Sinuses

41. All are paired venous sinuses, except: (Recent Question 2014)

- a. Superior petrosal
- b. Inferior petrosal
- c. Superior sagittal
- d. Transverse

42. The great vein of Galen drains into the: (DNB 2002)

- a. Straight sinus
- b. Inferior sagittal sinus
- c. IJV
- d. EJV

43. Which is a direct content of cavernous sinus? (DNB 2004)

- a. Ophthalmic division of trigeminal vein
- b. Trochlear nerve
- c. Abducent nerve
- d. Oculomotor nerve

44. All of the following structures are in the lateral wall of cavernous sinus, except: (DNB 2006)

- a. Oculomotor
- b. Trochlear
- c. Trigeminal
- d. Ophthalmic



45. Which of the following is not a tributary of the cavernous sinus? (AI 2008)

- a. Superficial middle cerebral vein
- b. Superior petrosal sinus
- c. Inferior ophthalmic vein
- d. Deep middle cerebral vein

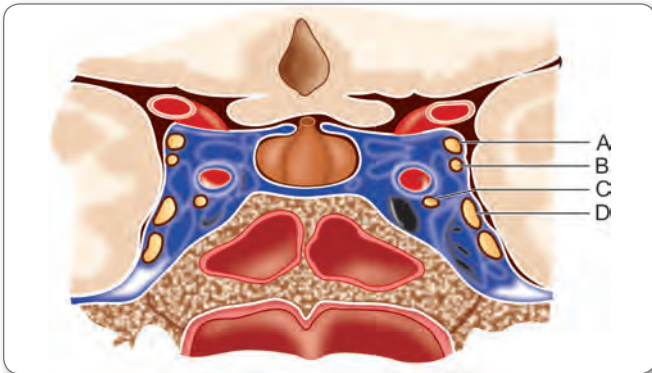
46. Paralysis of 3rd, 4th, 6th nerves with involvement of ophthalmic division of 5th nerve, localizes the lesion to: (AI 2005)

- a. Cavernous sinus
- b. Apex of the orbit
- c. Brainstem
- d. Base of the skull

47. Vein of Labbe is (JIPMER May 2017)

- a. Superior anastomosing vein
- b. Inferior anastomosing vein
- c. Superior cerebral vein
- d. Superficial middle cerebral vein

48. Identify the nerve which injury causes lateral gaze palsy (AIIMS Nov 2015)



- a. A
- b. B
- c. C
- d. D

49. Central area of face is called dangerous area of face because: (AIIMS 1990)

- a. Infection in this area causes cavernous sinus thrombosis
- b. Area is liable to formation of tumor
- c. Area is directly connected to ear
- d. Infection directly reach to meninges

50. Falx cerebri contains: (Recent Question 2014)

- a. Straight sinus
- b. Occipital sinus
- c. Transverse sinus
- d. Sigmoid sinus

51. All of the following are true about cavernous sinus thrombosis, except: (AIIMS Nov. 2014)

- a. Spreads through ethmoidal sinus
- b. Loss of sensation around orbit
- c. Loss of jaw jerk
- d. Infection spreads to cavernous sinus from danger area of face via superior ophthalmic vein muscles of mastication and temporomandibular joint

52. All of the following muscles are grouped together as muscle of mastication, except: (AI 2003)

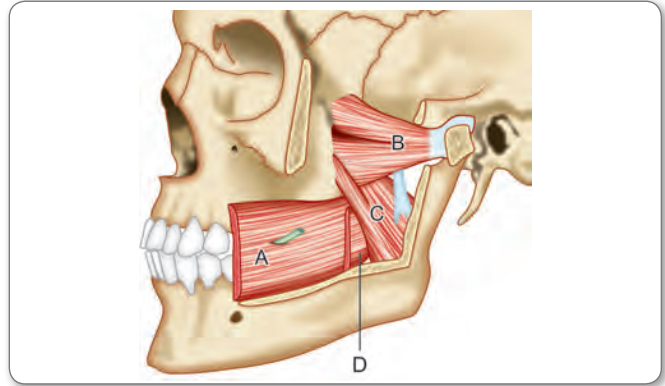
- a. Buccinator
- b. Masseter
- c. Temporalis
- d. Pterygoid

53. Retraction of protruded mandible is done by: (DNB 2007, AI 2005)

- a. Medial pterygoid
- b. Lateral pterygoid
- c. Masseter
- d. Temporalis

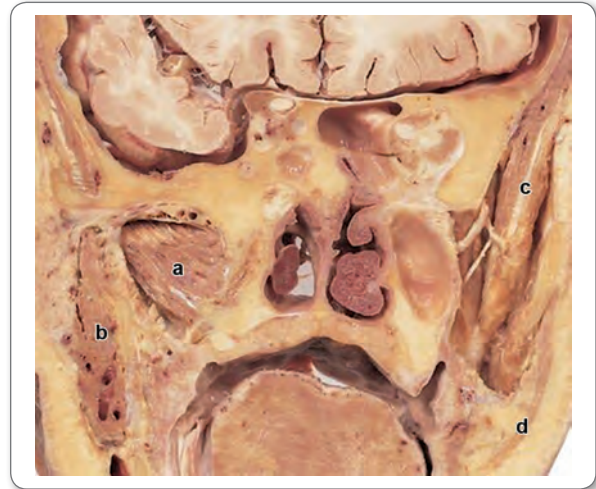
54. Identify the muscle which protrude the mandible (AIIMS 2015)

(AIIMS 2015)



55. Which of the following marked muscle helped in opening of jaw (AIIMS Nov 2017)

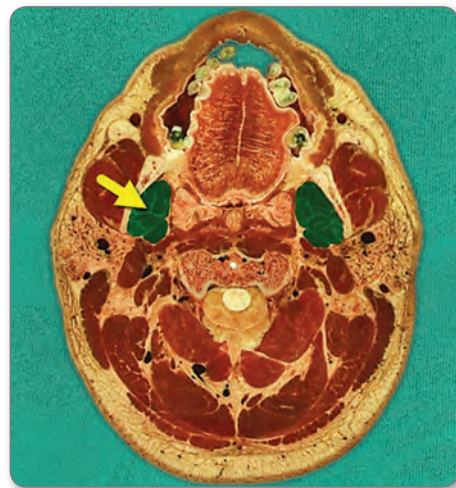
(AIIMS Nov 2017)



- a. A
- b. B
- c. C
- d. D

56. Main action of the marked muscle (AIIMS May 2017)

(AIIMS May 2017)



- a. Elevation
- b. Depression
- c. Protrusion
- d. Retraction

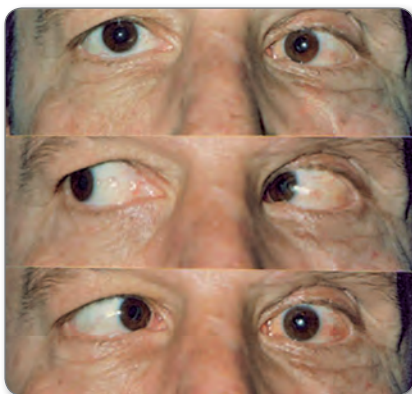


- 57. Depressor's of mandible:** (Recent Question 2003)
a. Medial pterygoid b. Masseter
c. Lateral pterygoid d. Temporalis
- 58. Which of the following is not depressor of mandible:**
a. Hyoglossus b. Digastric (AIIMS 2006)
c. Geniohyoid d. Mylohyoid
- 59. The following ligaments are present in temporomandibular joint, except:** (DNB 2004)
a. Lateral temporomandibular ligament
b. Sphenomandibular ligament
c. Stylomandibular ligament
d. Alar ligament
- 60. Person is having difficulty in opening mouth but not in closing mouth. Which of the following is correct about the concerned muscle:** (PGI May 2013)
a. Origin from lateral pterygoid plate
b. Origin from medial pterygoid plate
c. Insertion to anterior margin of disc
d. Supplied by mandibular nerve
e. Depress the mandible while opening it
- 61. In the dislocation of jaw, displacement of articular disk beyond tubercle of TMJ results from spasm of following muscle:** (AIIMS 2003)
a. Buccinator b. Lateral pterygoid
c. Masseter d. Temporalis
- 62. What is true about opening of jaw:** (DNB 1999, AI 1991)
a. Lateral pterygoid contracts
b. Movement in vertical axis
c. Articular disk moves backwards
d. Head of the mandible moves forwards
- 63. In temporomandibular joint least vascularity is seen:** (AIIMS 2002)
a. Articular cartilage
b. Anterior part of the articular disc
c. Posterior part of the articular disc
d. Central part of articular disc glands
- 64. Isthmus of thyroid gland is across tracheal ring:** (PGI Dec. 2007, June 2006)
a. 3 and 4th tracheal ring b. 5th and 6th tracheal ring
c. 1 and 2 tracheal ring d. 2 and 3rd tracheal ring
- 65. Middle thyroid vein drains into:** (PGI 1991)
a. External jugular vein b. Anterior jugular vein
c. Internal jugular vein d. Brachiocephalic vein
- 66. Recurrent laryngeal nerve in close relation to which of the following artery:** (AIIMS 2003)
a. Superior thyroid artery b. Middle thyroid artery
c. Inferior thyroid artery d. Superior thyroid vein
- 67. Which of the following is not true?** (AIIMS Nov. 2009)
a. Superior thyroid artery – external carotid
b. Inferior thyroid artery – thyrocervical trunk
c. Parathyroid artery – superior thyroid artery
d. Thyroidea ima artery – arch of aorta
- 68. Recurrent laryngeal nerve has variable course in the neck. Which of the following is true?** (PGI 2001)
a. RLN pass between inferior thyroid artery branches
b. RLN pass posterior to inferior thyroid artery branches
c. RLN pass anterior to inferior thyroid artery branches
d. RLN has no relation to inferior thyroid artery
e. RLN passes through sternomastoid muscle
- 69. In emergency tracheostomy all the following structures are damaged, except?** (AIIMS 2009)
a. Isthmus of thyroid
b. Arteria thyroidima
c. Inferior thyroid artery
d. Inferior thyroid vein
- 70. All are true regarding parathyroid gland, except:** (PGI 1993)
a. Usually 4 in number
b. Inferior thyroid is main supply
c. Parasympathetic - secretomotor nerve supply
d. Superior glands constant in position and lie at level of inferior border of cricoid
e. Color distinguish them from thyroid gland
- 71. Parathyroid glands are supplied by which artery:** (DNB 2002)
a. Common carotid b. Superior thyroid
c. Middle thyroid d. Inferior thyroid
- 72. Which is true about parotid gland?** (AI 1990)
a. Stensen's and Wharton's duct join and open at the upper second molar teeth
b. Stensen's duct opens opposite upper second molar
c. Parotid duct pierces the masseter
d. Development from mesoderm
- 73. The parasympathetic secretomotor fibers to parotid traverse thorough the following, except:** (AI 2009)
a. Otic ganglion
b. Tympanic plexus
c. Greater petrosal nerve
d. Auriculotemporal nerve
- 74. True regarding parotid, except:** (AIIMS 2001)
a. Accessory gland above the duct
b. Mandibular ramus grooves anteromedial surface
c. Styloid and mastoid muscles are posteromedially
d. Facial nerve divides into 5 terminal branches after entering the gland
- 75. True about parotid:** (PGI June 2006)
a. Duct opens opposite to upper 2 molar tooth
b. Duct pierces masseter
c. Develops from ectoderm
d. Develops from mesoderm
e. Secretomotor fibers from facial nerve
- 76. True about parotid:** (PGI Dec. 2008)
a. Covered with deep fascia
b. Retromandibular vein relation
c. Facial nerve relation
d. External carotid artery enters through anteromedial surface
e. Parotid nodes lies behind the gland
- 77. Correct statement:** (AIIMS May 2006)
a. Submandibular gland is seen to wrap around the posterior border of mylohyoid
b. Facial artery and vein are divided as they course through the deep part of the gland
c. The hypoglossal nerve is seen to loop under submandibular duct
d. Damage to lingual nerve will cause loss of sensation to posterior third of tongue



Orbit and Extraocular Muscles

- 78. **True statement about orbital articulation is:** (DNB 2003)
 - a. Medial wall of orbit is formed by maxilla, sphenoid, ethmoid and the lacrimal bone.
 - b. Floor is formed by maxilla, zygomatic and ethmoid.
 - c. Lateral wall of orbit is formed by the frontal bone, zygomatic bone and greater wing of sphenoid.
 - d. Inferior orbital fissure is formed between the medial wall and the floor of orbit.
- 79. **The superior oblique muscle is supplied by:** (AI 2005)
 - a. 3RD cranial nerve
 - b. 4th cranial nerve
 - c. 5th cranial nerve
 - d. 6th cranial nerve
- 80. **The antagonistic muscle to superior rectus is** (DNB 2002)
 - a. Inferior oblique
 - b. Inferior rectus
 - c. Superior oblique
 - d. Lateral rectus
- 81. **The person has inability to look downward and laterally The nerve injured is:** (DNB 2003)
 - a. Oculomotor
 - b. Trochlear
 - c. Abducent
 - d. Trigeminal
- 82. **Lockwood ligament is found in:** (AIIMS 1990)
 - a. Orbit
 - b. Pharynx
 - c. Larynx
 - d. TMJ
- 83. **Lamina cribrosa is a modification of:** (DNB 1998)
 - a. Sclera
 - b. Choroid
 - c. Optic nerve sheath
 - d. Retina
- 84. **Onodi and Haller cells of ethmoid labyrinth is seen in relation to following respectively:** (AIIMS Nov. 2010, 2009)
 - a. Optic nerve and floor of the orbit
 - b. Optic nerve and internal carotid artery
 - c. Optic nerve and nasolacrimal duct
 - d. Orbital floor and nasolacrimal duct
- 85. **Which ocular muscle not arise from the apex of orbit:** (AIIMS 1993)
 - a. Superior rectus
 - b. Inferior rectus
 - c. Superior oblique
 - d. Inferior oblique
- 86. **Which is not feature of oculomotor palsy?** (DNB 1998)
 - a. Miosis
 - b. Difficulty in accommodation
 - c. Ptosis
 - d. Diplopia
- 87. **The following picture exhibit which cranial nerve palsy?** (AIIMS Nov 2017)



- a. III
- b. IV
- c. VI
- d. VIII

- 88. **All the following are characteristics of oculomotor nerve, except:** (AIIMS Nov. 2006)
 - a. Carries parasympathetic nerve fibers
 - b. Supplies inferior oblique muscle
 - c. Enters the orbit through inferior orbital fissure
 - d. Causes constriction of pupil
- 89. **Dilator pupillae is supplied by** (AI 2012, AIIMS Nov. 2011)
 - a. Oculomotor nerve
 - b. Sympathetic fibers from V cranial nerve
 - c. Postganglionic parasympathetic fibers from edinger Westphal nucleus
 - d. Postganglionic sympathetic fibers from cervical ganglion
- 90. **The action of superior oblique is A/E :** (PGI 1993)
 - a. Abduction
 - b. Intorsion
 - c. Adduction
 - d. Depression
- 91. **Thinnest area of sclera is:** (AIIMS 2009)
 - a. Limbus
 - b. Behind rectus insertion
 - c. Equator
 - d. In front of rectus insertion
- 92. **True statement regarding ciliary ganglion is are:** (PGI May 2011)
 - a. Situated between optic nerve and medial rectus tendon
 - b. Contain sensory fiber
 - c. Motor root arise from inferior oblique
 - d. Parasympathetic root – Edinger-Westphal nucleus
 - e. Sympathetic root – sphincter pupillae

Nose and Paranasal Sinus

- 93. **The roof of the olfactory region is formed by:** (DNB 2003)
 - a. Nasal bone
 - b. Cribriform plate of ethmoid
 - c. Sphenoid
 - d. Temporal bone
- 94. **Olfactory region in the nose is:** (Recent Question 2013)
 - a. Below the inferior turbinate
 - b. Above the superior turbinate
 - c. Between middle and inferior turbinate
 - d. None of the above
- 95. **Which of the following bones do not contribute to the nasal septum?** (AI 2008, DNB 2004)
 - a. Sphenoid
 - b. Lacrimal
 - c. Palatine
 - d. Ethmoid
- 96. **Nasal septum is formed by:** (PGI Nov. 2008)
 - a. Perpendicular plate of ethmoid
 - b. Vomer
 - c. Nasal bone
 - d. Lateral cartilage
 - e. Palatine bone
- 97. **Uncinate process of ethmoid attached anteriorly to** (JIPMER Nov 2017)
 - a. Sphenoid
 - b. Ethmoid
 - c. Frontal
 - d. Lacrimal bone
- 98. **Which of the following is not branch of external carotid takes part in Kiesselbach's plexus** (AIIMS Nov 2017)
 - a. Sphenopalatine artery
 - b. Greater palatine artery
 - c. Anterior ethmoidal artery
 - d. Septal branch of superior labial artery
- 99. **Which of the following sinus grow till early adulthood?**
 - a. Frontal
 - b. Ethmoid
 - c. Sphenoid
 - d. Maxillary

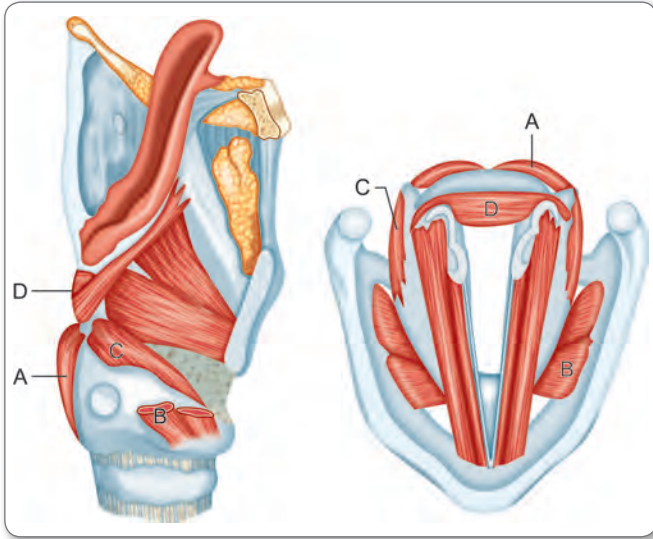


- 100. Blood supply of little's area is/are:** (PGI 2002)
a. Greater palatine artery
b. Septal branch of superior labial artery
c. Anterior ethmoidal artery
d. Septal branch of sphenopalatine artery
e. Nasal branch of sphenopalatine artery
- 101. True about lateral wall of nose:** (PGI May 2013)
a. Superior turbinate is a separate bone
b. Ethmoid bone forms important part of lateral wall
c. Middle turbinate is formed by medial process of ethmoidal labyrinth
d. Opening of inferior meatus is present
e. Inferior turbinate is from ethmoid bone
- 102. Anterior ethmoidal nerve supplies all, except:** (AIIMS May 2010)
a. Maxillary sinus
b. Internal nasal cavity
c. Dura mater in the anterior cranial fossa
d. Ethmoidal cells
- 103. Sensory supply to cornea by:**
a. Infraorbital nerve b. Supraorbital nerve
c. Infratrochlear nerve d. Nasociliary nerve
- Tongue**
- 104. Palsy of right genioglossus causes:** (DNB 1997)
a. Deviation of tongue to right side
b. Deviation of tongue to left side
c. Deviation of soft palate to right side
d. Deviation of soft palate to left side
- 105. In carcinoma base of tongue, pain is referred to the ear through:** (DNB 2000)
a. Hypoglossal nerve b. Vagus nerve
c. Glossopharyngeal nerve d. Lingual nerve
- 106. Muscles of tongue are supplied by:** (DNB 2002)
a. Lingual nerve b. Glossopharyngeal nerve
c. Chorda tympani d. Hypoglossal nerve
- 107. Safety muscle of the tongue is:** (DNB 2005)
a. Hyoglossus b. Genioglossus
c. Palatoglossus d. Styloglossus
- 108. General sensation to the posterior one third of the tongue is mediated by:** (DNB 2002)
a. Hypoglossal nerve b. Vagus nerve
c. Glossopharyngeal nerve d. Lingual nerve
- 109. Tip of tongue drains into:** (DNB 2004)
a. Occipital lymph node
b. Submental lymph node
c. Deep cervical lymph node
d. Tonsillar lymph node
- 110. Which of the following is demarcating anterior 2/3 from base** (AIIMS May 2016)
a. Circumvallate papillae b. Filiform papillae
c. Sulcus terminalis d. Passavant's ridge
- 111. Unilateral injury to hypoglossal nerve leads to all, except:**
a. Hemiatrophy of involved side (AIIMS May 2012, 2008)
b. Deviation of tongue towards same side
c. Loss of taste sensation in same side of tongue
d. Fasciculations of the tongue
- 112. Not true about tongue:** (PGI May 2012)
a. Facial nerve supplies fungiform papillae
b. Glossopharyngeal nerve supplies circumvallate papillae
c. The posterior most part of tongue develops from 3rd arch
d. Genioglossus causes tongue protrusion
e. Blood supply from lingual artery
- 113. The sensory supply of the palate is through all of the following, except:** (DNB 2007)
a. Facial nerve
b. Hypoglossal nerve
c. Glossopharyngeal nerve
d. Maxillary division of trigeminal nerve
- 114. Nerve supply of muscles of palate is/are:** (PGI Nov. 2009)
a. Glossopharyngeal nerve
b. Vagus nerve
c. Trigeminal nerve
d. Greater palatine nerve
e. Hypoglossal nerve
- 115. Which of the following does not supply the palate:** (PGI 2004)
a. Tonsillar branch of facial artery
b. Ascending palatine artery
c. Descending palatine artery
d. Ascending pharyngeal artery
e. Pharyngeal branch of ascending pharyngeal artery
- 116. Lymph from the tonsil drain into the:** (DNB 2004)
a. Jugulo omohyoid node
b. Jugulodigastric node
c. Submental node
d. Upper deep cervical node
- 117. True about tonsils are:** (PGI 2003)
a. Develops from 4th pharyngeal pouch
b. Lymph node drains into jugulodigastric node
c. Has sensory innervations from vagus
d. Rest on superior constrictor
e. Long axis is forward and medially
- 118. Main nerve supply of palatine tonsil:** (DNB 1997)
a. Lesser palatine nerve
b. Greater palatine nerve
c. Glossopharyngeal nerve
d. Facial nerve
- 119. Waldeyer's ring is formed by all, except:** (DNB 1999)
a. Palatine tonsil
b. Pharyngeal tonsil
c. Tubal tonsil
d. Postauricular nodes
- 120. Excessive hemorrhage in tonsillectomy result from the injury to:** (DNB 2000)
a. Ascending palatine artery
b. Venous comitans of facial artery
c. Palatine vein
d. Internal carotid artery
- 121. Oral diaphragm is formed by:** (DNB 2003)
a. Mylohyoid
b. Genioglossus
c. Hyoglossus
d. Buccinator



Larynx

122. In the diagram given below, different muscles of larynx are marked by labelled arrows. Abduction of vocal cord is done by the muscle (AIIMS May 2016)



- a. A
- b. B
- c. C
- d. D

123. Tensor of Vocal Cord (Recent Question 2018)

- a. Cricothyroid
- b. Transverse arytenoid
- c. Posterior cricoarytenoid
- d. Lateral cricoarytenoid

124. Sensory innervation of pyriform fossa is supplied by (JIPMER May 2015)

- a. Internal laryngeal nerve
- b. Recurrent laryngeal nerve
- c. External laryngeal nerve
- d. Glossopharyngeal nerve

125. Adult larynx extends from cervical spine: (AIIMS 2002, AI 1993, 1999)

- a. C3 to C6
- b. C7 to T1
- c. C3 C4
- d. C2 C3

126. Laryngeal skeleton has cartilages: (DNB 2005)

- a. 3 paired, 2 unpaired
- b. 3 paired, 3 unpaired
- c. 2 paired, 3 unpaired
- d. 2 paired, 2 unpaired

127. True about epiglottis: (PGI Nov. 2011)

- a. Contains serous gland
- b. Contains mucous secreting gland
- c. Oval shaped
- d. Made up of elastic cartilage
- e. Lined by stratified squamous epithelium

128. The commonest cartilage to ossify: (DNB 2000)

- a. Thyroid
- b. Corniculate
- c. Cuneiform
- d. Apex of the arytenoids

129. Which of the following is are properly matched?

- a. Trachea bronchial cartilage – fibrous (PGI Dec. 2007)
- b. Thyroid cartilage – hyaline
- c. Cricoid – hyaline
- d. Corniculate – elastic
- e. Epiglottis – elastic

130. Abductor of the vocal cord is: (DNB 2002)

- a. Posterior cricoarytenoid
- b. Lateral cricoarytenoid
- c. Cricothyroid
- d. Thyroepiglottis

131. Nerve supply of the mucosa of larynx is: (DNB 2004)

- a. External laryngeal and recurrent laryngeal
- b. Internal laryngeal
- c. External laryngeal
- d. Superior laryngeal

132. Most laryngeal muscles supplied by: (DNB 2011)

- a. Internal laryngeal nerve
- b. External laryngeal nerve
- c. Recurrent laryngeal nerve
- d. Vagus directly

133. Damage to internal laryngeal nerve results in: (DNB 2002)

- a. Hoarseness of voice
- b. Loss of timbre of voice
- c. Anaesthesia of larynx
- d. Breathing difficulty

134. Extrinsic membranes of larynx are all, except: (AIIMS May 2010)

- a. Cricothyroid
- b. Thyrohyoid
- c. Hyoepiglottic
- d. Cricotracheal

135. During thyroid surgery, nerve course along superior thyroid artery is injured, what can be the possible consequences: (PGI May 2014)

- a. Loss of sensation above the vocal cords
- b. Loss of sensation below the vocal cords
- c. Paralysis of cricothyroid muscle
- d. Paralysis of posterior cricoarytenoid muscle
- e. Loss of sensation in the pyriform fossa

136. Adductors of vocal cord: (PGI 2002, 2007)

- a. Posterior cricoarytenoid
- b. Cricothyroid
- c. Transverse arytenoids
- d. Vocalis
- e. Lateral cricoarytenoid

Ear

137. Which is true about pharyngotympanic tube: (AI 1991)

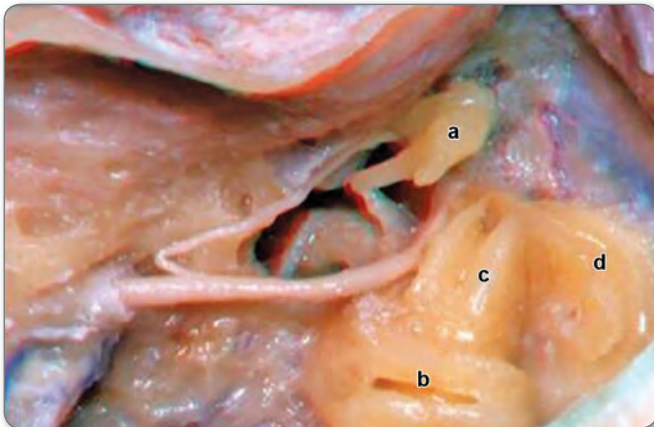
- a. It opens in to oropharynx
- b. Supplied by glossopharyngeal nerve
- c. Lined by stratified squamous epithelium
- d. It is cartilaginous throughout its length

138. Modiolus (apex) is directed: (DNB 2001)

- a. Anterolateral – superior
- b. Anterolateral – inferior
- c. Posteromedial – superior
- d. Posteromedial – inferior

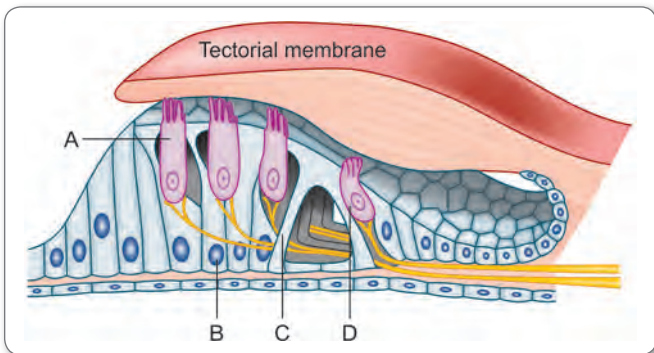


139. Identify the lateral semicircular canal in the following diagram (AIIMS Nov 2017)



- a. A
- b. B
- c. C
- d. D

140. Which of the following were innervated by spiral ganglion (AIIMS Nov 2016)



- a. A
- b. B
- c. C
- d. D

141. True about internal ear anatomy: (DNB 1997)

- a. Three semicircular canals here 6 openings in to the vestibule
- b. The angle between anterior and posterior SCC is 180°
- c. Vestibule is the central chamber
- d. Spiral canal makes 2 turns
- e. Basal turn has lowest radius.

142. Horizontal semicircular canal is: (DNB 1996)

- a. Anterior
- b. Superior
- c. Posterior
- d. Lateral

143. Endolymphatic duct drains into: (DNB 2004)

- a. Subdural space
- b. External space
- c. Subarachnoid space
- d. Succulus

144. Infection of CNS spreads to inner ear through: (DNB 2011)

- a. Cochlear aqueduct
- b. Endolymphatic sac
- c. Vestibular aqueduct
- d. Tympanic membrane

145. Toynebee s muscle is: (DNB 2001)

- a. Stapedius
- b. Tensor tympani
- c. Scalenus minimus
- d. Levator ani

146. Superior malleolar ligament connects: (DNB 2005)

- a. Malleus to incus
- b. Head of malleus to roof of epitympanum
- c. Incus to fossa incudis
- d. Malleus to fossa incudis

147. Tympanic plexus present in: (DNB 2009)

- a. Tunica adventitia of internal jugular vein
- b. Medial projection of middle ear cavity
- c. Part of tympanic membrane
- d. Petrous part of temporal bone

148. Which of the following does not give sensory supply to the pinna: (DNB 2011)

- a. Auriculotemporal nerve
- b. Great auricular nerve
- c. Lesser occipital nerve
- d. Tympanic branch of glossopharyngeal nerve

Skull and Foramina

149. All of the structures pass through optic foramen, except: (DNB 2005)

- a. Optic nerve
- b. Ophthalmic artery
- c. Ophthalmic nerve
- d. Dura mater

150. Maxilla bone does not articulate with: (AIIMS Nov. 2015)

- a. Ethmoid
- b. Sphenoid
- c. Lacrimal
- d. Frontal

151. Foramen spinosum transmits the following: (DNB 2006)

- a. Meningeal branch of the mandibular nerve, middle meningeal artery
- b. Superior ophthalmic vein from the cavernous sinus
- c. Both A and B of the above
- d. None of the above

152. Which structure lies in floor of sphenoidal sinus (JIPMER May 2017)

- a. Vidian nerve
- b. Mandibular nerve
- c. Greater petrosal nerve
- d. Maxillary nerve

153. Talocalcaneonavicular joint is (AIIMS Nov 2017)

- a. Saddle
- b. Plane
- c. Ellipsoid
- d. Ball and socket

154. Sphenopalatine foramen opens into which wall of pterygopalatine fossa: (DNB 2011)

- a. Medial
- b. Lateral
- c. Superior
- d. Inferior

155. Which of the following cranial nerves present in the posterior cranial fossa: (AIIMS May 2006)

- a. 3 to 12
- b. 4 to 12
- c. 5 to 12
- d. 6 to 12

Nerves

156. The cranial nerve with longest intracranial course is: (DNB 2003, AI 1999)

- a. Abducent nerve
- b. Trochlear
- c. Optic
- d. Trigeminal

157. Trochlear nerve all true, except: (AIIMS May 2011)

- a. Longest intracranial course
- b. Arise from the dorsum of brain stem
- c. Supply ipsilateral superior oblique muscle
- d. Enters the orbit through superior orbital fissure outside the ring



158. Skin over the angle of mandible is supplied by: (DNB 2011)
- Trigeminal nerve
 - Posterior rami of C2, C3, C4
 - Great auricular nerve
 - Cervical branch of mandibular nerve
159. Nerve supply of tip of nose: (DNB 2003, AIIMS 1991)
- Ophthalmic division
 - Maxillary division
 - Facial nerve
 - Mandibular division
160. Afferent component of corneal reflex is mediated by: (AI 2006)
- Vagus nerve
 - Facial nerve
 - Trigeminal nerve
 - Glossopharyngeal nerve
161. Middle superior alveolar nerve is a branch of: (AI 2009)
- Mandibular nerve
 - Maxillary nerve
 - Lingual nerve
 - Facial nerve
162. Upper premolars are supplied by: (DNB 2010)
- Anterior superior alveolar nerve
 - Middle superior alveolar nerve
 - Posterior superior alveolar nerve
 - Inferior alveolar nerve
163. Which of the following is not supplied by the anterior division of mandibular nerve? (AI 2011)
- Temporalis
 - Medial pterygoid
 - Lateral pterygoid
 - Masseter
164. True about mandibular nerve is all, except: (PGI Nov. 2009)
- Lingual nerve joins with chorda tympani
 - Auriculotemporal nerve embrace with middle meningeal artery
 - Otic ganglion is medial to nerve
 - Pure motor
 - Formed in foramen ovale
165. Not true about otic ganglion relation: (AIIMS 2015)
- Anterior to middle meningeal artery
 - Lateral to tensor veli palatini
 - Lateral to mandibular nerve
 - Inferior to foramen ovale
166. Mandibular does not supply: (DNB 2004, AIIMS 1997)
- Buccinator
 - Masseter
 - Tensor tympani
 - Temporalis
167. All the muscles of the face are supplied by facial nerve, except: (DNB 2004, JIPMER 1995)
- Levator anguli oris
 - Corrugator supercilii
 - Levator palpebrae superioris
 - Risorius
168. Which of the following is/are branch of facial nerve? (PGI June 2009)
- Chorda tympani
 - Lesser petrosal nerve
 - Greater petrosal nerve
 - Zygomatic nerve
 - Nerve to stapedius
169. Person met with knife injury to face and resultant damage in facial nerve. It leads to impaired decreased secretion of: (PGI May 2012)
- Parotid gland
 - Sublingual gland
 - Lacrimal gland
 - Nasal, sub mandibular and palatal glands
 - None
170. A patient presents with loss of taste sensation in anterior 2/3 of tongue but Schirmer's test is negative. Where is the probable site of lesion? (JIPMER Nov 2014)
- Stylomastoid foramen
 - Geniculate ganglion
 - Internal auditory canal/acoustic meatus
 - Horizontal intratympanic path of facial nerve
171. Posterior belly of digastric is supplied by: (DNB 2006)
- Mandibular nerve
 - Hypoglossal nerve
 - Accessory nerve
 - Facial nerve
172. In the fracture of middle cranial fossa, absence of tears would be due to lesion in: (AI 2001)
- Trigeminal ganglion
 - Ciliary ganglion
 - Greater petrosal nerve
 - Cervical ganglion
173. Lacrimal gland is supplied by which of the following ganglia: (DNB 2008)
- Otic ganglia
 - Ciliary ganglia
 - Pterygopalatine ganglion
 - Submandibular
174. All the followings are supplied by facial nerve, except: (AI 2001)
- Lacrimal gland
 - Submandibular gland
 - Nasal glands
 - Parotid glands
175. The following statements concerning the chorda lymphatic nerve are true, except: (AI 2005)
- Carries the secretomotor fibers to the submandibular gland
 - Joins lingual nerve in infra-temporal fossa
 - Is a branch of facial nerve
 - Contains postganglionic parasympathetic fibers.
176. Nerve supply to the tympanic membrane is by: (DNB 2004, AI 1995)
- Auriculotemporal
 - Lesser occipital
 - Greater occipital
 - Parasympathetic ganglia
177. Sensory supply to the middle ear cavity is provided by: (DNB 2002, AI 1995)
- Facial nerve
 - Glossopharyngeal nerve
 - Trigeminal nerve
 - Vagus nerve
178. All the following statements about vagus nerve are true, except: (AIIMS Nov. 2005)
- Supplies heart and lung
 - Carries postganglionic parasympathetic fibers
 - Innervates right two third of transverse colon
 - Stimulates peristalsis and relaxes sphincters
179. Parasympathetic nervous system includes: (AIIMS Nov. 2016)
- Cranial nerve 3, 5, 7, 9 and sacral plexus
 - Cranial nerve 3, 5, 7, 9, 10 and S1 and S4 of sacral plexus
 - Cranial nerve 3, 7, 9, 10 and sacral plexus
 - All cranial nerves and sacral plexus
180. Cranial nerve not carrying parasympathetic fibers: (AIIMS May 2010)
- 4
 - 7
 - 3
 - 9
181. Cranial part of accessory nerve supplies: (DNB 2001, AI 1996)
- Sternocleidomastoid
 - Levator scapulae
 - Superior constrictor
 - Styloglossus



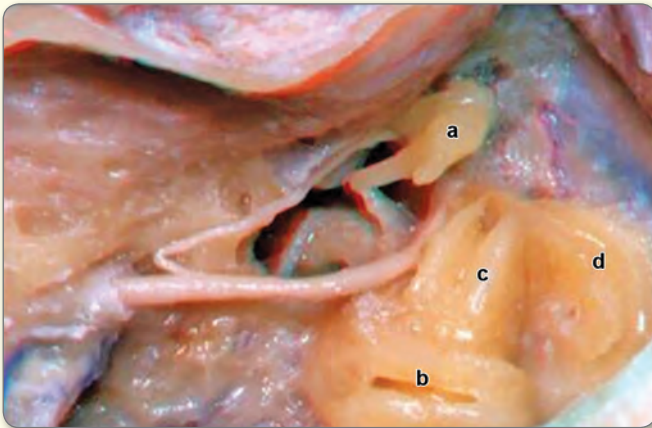
206. Inferior thyroid artery is a branch of: (AIIMS May 2018)

- a. Thyrocervical trunk
- b. Costocervical trunk
- c. ICA
- d. ECA

207. All will occur in damage to oculomotor nerve damage except: (AIIMS May 2018)

- a. Lateral and upward deviation
- b. Loss of light reflex
- c. Dilated pupil
- d. Ptosis

208. Identify the marked structure A in the given image: (AIIMS May 2018)



- a. Malleus
- b. Incus
- c. Stapes
- d. Lateral semi-circular canal

209. What is the action of marked muscle in the given image? (AIIMS Nov 2018)



- a. Elevation
- b. Depression
- c. Protraction
- d. Retraction

210. What is normally seen in lumbar spine? (AIIMS Nov 2018)

- a. Scoliosis
- b. Lordosis
- c. Kyphosis
- d. Recurvatum

211. Correct pairing regarding between lymph node and their anatomical boundaries is: (AIIMS Nov 2018)

- a. Level 5: Base of skull to cricoid
- b. Level 4: Hyoid to cricoid
- c. Level 6: Hyoid to clavicle
- d. Level 3: Cricoid to clavicle

212. Identify the nerve affected in this image (AIIMS Nov 2018)



- a. III nerve injury
- b. IV nerve injury
- c. VI nerve injury
- d. Intra nuclear ophthalmoplegia

213. Dangerous spaces of neck is situated (JIPMER May 2018)

- a. Between alar fascia and prevertebral fascia
- b. Between alar and buccopharyngeal fascia
- c. Between alar and retropharyngeal fascia
- d. Behind prevertebral fascia

214. Suspensory ligament of lock wood encloses

- a. Superior oblique and superior rectus (JIPMER May 2018)
- b. Medial and lateral rectus
- c. Inferior rectus and inferior oblique
- d. LPS and superior rectus

215. Fish bone area sensory supply (JIPMER Nov 2018)

- a. External laryngeal nerve
- b. Internal laryngeal nerve
- c. Recurrent laryngeal nerve
- d. Superior laryngeal nerve

216. Not true about pterygopalatine fossa (JIPMER Nov 2018)

- a. Contains pterygopalatine ganglion and 3rd part of maxillary artery
- b. Medially communicates with infra temporal fossa
- c. Communicates with middle cranial fossa through Vidian nerve canal
- d. Maxillary nerve passing through foramen rotundum

217. Site of blocking superior laryngeal nerve (JIPMER Nov 2018)

- a. Angle of mandible
- b. Cricoid cartilage
- c. Transverse process of C7
- d. Great cornua of hyoid

218. Killian's dehiscence is part of (JIPMER Nov 2018)

- a. Nasopharynx
- b. Oropharynx
- c. Cricopharyngeus
- d. Thyropharyngeus

219. Stellate ganglion location (JIPMER Nov 2018)

- a. C6
- b. C7
- c. Posterior to prevertebral fascia
- d. Vertebral artery

220. 22q11 deletion syndrome is associated with (JIPMER Nov 2018)

- a. Hypocalcaemia
- b. Hypercalcemia
- c. Hypokalaemia
- d. Hyperkalaemia

221. Which joint helps to look left and right (Recent Question 2018)

- a. Atlanto-occipital
- b. Atlanto-axial
- c. C3-c4
- d. C4-c5

222. Philtrum derived from (Recent Question 2018)

- a. Medial nasal process
- b. Lateral nasal process
- c. Maxillary process
- d. Mandibular process

**223. Pretrematic nerve of 1st pharyngeal arch***(Recent Question 2018)*

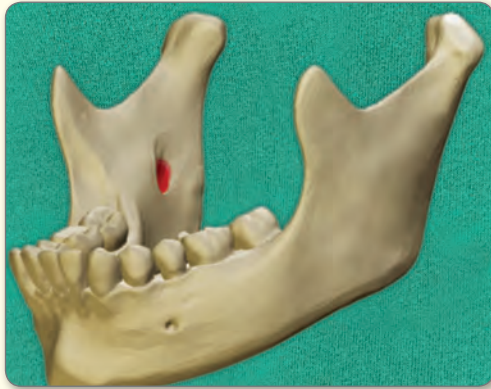
- a. Chorda tympani nerve b. Mandibular nerve
c. Glossopharyngeal nerve d. Superior laryngeal nerve

224. Fascia over the posterior triangle is pierced by*(Recent Question 2018)*

- a. Spinal accessory nerve b. Supra clavicular nerve
c. External jugular vein d. Internal jugular vein

225. Joint responsible for person turning left to right*(Recent Question 2019)*

- a. Atlanto-occipital joint b. Atlantoaxial
c. Joint over C2-3 d. Joint over C6-7

226. The structure passing through the marked foramen*(Recent Question 2019)*

- a. Inferior alveolar nerve b. Lingual nerve
c. Maxillary nerve d. Facial

227. In Frey's syndrome which postganglionic nerve innervate the sweat gland*(Recent Question 2019)*

- a. Glossopharyngeal b. Vagus
c. Facial d. Trigeminal

228. Muscles derived from 1st arch*(Recent Question 2019)*

- a. Buccinator
b. Anterior belly of digastric
c. Sternohyoid
d. Levator palatini

229. Component(s) of inner Waldeyer's ring:*(PGI May 2018)*

- a. Jugulodigastric lymph nodes
b. Jugulo-omohyoid lymph nodes
c. Tubal tonsil
d. Nasopharyngeal tonsil
e. Lingual tonsil

230. All are true about parotid except:*(PGI May 2018)*

- a. 2nd largest salivary gland
b. Stenson's duct opens into the vestibule of the mouth opposite upper third molar
c. Divided into superficial and deep lobe by facial nerve
d. Majority of lymph nodes are embedded in deep lobe
e. Deep lobe abscess can extend into parapharyngeal space

231. Cavernous vein/sinus receives input from:*(PGI May 2018)*

- a. Cephalic vein
b. Superior ophthalmic vein
c. Superior petrosal sinus
d. Inferior petrosal sinus
e. Superficial middle cerebral vein

232. Nasal septum formed by*(PGI May 2018)*

- a. Quadrangular cartilage b. Ethmoid
c. Vomer d. Sphenoid
e. Nasal bone

233. DiGeorge syndrome*(PGI May 2018)*

- a. Hypothyroidism
b. Hyperthyroidism
c. Hypocalcaemia
d. Thymus hyperplasia
e. Lymphopenia



Answers with Explanations

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1. Ans. **d. d**

- a – pharyngeal arch
- b – head bulge
- c – upper limb bud
- d – heart bulge

2. Ans. **c. 3**

- 3rd pharyngeal pouch differentiates into inferior parathyroid and thymus
- Failure of this leads to DiGeorge syndrome

3. Ans. **d. Descends anterior to brachiocephalic vein**

Thymus from 3rd endodermal pouch, decrease in size with age.

4. Ans. **b. B**

B – palatoglossus – from NCC – 4th pharyngeal arch.

- A – styloglossus
- B – palatoglossus
- C – hyoglossus
- D – genioglossus

5. Ans. **b. B**

B – pars nervosa from neuro ectoderm

6. Ans. **a. 1st Pharyngeal arch**

[Ref: A.K. Datta Human Embryology 6th /E]

7. Ans. **c. Tensor veli palate**

[Ref: A.K. Datta Human Embryology 6th /E 1st arch]

Tensor tympani, Tensor veli palatine, Mylohyoid, Muscles of mastication and Anterior belly of digastrics. (T2 M2 A)

8. Ans. **c. 3rd pouch**

[Ref: A.K. Datta Human Embryology 6th /E]

9. Ans. **d. Greater cornu of hyoid bone**

[Ref: A.K. Datta Human Embryology 6th /E]

10. Ans. **d. Petrous temporal**

[Ref: A.K. Datta Human Embryology 6th /E]

11. Ans. **b. Levator palpebrae superioris**

[Ref: A.K. Datta Human Embryology 6th /E]

Levator palpebrae superioris – muscle of orbit.

12. Ans. **b. Palatine tonsils**

[Ref: A.K. Datta Human Embryology 6th /E; Q 32, 33]

Palatine tonsils from 2 endodermal pouch

13. Ans. **d. Neural crest cells, > a. Ultimo – brachial body**

[Ref: Last Anatomy 12th Edition, Pg 340]

Parafollicular cells derived from neural crest and ultimo brachial body

Neural crest is the best option

14. Ans. **d. Derivative of neural crest, > b. Develops from second pharyngeal pouch**

[Ref: Last Anatomy 12th Edition, Pg 26]

Second pouch forms tonsillar fossa not tonsil.

Tonsil collection of lymphatics which is derived from secondary mesenchyme – neural crest cells

15. Ans. **c. Second arch**

[Ref: Last Anatomy 12th Edition, Pg 383]

Hypobranchial eminence formed in the relation to 2, 3, 4 endodermal pouch

It overgrows the second arch fuse with lingual swelling and tuberculum impar.

16. Ans. **c. First ectodermal cleft**

[Ref: Langman's Embryology 12th Edition, Pg 325-328]

External ear canal – external auditory meatus develop from first ectodermal cleft.

17. Ans. **b. Medial nasal process**

[Ref: IB Singh Embryology 7th Edition Pg 142-147]

Defect	Caused by
Cleft upper lip	Failure of fusion between maxillary process and medial nasal process
Medial cleft upper lip	Failure of fusion between 2 medial nasal process
Oblique facial cleft	Failure of fusion between maxillary process and medial and lateral nasal process
Lower lip cleft	Failure of fusion of two mandibular process

18. Ans. **d. Subcutaneous tissue**

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 pg 60]

19. Ans. **d. Develop by 8th week IUL**

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 2]

Diploic Veins

Bilamellar cranial vault consists outer table and inner table and intervening vascular tissue known as DIPLOE. Veins draining diploe are called as Diploic Veins

Diploic veins

- At birth – not formed
- At 2nd year – start to form
- 4th year – appears
- Fully formed – 35th year



Walls of diploic veins are thin walled and lined by single layer of endothelium supported by elastic tissue.
Like other intracranial veins it is also valve less

20. Ans. c. Aponeurotic and periosteum

[Ref: Tissue Expansion Reconstruction of the Scalp Robert L. McCauley, M.D. 1, 2]

Tissue expanders used for scalp injuries.
Expanders placed in below the aponeurotic layer, as it provides the easy plane of cleavage.

21. Ans. a. Auriculotemporal nerve, b. Zygomatic nerve, c. Occipital nerve

[Ref: Last Anatomy 12th edition, pg 356]

Infratrochlear nerve and frontal nerve does not supply the scalp.

22. Ans. c. Parotid duct

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 66]

23. Ans. a. Lingual nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 127]

Lingual nerve comes in direct contact with mandible medial to the 3rd molar tooth and covered only by mucous membrane

24. Ans. a. Platysma

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 67]

25. Ans. a. A

- A – vagus
- B – sympathetic trunk
- C – spinal nerve
- D – recurrent laryngeal nerve

26. Ans. c. Prevertebral fascia forms the floor of posterior triangle

27. Ans. b. B

- A – prevertebral space
- B – dangerous area of neck
- C – retropharyngeal space
- D – pretracheal space

28. Ans. b. Anterior digastrics

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 96]

29. Ans. c. Mylohyoid

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 97]

Floor of digastric triangle – mylohyoid, hyoglossus and middle constrictor

Floor of carotid triangle – thyrohyoid, inferior constrictor, hyoglossus and middle constrictor

30. Ans. d. Great auricular nerve

Head and neck Nerves thickened in leprosy

- Supra orbital nerve
- Supra trochlear
- Great auricular nerve
- Transverse cervical nerve
- Supra clavicular nerve

31. Ans. d. D

Key to identify the phrenic nerve

- A-Cervical sympathetic chain
- B-Recurrent laryngeal nerve
- C-Vagus
- D-Phrenic nerve

32. Ans. d. Mylohyoid artery and nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 97]

Nerve to mylohyoid supplies mylohyoid muscle and anterior belly of digastric
Nerve to mylohyoid branch from inferior alveolar nerve (branch from posterior division of mandibular nerve)

33. Ans. c. Both

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 97]

Hypoglossal nerve present in both carotid triangle and digastrics triangle
Cervical sympathetic chain present behind the carotid sheath not included in the content of carotid triangle

34. Ans. d. Sternocleidomastoid

[Ref: Last's Anatomy 12th Edition Pg 344]

35. Ans. c. Omohyoid

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 132]

Inferior belly of omohyoid is strap muscle. Strap muscles are contained in muscular triangle

36. Ans. c. Digastrics

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 133]

Anterior belly supplied by nerve to mylohyoid – inferior alveolar nerve – branch of posterior division of mandibular nerve
Posterior belly supplied by – facial nerve

37. Ans. a. Prevertebral fascia

[Ref: Gray's Anatomy 40th Edition Pg 438-440]

Prevertebral fascia forms axillary sheath
Pretracheal and prevertebral fascia forms carotid sheath

38. Ans. a. Arises from sternum and clavicle, b. Turns face to opposite side, c. Shortened in congenital torticollis, e. Supplied by occipital artery

[Ref: Last's Anatomy 12th Edition Pg 332]

Sternomastoid supplied by spinal part of accessory nerve
Receives blood supply from occipital, posterior auricular artery, superior thyroid artery and supra scapular artery

**39. Ans. b. Posterior auricular artery**

As per recent Gray's, all these arteries supply the sternocleidomastoid.
Suprascapular artery branch of thyrocervical trunk
But as per recent journal, posterior auricular artery not supply the muscle

40. Ans. a. Damage to spinal accessory nerve, b. Paralysis of trapezius muscle

[Ref: Gray's Anatomy 40th Edition Pg 809-811]

Spinal accessory nerve appears in the posterior triangle deep to the midpoint of the posterior border of sternocleidomastoid muscle
Plastered to the investing layer
Spinal accessory innervates two muscles trapezius and sternomastoid
Trapezius palsy features – loss of overhead abduction and loss of shrugging of shoulder
Sternomastoid palsy features – not able to turn head towards same side and face towards opposite side, not able to protract head

41. Ans. c. Superior sagittal

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 193]

Superior sagittal sinus – unpaired sinus on the superior border of falx cerebri
Inferior sagittal sinus – unpaired sinus on the inferior border of falx cerebri
Occipital sinus – unpaired sinus situated on the falx cerebelli

42. Ans. a. Straight sinus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 195]

The great cerebral vein formed by union of two internal cerebral veins and receives basal vein one on each side before its termination into straight sinus

43. Ans. c. Abducent nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 194]

44. Ans. c. Trigeminal

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 193]

Trigeminal nerve not in the lateral wall, only its ophthalmic division and maxillary division in the lateral wall

45. Ans. b. Superior petrosal sinus

[Ref: Bd Chaurasia Human Anatomy 6th Edition Vol 3 Pg 194]

Superior petrosal is not a tributary to cavernous sinus. It drains the cavernous sinus in to transverse sinus.

46. Ans. a. Cavernous sinus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 195]

Based on the contents, cavernous sinus lesion may be associated with paralysis of 3rd, 4th, 5th (ophthalmic and maxillary division) and 6th nerve.

47. Ans. b. Inferior anastomosing vein

Vein of Labbe – inferior anastomosing vein

48. Ans. c. C

Lateral gaze palsy due to VI nerve injury
A – oculomotor nerve
B – trochlear nerve
C – abducent nerve
D – ophthalmic nerve

49. Ans. a. Infection in this area causes cavernous sinus thrombosis

Facial vein communicates with cavernous sinus through superior ophthalmic vein and deep facial vein
So infection from the central (area between lower part of nose and upper part of lip – dangerous area) spread to cavernous sinus

50. Ans. a. Straight sinus

[Ref: Last Anatomy 12th Edition Pg 441]

Falx cerebri narrow in front and broad behind where it blends with tentorium cerebella, straight sinus run along this attachment
Superior sagittal sinus presents along superior attached margin
Inferior margin is free and contains inferior sagittal sinus

51. Ans. c. Loss of jaw jerk

Routes of spread

- From the infection of sphenoid sinus, ethmoid sinus and frontal sinus
 - Through facial vein draining danger area of face via superior ophthalmic vein and angular vein
- Clinical features of cavernous sinus thrombosis
- Head ache
 - Involvement of 3, 4, 5, 6 cranial nerve
 - Papilledema – increase of intra cranial tension
 - Loss of vision – involvement of optic nerve
 - Proptosis – protrusion of eyeball
 - Ophthalmoplegia – paralysis of eyeball muscles
 - Chemosis – swelling of conjunctiva

52. Ans. a. Buccinator

[Ref: Last Anatomy 12th Edition Pg 351]

Buccinator is a muscle of facial expressions

53. Ans. d. Temporalis

[Ref: BD Chaurasia 5th Edition Vol3 Pg 148-149]

54. Ans. b. B lateral pterygoid > C medial pterygoid**55. Ans. a. A**

Lateral pterygoid opens the mandible
A – lateral pterygoid
B – masseter
C – temporalis
D – buccinator

**56. Ans. a. Elevation**

Marked muscle
Medial pterygoid
Main action – elevation

57. Ans. c. Lateral pterygoid

[Ref: Last Anatomy 12th Edition Pg 361,362]

58. Ans. a. Hyoglossus

[Ref: Last Anatomy 12th Edition Pg 381]

Mandible is depressed by gravity (prime mover), lateral pterygoid muscle and supra hyoid muscles (digastrics, geniohyoid, mylohyoid)
Hyoglossus is not depressor

59. Ans. d. Alar ligament

[Ref: BD Chaurasia 5th Edition Vol3 Pg 154-156]

60. Ans. a. Origin from..., c. Insertion to anterior margin..., d. Supplied by..., e. Depress the mandible...

[Ref: Last Anatomy 12th Edition Pg 361, 362]

Opening of mouth – lateral pterygoid muscle
Origin from – lateral surface of lateral pterygoid plate and from roof of infratemporal fossa
Insertions – neck (fovea) of mandible, articular disc and blends with fibrous capsule of temporomandibular joint

HIGH YIELD POINTS

Medial pterygoid arises from medial surface of lateral pterygoid plate and maxillary tuberosity.

61. Ans. b. Lateral pterygoid

[Ref: Last Anatomy 12th Edition PG 361, 362]

Lateral pterygoid muscle inserted to articular disc

62. Ans. a. Lateral pterygoid contracts

[Ref: Last Anatomy 12th Edition Pg 361, 362]

Head of mandible rotates in horizontal axis
Articular disc moves forwards

63. Ans. d. Central part of articular disc

[Ref: Last Anatomy 11th Edition Pg 427-429]

Articular disc is white fibrous cartilage – avascular
Disc consists of anterior extension, anterior thick band, central zone, posterior thick band, bilamellar region
Capillary network hug around the margins of the disc, vascularity is thickest in the posterior aspect than anterior, but central zone is avascular

64. Ans. d. 2 and 3 tracheal ring

[Ref: Last Anatomy 12th Edition Pg 339]

65. Ans. c. Internal jugular vein

[Ref: Last Anatomy 12th Edition Pg 340]

Superior and middle thyroid vein drains into internal jugular vein and inferior thyroid vein drains into brachiocephalic vein

66. Ans. c. Inferior thyroid artery

[Ref: Last Anatomy 12th Edition Pg 340]

Inferior thyroid artery related to recurrent laryngeal nerve
Superior thyroid artery related to external laryngeal nerve

67. Ans. c. Parathyroid artery – superior...

[Ref: Last anatomy 12th Edition Pg 340]

Parathyroid artery – inferior thyroid artery

68. Ans. a. RLN pass between..., b. RLN pass posterior to..., c. RLN pass anterior to.....

[Ref: Last Anatomy 12th Edition Pg 340]

Recurrent laryngeal nerve in variable relation to inferior thyroid artery. Sometimes RLN pass anterior to inferior thyroid artery, sometimes pass posterior to inferior thyroid artery, pass in between the loops of inferior thyroid artery.

69. Ans. c. Inferior thyroid artery

In tracheostomy midline structures are damaged
Isthmus of thyroid, arteria thyroid ima, inferior thyroid veins are in midline, whereas inferior thyroid artery is not in midline

70. Ans. c. Parasympathetic - secretomotor nerve supply

[Ref: Last Anatomy 12th Edition Pg 340]

Nerve supply is by sympathetic – vasomotor, not secretomotor
Secretomotor function of the gland is hormonally regulated

71. Ans. d. Inferior thyroid

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 146]

72. Ans. b. Stensen's duct opens opposite upper second molar

[Ref: Last Anatomy 12th Edition Pg 358 - 360]

Wharton's duct opens in the sub lingual papillae
Parotid develops from ectoderm and pierces the buccinator.

73. Ans. c. Greater petrosal nerve

[Ref: Gray's Anatomy 39th Edition Pg 515 – 517]

Lesser petrosal nerve involved in the parasympathetic pathway

74. Ans. d. Facial nerve divides into 5 terminal branches after entering the gland

[Ref: Last Anatomy 12th Edition Pg 358 - 360]

Facial nerve divides into cervicofacial and temporo-facial inside the gland, not five terminal branches. Temporo-facial divides into temporal and zygomatic branches. Cervicofacial divides into buccal, marginal mandibular and cervical branch.



75. Ans. a. Duct opens opposite to upper 2 molar tooth, c. Develops from ectoderm

[Ref: Last Anatomy 12th Edition Pg 358 - 360]

Secretomotor fibers of parotid from glossopharyngeal nerve

76. Ans. a. Covered with..., b. Retromandibular vein relation, c. Facial nerve relation

[Ref: Last Anatomy 12th Edition Pg 358 - 360]

External carotid artery is deeply placed, not in the antero-medial surface

Parotid nodes lie in the superficial surface.

77. Ans. a. Submandibular gland is seen to wrap around the posterior border of mylohyoid

Lingual nerve related to duct

Glossopharyngeal nerve loss leads to posterior third tongue sensory loss

78. Ans. a. Medial wall of orbit is formed by maxilla...

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 29]

79. Ans. b. 4th cranial nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 208]

80. Ans. b. Inferior rectus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 208]

The main action of superior rectus in primary position – elevation, adduction, intorsion.

The main action of inferior rectus in primary position – depression, adduction, extorsion.

81. Ans. b. Trochlear

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 209]

Inability to look downward and laterally – superior oblique palsy – so trochlear nerve injured.

82. Ans. a. Orbit

[Ref: Last Anatomy 12th Edition Pg 402]

The sheaths of medial and lateral rectus are attached to lacrimal and zygomatic bone and form medial and lateral check ligaments respectively

The sheath of inferior rectus thickens and blends with sheath of inferior oblique forms hammock like suspensory ligament of Lockwood. Because of this ligament eyeball retains this position even if the floor of the orbit is removed.

83. Ans. a. Sclera

[Ref: Last Anatomy 12th Edition Pg 405]

Lamina cribrosa is sieve like structure (allows the passage of axons of retinal ganglion cells and retinal vessels) in the posterior part of sclera.

Since it is sieve like it is the weakest part of sclera.

84. Ans. a. Optic nerve and floor of the orbit

[Ref: Gray's Anatomy 40th Edition Pg 558]

Sphenoethmoid cells or onodi cells related to optic nerve canal and internal carotid artery

Haller cells related to orbital floor

Agger nasi related to lacrimal duct

85. Ans. d. Inferior oblique

[Ref: Last Anatomy 12th Edition Pg 401 Gray's 41st Ed./671, Gray's 39th Ed./ 693]

Inferior oblique muscle arises from the orbital surface of maxilla in floor of the orbit, whereas other muscles arise the apex of orbit.

86. Ans. a. Miosis

[Ref: Last Anatomy 12th Edition Pg 494, 501]

Oculomotor palsy causes mydriasis not miosis

87. Ans. c. VI

Lateral gaze palsy – VI nerve injury

88. Ans. c. Enters the orbit through inferior...

[Ref: Last Anatomy 12th Edition Pg 494]

Oculomotor nerve (superior and inferior division) enters the orbit through superior orbital fissure

89. Ans. d. Postganglionic sympathetic fibers...

[Ref: Last Anatomy 12th Edition Pg 403]

Nerve root	Derived from	Supplies
Parasympathetic root Or motor root	Nerve to inferior oblique	Sphincter pupillae and ciliaris muscle
Sensory root	From nasociliary nerve	Carries pain, touch and thermal sensation from eyeball
Sympathetic root	From internal carotid plexus	Vasomotor in function and supplies dilator pupillae

90. Ans. c. Adduction

[Ref: Last Anatomy 12th Edition Pg 404]

Superior oblique actions – abduction, depression and intorsion

91. Ans. b. Behind rectus insertion

[Ref: Last Anatomy 12th Edition Pg 405]

Sclera is thinnest under the insertion of recti

92. Ans. b. Contain sensory fiber, c. Motor root arise from..., d. Parasympathetic root ...

[Ref: Last Anatomy 12th Edition Pg 403]



Ciliary ganglion situated between optic nerve and lateral rectus
Sympathetic root supplies dilator pupillae

93. Ans. b. Cribriform plate of ethmoid

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 239]
Intermediate part of roof (olfactory) formed by cribriform plate of ethmoid bone which is pierced by olfactory nerves

94. Ans. b. Above the superior turbinate

[Ref: Essentials of Human Anatomy by AK Dutta 5th edition volume 2 page 262]

95. Ans. b. Lacrimal

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 241]
Sphenoidal crest and rostrum contribute to septum
Crest of palatine bone contribute to septum
Perpendicular plate ethmoid contributes to septum

96. Ans. a. Perpendicular plate..., b. Vomer, c. Nasal bone, e. Palatine bone

[Ref: Essentials of human anatomy by AK Dutta 5th edition volume 2 page 263, 264]
Septal cartilage and inferior nasal cartilage contribute to nasal septum not lateral cartilage

97. Ans. d. Lacrimal bone

Uncinate process anteriorly articulates with lacrimal bone & posteriorly with inferior turbinate

98. Ans. c. Anterior ethmoidal artery

Anterior ethmoidal artery – from ophthalmic artery – from internal carotid artery

99. Ans. a. Frontal

Sinus	Gestational Month when development Starts	Present in Clinically Significant Size	Fully Developed
Maxillary	2	Birth	12 years
Ethmoid	3	Birth	12 years
Frontal	4	3 years	18–20 years
Sphenoid	3	8 years	12–15 years

- Maxillary sinus –
 - Begin to develop during late fetal life.
 - Small at birth
 - Grow slowly until puberty and are not fully developed until all of the permanent teeth have erupted in early adulthood
- Frontal or sphenoid – not seen at birth.
- Ethmoidal sinuses – small before 2 years and they do not grow rapidly until 6 to 8 years of age
- Frontal sinuses visible on the radiograph by radiograph by 7 years

100. Ans. a. Greater palatine..., b. Septal branch of..., c. Anterior ethmoidal... d. Septal branch of ...

[Ref: Essentials of human anatomy by AK Dutta 5th edition volume 2 page 264]

Little's Area

Anteroinferior part of nasal septum is highly vascular and it is called Little's area or Kiesselbach's area
Arteries converge in the little area

- Septal branch of sphenopalatine artery (branch of maxillary artery)
- Greater palatine artery (branch of maxillary artery)
- Anterior ethmoidal artery (branch of ophthalmic artery)
- Superior labial artery (branch of facial artery)

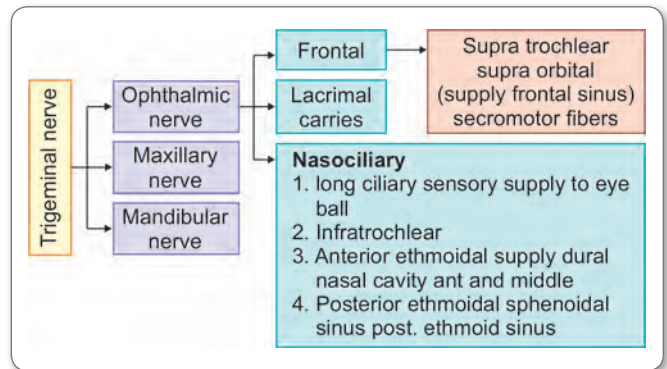
101. Ans. b. Ethmoid bone..., c. Middle turbinate is formed..., d. Opening of inferior...

[Ref: Last Anatomy 12th Edition 372-374]
Superior and middle turbinate is formed by medial extensions of ethmoidal labyrinth
Inferior turbinate is separate bone
In the inferior meatus, nasolacrimal duct opens

102. Ans. a. Maxillary sinus

103. Ans. d. Nasociliary nerve

[Ref: BDC Chaurasia 6th Edition Volume III, Pg 296]



104. Ans. a. Deviation of tongue to right side

[Ref: Last Anatomy 12th Edition 502]
The protruded tongue deviates to same side of lesion, due to unopposed action of muscle on the normal side

105. Ans. c. Glossopharyngeal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 286]
Base: Directed backwards towards oropharynx and its formed by posterior one third of tongue which is innervated by glossopharyngeal nerve

106. Ans. d. Hypoglossal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 268]



107. Ans. b. Genioglossus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 266]

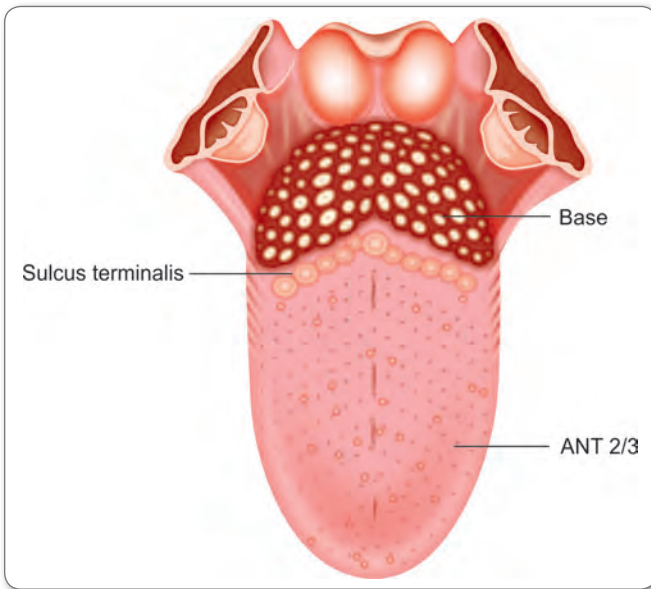
108. Ans. c. Glossopharyngeal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 268]

109. Ans. b. Submental lymph nodes

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 268]

110. Ans. c. Sulcus terminalis



111. Ans. c. Loss of taste sensation in same side...

[Ref: Last Anatomy 12th Edition 502]

Taste sensation of tongue is carried by chorda tympani and glossopharyngeal nerve. Hypo glossal nerve is purely motor nerve.

112. Ans. c. The posterior most part of...

[Ref: Last Anatomy 12th Edition 380 - 382]

Posterior most part of tongue develops from the 4th arch, not from 3rd arch.

Tongue supplied by lingual artery

113. Ans. b. Hypoglossal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 224]

Hypoglossal nerve supply the muscles of tongue
 Facial nerve, glossopharyngeal nerves and palatine branches conveys general and special sensation to palate.

114. Ans. b. Vagus nerve, c. Trigeminal nerve

[Ref: Last Anatomy 12th Edition 388-390]

Muscles of palate except tensor veli palatine supplied by pharyngeal plexus which carries fibers from vagus

Tensor veli palatine supplied by mandibular branch of trigeminal nerve

115. Ans. a. Tonsillar branch..., e. Pharyngeal branch...

[Ref: Last Anatomy 12th Edition 388-390]

Blood supply of palate

Greater palatine artery – branch of descending palatine artery which is branch of maxillary art

Lesser palatine artery – branch of descending palatine artery which is branch of maxillary art

Ascending palatine artery – branch of facial artery

Palatine branch of ascending pharyngeal artery

116. Ans. b. Jugulodigastric node

[Ref: BD Chaurasia Human Anatomy 6th edition vol 3 pg 230]

117. Ans. b. Lymph node..., d. Rest on superior...

[Ref: Last Anatomy 12th Edition 387]

Develops from 2nd arch

Sensory supply from glossopharyngeal and lesser palatine nerves

Directions – above downwards and laterally

118. Ans. c. Glossopharyngeal nerve

[Ref: Last Anatomy 12th Edition 387]

Main nerve supply of tonsil is glossopharyngeal nerve

119. Ans. d. Postauricular nodes

[Ref: Last Anatomy 12th Edition 387]

Waldeyer's ring – collection of lymphoid tissue surrounding upper part of digestive and respiratory tract

- Dorsally – adenoid
- Ventrally – lingual tonsil
- Laterally – palatine and tubal tonsil

120. Ans. c. Palatine vein

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 231]

During tonsillectomy bleeding due to external palatine vein or para tonsillar vein and by tonsillar artery (which is lesser common).

121. Ans. a. Mylohyoid

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 132]

Oral diaphragm	Mylohyoid
Cervical diaphragm	Sibson's fascia (scalenus minimus)
Thoraco-abdominal	Diaphragm
Urogenital diaphragm	Musculofascial diaphragm situated in anterior part of perineum
Pelvic diaphragm	Levator ani



122. Ans. a. A

- A – Posterior cricoarytenoid – abductor of vocal cord
- B – Cricothyroid – tensor
- C – Lateral cricoarytenoid – adductor
- D – Transverse arytenoid – adductor

123. Ans. a. Cricothyroid

Cricothyroid – tensor

124. Ans. a. Internal laryngeal nerve

Pyriform fossa supplied by internal laryngeal nerve

125. Ans. a. C3 to C6

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 252]

126. Ans. b. 3 paired, 3 unpaired

[Ref: Last Anatomy 12th Edition 391]

According to Gray's Anatomy 41th edition, 4 pairs of paired cartilage.

Rest of other textbooks given as 3 pairs of paired cartilage

So by the given option, the correct answer is 3 pairs of paired and 3 pairs of unpaired cartilage.

127. Ans. b. Contains mucous..., d. Made up of..., e. Lined by stratified...

[Ref: Last Anatomy 12th Edition 392]

Epiglottis contain the mucous glands not serous
It is leaf shape or heart shape

128. Ans. a. Thyroid

[Ref: Last Anatomy 12th Edition 391-392]

Only hyaline cartilage undergoes ossification

So thyroid, cricoid and arytenoid except the apex of arytenoid undergoes ossification

129. Ans. b. Thyroid cartilage – hyaline, c. Cricoid – hyaline, d. Corniculate – elastic, e. Epiglottis – elastic

[Ref: Last Anatomy 12th Edition 391 - 392]

Trachea bronchial cartilage – hyaline

130. Ans. a. Posterior cricoarytenoid

[Ref: Last Anatomy 12th Edition 394-395]

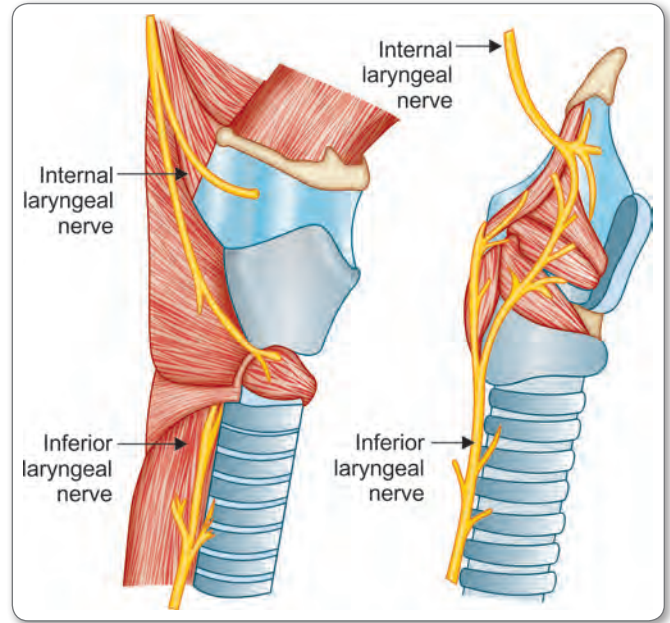
Posterior cricoarytenoid – safety muscle of larynx

131. Ans. b. Internal laryngeal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 261]

Mucosa above the vocal fold supplied by – internal laryngeal nerve

Mucosa below the vocal fold supplied by – recurrent laryngeal nerve



132. Ans. c. Recurrent laryngeal nerve

[Ref: Last Anatomy 12th Edition 396]

All the muscles supplied by recurrent laryngeal nerve, except cricothyroid which is supplied by external laryngeal nerve.

133. Ans. c. Anesthesia of larynx

[Ref: Last Anatomy 12th Edition 396]

Internal laryngeal nerve supplies mucosa of larynx
So injury causes only anesthesia of larynx

134. Ans. a. Cricothyroid

[Ref: Last Anatomy 12th Edition 392-393]

Cricothyroid is intrinsic membrane, rest of others are extrinsic membrane.

135. Ans. c. Paralysis of cricothyroid muscle

[Ref: Last Anatomy 12th Edition 396]

External laryngeal nerve accompanies superior thyroid artery.
Pyriform fossa is supplied by superior laryngeal nerve

136. Ans. c. Transverse arytenoids, e. Lateral cricoarytenoid

[Ref: Last Anatomy 12th Edition 394-395]

137. Ans. b. Supplied by glossopharyngeal nerve

138. Ans. b. Anterolateral – inferior

[Ref: Last Anatomy 12th Edition 419]

**139. Ans. c. C**

- A – Incus
- B – Posterior semicircular canal
- C – Lateral semicircular canal
- D – Superior semicircular canal

140. Ans. d. D

Key-given image is organ of Corti

- A – Outer hair cell
- B – Deiter's cell
- C – Pillar cell
- D – Inner hair cell

Spiral ganglion is bipolar. The peripheral process innervate the organ of Corti.

(Most of them innervate inner hair cells. Very few to outer hair cell)

Central process forms the cochlear nerve

141. Ans. c. Vestibule is the central chamber

[Ref: Last Anatomy 12th Edition 418 - 420]

Semicircular canals have 5 openings

Angle between each canal is 90

Spiral canal makes 2 and half turns

Basal turn is having highest radius.

142. Ans. d. Lateral

[Ref: Last Anatomy 12th Edition 420]

143. Ans. a. Subdural space

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 283]

144. Ans. a. Cochlear aqueduct

[Ref: Last Anatomy 12th Edition 419]

Perilymph communicates with CSF through aqueduct of cochlea

Endolymph – secreted by secretory cells of stria vascularis of cochlea)

Toynbee is the name of the scientist after whom it is named. (J Toynbee). Also, it is related to Toynbee's maneuver. Toynbee muscle is **Tensor Tympani**.

Stapes is the smallest bone and stapedius is the smallest muscle in the body

Incus and tallus – bone with no muscle attachment

145. Ans. b. Tensor tympani

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 277]

Muscles of middle ear

146. Ans. b. Head of malleus to roof of epitympanum

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 280]

Ligaments Present in Tympanic Cavity

Superior malleolar ligament - from the head of malleus to superior attic wall

Superior incudal ligament - from incus body to superior attic wall

Medial incudal ligament - from long process of incus to tendon of stapedius muscle.

147. Ans. b. Medial projection of middle ear cavity

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 277]

Tympanic Plexus

Tympanic branch of glossopharyngeal nerve and branch from plexus over the internal carotid artery joins to form tympanic plexus.

This tympanic plexus ramifies over the promontory (which is in the medial wall of the middle ear cavity)

148. Ans. d. Tympanic branch of glossopharyngeal nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 273]

Nerves Supplying Pinna

Great auricular nerve

Lesser occipital nerve

Auriculotemporal nerve

Auricular branch of vagus (Arnolds nerve)

Motor Supply of Viscera in the Head and Neck

All the muscles of pharynx supplied by cranial accessory through pharyngeal plexus except stylopharyngeus by glossopharyngeal nerve. The inferior constrictor in addition receives branch from recurrent and ext laryngeal nerves.

All the muscles of palate are supplied by cranial accessory through pharyngeal plexus except tensor veli palatini by mandibular nerve.

All the muscles of tongue supplied by hypoglossal nerve except palatoglossus which is supplied by pharyngeal plexus

All the muscles of larynx supplied by recurrent laryngeal nerve except cricothyroid muscle which is supplied by external laryngeal nerve.

149. Ans. c. Ophthalmic nerve

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 26]

150. Ans. b. Sphenoid

[Ref: Gray's Anatomy 40th Edition Pg 473-476]

Maxilla bone articulates with the following bones

- Frontal
- Ethmoid
- Lacrimal
- Nasal
- Inferior concha
- Zygomatic
- Palatine
- Vomer

Mn – ZN FEL In PV

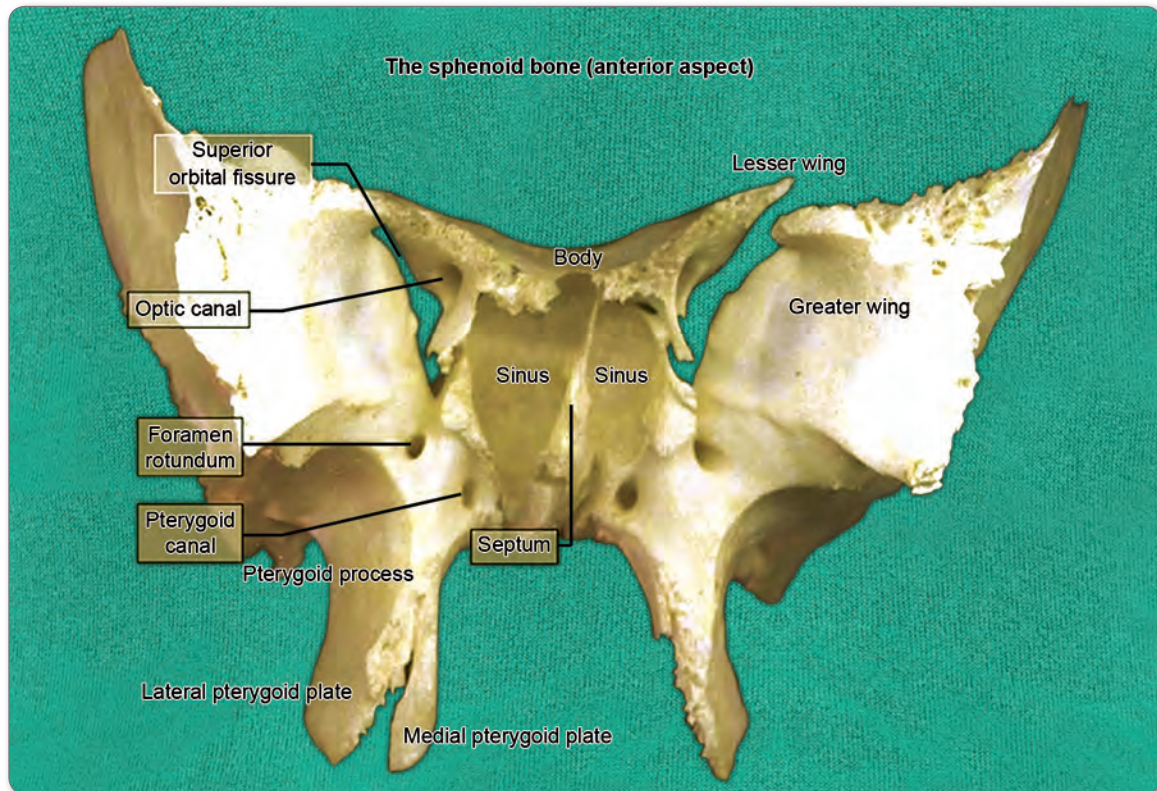
151. Ans. a. Meningeal branch of the mandibular...

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 19]

Optic foramen transmits **optic nerve invested by sheath derived from the three meninges and ophthalmic artery.**



152. Ans. a. Vidian nerve



Floor of sphenoidal sinus – pterygoid canal – which transmits vidian nerve

153. Ans. d. Ball and socket

Ball and socket

- Shoulder joint
- Hip joint
- Talocalcaneonavicular joint
- Articulation between incus and stapes

154. Ans. a. Medial

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 247]

155. Ans. a. 3 to 12

[Ref: Last Anatomy 12th Edition Pg 448-452]

Cranial nerve 1 and 2 not arise from the brain stem
Rest of the cranial nerve arise from the brain stem, so they pass through posterior cranial fossa

- Cranial nerve attaches to mid brain – 3rd and 4th
- Cranial nerve found in pons – 5th
- Cranial nerve found in the junction between pons and medulla – 6th, 7th, 8th
- Cranial nerve attaches to medulla – 9th, 10th, 11th, 12th

HIGH YIELD POINTS

Cranial nerve related to apex of petrous bone – 5 and 6

156. Ans. b. Trochlear

[Ref: A.K Datta, part II 5th ed]

157. Ans. c. Supply ipsilateral superior oblique muscle

[Ref: Last Anatomy 12th Edition Pg 495]

Trochlear nerve decussates before reaching the target
So, it supplies the contralateral muscle, not ipsilateral

158. Ans. c. Great auricular nerve

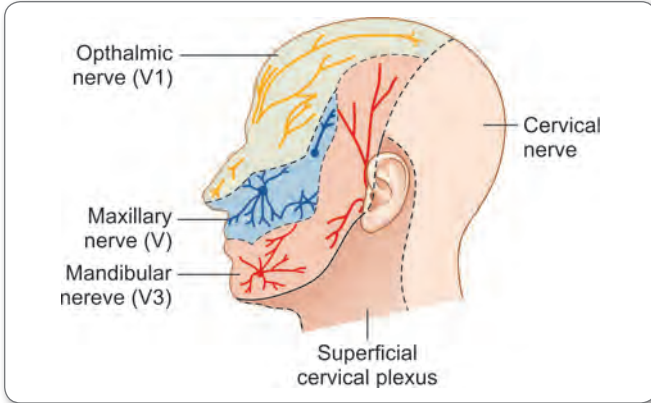
[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 69]

Nerve Supply of the Face

Motor—facial nerve supplying muscles of facial expression.
Sensory—skin of the face—supplied by branches of trigeminal nerve
Skin over the angle of the mandible—and skin over parotid gland—by great auricular nerve.

159. Ans. a. Ophthalmic division

[Ref: Last Anatomy 12th Edition Pg 495]



160. Ans. c. Trigeminal nerve

[Ref: A.K. Datta Essentials of Human Anatomy 5th ed II part]

Conjunctival or Corneal Reflex

Stimulus applied to the conjunctiva or cornea by light produce blinking.

Afferent – from corneal touch to nasociliary nerve to ophthalmic nerve to trigeminal nerve

Efferent - To Orbicularis by facial nerve.

161. Ans. b. Maxillary nerve

[Ref: A.K.Datta Essentials of Human Anatomy 5th ed II part]

162. Ans. b. Middle superior alveolar nerve

[Ref: A.K.Datta Essentials of Human Anatomy 5th ed part II]

Innervation of Upper Tooth

Premolars – Middle superior alveolar nerve

Canine and Incisor – Anterior superior alveolar nerve

Molar – Posterior superior alveolar nerve

163. Ans. b. Medial pterygoid

[Ref: A.K.Datta Essentials of Human Anatomy 5th ed II part
Ref: Qno 6

164. Ans. d. Pure motor

[Ref: Last Anatomy 12th Edition Pg 496 –497]

Relation of otic ganglion

- Above – foramen ovale
- Medial – tensor veli palatine
- Lateral – mandibular nerve (so ganglion is medial)
- Behind – middle meningeal artery (so ganglion is in front of artery)
- In front – medial pterygoid muscle

Mandibular nerve is mixed nerve

Consists of sensory root (arise from the ganglion) and motor root (arise from pons), pass through foramen ovale and unite to form trunk of mandibular nerve

165. Ans. c. Lateral to mandibular nerve

[Ref: Last Anatomy 12th Edition Pg 366]

166. Ans. a. Buccinator

[Ref: A.K.Datta Essentials of Human Anatomy 5th ed part II]

167. Ans. c. Levator palpebrae superioris

[Ref: A.K.Datta 5th ed part II Essentials of Human Anatomy]

Levator palpebrae of superioris is supplied by upper ramus of oculomotor nerve.

Facial nerve supplies facial muscles. Levator palpebrae superioris is present in the roof of the orbit supplied by oculomotor

168. Ans. a. Chorda tympani, c. Greater petrosal nerve, d. Zygomatic nerve, e. Nerve to stapedius

[Ref: Last Anatomy 12th Edition Pg497 - 498]

Lesser petrosal nerve – branch from glossopharyngeal nerve

169. Ans. e. None

[Ref: Last Anatomy 12th Edition Pg 497-498]

All the secretomotor fibers arise from facial nerve before they reach cranium

So, in the face injury, none of the gland affected

170. Ans. d. Horizontal intratympanic path of facial nerve

Schirmer's test negative – lacrimation normal – greater petrosal nerve intact

So lesion in intratympanic pathway

171. Ans. d. Facial nerve

[Ref: A.K.Datta 5th ed part II Essentials of Human Anatomy]

Anterior belly of digastric	Mylohyoid branch of the inferior alveolar branch of mandibular nerve
Posterior belly digastric	Facial nerve

172. Ans. c. Greater petrosal nerve

[Ref: A.K.Datta Essentials of Human Anatomy part II 5th ed]

Greater petrosal nerve branch of facial nerve involved in the lacrimal pathway

173. Ans. c. Pterygopalatine ganglion

[Ref: A.K.Datta Essentials of Human Anatomy part II 5th ed]

174. Ans. d. Parotid glands

[Ref: Last Anatomy 12th Edition Pg 497 - 498]

175. Ans. d. Contains postganglionic parasympathetic fibers

[Ref: A.K. Datta Essentials of Human Anatomy part II 5th ed]

Chorda Tympani Nerve

Branch of facial nerve

Passes through the tympanic membrane at the junction of pars flaccid and pars densa.



Enters the infratemporal fossa through the medial end of the pterygotympanic fissure.
It joins the posterior border of lingual nerve at an acute angle.
It conveys the preganglionic secretomotor fibers to the submandibular and sublingual glands and taste fibers of anterior two thirds of the tongue.

176. Ans. a. Auriculotemporal

[Ref: A.K. Datta Essentials of Human Anatomy 5th ed part II]

Tympanic Membrane Nerve Supply

Auriculotemporal nerve - Upper and anterior part of membrane

Auricular branch of vagus - Lower and posterior part of the membrane
glossopharyngeal nerve - Mucosa layer

177. Ans. b. Glossopharyngeal nerve

[Ref: A.K. Datta Essentials of Human Anatomy part II 5th ed]

Tympanic plexus (formed by Tympanic branches of glossopharyngeal nerve and plexus over internal carotid artery) supplies the mucosa of middle ear.

178. Ans. b. Carries postganglionic ...

[Ref: Last Anatomy 12th Edition Pg 499]

Parasympathetic System

Craniosacral flow

3, 7, 9, 10 cranial nerves carry parasympathetic fibers and Parasympathetic in general stimulate the peristalsis and evacuate

Vagus – largest contribution of parasympathetic system which carries preganglionic fibers

Supplies heart, lungs and gut up to junction between right 2/3 and left 1/3 of transverse colon

Pelvic flow from sacral component S2,3,4 supplies hind gut, testis, ovary, uterus, fallopian tube, urinary bladder.

179. Ans. c. Cranial nerve 3, 7, 9, 10 and sacral...

Parasympathetic Preganglionic Neurons

First group-located in general visceral efferent. They pass through 3, 7, 9, 10

Second group-located in S2, 3, 4

Parasympathetic Postganglionic Neurons

Located in ciliary, otic, pterygopalatine, sub mandibular ganglion

Related to vagus located in thoracic and abdominal autonomic plexus

Postganglionic neurons related to sacral outflow is located in pelvic autonomic plexus

5th cranial nerve-not involved in parasympathetic.

180. Ans. a. 4

181. Ans. c. Superior constrictor

[Ref: A.K. Datta Essentials of Human Anatomy part II 5th ed]

Spinal accessory nerve supplies Sternocleidomastoid and Trapezius

Cranial accessory – forms pharyngeal plexus which supplies muscles of palate and pharynx

Levator scapulae is supplied by Dorsal scapular nerve.

182. Ans. a. C1 – C4

[Ref: BDC 6th edition Volume 3 Pg 309]

Superior: Grey rami communicantes to C1 to C4 and last four cranial nerves

Middle: Grey rami communicantes to C5, 6

Inferior: Grey rami communicantes to C7, 8

183. Ans. a. Lies along external jugular vein

[Ref: BDC 6th edition volume 3 pg 96]

Deep cervical nodes lie along internal jugular nodes.

184. Ans. c. Superior border of thyroid cartilage

[Ref: BDC 6th edition volume 3 pg 134]

185. Ans. d. Ascending pharyngeal artery

186. Ans. c. Subscapular artery

[Ref: BDC 5th edition volume 3 pg 179]

Subscapular artery is branch of axillary artery

187. Ans. a. Superior thoracic

Anastomosis between first part of subclavian artery and 3rd part of axillary artery

Supra scapular artery and superficial cervical branch from thyrocervical trunk (subclavian artery) and subscapular and circumflex branch arising from axillary artery 3 part

188. Ans. a. Thyrocervical trunk

189. Ans. d. Anterior inferior cerebellar artery

Labyrinthine artery is branch from anterior inferior cerebellar artery or sometimes from basilar artery

190. Ans. a. Occipital artery

Circoid aneurysm-congenital malformation due to AV shunting
Most commonly seen in occipital artery

191. Ans. a. Ascending pharyngeal artery, b. Middle meningeal artery, d. Stylomastoid branch of occipital artery

Facial Nerve is Supplied by

Branch from middle meningeal artery

Stylomastoid branch of occipital artery

Branch from ascending pharyngeal artery

192. Ans. c. Genioglossus

[Ref: BDC-III, 6th edition pg 266]

Genioglossus is the safety muscle – protrusion of tongue

Depression of tongue

Push the tongue towards midline



193. Ans. c. Genioglossus

[Ref. BDC-III, 6th edition pg.266]

194. Ans. b. Palatopharyngeus

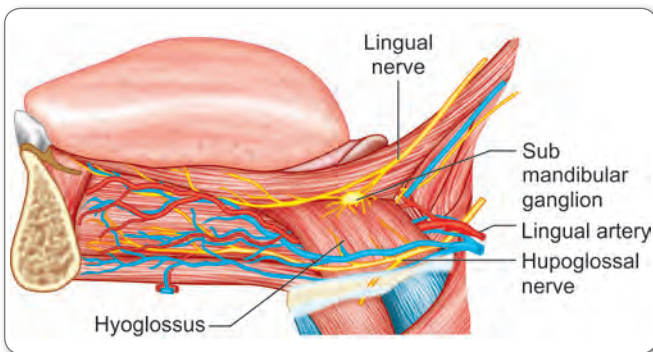
[Ref. BDC-III 6th edition pg. 266]

Muscles of tongue

- Genioglossus - supplied by hypoglossal nerve
- Hyoglossus - supplied by hypoglossal nerve
- Styloglossus - supplied by hypoglossal nerve
- Palatoglossus - supplied by pharyngeal plexus

195. Ans. a. Lingual artery

[Ref: BDC -III 6th edition pg. 267 and 133]



Lingual artery is deep to hyoglossus muscle. Other structures are superficial to hyoglossus

196. Ans. c. Superior transverse ligament of the eye

[Ref. BDC-III, 6th edition pg.206]

Whitnall's ligament - superior transverse ligament of the eye is transverse ligament in the eye surrounding the LPS.

197. Ans. d. C6-C7

[Ref. BDC-III 6th edition pg.140]

Other vertebral levels

Vertebral levels

- C3 - Hyoid bone
- C4 - bifurcation of common carotid artery
- C4-5 - Thyroid cartilage
- C6 - Cricoid cartilage, junction between larynx and trachea and pharynx and oesophagus, location of superior parathyroid
- Beginning of trachea, esophagus and first constrictions of esophagus - C6
- Termination of thoracic duct - C7
- Thoracic inlet - T1
 - Trachea bifurcation at new born - T3
 - Manubrium sternum, oblique fissure of lung - T3 and T4
 - T4 - Sternal angle and demarcation between superior and inferior mediastinum
 - Bifurcation of trachea in cadaver, superior vena cava pierces fibrous pericardium

- Arch of azygous vein termination, beginning and termination of arch of aorta
- Thoracic duct deviation from right to left, second constrictions of oesophagus
- Sternal body and pericardium - T5 to T8
- Trachea bifurcation in living and third constriction of oesophagus - T6
- Termination of accessory hemi azygos vein - T7
- Termination of hemi azygous vein - T8
- Xiphisternal joint - T8 and T9
- Oesophagus piercing diaphragm and fourth constriction of oesophagus - T10
- Beginning of thoracic duct - T12
- T11 - cardiac orifice of stomach
- T12 - aortic orifice of diaphragm, origin of coeliac trunk, epiploic foramen, upper end of kidney
- L1 - origin of superior mesenteric artery, pylorus of stomach, fundus of gall bladder, hilum of kidney, termination of spinal cord
- L2 - neck of pancreas and formation of portal vein
- L3 - origin of inferior mesenteric artery, third part of duodenum, lower end of kidney
- L1 TO L3 - second part of duodenum
- L3 TO L4 - umbilicus level
- L4 - termination of aorta into two common iliac arteries
- L5 - formation of inferior vena cava
- S3 - Beginning of rectum
- Tip of coccyx-recto sigmoid junction

198. Ans. c. Posterior to inferior turbinate

199. Ans. b. Articular disc is concavo-convex in the superior surface and concave inferior surface

Lateral pterygoid - depress the mandible
Protrusion is by medial and lateral pterygoid

200. Ans. b. Investing layer of deep cervical fascia

[Ref. BDC vol 1 6th edition pg.107]

Parotid and sub mandibular gland - covered by investing layer of deep cervical fascia
Thyroid gland - pretracheal layer of deep cervical fascia

201. Ans. b. Malleus

[Ref. BDC vol 1 6th edition pg.280]

Tensor tympani attach to handle of malleus
Stapedius - neck of stapes

202. Ans. a. Cricothyroid

[Ref. BDC vol 3, 6th ed. pg.258]

Tensor of vocal cord - cricothyroid
Relaxor of vocal cord - thyroarytenoids

203. Ans. a. Supraglottis

[Ref. BDC-III 6th edition pg.-256]

Supra glottis - area above the vocal fold
Glottis - including vocal cord
Infraglottis - area below the vocal fold



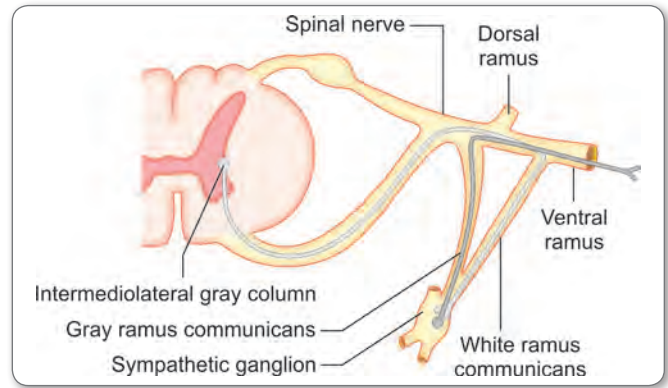
204. Ans. d. Levator vali palatini muscle

[Ref. BDC-III, 6th/e pg. 234]

- Structure passing through sinus of morgagni
- Auditory tube
- Levator vali palatine
- Ascending palatine artery
- Palatine branch of ascending pharyngeal artery
- Structures forming mammary bed
 - Pectoralis major in medial two third
 - Serratus anterior in lateral one third
 - External oblique aponeurosis in inferomedial quadrant
- Structures piercing clavipectoral fascia
 - Cephalic vein
 - Lateral pectoral nerve
 - Thoracoacromial vessels
- Structures crossed by the root of mesentery
 - Third part of duodenum
 - Abdominal aorta
 - Inferior vena cava
 - Right gonadal vessels
 - Right ureter
 - Right psoas major
 - Right genitofemoral nerve
 - Right sacroiliac joint
- Structures forming stomach bed
 - Left crus of diaphragm
 - Left supra renal gland
 - Anterior surface of left kidney
 - Tortuous splenic artery
 - Pancreas except tail
 - Anterior layer of transverse meso colon
 - Gastric impression of spleen
- Structures piercing the oblique popliteal ligament
 - Middle genicular vessels
 - Middle genicular nerve
 - Genicular branch of posterior division of obturator nerve
- Structures piercing the buccinators
 - Parotid duct
 - Buccal branch of mandibular nerve
 - Molar mucous gland
- Structures present within parotid gland
 - Facial nerve
 - Retromandibular vein
 - External carotid artery
- Structures passing through cavernous sinus
 - Internal carotid artery
 - Abducent nerve
- Structures in the lateral wall of cavernous sinus
 - Oculomotor nerve
 - Trochlear nerve
 - Ophthalmic nerve
 - Maxillary nerve
- Structures passing between superior and middle constrictor
 - Glossopharyngeal nerve
 - Stylopharyngeus muscle
- Structures pass between middle and inferior constrictor

- Internal laryngeal nerve
 - Superior laryngeal vessels
- Structures pass below inferior constrictor
- Recurrent laryngeal nerve
 - Inferior laryngeal vessels

205. Ans. c. Preganglionic



Structure of spinal nerves: Sympathetic pathways

Grey rami communicans

- Each spinal nerve receives branch called gray rami communicans from the adjacent paravertebral ganglion
- These fibres are postganglionic – unmyelinated

White rami communicans

- Preganglionic emerge from spinal nerve to reach the corresponding sympathetic chain
- Myelinted fibres

206. Ans. a. Thyrocervical trunk

(Ref: Gray's Anatomy, 41st ed., Pg 455-458)

Branches from 1st part of vertebral artery

- a. Vertebral artery
- b. Internal thoracic
- c. Thyrocervical trunk—which in turn gives suprascapular, inferior thyroid, transverse cervical artery.

207. Ans. a. Lateral and upward deviation

Oculomotor nerve damage cause:

- Down and out eyeball—due to only action of superior oblique and lateral rectus
- Ophthalmoplegia, diplopia
- Ptosis—LPS muscle involvement
- Mydriasis—sphincter pupillae muscle affected
- Loss of accommodation reflex—due to ciliaris muscle, sphincter pupil, medial rectus (all these muscles supplied by oculomotor nerve)

208. Ans. b. Incus

- A – Incus
- B – Posterior semicircular canal
- C – Lateral semicircular canal
- D – Superior semicircular canal



209. Ans. a. Elevation

- Marked muscle temporalis
- Main action—elevation.
- Posterior fibers helps in retraction

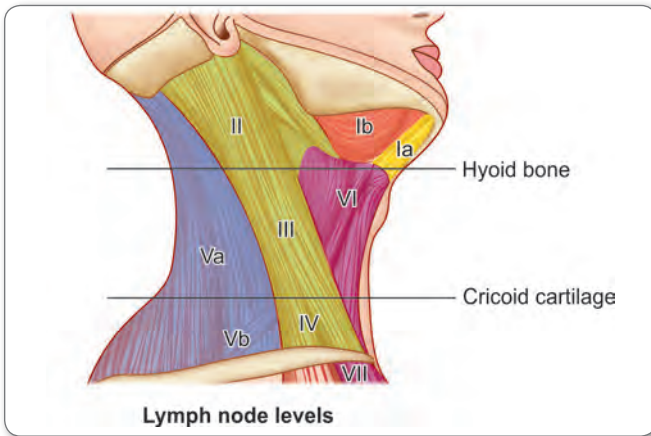
210. Ans. b. Lordosis

Lumbar Spine – Concave Posteriorly

Lordosis

Primary curvatures	Secondary curvatures
Present since birth	Acquired after birth
Thoracic and Sacral curvatures	Cervical and lumbar curvatures
Concave Anteriorly (kyphosis)	Concave posteriorly (lordosis)

211. Ans. c. Level 6 – hyoid to clavicle



212. Ans. a. III nerve injury

- In image they given medial rectus palsy,
- Eyeball position down and out
- Ptosis
- All these suggestive of III nerve injury

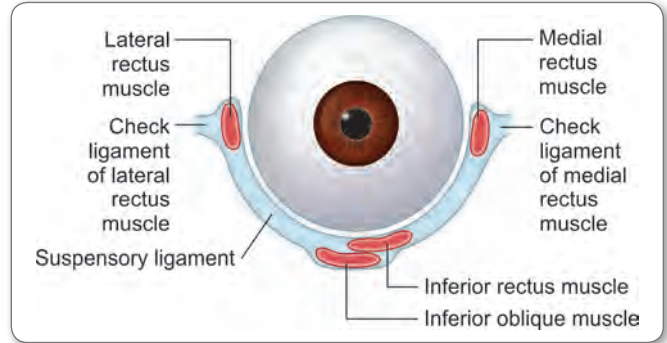
213. Ans. a. Between alar fascia and prevertebral fascia

Alar Fascia

Ancillary layer of deep cervical fascia between pretracheal and prevertebral fascia and forms subdivision of retropharyngeal space extends from base of the skull to C7 where it merges with pretracheal fascia.

Dangerous area of neck space bounded anteriorly by alar fascia and posteriorly by prevertebral layer it is extending from base to skull superiorly to diaphragm inferiorly provide the route of spread of infection.

214. Ans. c. Inferior rectus and inferior oblique



Lower part of Tenon's capsule thickened and forms suspensory ligament of lock wood which encloses inferior rectus and inferior oblique.

215. Ans. b. Internal laryngeal nerve

A small piriform fossa lies on each side of the laryngeal inlet, bounded medially by the aryepiglottic fold and laterally by the thyroid cartilage and thyrohyoid membrane. Branches of the internal laryngeal nerve lies beneath its mucous membrane.

216. Ans. b. Medially communicates with infratemporal fossa

Boundaries of Fossa

Anterior	Posterior surface of maxilla
Posterior	Root of the pterygoid process and adjoining greater wing of sphenoid
Above	Communicates with orbit
Below	Apex of the fossa
Medial	Perpendicular plate of palatine bone
Lateral	Communicates with infratemporal fossa

217. Ans. d. Great cornua of hyoid

Superior laryngeal nerve—blocked by external or internal approach

Patient in supine position—with neck extension to facilitate identification of hyoid bone

Needle is inserted from lateral side of neck aiming great cornu of hyoid bone

Then needle is directed inferiorly and inject. This will block both internal and external laryngeal nerve

218. Ans. c. Cricopharyngeus

- Cricopharyngeus as consisting of a superficial upper oblique portion, the pars oblique, and a lower, deeper, transverse portion, the pars fundiformis.
- The area demarcated by the pars oblique and pars fundiformis of cricopharyngeus is termed Killian's dehiscence (or Killian's triangle).

**219. Ans. b. C7**

The ganglion lies on or just lateral to the lateral border of longus colli between the base of the seventh cervical transverse process and the neck of the first rib (which are both posterior to it).

But in ganglion block – needle is inserted at C6

220. Ans. a. Hypocalcaemia

DiGeorge syndrome – 22q11 deletion
Hypocalcaemia and thymic hypoplasia

221. Ans. b. Atlanto-axial

Left to right – no movement – Atlanto-axial joint
Nodding movement – yes movement – Atlanto-occipital joint

222. Ans. a. Fusion of two medial nasal process

- Two medial nasal process fuses with each other and form philtrum
- Maxillary process forms upper limb and fuse with medial nasal process
- Lateral nasal process forms ala and side of nose and fuse with maxillary process

223. Ans. a. Chorda tympani nerve

Post-trematic nerve is the nerve of the corresponding arch
1st arch nerve – mandibular nerve
2nd arch – facial
3rd arch – glossopharyngeal nerve
4th arch – superior laryngeal nerve
6th arch – recurrent laryngeal nerve
Pretrematic nerve persist for 1st arch only and that is chorda tympani branch of facial nerve

224. Ans. c. External jugular vein

- Posterior triangle boundaries
- In front – posterior border of sternomastoid
- Behind – anterior border of trapezius
- Base – clavicle
- Roof – skin, superficial fascia, platysma and investing layer of deep cervical fascia
- Investing layer of deep cervical fascia is pierced by branches of cervical plexus and external jugular veins

225. Ans. b. Atlantoaxial

Atlantoaxial – No movement
Atlanto-occipital – Yes movement

226. Ans. a. Inferior alveolar nerve

Marked foramen is mandibular foramen
Mandibular foramen transmits inferior alveolar nerve and vessels

227. Ans. d. Trigeminal

Frey's syndrome often results as a side effect of surgeries of or near the parotid gland or due to injury to the auriculotemporal nerve
The Auriculotemporal branch of the Trigeminal nerve carries parasympathetic fibers to the parotid gland joins with great auricular nerve to reach sweat glands.

228. Ans. b. Anterior belly of digastric

Anterior belly of digastric derived from 1st arch

229. Ans. c. Tubal tonsil; d. Nasopharyngeal tonsil; e. Lingual tonsil

Jugulodigastric and jugulo-omohyoid not part of Waldeyer's ring

230. Ans. a. 2nd largest salivary gland; b. Stenson's duct opens into the vestibule of the mouth opposite upper third molar; d. Majority of lymph nodes are embedded in deep lobe

Largest salivary gland
Stenson's duct – opens into upper second molar tooth
Parotid nodes in superficial surface

231. Ans. b. Superior ophthalmic vein; e. Superficial middle cerebral vein

- Superior ophthalmic vein and superficial middle cerebral vein – input channels
- Superior petrosal and inferior petrosal – out going channels

232. Ans. a. Quadrangular cartilage; b. Ethmoid; c. Vomer; d. Sphenoid; e Nasal bone

Nasal septum formed by perpendicular plate of ethmoid, vomer, septal cartilage (quadrangular cartilage).
Minor contribution by nasal spine of frontal bone, crest of nasal bone, sphenoidal rostrum, palatine crest and crest of maxilla

233. Ans. c. Hypocalcaemia

DiGeorge syndrome – due to III endodermal pouch fails to differentiate into thymus and parathyroid III. So, thymus hypoplasia, hypocalcaemia (hypoparathyroidism)

NOTES

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9



NEUROANATOMY AND BACK



BASICS OF NEUROANATOMY

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NEURON

- Neuron consists of cell body and axons
- Collection of cell bodies inside the CNS called **nucleus** (developed from **neural tube**)
- Collection of cell bodies inside the PNS called **ganglion** (developed from **neural crest cells**)
- Axons in CNS called as **tracts**, lemniscus or fasciculus
- Axons in PNS called as **nerve fiber**.

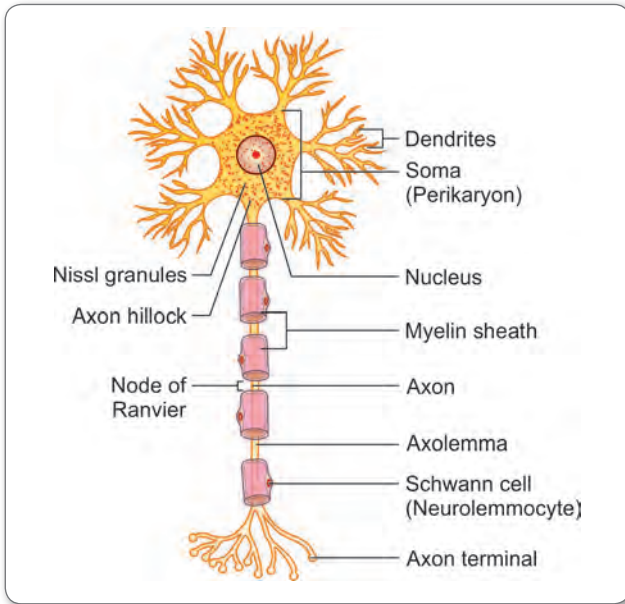


Fig. 1: Structure of neuron

Types of Neuron

Based on Polarity

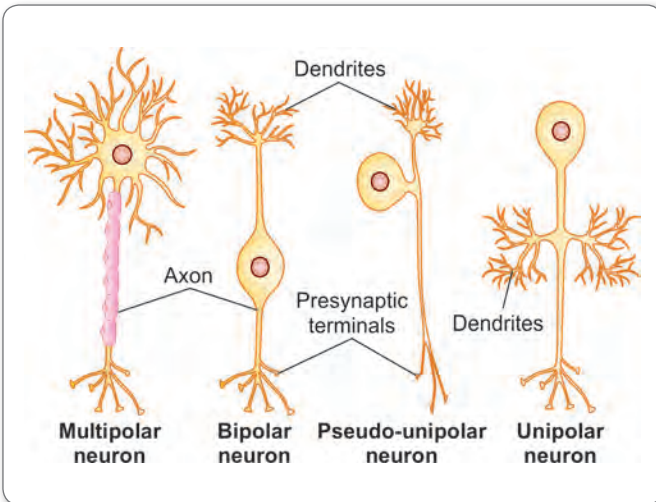


Fig. 2: Types of neuron

Unipolar	Fetal neurons and mesencephalic nucleus of trigeminal nerve
Pseudo unipolar	Single process emerges from cell body and bifurcates at T junction into peripheral process and central process. E.g. Dorsal root ganglia of spinal nerves and sensory ganglia of mixed cranial nerves V, VII, IX, X
Bipolar	Have two process. One dendrite and one axon E.g. Neurons in olfactory epithelium , 1 st order neurons of retina of the eyeball and sensory ganglia of cochlear and vestibular nerve
Multipolar	Have several dendrites and single axon E.g. All motor neurons that control the skeletal muscles, pyramidal cells of hippocampus, Purkinje cells of cerebellum

Functional Classification

- **Sensory neurons:** Carry impulse from receptor organ to CNS
- **Motor neurons:** Carry impulse from CNS to muscles and glands
- Types of motor neuron:
 - **Upper motor neuron (UMN):** Cell bodies are located in cerebral hemisphere, viz motor area of cerebral cortex and brainstem. These upper motor neuron influence lower motor neurons. UMN lost their control on LMN, in UMN lesion. So UMN lesion – causes **spastic paralysis**, increased tone of muscles and exaggerated tendon reflexes.
 - **Lower motor neuron (LMN):** Neurons that innervate the skeletal muscles. Found in **anterior horns of spinal cord**. LMN lesion result from damage to motor neurons which result in **flaccid paralysis**.



Clinical Aspect

Features of UMN and LMN lesions

UMN lesion	LMN lesion
<ul style="list-style-type: none"> • Spastic paralysis • Hyper reflexia (exaggerated DTR) • Muscle tone increased : • Clasp – knife rigidity • Clonus – rhythmic contractions of muscles in response to sudden, passive movements • Extensive damage plate here • Babinski sign: Present • No reaction of degeneration 	<ul style="list-style-type: none"> • Flaccid paralysis • Areflexia (Absent tendon reflexes) • Hypotonia (Muscle tone abolished) • Muscle atrophy • Fasciculations • Fibrillations • Limited damage • Plantar stimuli gives plantar flexion of great toe • Babinski negative • Reaction of degeneration seen



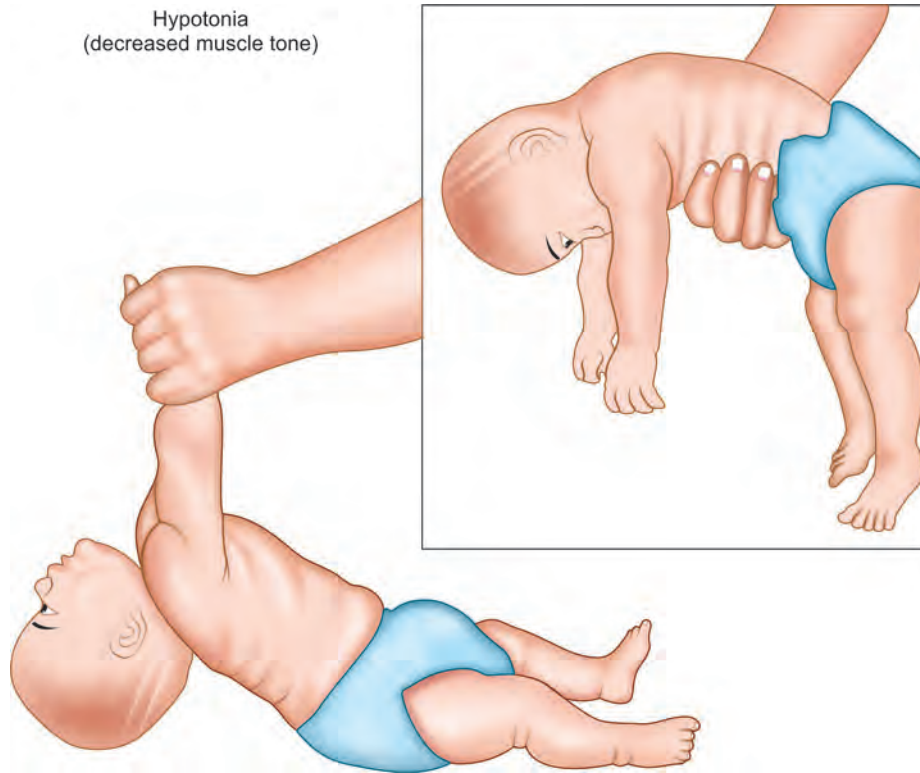
Clinical Aspect

Babinski's Sign

In case of lesion of corticospinal tract there is dorsiflexion of big toe and fanning of other toes in response to scratching the skin on the lateral side of sole. This sign is positive in case of upper motor neuron lesion.

Disease of LMN

- Polio: Asymmetric LMN lesion due to viral infection result in flaccid paralysis
- Werdnig: Hoffmann disease—heredofamilial degenerative lesion of infants—symmetric lesion—results in floppy baby.



Floppy baby in Werdnig-Hoffman's disease

Combined Upper and Lower Motor Neuron Lesion

Amyotrophic lateral sclerosis—involves both UMN and LMN. Progressive muscular atrophy refers to LMN lesion. Pseudobulbar palsy refers to UMN component.

Peripheral Nerve Disease

- Herpes zoster: Viral infection, affect the dorsal root ganglia
- Guillain-Barré syndrome (GBS)—postinfectious polyneuritis. Usually follows an infectious illness. Elevates CSF protein, however CSF cell count remains normal—albuminocytologic dissociation.

OTHER CELLS IN CNS

- Astrocyte—forms blood brain barrier
- Oligodendrocytes—myelin sheath formation in CNS
- Schwann cells—myelin sheath formation in PNS
- Microglia—phagocytic function
- Ependymal cells—line the ventricles.

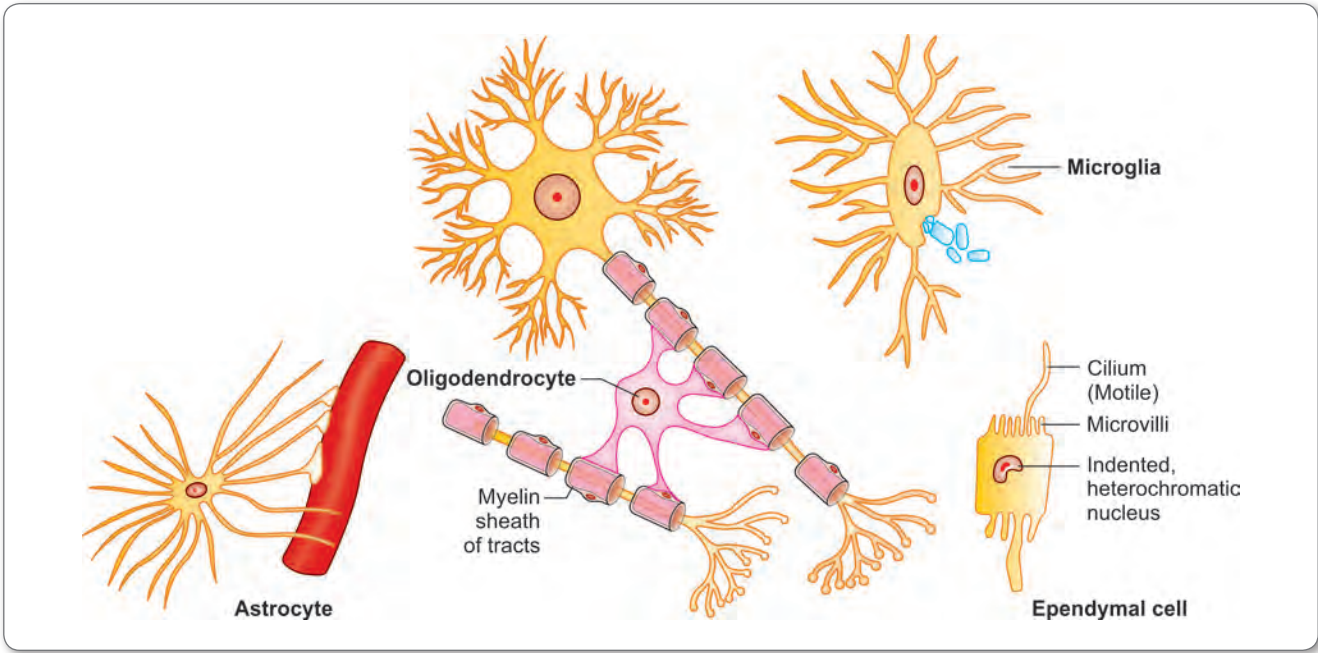
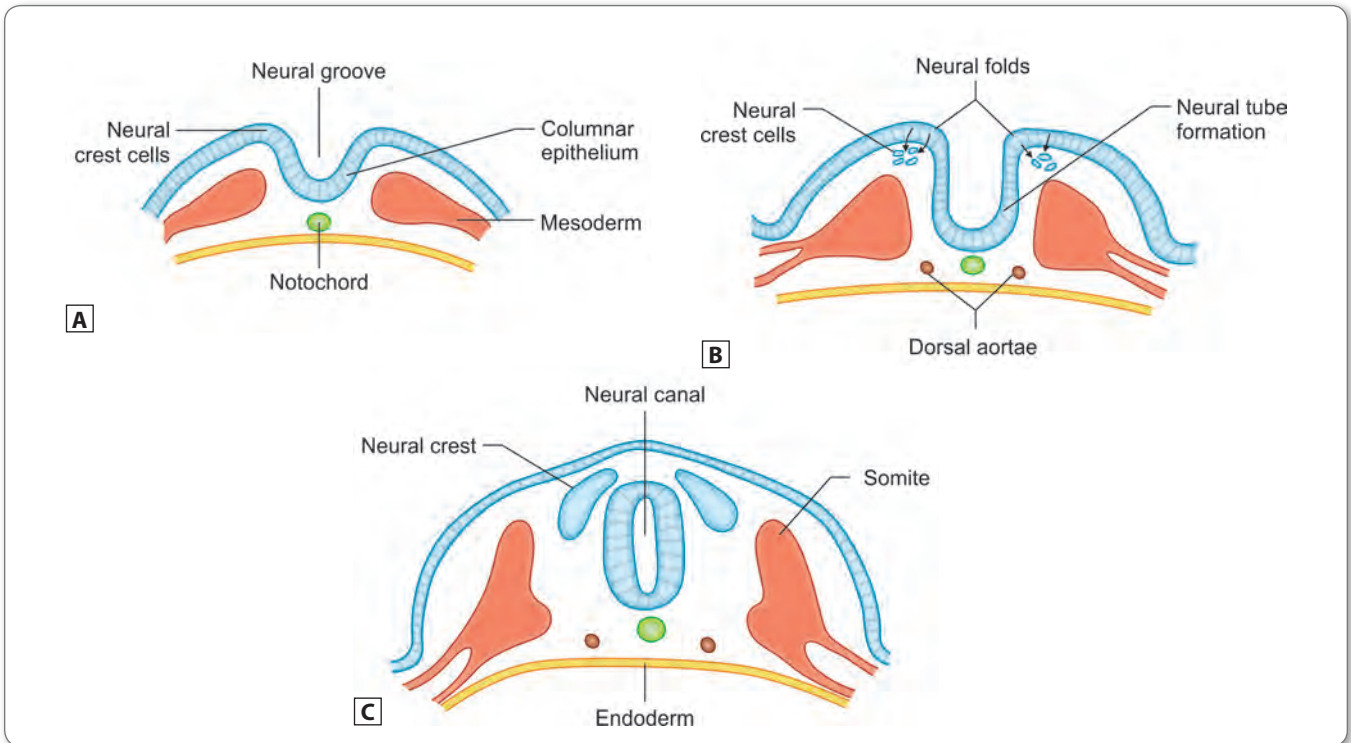


Fig. 3: Other cells in CNS

EMBRYOLOGY

Neural Tube Development



Figs 4A to C: Development of neural tube

- Begins in 3rd week
- Notochord induces overlying ectoderm to form neural plate.



Neural Groove and Neural Folds

- Forms as neural plate begins to grow and fold inward
- Located centrally and flanked by neural folds
- Neural folds fuse in the midline beginning in the middle and proceed cranially and caudally to form neural tube
- Edges are site of neural crest differentiation.

Formation of Neural Tube

- Forms as the neural folds fuse in the midline and separate from surface ectoderm
- Lies between surface ectoderm and notochord
- Cranial part of neural tube forms brain
- Caudal part forms spinal cord
- Cavity in the neural tube forms central canal of spinal cord and ventricles of brain
- Neural tube formation first begins in the cervical region, so central canal communicates with amniotic cavity cranially and caudally forming cranial (anterior) and caudal (posterior) neuropore
- Anterior neuropore becomes lamina terminalis
- Anterior neuropore closes at **25th day**
- Anterior neuropore fails to close, results in anencephaly
- Posterior neuropore close 2–3 days later—**27–28th day**
- Failure of closure of posterior neuropore results in rachischisis.

HIGH YIELD POINTS

Neural Crest Cells

- Forms near the edges of neural folds
- Neural crest cells: When neural tube is formed, neural crest cells also separated from surface ectoderm
- Considered as the fourth germ layer
- Also called as secondary mesenchyme
- These are group of multipotent migratory cells.

REMEMBER

Neural Crest Derivatives

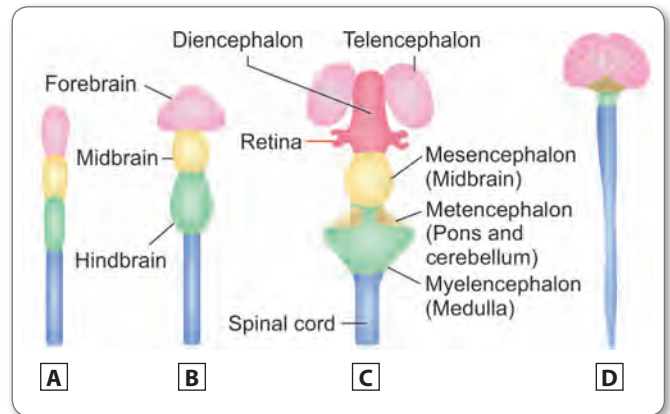
- Connective tissue and bones of the face and skull
- Cranial nerve ganglia
- C cells of the thyroid gland
- Conotruncal septum in the heart
- Odontoblasts
- Dermis in face and neck
- Spinal (dorsal root) ganglia
- Sympathetic chain and preaortic ganglia
- Parasympathetic ganglia of the gastrointestinal tract
- Adrenal medulla
- Schwann cells
- Glial cells
- Arachnoid and pia mater (leptomeninges)
- Melanocytes.

Placodes

- Localized thickening of cephalic part of surface ectoderm
- **Olfactory placodes** induce the formation of olfactory bulbs
- **Otic placodes**—forms organ of Corti and spiral ganglion, crista ampullaris, macula of utricle and saccule and vestibular ganglion and vestibulocochlear nerve.
- Optic placodes—which form the lens
- Trigeminal placodes—forms cells of trigeminal ganglion.

Brain Development

- Cranial part of neural tube forms brain and form three dilations prosencephalon, mesencephalon and rhombencephalon
 - Prosencephalon forms **telencephalon and diencephalon**
 - Rhombencephalon forms **metencephalon and myelencephalon**



Figs 5A to D: Development of brain; (a) Neural tube; (b) Primary brain vesicles; (c) Secondary brain vesicles; (d) Postnatal CNS

Table 1: Derivatives from dilatations of neural tube

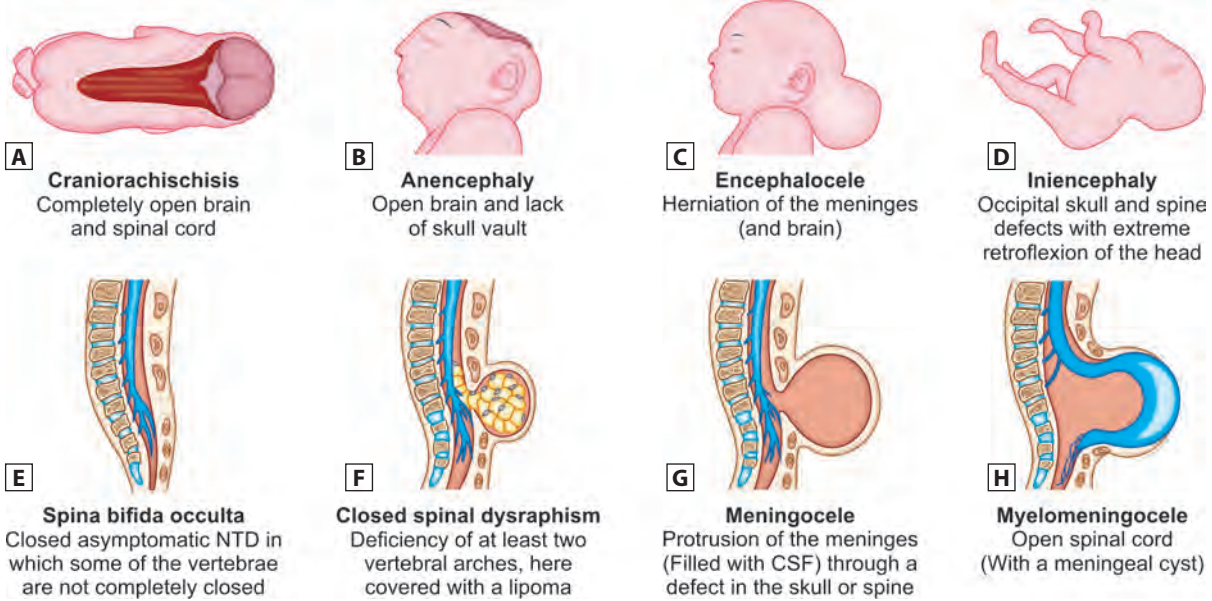
Part	Derivatives	Cavity
Telencephalon	Cerebrum and corpus striatum	Lateral ventricle
Diencephalon	Thalamus, hypothalamus, epithalamus, metathalamus, subthalamus, pars nervosa, retina, optic nerve etc.	III ventricle
Mesencephalon	Mid brain	Cerebral aqueduct of Sylvius
Metencephalon	Pons and cerebellum	IV ventricle
Myelencephalon	Medulla	IV ventricle



Clinical Aspect

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Neural Tube Defects



Figs 6A to H: Neural tube defects

Table 2: Neural tube defects

Anencephaly	<ul style="list-style-type: none"> • Cranial neuropore fails to close • Brain–exposed • Loss of swallow reflex results in polyhydramnios
Spina bifida	<ul style="list-style-type: none"> • Spina bifida occulta—vertebral arches fail to close. Tuft of hair seen over the defect • Spina bifida with meningocele: Vertebral arches fails to close and meninges protrude through the defect form sac which is filled with CSF • Spina bifida with myelomeningocele: Vertebral arches fail to close and meninges and spinal cord protrude through the defect and forms sac. Usually present in Arnold-Chiari malformation
Arnold-Chiari malformation	<ul style="list-style-type: none"> • Cerebellomedullary malformation where caudal part of vermis herniates through foramen magnum and results in obstructive hydrocephalus
Dandy walker syndrome	<ul style="list-style-type: none"> • Cyst of the posterior fossa with atresia of outlet of fourth ventricle • So dilatation of IV ventricle • Agenesis of cerebellar vermis
Aqueductal stenosis	<ul style="list-style-type: none"> • Most common cause of congenital hydrocephalus • Transmitted by X linked trait
Fetal alcohol syndrome	<ul style="list-style-type: none"> • Includes growth retardation, microcephaly and congenital heart anomalies

Note:

- Neural tube defects due to deficiency of folic acid
- Alpha-fetoprotein level elevated in NTD.

Layers of Neural Tube

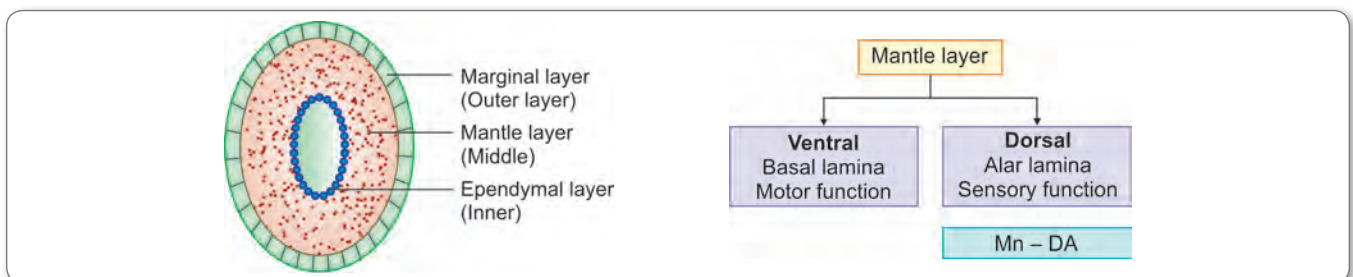


Fig. 7: Layers of neural tube



Table 3: Structures derived from basal and alar lamina

	From alar lamina (dorsal – sensory)	From basal lamina
Medulla	<ul style="list-style-type: none"> • Somatic afferent—spinal nucleus of trigeminal • Special visceral afferent—nucleus tractus solitarius • General visceral afferent—dorsal nucleus of vagus 	<ul style="list-style-type: none"> • Somatic efferent—hypoglossal nucleus • Special visceral efferent—nucleus ambiguus • General visceral efferent—inferior salivatory nucleus
Pons	<ul style="list-style-type: none"> • Special somatic afferent—vestibular and cochlear nuclei • Somatic afferent—chief sensory and spinal nucleus of trigeminal • Special visceral afferent—nucleus tractus solitarius Pontine nucleus 	<ul style="list-style-type: none"> • Somatic efferent—abducent nucleus • Special visceral efferent—motor nucleus of facial nerve, motor nucleus of trigeminal nerve • General visceral efferent—superior salivatory nucleus and lacrimatory nucleus
Midbrain	<ul style="list-style-type: none"> • Superior and inferior colliculi • Substantia nigra • Red nucleus • Mesencephalic nucleus of trigeminal nerve 	<ul style="list-style-type: none"> • Somatic efferent—occulomotor and trochlear nucleus • General visceral efferent—Edinger Westphal nucleus.

FUNCTIONAL COLUMNS AND NUCLEI OF CRANIAL NERVE

Sulcus limitans divides the mantle zone of brain stem and spinal cord into anterior motor efferent basal plate and posterior sensory afferent alar plate.

Sensory component form in dorsal alar plate and motor component in ventral basal plate.

Table 4: Afferents and efferents from brainstem

Efferent	Afferent
<p>General somatic efferent Supply somatic origin striated muscles. Occipital somites form tongue muscles Supplied by XII nerve Pre occipitalsomites -form extraocular muscles Supplied by III, IV and VI nerve. So, nucleus of III, IV, VI and XII in this column.</p>	<p>General somatic afferent Carry general sensation</p> <ul style="list-style-type: none"> • Chief sensory nucleus in pons, • Spinal nucleus in medulla and • Mesencephalic nucleus of trigeminal nerve in mid brain
<p>Special visceral efferent To supply Pharyngeal arch muscles Motor nucleus of V, VII & nucleus ambiguus (IX, X, XI) Nucleus ambiguus—fibers from IX, X and XI mingle</p>	<p>Special somatic afferent Somatic origin and Carry special sensation I, II and VIII (vestibular and cochlear nuclei)</p>
<p>General visceral efferent—(parasympathetic) Supply the glands and smooth muscles</p> <ul style="list-style-type: none"> • Superior salivatory nucleus • Lacrimatory nucleus (caudal part of superior salivatory nucleus) • Inferior salivatory nucleus • Dorsal nucleus of vagus • Edinger westpaul nucleus <p>(Cranial nerve with parasympathetic function III, VII, IX, X)</p>	<p>General visceral afferent – Nucleus tractus solitarius Carry general sensation from viscera (heart, lung, GIT)</p>
	<p>Special visceral afferent – Nucleus tractus solitarius Carry special sensation taste from tongue Nucleus of solitary tract (VII, IX and X)</p>



SPECIAL VISCERAL EFFERENT

- 1st arch—Mandibular nerve—Motor nucleus of trigeminal nerve
- 2nd arch—facial nerve—Motor nucleus of facial nerve
- 3rd arch—glossopharyngeal nerve—nucleus ambiguus
- 4th arch—superior laryngeal nerve—nucleus ambiguus
- 6th arch—recurrent laryngeal nerve—nucleus ambiguus

General Visceral Afferent Inferior Salivatory Nucleus

Auriculo-temporal nerve

Inferior salivatory nucleus **IX** otic ganglion _____ parotid

Fibers from inferior salivatory nucleus reach otic ganglion. Fibers from otic ganglion reach the parotid gland

Glossopharyngeal nerve carries preganglionic fibres from nucleus to otic ganglion

Auriculotemporal nerve carries postganglionic fibres from otic ganglion to parotid gland.

Superior Salivatory Nucleus

Superior salivatory nucleus **VII** Submandibular ganglion _____ Submandibular gland and sublingual gland

Fibres from Superior salivatory nucleus reach submandibular ganglion. From submandibular ganglion reach the submandibular gland and sublingual gland.

Facial nerve carries preganglionic parasympathetic fibres from nucleus to submandibular ganglion.

Lacrimal Nucleus

Lacrimal Nucleus **VII** Pterygopalatine sphenopalatine ganglion _____ Lacrimal gland palatal gland nasal gland

Fibres from Lacrimal nucleus reach pterygopalatine ganglion. Fibres from ganglion reach lacrimal gland, palatal gland and nasal gland

Facial nerve carries preganglionic fibres from nucleus to pterygopalatine ganglion

Edinger westphal nucleus

Edinger westphal nucleus **III** Ciliary ganglion Sphincter pupillae ciliaris muscle

Fibres from Edinger westphal nucleus reach ciliary ganglion. From ciliary ganglion reach sphincter pupillae muscle and ciliaris muscle

Note: Lesion of III nerve leads to paralysis of sphincter pupillae and ciliaris muscles leads to paralysis of these muscle and results in mydriasis and loss of accommodation

Mesencephalic nucleus—general somatic afferent

- Present in mid brain
- Contains unipolar neurons
- Centre for jaw jerk
- Conveys proprioceptions

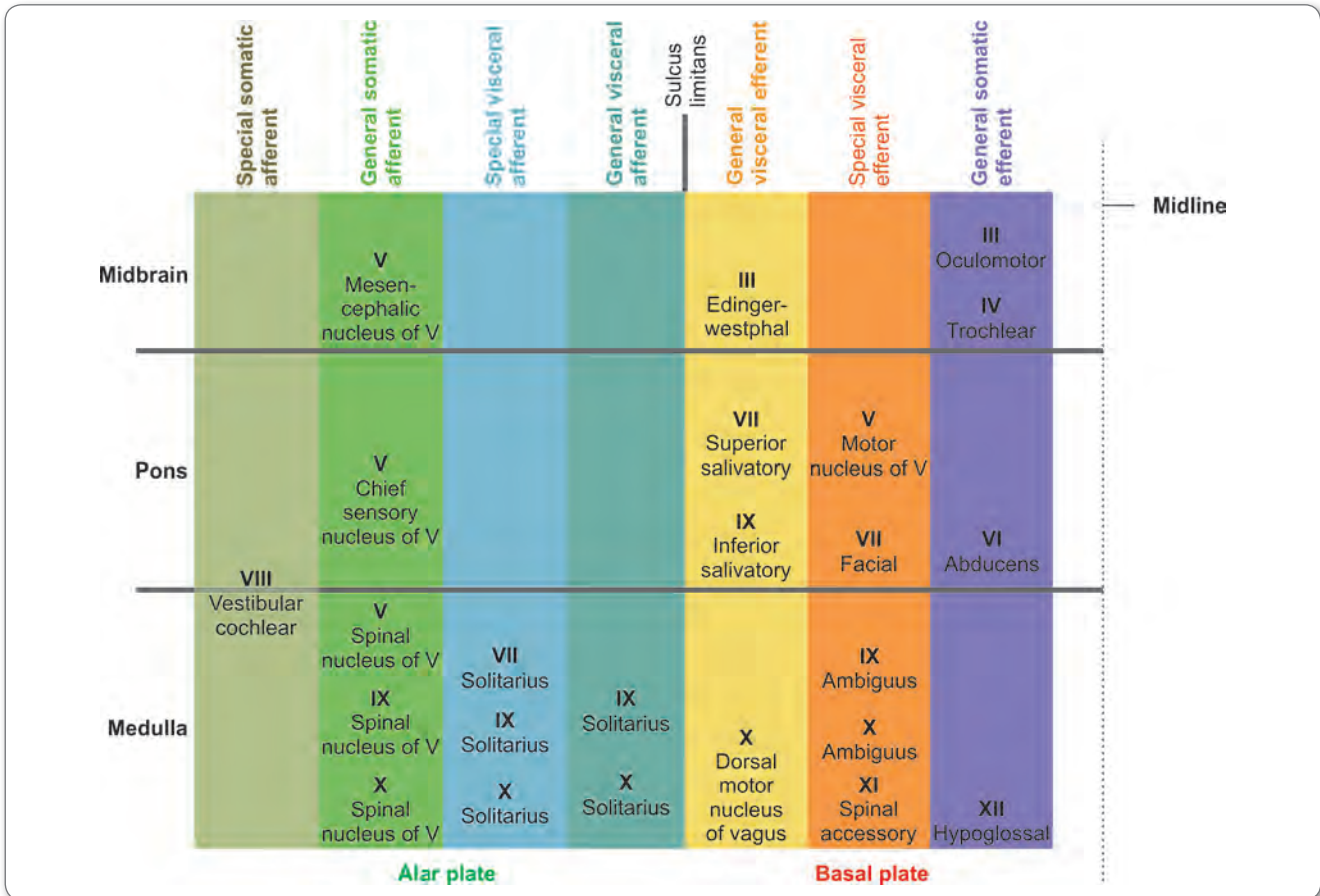


Fig. 8: Brainstem cranial nerves and nuclei

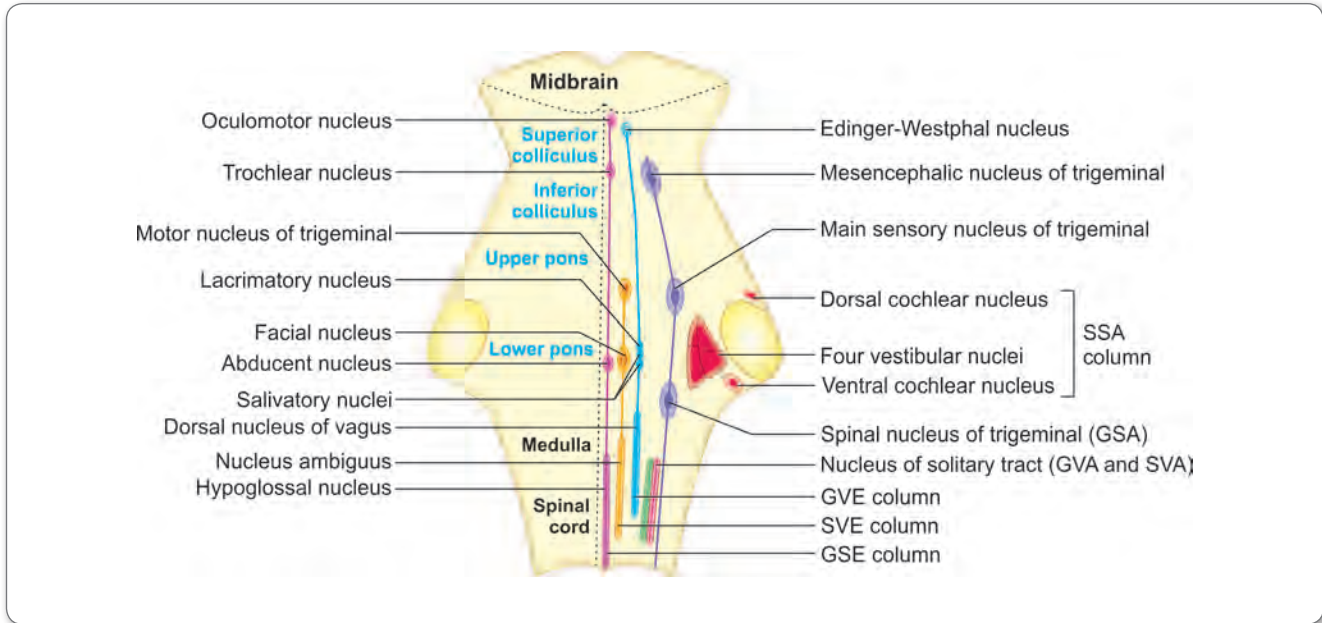


Fig. 9: Nuclei in brainstem

Nucleus Ambiguus

- Elongated motor neuron extending throughout the medulla
- It is not clearly defined in sections of medulla hence the name
- Occupies position dorsal to inferior olivary nucleus
- Fibers from this nucleus mingle with IX, X, XI A and emerge in the posterolateral sulcus of medulla.
- These fibers supply the muscles derived from III, IV and VI arch.

Nucleus Tractus Solitarius

- Situated in medulla
- Rostral part of nucleus is concerned with taste sensation and receives afferent fibers from VII, IX and X and referred to gustatory nucleus
- The caudal part of nucleus receives general visceral sensation
- Axons from this nucleus to the thalamus and hypothalamus through solitario-thalamic and solitario-hypothalamic tract
- Then these fibers join the **medial lemniscus** of the opposite side on their way to thalamus and hypothalamus
- The neurons from thalamus then project to the cerebral cortex.

MENINGES AND CEREBROSPINAL FLUID

Meninges of Brain

- Comprise of three membrane that invest the brain and spinal cord
- Consist of pia mater, arachnoid (together known as leptomeninges derived from neural crest) and dura mater (pachymeninges derived from mesoderm)

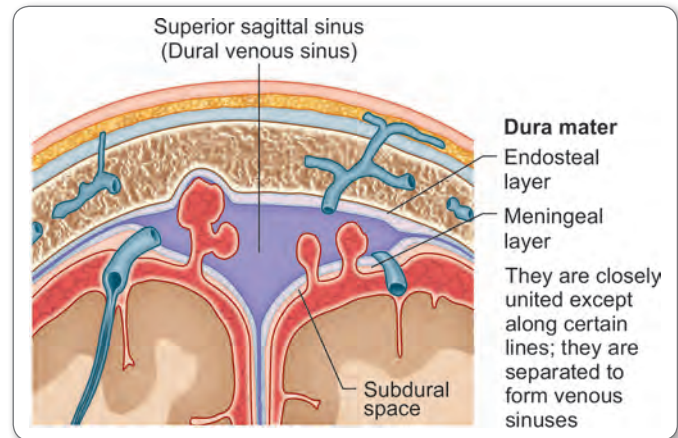


Fig. 10: Coronal section of upper part of head

Dura Mater

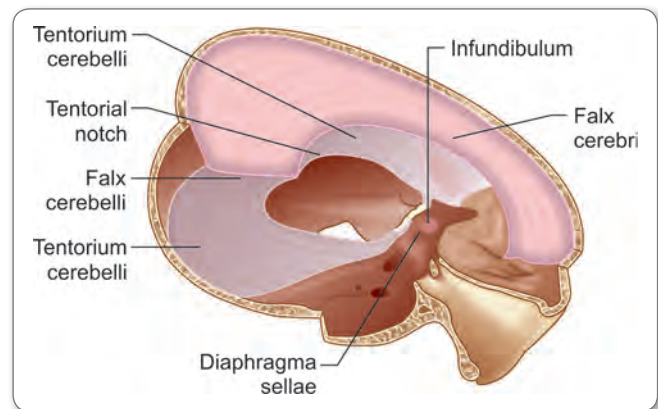


Fig. 11: Dura mater



- Outermost layer and consists of outer endosteal layer and inner meningeal layer. In between two layers venous sinuses present
- These layers gets reduplicated and form dural folds.

Dural Folds

- **Falx cerebri:** Large-sickle shaped fold which dip into longitudinal fissure between 2 cerebral hemisphere. Contains superior sagittal sinus, inferior sagittal sinus and straight sinus.
- **Tentorium cerebelli:** Tent-like semilunar fold over the roof of posterior cranial fossa with cerebellum below. This separates brain into supratentorial and infratentorial compartments. Contains superior petrosal sinus and transverse sinus.
- **Falx cerebelli:** Small sickle-shaped fold between 2 cerebellar hemispheres. Contains occipital sinus.
- **Diaphragma sellae:** Small circular fold which roofs pituitary fossa. Contains anterior and posterior intercavernous sinus.

Blood Supply

Blood supply of meninges concerns blood supply of outer layer of dura rather than inner layer of dura, arachnoid, pia which do not require large blood supply.

Anterior cranial fossa supplied by:

- Anterior ethmoidal artery
- Posterior ethmoidal artery
- Ophthalmic artery

Middle cranial fossa supplied by:

- Middle meningeal artery
- Accessory middle meningeal artery
- Meningeal branch of internal carotid artery

Posterior cranial fossa supplied by vertebral and occipital artery.

Nerve Supply

- Dura is mainly innervated by trigeminal nerve
- **Anterior cranial fossa supplied by:**
 - Anterior ethmoidal nerves and posterior ethmoidal nerves (branch of ophthalmic division of trigeminal)
- **Middle cranial fossa supplied by:**
 - Nervus spinosum and meningeal branch of maxillary nerve
- **Posterior cranial fossa supplied by:**
 - Meningeal branch of C1, C2, C3
 - Cervical sympathetic trunk
 - Some contribution from facial nerve, glossopharyngeal, vagus and hypoglossal.



Clinical Aspect

Inflammation of pia mater and arachnoid mater is known as meningitis. This is commonly tubercular or pyogenic. It is characterized by fever, marked headache, neck rigidity, and a changed biochemistry of CSF.

Arachnoid Membrane

- Thin transparent avascular membrane lying between piamater internally and dura externally.
- Invest brain loosely and continue as spinal meninges.

Arachnoid Granulations (*Pacchionian bodies*)

- Accumulations of arachnoid villi, formed by evaginations of arachnoid through meningeal layer of dura
- Enter the dural venous sinuses and facilitate the flow of CSF from subarachnoid space to venous circulation.
- Found in large number along superior sagittal sinuses but associated with all other dural sinuses.

Piamater

- Transparent vascular membrane which closely invests the brain.
- **Forms sheath of cranial nerves**
- Perivascular sheath around the vessels which enter or leave the brain.
- Connected to arachnoid by arachnoid trabeculae
 - **Denticulate ligaments:** Consists of two lateral flattened bands of pial tissue. Adhere to spinal dura with 21 pairs of attachments
 - **Filum terminale:** Extension of pia. Extends from conus medullaris to coccyx.

Meningeal Spaces

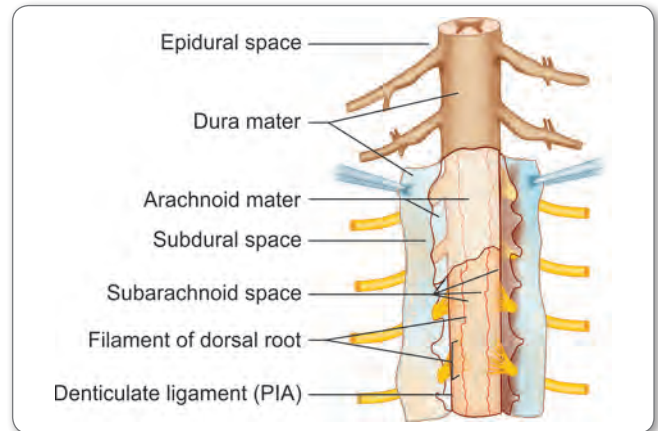


Fig. 12: Meningeal spaces

- **Spinal epidural space**
 - Located between spinal dura and vertebral periosteum
 - Contains loose areolar tissue, venous plexuses and lymphatics
- **Cranial epidural space**
 - Potential space between dura and bones of cranial vault
 - Contains meningeal arteries and veins
- **Subdural space**
 - Potential space between dura and arachnoid
 - Transmits cerebral veins to superior sagittal sinus
 - Injury of these bridging veins cause subdural hematoma
- **Subarachnoid space**
 - Between pia and arachnoid
 - Contains CSF which surrounds brain and spinal cord
- **Subarachnoid cistern**
 - Dilatations of subarachnoid space, which contain CSF. Named after the structures over which they lie
 - **Cerebellopontine angle cistern** receives CSF from the fourth ventricle via foramen of Luschka. Contains facial nerve and vestibulocochlear nerve



- **Cerebellomedullary cistern (cisterna magna)** receives CSF from the fourth ventricle via foramen magndie. Can be tapped for CSF (suboccipital tap)
- **Ambient cistern:** Interconnects the superior and interpeduncular cisterns. Contains trochlear nerve
- **Superior cistern:** Overlies midbrain tectum.

- CSF is the ultrafiltrate of blood
- Escapes from lateral ventricle into third ventricle via foramen of monro
- From third ventricle passes through aqueduct of sylvius into fourth ventricle and then into fourth ventricle
- From the fourth ventricle to sub arachnoid space by three formina. Central foramen—foramen of magendie and 2 lateral foramen—foramen of Luschka
- CSF—absorbed from subarachnoid space by arachnoid villi and drain into superior sagittal sinus
- CSF is also absorbed by perineural lymphatics around 1st, 2nd and 8th cranial nerves
- CSF is first produced by amniotic fluid and then by lateral ventricle (chiefly), third and fourth ventricle.
- CSF circulation is given in the flowchart.

Cerebrospinal Fluid

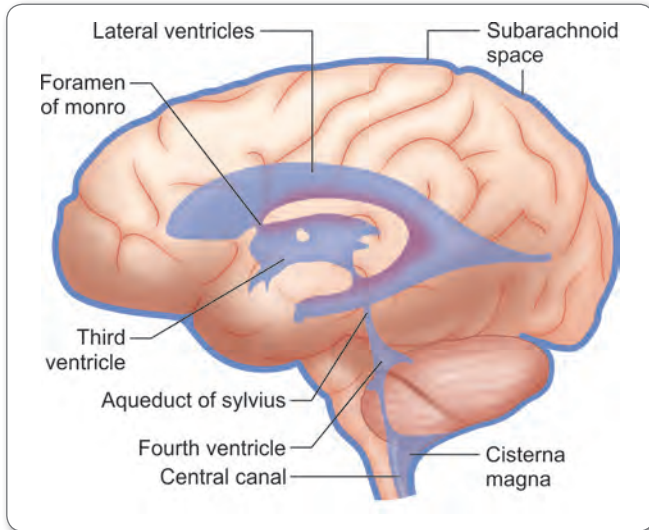


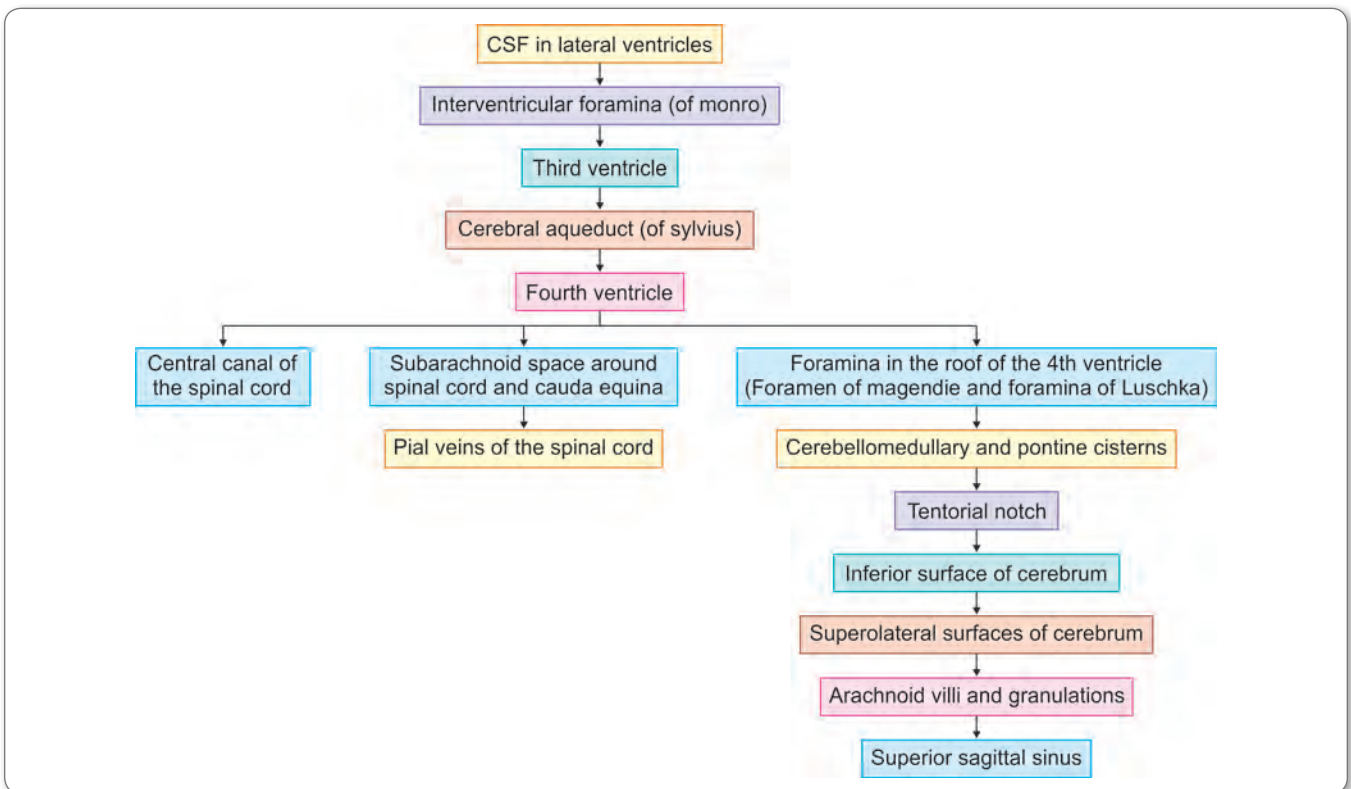
Fig. 13: Circulation of cerebrospinal fluid (CSF)

REMEMBER

Numerical Values of CSF

- Normal rate of formation of CSF—600–700 mL/day
- In supine position, CSF pressure—80–180 mm of water
- In sitting posture—300–400 mm of water.

Circulation and Absorption of CSF





VENTRICLES

- Lined with ependyma and contain CSF
- Contain choroid plexus, which produces CSF
- Consists of four fluid filled communicating cavities within the brain
- Lateral ventricle in cerebrum, III ventricle in diencephalon and IV ventricle in pons and medulla.

Lateral Ventricle

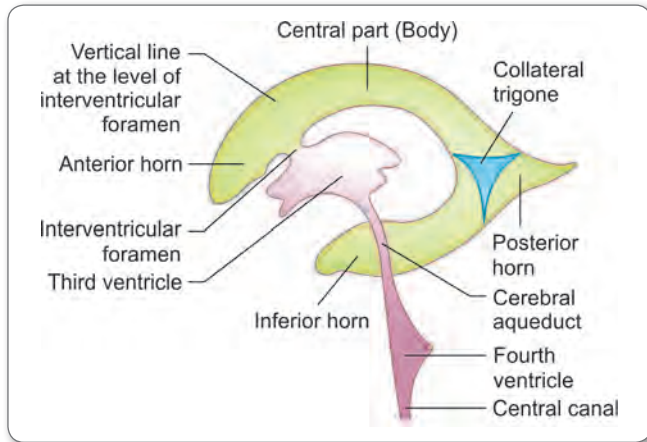
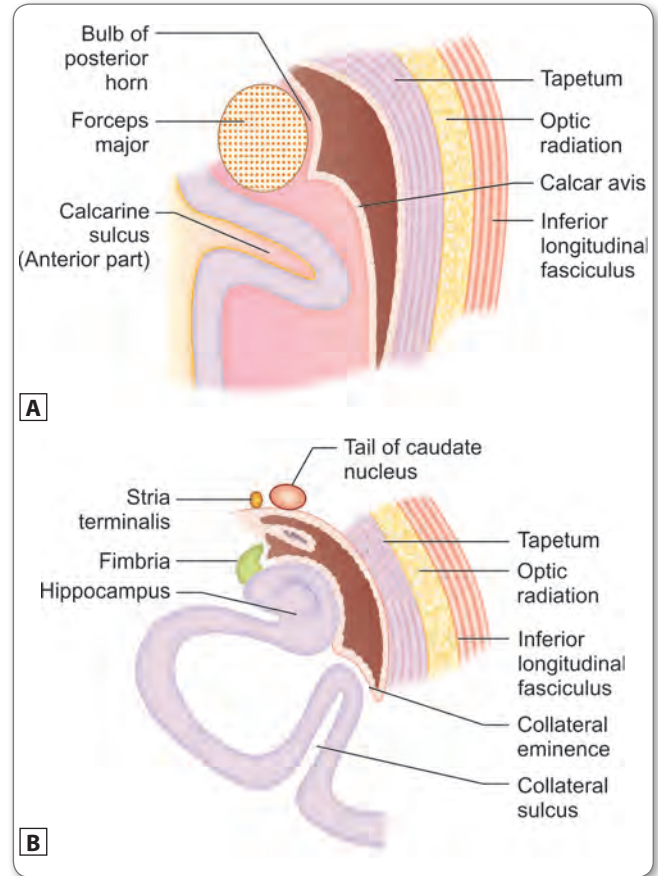


Fig. 14: Lateral ventricle of brain

- Located within cerebral hemisphere. Communicate to third by foramen of monro
- Lateral ventricle consists of central part and three horns
- Trigone (atrium)—located at the junction of body, occipital horn and temporal horn of lateral ventricle. Contains glomus (tuft of choroid plexus which is calcified in adults and it is visible on X-ray and CT).

Parts and Relations of Lateral Ventricle



Figs 15A and B: Relations of lateral ventricle

Table 5: Relations of lateral ventricle

Central part	Anterior horn	Posterior horn	Inferior horn
Lies in parietal lobe extends from interventricular foramen in front to splenium of corpus callosum	Extends from central part into frontal lobe	Extends from central part into occipital lobe	The largest and the longest horn
<ul style="list-style-type: none"> • Roof under surface of corpus callosum • Floor body of caudate nucleus • Medial wall septum pellucidum 	<ul style="list-style-type: none"> • Roof under surface of anterior part of body of corpus callosum • Floor-upper surface of rostrum of corpus callosum • Medial wall septum pellucidum • Lateral wall bulging of head of caudate nucleus 	<ul style="list-style-type: none"> • Roof, lateral wall, floor tapetum, optic radiation • Medial wall: Forceps major, calcar avis 	<ul style="list-style-type: none"> • Roof: Tapetum, tail of caudate nucleus • Floor-hippocampus collateral eminence



Third Ventricle

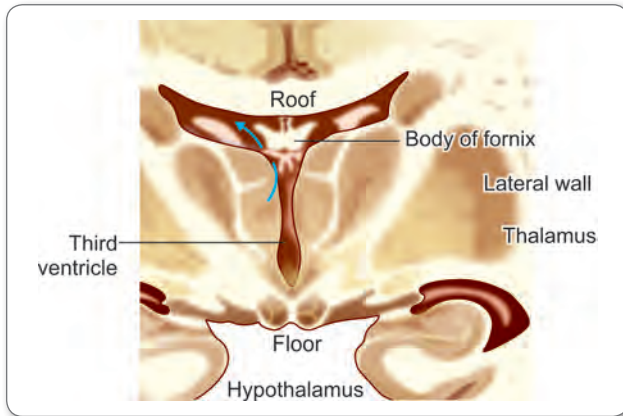


Fig. 16: Third ventricle

- **Slit-like cavity** present between the two thalami (diencephalon)
- Communications
 - With lateral ventricle by interventricular foramen of monro
 - With fourth ventricle by cerebral aqueduct of sylvius
- Contains choroid plexus in the roof.

Relations

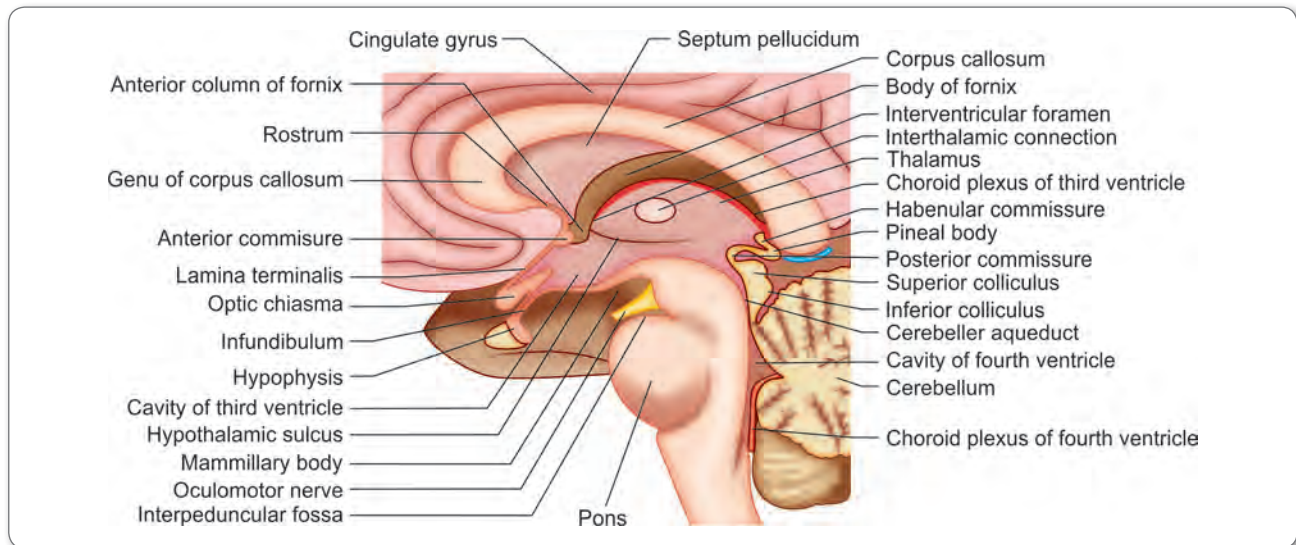


Fig. 17: Relations of IIIrd ventricle

Table 6: Parts and relations of IIIrd ventricle

Anterior wall	Posterior wall	Floor	Lateral wall
<ul style="list-style-type: none"> ● Anterior commissure ● Anterior column of fornix ● Lamina terminalis 	<ul style="list-style-type: none"> ● Posterior and habenular commissure ● Pineal gland 	Optic chiasma Infundibulum Pituitary Tuber cinereum Mammillary body Posterior perforated substance Tegmentum of mid brain	<ul style="list-style-type: none"> ● Thalamus ● Hypothalamus

Note: Interpeduncular fossa contents = floor of the IIIrd ventricle except the (first and last) + IIIrd nerve



INTERPEDUNCULAR FOSSA DIAMOND/ RHOMBOID-SHAPED SPACE

Boundaries

- Either side: Crus cerebri of cerebral peduncle
- Anterior: Optic chiasma and optic tract
- Posterior: Pons

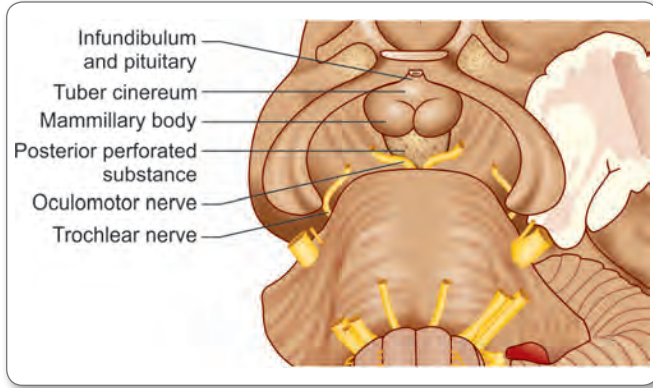


Fig. 18: Interpeduncular fossa

Contents

- Infundibulum
 - Pituitary
 - Tuber cinereum
 - Mammillary body
 - Posterior perforated Substance pierced by central branches of posterior cerebral artery
 - Oculomotor nerve
- Trochlear nerve is not content of interpeduncular fossa.

Contents

- Tubercinereum
- Mammillary body
- Infundibulum (MN - ItEM for first three)
- Posterior perforated substance
- Occulomotor nerve
- MN - SChooL PC

REMEMBER

Cerebral Aqueduct of Sylvius

- Lies in mid brain
- Connects third and fourth ventricle
- Lacks choroid plexus
- Blockage (aqueductal stenosis) leads to hydrocephalus.

Fourth Ventricle

- Lies between cerebellum and brain stem
- Contains choroid plexus in the caudal aspect of its roof
- It is the **rhomboid (diamond)-shaped** cavity of hindbrain behind the lower part of pons and upper part of medulla.

Boundaries

Table 7: Boundaries of the fourth ventricle

• Lateral wall	• Roof
• Above and laterally – superior cerebellar peduncle	• Superior and inferior medullary velum (cerebellum)
• Below laterally – inferior cerebellar peduncle	• Tela choroidea containing choroid plexus

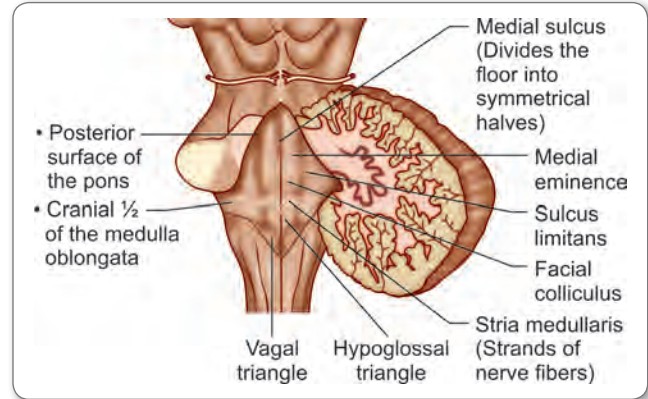


Fig. 19: Posterior view of the fourth ventricle

Features of Floor of Fourth Ventricle

- Entire floor divided by right and left half by median sulcus
- On either side of median sulcus there is longitudinal elevation—median eminence
- Median eminence bounded laterally by sulcus limitans
- **Vestibular area** lies lateral to sulcus limitans
- **Facial colliculus**: On either side, median eminence shows an oval swelling in the **lower pons**. The swelling is produced by fibers from **motor nucleus of facial nerve** wind around the **abducent nucleus**.

Note: Facial colliculus is due to axons of facial neve > abducent nuclei

- **Stria medullaris**: Transverse fibers, which are derived from arcuate nuclei, emerge from median sulcus and enter into inferior cerebellar peduncle
- **Inferior fovea**: Lowermost part of sulcus limitans presents small depression called inferior fovea
- From inferior fovea, the sulcus limitans descends obliquely toward median sulcus. This sulcus divides the floor into two triangles hypoglossal triangle – contains hypoglossal nuclei
- **Vagal triangle** crossed by funiculus separans. Area between funiculus separans above and gracile tubercle below is called area postrema—chemoreceptor zone—centre of vomiting. No blood brain barrier (**circumventricular organ**)
- **Taenia**: Inferolateral margins of IV ventricle are marked by narrow white ridge. Two tenias meet at inferior angle to form apex which is the caudal tip of IV ventricle.



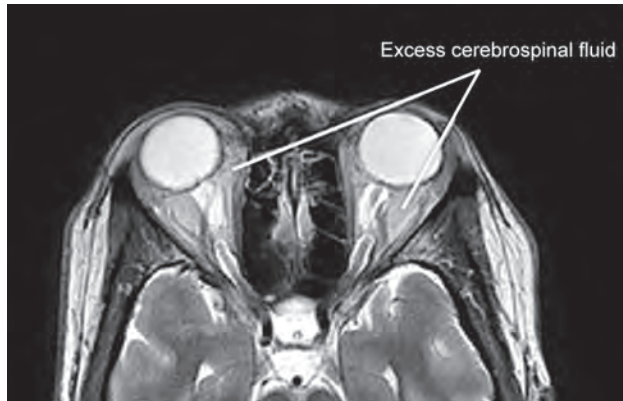
Clinical Aspect

Hydrocephalus

It is the dilatation of the ventricular system and occurs due to obstruction of CSF circulation. It may be of the following types:

- **Communicating:** If the obstruction is outside the ventricular system, usually in the subarachnoid space or arachnoid granulations, it is termed as communicating. This occurs due to fibrosis following meningitis. It is also called external hydrocephalus. Clinical features are:
 - Head size is rather large.
 - Tense anterior fontanel
 - Dilated veins over thin scalp.
- **Noncommunicating:** If the obstruction is within the ventricular system. It is called noncommunicating or internal hydrocephalus.
 - This is usually caused by a tumor or inflammation.
 - A shunt procedure is employed to divert the CSF from the ventricular system into the peritoneal cavity.
 - Aqueductal stenosis example of noncommunicating hydrocephalus.
 - Most common congenital hydrocephalus—congenital aqueductal stenosis. So III ventricle dilated.

Pseudotumor Cerebri



Benign intracranial hypertension

- Results from increased resistance to CSF outflow at the arachnoid villi
- Occurs typically in young obese women
- Elevated CSF pressure, papilledema without mass (deteriorating vision)

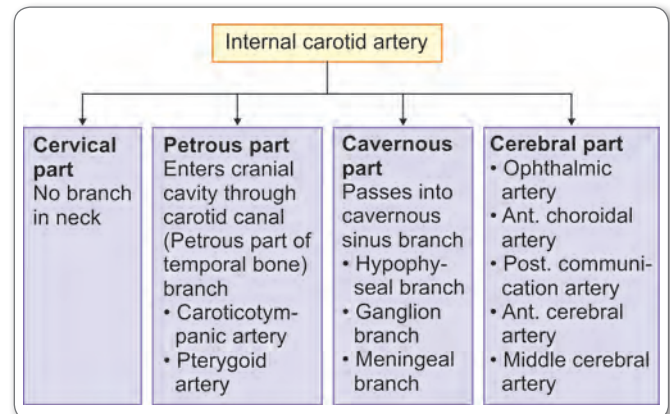
BLOOD SUPPLY OF BRAIN AND SPINAL CORD

Arterial blood supply to brain and spinal cord

ARTERIAL SUPPLY

Supplied by carotid (internal carotid artery)—basilar (basilar artery) system.

Internal Carotid Artery



- Enters the cranium via carotid canal in the temporal bone
- Lies within the cavernous sinus as the carotid siphon
- It is divided into four parts and branches are given in the table
- **Ophthalmic artery** enters the apex of the orbit via optic canal with optic nerve
- **Posterior communicating artery**
 - Joins the posterior and middle cerebral artery
 - berry aneurysms of **posterior communicating artery** compress III nerve

(Note: Anterior communicating artery – **most common site** of berry aneurysms. Aneurysms of this artery compress **optic chiasma** which results in **bitemporal hemianopia**)

- Supplies optic chiasm and tract, hypothalamus, subthalamus

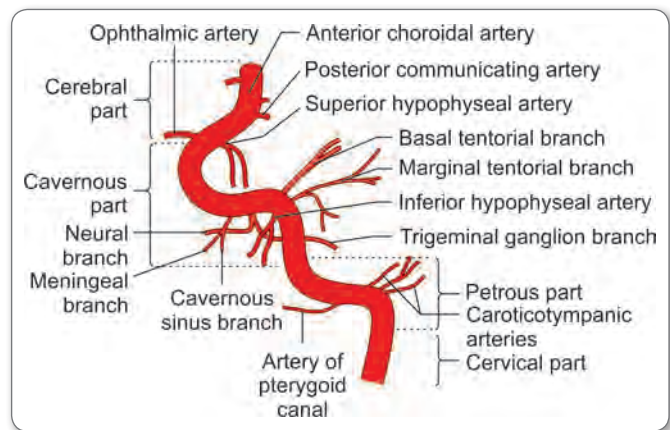


Fig. 20: Internal carotid artery

- **Anterior choroidal artery**
 - Supplies the choroid plexus of lateral ventricle, hippocampus, optic tract, lateral geniculate body and part of posterior limb of internal capsule
- **Anterior cerebral artery**
 - Terminal branch of internal carotid
 - Supplies medial surface of frontal and parietal lobes and corpus callosum (leg and perineum are represented in the medial surface of cerebrum)



- So occlusion of this artery results in sensory and motor function loss of leg and perineum
- **Middle cerebral artery**
 - Terminal branch of internal carotid
 - Supplies lateral surface of cerebral hemisphere and insula (trunk, face, arm are represented in the lateral surface, Wernicke's area and Broca's area also present in lateral surface)
 - Occlusion of this artery results in sensory and motor loss of those areas and also cause Wernicke's and Broca's aphasia.

HIGH YIELD POINTS

- Internal carotid artery divides into two terminal branches (anterior cerebral artery and middle cerebral artery) between optic nerve and oculomotor nerve
- Abnormal communication between the cavernous sinus & internal carotid artery may result in pulsating exophthalmos.

Vertebral Artery

- Branch of subclavian artery and joins to form basilar artery
- Arterial blood supply in the vertebra.**

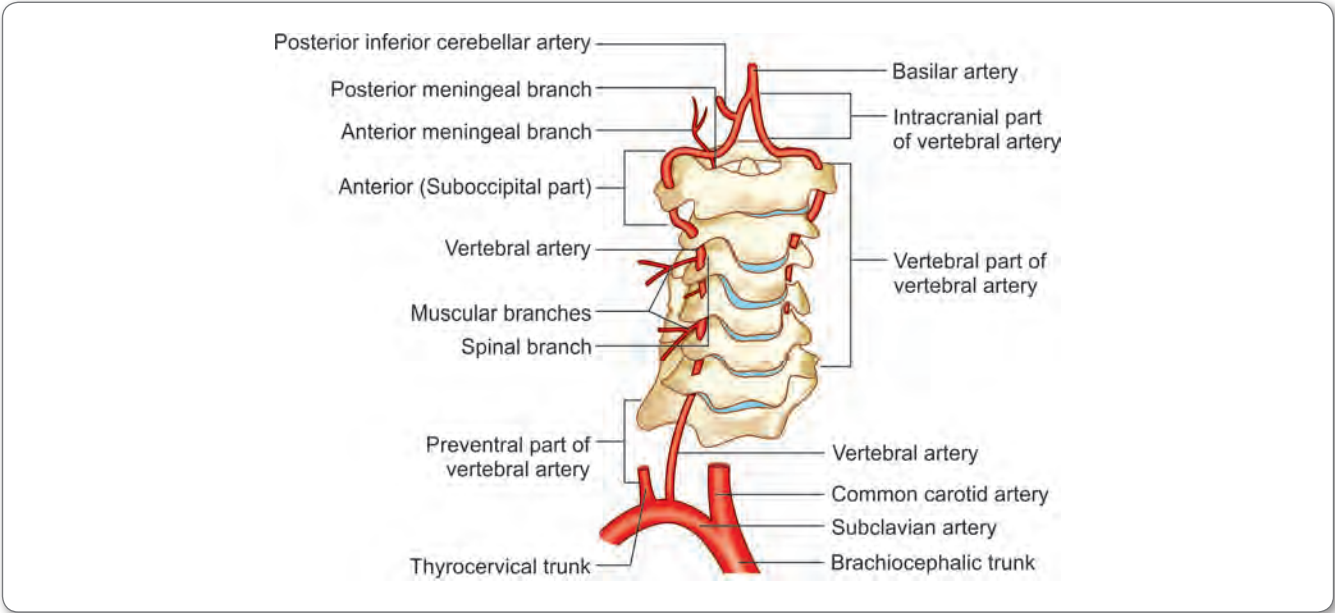
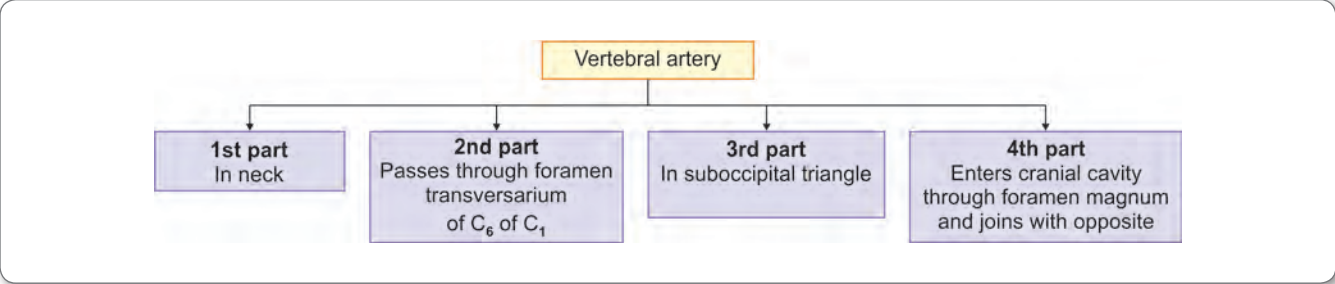


Fig. 21: Vertebral artery

- Branches are:
- **Anterior spinal artery**
 - Branch of vertebral artery
 - Supplies anterior two-thirds of spinal cord (including anterior and lateral horns and anterior and lateral white column) and also medulla
 - **Posterior spinal artery**
 - Branch of vertebral artery
 - Supplies posterior one-third of spinal cord (including posterior horns and posterior columns) and medulla
 - **Segmental arteries**
 - Supply the spinal cord
 - Arise from aorta, vertebral artery and common iliac arteries, which anastomose with anterior and posterior spinal artery



- Spinal arteries become inconsistent at thoracic and lumbar levels, in those areas spinal cord is supplied by segmental arteries
- **Artery of Adamkiewicz** (artery of T11 spinal segment) is large and supplies several segments of the cord above and below. Fracture of vertebra involving this artery leads to ischemia of several segments of the cord
- **Posterior inferior cerebellar artery**
 - Branch of vertebral artery
 - Sometimes it gives rise to posterior spinal artery
 - Supplies medulla, posteroinferior aspect of cerebellum
- Lesion of which leads to **Wallenberg syndrome (lateral medullary syndrome)**.

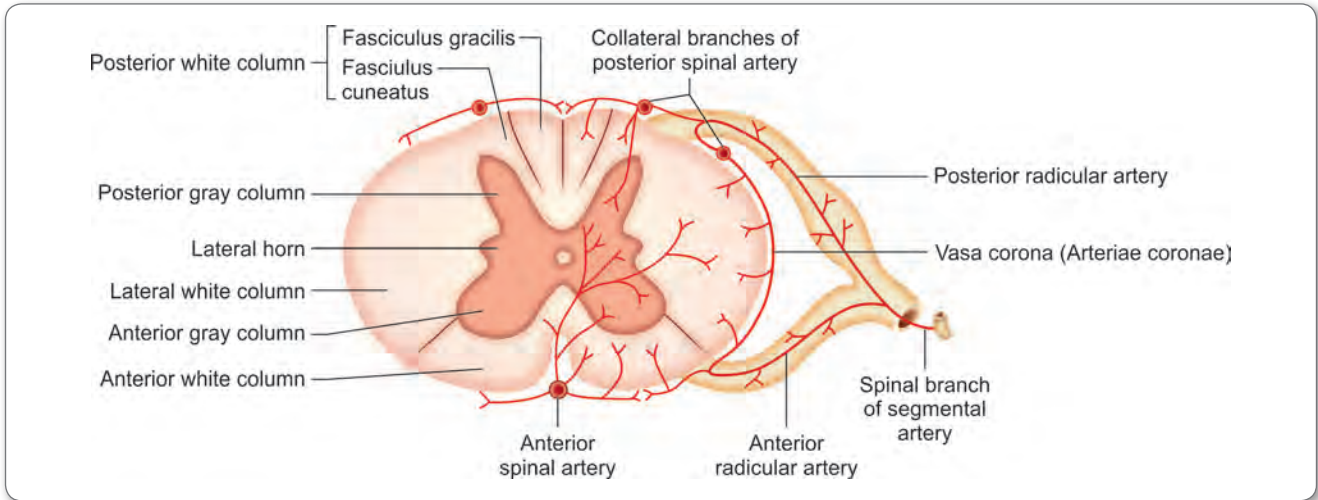


Fig. 22: Segmental arteries

Basilar Artery

Two vertebral arteries fuse to form basilar artery and branches are:

- Pontine branches
 - Supply the pons
- Anterior inferior cerebellar artery
 - Supplies inferior surface of cerebellum
 - It gives **labyrinthine artery** in most of the cases.

Note: Labyrinthine artery arises from AICA (80%) > basilliar artery (20%)

- Superior cerebellar artery
 - Supplies superior surface of cerebellum and pons
- Posterior cerebral artery
 - Terminal branch of basilar artery
 - Supplies mid brain, thalamus and visual cortex.

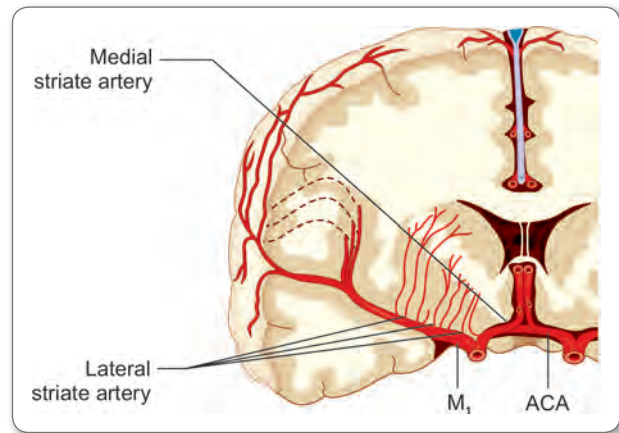


Fig. 23: Medial and lateral striate arteries

BRANCHES FROM CEREBRAL ARTERY

All cerebral artery gives three types cortical, central (striate) and choroidal arteries

- Cortical branches—supply the outer surface
- Central or striate branches—supply the central surfaces

- Lateral striate artery—from middle cerebral artery—artery of charcot hemorrhage
- Medial striate artery—from anterior cerebral artery—recurrent artery of heubner
- Posterior striate artery—from posterior cerebral artery.

Choroidal artery:

- Form choroidal plexus which secrete CSF
- Anterior choroidal artery—from internal carotid artery
- Posterior choroidal artery—from posterior cerebral artery.



Circle of Willis

- Anastomosing channel between two internal carotid and basilar artery.

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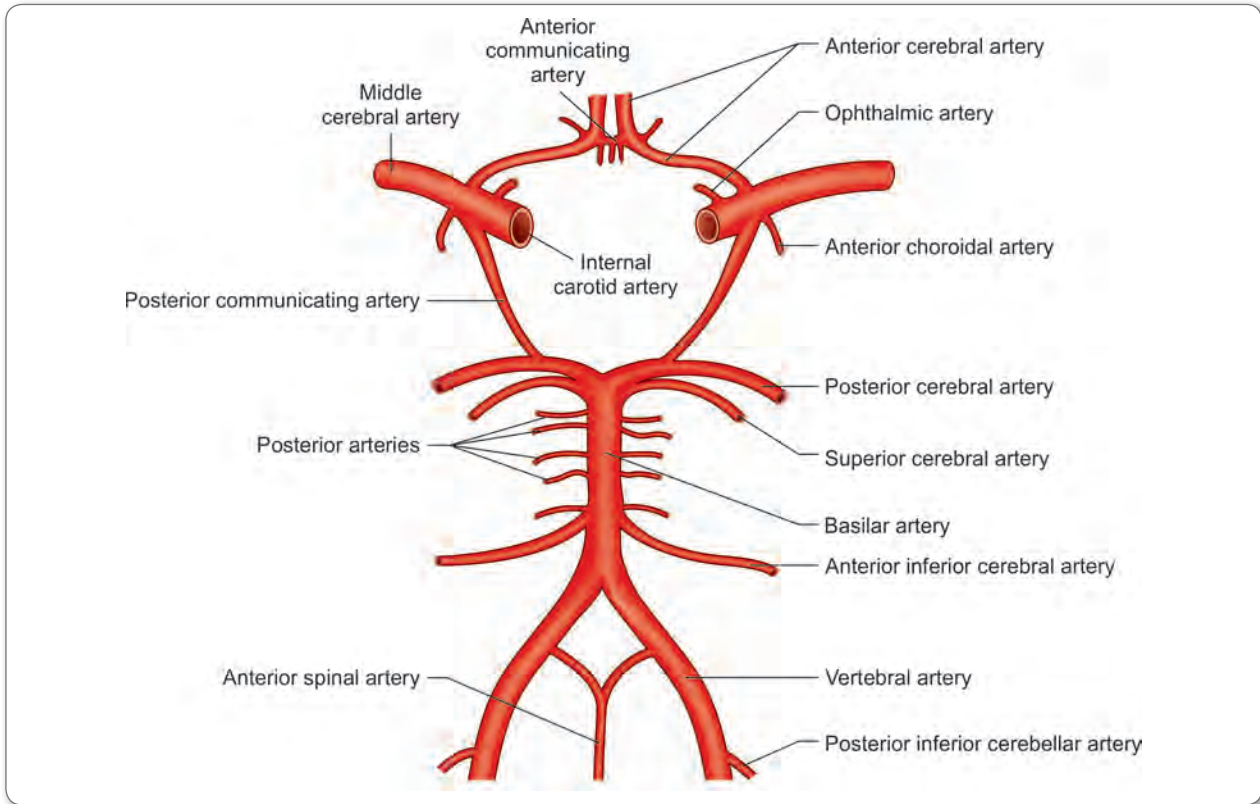


Fig. 24: Circle of Willis

- In front: Anterior communicating artery.
- Anterolaterally: Two anterior cerebral artery.
- Laterally: Proximal segments of both internal carotid artery.
- Posterolaterally: Two posterior communicating artery.
- Behind: Posterior cerebral arteries.

Blood Supply of Various Parts of Brain

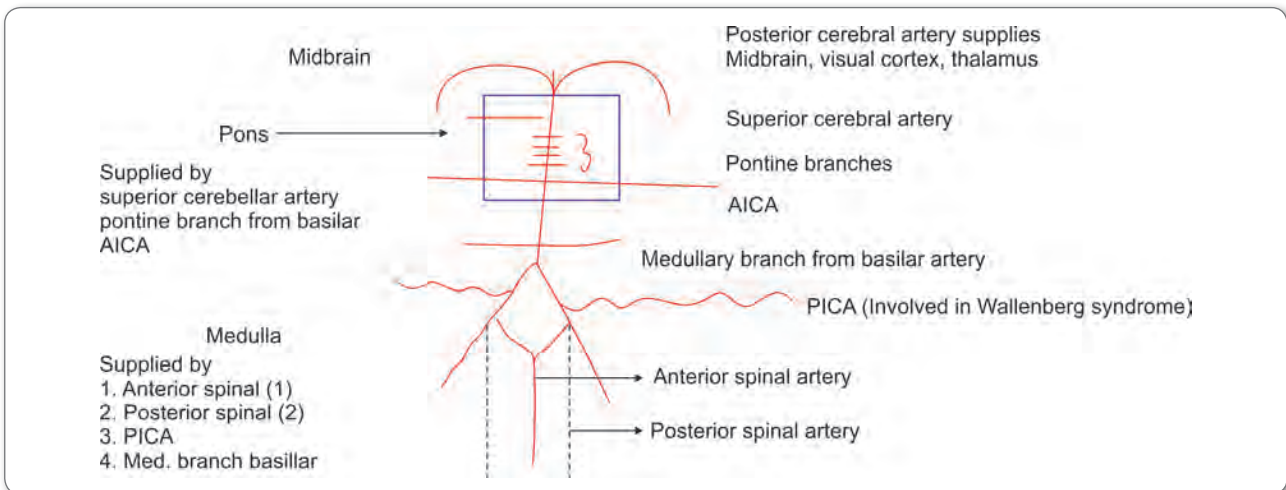


Fig. 25: Blood supply of various parts of brain



Medulla	<ul style="list-style-type: none"> • Anterior spinal artery • Posterior spinal artery • Posterior inferior cerebellar artery • Medullary branch from basilar artery
Pons	<ul style="list-style-type: none"> • Anterior inferior cerebellar artery • Pontine branch from basilar artery • Superior cerebellar artery
Mid brain	<ul style="list-style-type: none"> • Posterior cerebral artery • Superior cerebellar artery
Thalamus	<ul style="list-style-type: none"> • Posterior communicating • Posterior cerebral artery
Cerebellum	<ul style="list-style-type: none"> • Posterior inferior cerebellar artery • Anterior inferior cerebellar artery • Superior cerebellar artery

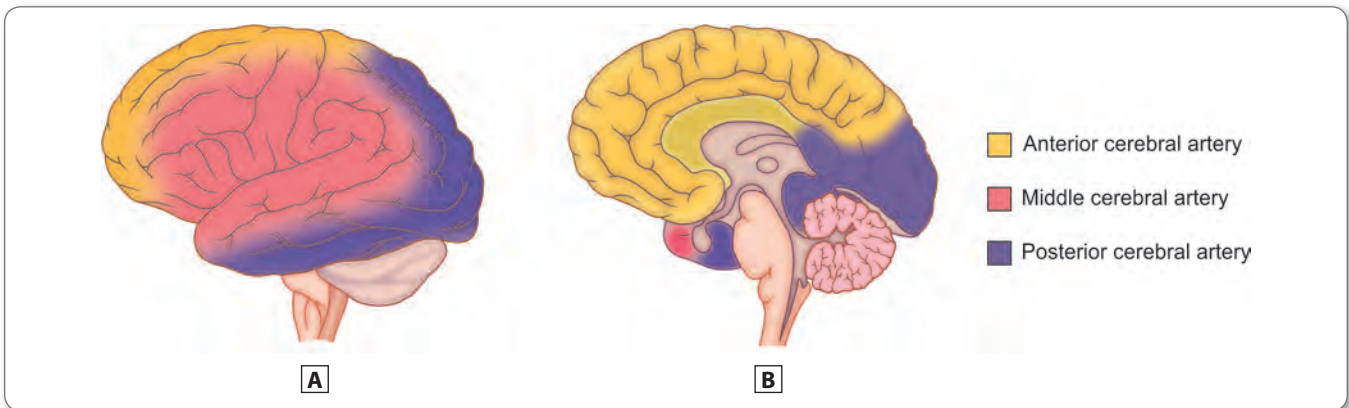
Blood Supply of Internal Capsule

Lateral striate branches of middle cerebral artery	Dorsal part of anterior limb, genu and posterior limb
Recurrent artery of Huebner	Ventral part of anterior limb
Direct branch from Internal carotid artery	Ventral part of genu
Branches from anterior choroidal artery	Ventral part of posterior limb, entire retrolentiform and sublenticular

HIGH YIELD POINTS

- One of the largest striate branches of middle cerebral artery commonly involved in ischemic and hemorrhagic stroke called Charcot's artery of cerebral hemorrhage
- Largest striate branch of anterior cerebral artery – recurrent artery of Huebner.

Blood Supply of Cerebrum



Figs 26A and B: Blood supply of cerebrum: (A) Lateral brain; (B) Medial brain

- Most of the lateral surface supplied by middle cerebral artery except along the superomedial border supplied by anterior cerebral artery and along temporal gyrus supplied by posterior cerebral artery
- Most of the medial surface supplied by anterior cerebral artery. Temporal pole—middle cerebral artery. Occipital cortex supplied by posterior cerebral artery. (Mn - MA)
- Most of the inferior surface supplied by posterior cerebral artery.

Blood Supply of Optic Chiasma

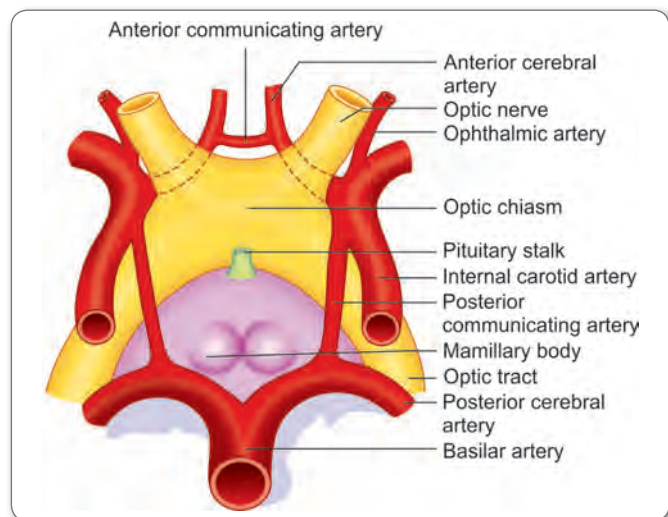


Fig. 27: Blood supply of optic chiasma

Blood Supply of Basal Ganglia

- Caudate nucleus: Lateral and medial striate branches from anterior, medial and posterior cerebral arteries.
- Putamen: Lateral and medial striate branches and anterior choroidal artery.
- Globus pallidus: Lateral striate branches and anterior choroidal artery.



- Anterior cerebral artery
- Internal carotid artery supply the median zone

Blood supply of optic tract

- Anterior choroidal artery
- Posterior communicating artery

Optic radiations

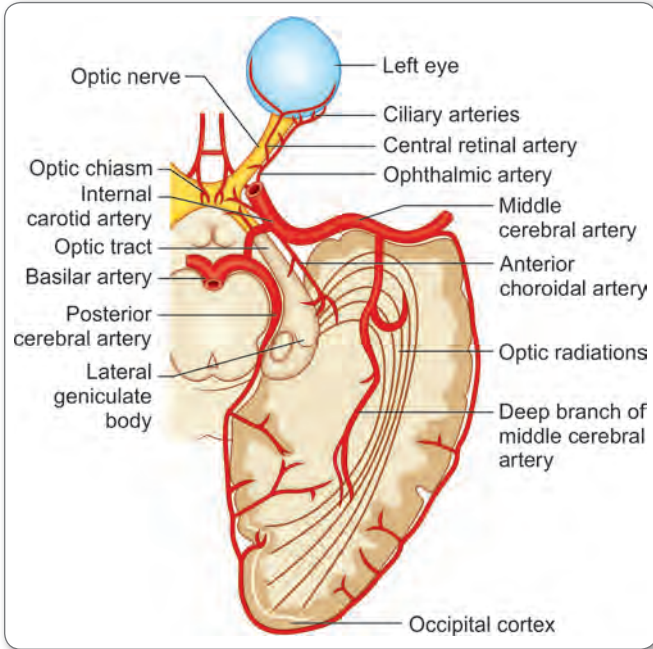


Fig. 28: Left eye optic nerve radiation

- Middle cerebral artery
- Posterior cerebral artery

VENOUS DRAINAGE

Venous Drainage of Brain

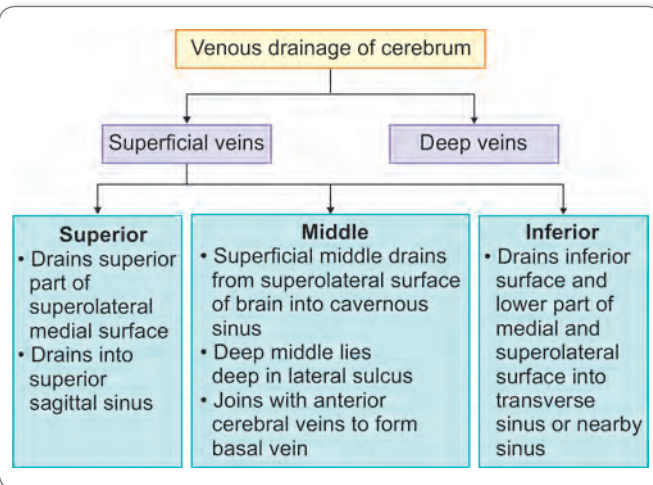


Table 8: Venous drainage of brain

Deep veins		
Basal vein	Internal cerebral vein	Great cerebral vein
Formed by anterior cerebral + Deep middle cerebral + Striate veins	Internal cerebral vein Formed by union of three veins thalamostriate septal Choroidal veins 2 Internal cerebral veins unite to form great cerebral vein of gales	It joins with inferior sagittal sinus to form straight sinus
Terminate into great cerebral vein of gales		

Venous Drainage of Spinal Cord

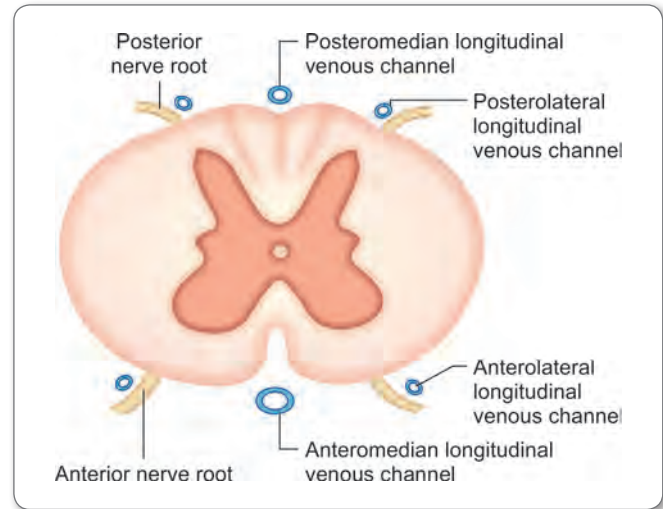


Fig. 29: Venous drainage of spinal cord

- Veins draining the cord form six longitudinal venous channel around the cord.
- Two-median longitudinal: One in anterior median fissure and other in posterior median sulcus.
- Two anterolateral: Posterior to anterior nerve roots on either side.
- Two posterolateral: Posterior to posterior nerve roots on either side.
- These longitudinal venous channels communicate with internal vertebral venous plexus and drain into vertebral veins, posterior intercostal veins, lumbar veins and lateral sacral veins.
- Internal vertebral venous plexus communicates above with basilar venous plexus.



Clinical Aspect

Intracranial Hemorrhage

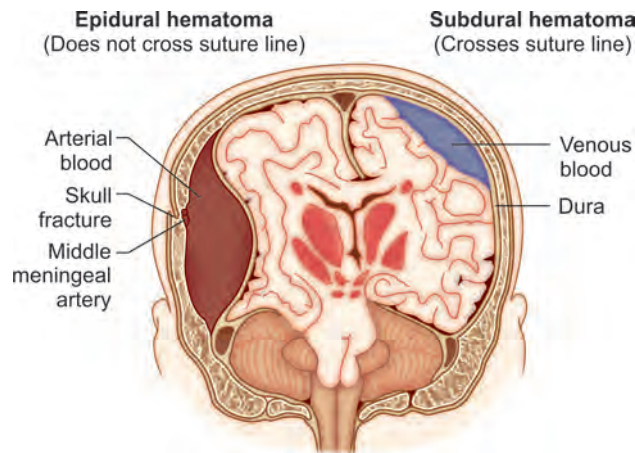


Fig. 30: Intracranial hemorrhage

Epidural hemorrhage	<ul style="list-style-type: none"> • Injury at pteron • Rupture of middle meningeal artery that lies between dura and inner table of skull due to trauma • Because of stripping of dura patient usually have lucid interval • Does not cross the sutural lines
Subdural hemorrhage	<ul style="list-style-type: none"> • Rupture of bridging veins that drain into superior sagittal sinus • No stripping of dura—so no lucid interval • Cross the sutural lines • Subdural hemorrhage also seen in brain atrophy conditions like Alzheimer's disease
Subarachnoid hemorrhage	<ul style="list-style-type: none"> • Rupture of aneurysms is common cause of nontraumatic subarachnoid hemorrhage • Aneurysms of anterior communicating artery may pressure the optic chiasma and cause bitemporal hemianopia • Aneurysms of posterior communicating artery may compress the oculomotor nerve

SPINAL CORD

- Derived from caudal part of neural tube
- Covered by three membrane meninges
- Extends from C1 to inferior border of **1st lumbar vertebra**
- In newborns, extends up to the L3
- The lower tapering end of spinal cord is triangular called **conus medullaris**.

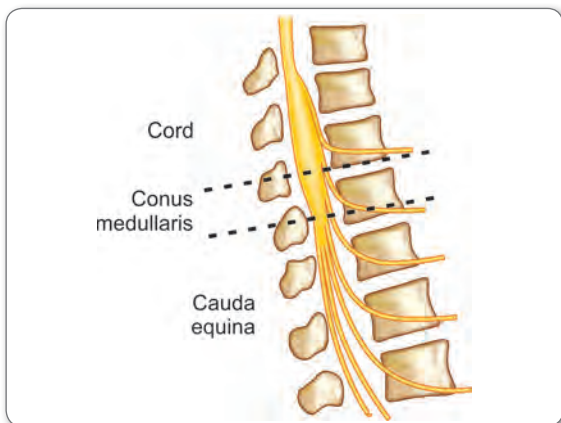


Fig. 31: Spinal cord

Table 9: Levels of vertebrae and corresponding spinal cord structures

Structures	Levels
Spinal cord in adults	From C1 up to L1
Spinal cord in infants	From C1 up to L3
Filum terminale	L1 to tip of coccyx
Piamater	Up to coccyx
Arachnoid membrane	Up to S2
Duramater	Converge at S2 Extend upto coccyx

Spinal Meninges

- Pia mater converge at L1 and then continue as filum terminale up to coccyx
- Subarachnoid space ends at S2
- Dura mater converge at S2 and ends up to coccyx.



Clinical Aspect

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Lumbar Puncture

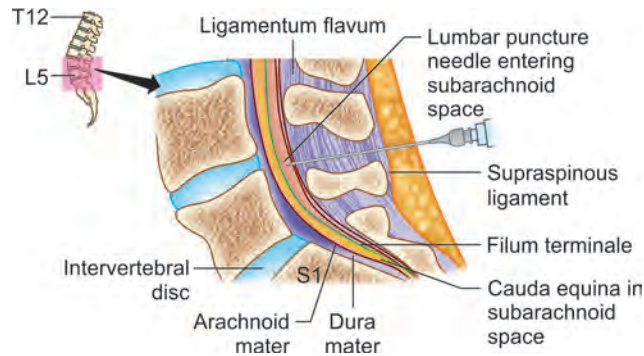


Fig. 32: Lumbar puncture

- Lumbar puncture is done to withdraw CSF from the subarachnoid space for therapeutic and diagnostic purposes
- Puncture is done well below the termination of spinal cord
- Spinal cord ends at L1, so LP performed at L3/L4 level or L4/L5 level
- Horizontal line (tuffier's line) joining the highest points of the iliac crest passes through spine of L4 so interspinous space above or below this landmark can be used. As the Subarachnoid space in this region is roomy and contains only filum terminale and cauda equina.

Structures pierced during this procedure from superficial to deep:

- Skin
- Superficial fascia
- Supraspinous ligament
- Interspinous ligament
- Ligamentum flavum
- Epidural space
- Dura mater
- Subdural space
- Arachnoid membrane.

HIGH YIELD POINTS

Classical first popping sensation is felt when the needle pierces the **ligamentum flavum**; second pop sensation is felt when the dura mater is pierced.

- 31 pairs of nerves that emerge from the spinal cord: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal
- C1 and coccygeal nerve neither have sensory root nor corresponding dermatomes
- C1 passes between atlas and skull
- C2 between atlas and axis
- Cervical nerves leave the vertebral canal above the corresponding vertebra with the exception of 8, which emerges between C7 and T1
- Remainder spinal nerves emerge below the corresponding vertebra
- Components of spinal nerves:
 - **Posterior root:** Enters the posterolateral sulcus as posterior rootlets and convey sensory input from body via spinal ganglion. Joins with anterior root distal to spinal ganglion and within the intervertebral foramen to form spinal nerve.
 - **Anterior root:** Emerges as anterior rootlets from the anterolateral sulcus and convey motor output from visceral and somatic motor neurons.
 - **Spinal ganglion:** Located in within the posterior root and contains pseudounipolar neurons.

SPINAL NERVES

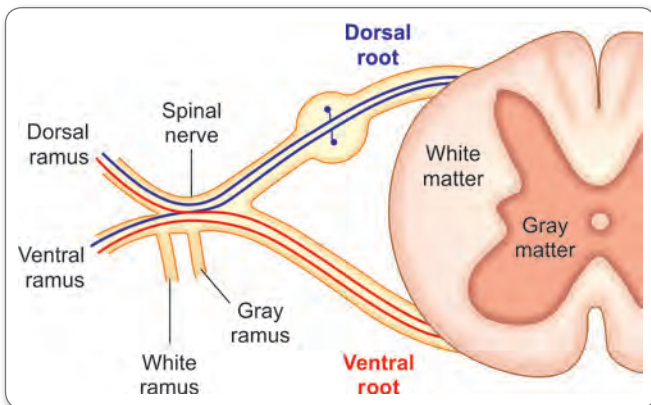


Fig. 33: Spinal nerve



SPINAL SEGMENTS

- Part of spinal cord to which pair of spinal nerves are attached
- Spinal cord is made up of 31 segments
- Spinal cord 45 cm is smaller than vertebral column 65 cm, so spinal segments are crowded and short
- Approximate vertebral levels of spinal segments is listed below.

Table 10: Approximate vertebral levels of spinal segments

Vertebra	Spinal segments
Upper cervical	Same segments
Lower cervical C5	Add 1 C6
Upper thoracic T2	Add 2 T4
Lower thoracic T7 to T9	Add 3 T12
T10 to T12	L1 to L5
L1	Sacral and coccygeal segments

SPINAL CORD ENLARGEMENTS

- Spinal cord enlarges opposite to attachments of nerve roots contributing to brachial and lumbosacral plexus.

Table 11: Comparison between cervical and lumbar spinal enlargements

Cervical enlargements	Lumbar enlargements
<ul style="list-style-type: none"> • Extend from C5-T1 spinal segments • C3-T1 – vertebral level • Supply muscles of upper limb and their associated girdles 	<ul style="list-style-type: none"> • Extend from L2-S3 spinal segments • T9-L1 vertebral level • Supply the muscles of lower limb and their associated girdles

CAUDA EQUINA

Consists of lumbosacral nerve roots that descend from spinal cord to exit through respective foramina.

INTERNAL STRUCTURE

- In transverse section, spinal cord consists of central gray mater and peripheral white mater
- Nerve cells groups in gray mater of spinal cord.

Rexed Lamina and Nuclear Groups

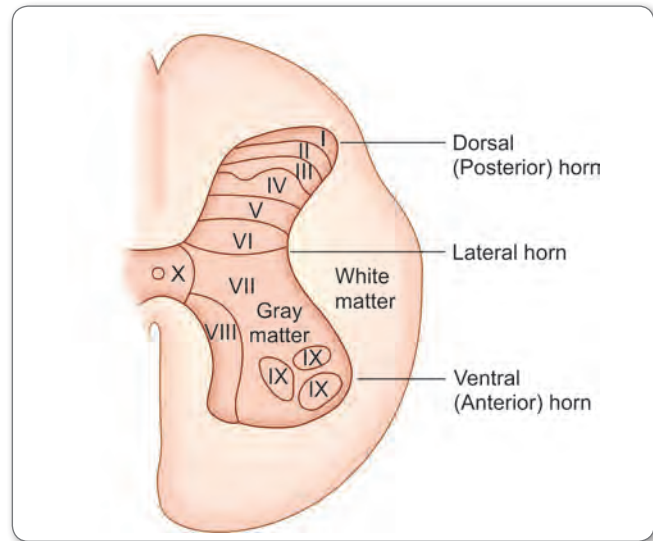


Fig. 34: Rexed laminae

Table 12: Laminae and their corresponding gray columns

Lamina	Corresponding gray columns
I	Posterior marginal nucleus
II	Substantia gelatinosa
III, IV	Nucleus proprius
V, VI	Base of dorsal column
VII	Nucleus dorsalis, intermediolateral and intermediomedial nuclei of lateral horn
VIII, IX	Medial and lateral group of nuclei of anterior gray column
X	Surrounds central canal and composed of gray

Division of White Matter of Spinal Cord

- Posterior white column: Between posterior median septum and posterior horn.
- Lateral white column: Between anterior and posterior horns.
- Anterior white column: Between anterior median fissure and anterior horn.

TRACTS OF SPINAL CORD

Collections of axons in central nervous system. It can be ascending and descending.



Table 13: Tracts of spinal cord

Position	Ascending tracts	Descending tracts
Posterior	Fasciculus gracilis Fasciculus cuneatus	Nil
Lateral	<ul style="list-style-type: none"> • Lateral spinothalamic • Anterior spinocerebellar and • Posterior spinocerebellar • Spinotectal 	<ul style="list-style-type: none"> • Rubrospinal • Lateral corticospinal Mn – RL (ringer lactate)
Anterior	Anterior spinothalamic	<ul style="list-style-type: none"> • Anterior corticospinal • Vestibulospinal • Olivospinal • Tectospinal Mn – A VOTe

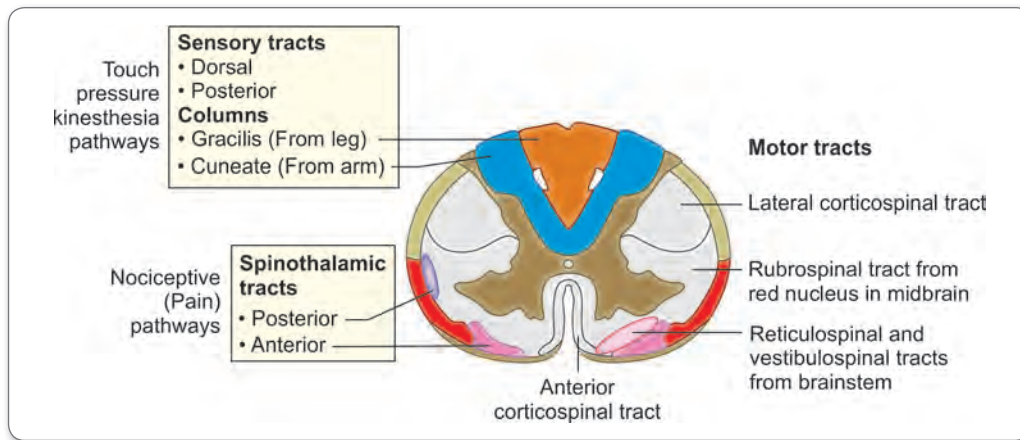


Fig. 35: Tracts of spinal cord

Ascending Tracts

- Represent functional pathways that convey sensory information from the periphery to higher levels.
- Usually consists of chain of three neurons, first, second and three order neurons. First order neurons always in the spinal ganglion.

Posterior Column–Medial Lemniscus Pathway

- Mediates vibration sense, two-point discrimination, stereognosis and conscious proprioceptions
- **First order neurons**
 - Located in spinal ganglion at all levels
 - Give rise to fasciculus gracilis from lower extremity
 - Give rise to fasciculus cuneatus from upper extremity
 - Axons ascend in posterior column and terminate in gracile and cuneate nuclei of the medulla.
- **Second order neurons**
 - Located in gracile and cuneate nuclei of the caudal medulla
 - Give rise axons of internal arcuate fibers that decussate and form compact fiber – medial lemniscus, which terminate in VPL nucleus of thalamus.
- **Third order neuron**
 - Located in VPL nucleus of thalamus
 - Project into sensory area postcentral gyrus via posterior limb of internal capsule.

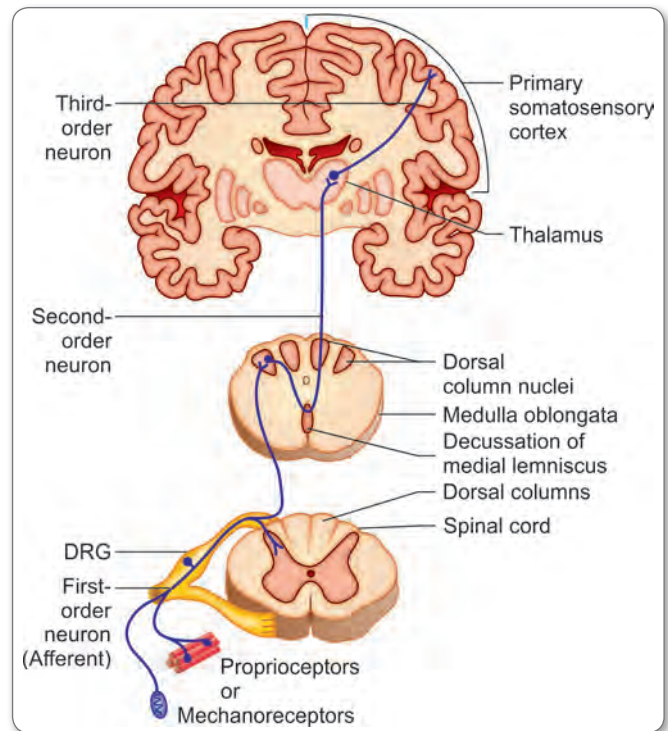


Fig. 36: Posterior column—medial lemniscus pathway



Anterior Spinothalamic Tract

- Carries light touch, crude touch, pressure
- First order neuron
 - Located in spinal ganglion at all levels
 - Axons project into second order neuron in the posterior horn
- Second order neuron
 - Located in posterior horn
 - Gives rise to axons that **decussate** in anterior white commissure and ascend in contralateral **anterior funiculus**
 - Terminate in VPL nucleus of thalamus
- Third order neuron
 - Found in VPL nucleus of thalamus
 - Project into sensory area post central gyrus via posterior limb of internal capsule.

Lateral Spinothalamic Tract

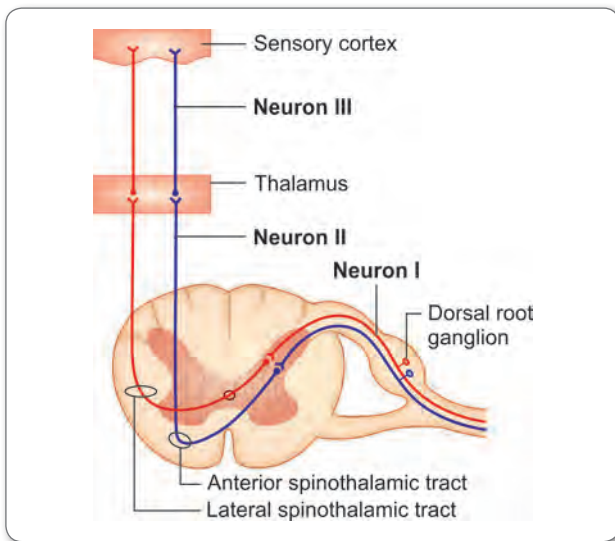


Fig. 37: Anterior and lateral spinothalamic tract

- Carries pain and temperature sensation
- **First order neuron**
 - Located in spinal ganglion at all levels
 - Axons project into second order neuron in the posterior horn
- **Second order neuron**
 - Located in posterior horn
 - Gives rise to axons that **decussate** in anterior white commissure and ascend in **contralateral lateral funiculus**
 - Terminates in VPL nucleus of thalamus
- **Third order neuron**
 - Found in VPL nucleus of thalamus
 - Projects into sensory area postcentral gyrus via posterior limb of internal capsule.

Spino cerebellar Tract

- Located in lateral white column and divided into posterior and anterior spino cerebellar tract

- They carry unconscious proprioceptive information to cerebellum and plays important role in muscular coordination.

Posterior Spino cerebellar Tract

- **Uncrossed tract**
- First order neuron lies in the dorsal root of spinal nerve. Central processes of these cells enter the posterior horn of the gray matter through posterior root of spinal nerve and fibers relay in Clarke's column
- Axons pass to dorsolateral part of the white column on the same side and ascend as posterior spino cerebellar tract.

Anterior Spino cerebellar Tract

- **Crossed tract**
- First order neuron course is same as posterior tract
- Axons of nucleus dorsalis cross to opposite side and pass to anterolateral part of lateral white column ascend as anterior spino cerebellar tract

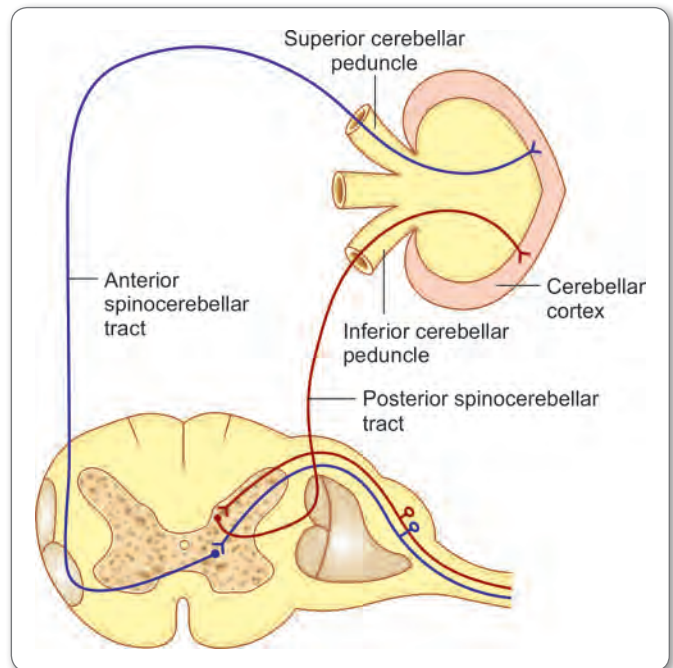


Fig. 38: Spino cerebellar tract

Table 14: Tracts and their functions

Tract	Functions
Lateral spinothalamic tract	Carries pain and temperature sensation MN – Low PiTch
Anterior spinothalamic tract	Carries light touch, crude touch, pressure sensation MN – ALL Case Pressure
Fasiculus gracilis and cuneatus (tracts of Gall and Burdach)	Vibration sense, two-point discrimination, stereognosis, conscious proprioceptions



Table 15: Tracts of 1st, 2nd and 3rd order with their clinical tests

Tracts	1st	2nd	3rd	Clinical tests
Lateral spinothalamic	Dorsal root ganglion	Substantia gelatinosa	Posterolateral ventral nucleus of thalamus	<ul style="list-style-type: none"> • Pain with pinprick • Temperature with hot and cold water in the test tubes
Anterior spinothalamic	Dorsal root ganglion	Nucleus proprius		<ul style="list-style-type: none"> • Joint sense • Vibration sense
Fasciculus gracilis	Dorsal root ganglion	Nucleus gracilis in medulla oblongata	Posterolateral ventral nucleus of thalamus	<ul style="list-style-type: none"> • Tactile localisation • Tactile discrimination • Rhomberg's test
Fasciculus cuneatus	Dorsal root ganglion	Nucleus cuneatus in medulla oblongata	Posterolateral ventral nucleus of thalamus	<ul style="list-style-type: none"> • Stereognosis • Crude touch • Crude pressure
Dorsal spinocerebellar	Dorsal root ganglion	Clarke's column	Nil	All cerebellar tests, like the finger-nose and heel-knee tests for intention tremors
Ventral spinocerebellar	Dorsal root ganglion	Neurons of posterior horn	Nil	

Descending Tracts

- Concerned with somatic and visceral motor activity
- Cells of origin in the cerebral cortex or in the brain stem.

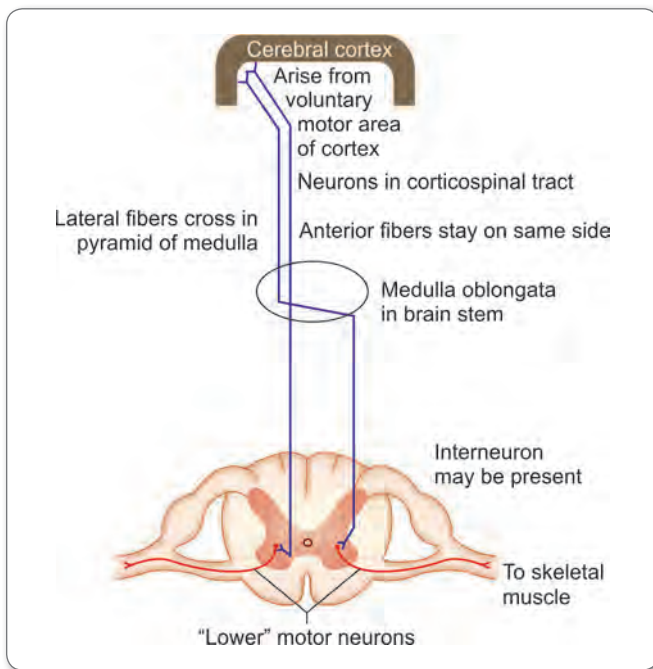


Fig. 39: Corticospinal tract

PYRAMIDAL TRACT

- Arises from pyramidal neurons in premotor cortex area 6 and precentral motor cortex area 4 and postcentral sensory cortex (3, 1, 2)
- Axons of giant cells of betz contribute large number of fibers

- Passes through posterior limb of internal capsule
- Passes through middle three-fifth of crus cerebri of midbrain through base of pons
- Constitutes pyramid of the medulla
- Undergoes 90% in caudal medulla
- Lies in the posterior quadrant of lateral funiculus of spinal cord.

Applied

- Lesion of pyramidal tract above the decussation results in spastic paralysis on the contralateral side
- Lesion of pyramidal tract in spinal results in spastic paralysis on the ipsilateral side.

Anterior Corticospinal Tract

Small uncrossed tract found at spinal cord at all levels in the anterior white commissure.

Rubrospinal Tract

- Arises in the contralateral red nucleus of the midbrain
- Controls the flexor tone
- Situated in lateral white column of spinal cord.

Vestibulospinal Tract

- Arises from deiters cells in the ipsilateral vestibular nucleus
- Controls the extensor tone
- Located in anterior white column.

Extrapyramidal System

- Consists of all descending tracts of the brain and spinal cord which do not pass through medullary pyramids
- Extrapyramidal tracts work along with pyramidal system to perform voluntary motor activity.

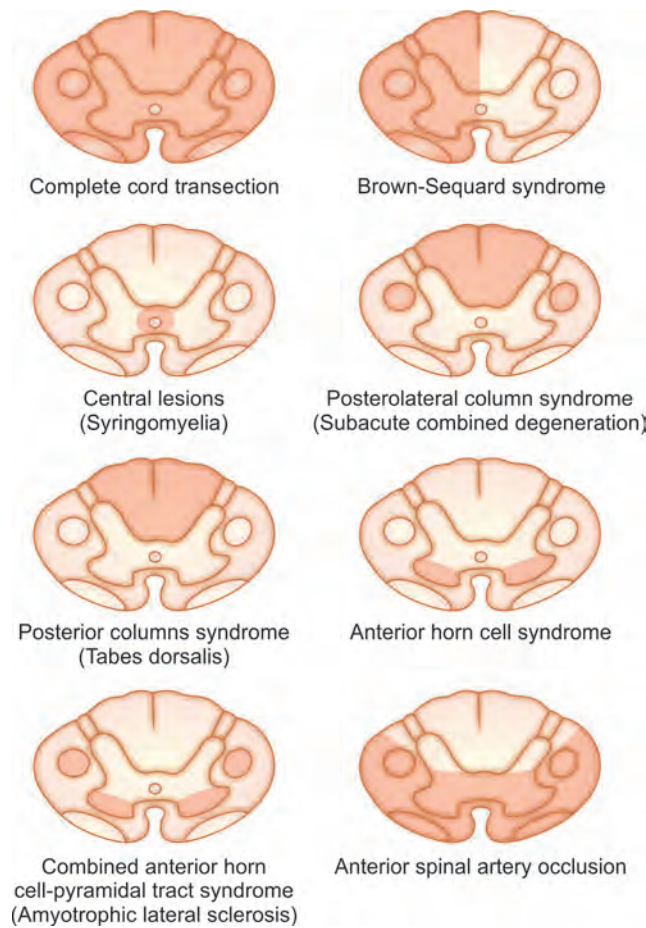


Table 16: Comparison of pyramidal and extrapyramidal tracts

Pyramidal tracts	Extrapyramidal tracts
Recent in evolution	Older in evolution
These comprise only corticospinal and corticonuclear tracts	These comprise olivospinal, vestibulospinal, tectospinal, reticulospinal, rubrospinal tracts
Origin from cerebral cortex	These arise from olivary vestibular, tectum (collicular) reticular and red nuclei
The impulse passes directly to anterior horn cells	Impulse passes by polysynaptic route via cortex, basal ganglia, cerebellum and brainstem
Function is to perform voluntary skilled movement	Control tone and equilibrium. These facilitate/inhibit flexor/ extensor reflexes
Injury leads to increased muscle tone and loss of motor activity	Injury leads to clasp-knife rigidity

 **Clinical Aspect**

Lesions of Spinal Cord



Contd...



Anterior spinal artery occlusion	<ul style="list-style-type: none"> • Infarction of anterior two-thirds of spinal cord (which is supplied by anterior spinal artery) • Spares posterior columns and posterior horns • Anterior horn destruction (LMN lesion)—complete flaccid paralysis and areflexia at the level of lesion • Anterior and lateral white column destruction—corticospinal tract transection (results in spastic paralysis below the lesion), spinothalamic tract transection (results in loss of pain and temperature below the lesion)
Tabes dorsalis	<ul style="list-style-type: none"> • Syphilitic degeneration of posterior white column • Loss of two-point discrimination, tactile sensation, vibration and position sense • Romberg sign—patient becomes ataxic when he closes his eyes because no visual knowledge
Syringomyelia	<ul style="list-style-type: none"> • Cavity developed around the center of spinal cord • Involves the decussation of spinothalamic tract—so loss of bilateral loss of pain and temperature below the lesion • Cavity extends to anterior horn causing LMN lesion with muscle wasting and hyporeflexia
Brown-Sequard syndrome	<ul style="list-style-type: none"> • Hemisectioning of spinal cord • Ipsilateral UMN (spastic paralysis) lesion below the level of hemisectioning • Ipsilateral loss of proprioceptive sense, vibrations, etc. due to involvement of posterior column • Contralateral loss of pain and temperature below the lesion due to involvement of spinothalamic tract
Subacute combined degeneration (Vitamin B12 neuropathy)	<ul style="list-style-type: none"> • Demyelination of posterior column (loss of vibration and position sense) • Demyelination of corticospinal tracts (results in spastic paralysis) • Demyelination of spinocerebellar tracts (arm and leg ataxia)
Friedreich's ataxia	<ul style="list-style-type: none"> • Autosomal recessive disorder • Spinal cord pathology similar to subacute combined degeneration • Involvement of cerebellum (ataxia) • Affects heart (cardiomyopathy) • Skeletal deformity—kyphoscoliosis • Affects pancreas—diabetes

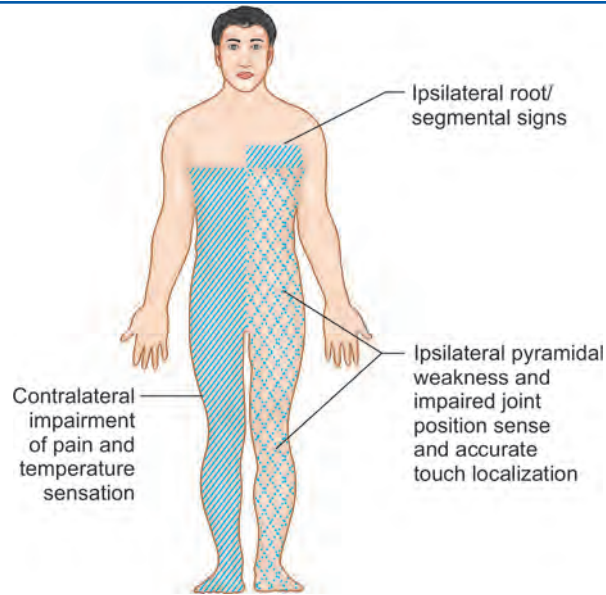


Fig. 40: Séquard syndrome



BRAIN STEM

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THEORY

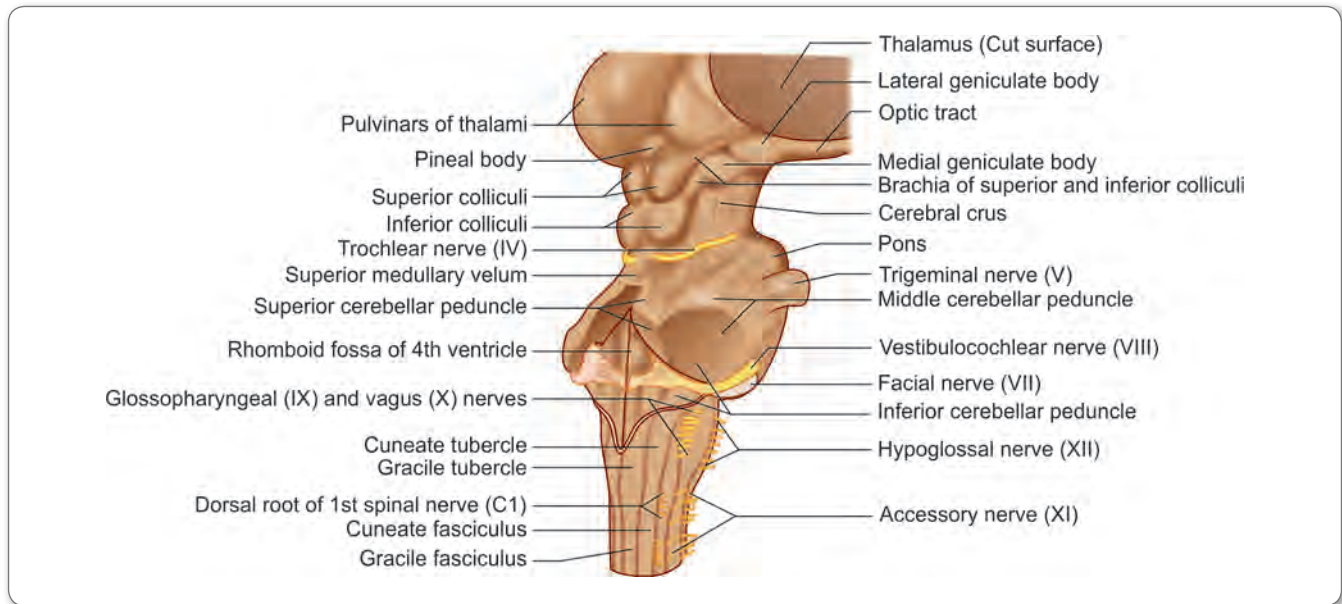


Fig. 41: The brain stem

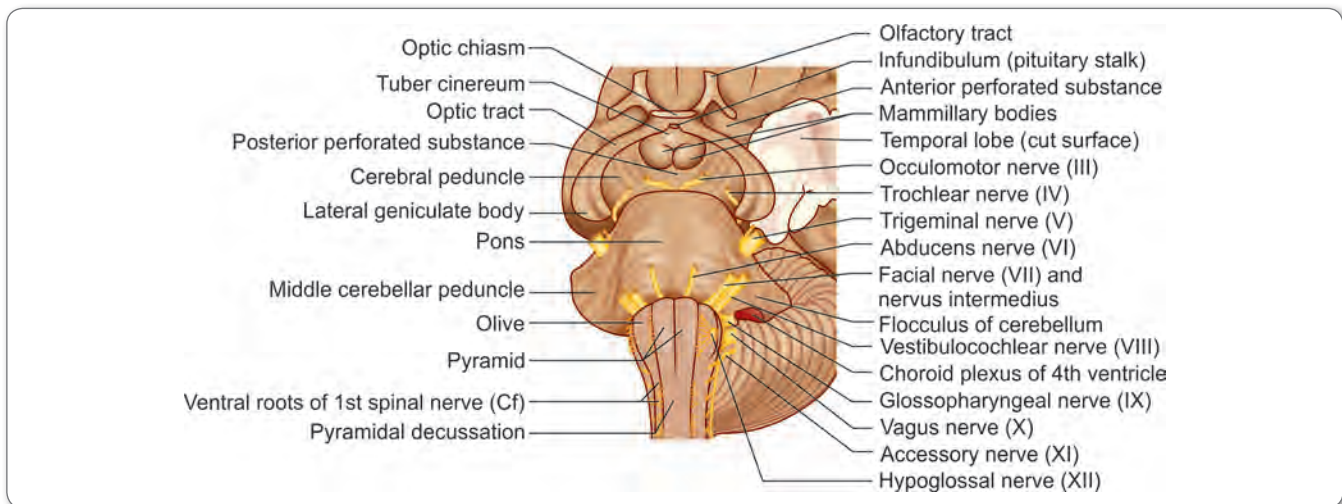


Fig. 42: Location of cranial nerves

Table 17: Parts of the brain stem and their associated cranial nerves

Midbrain	Pons	Medulla
<ul style="list-style-type: none"> • Oculomotor nerve • Trochlear nerve • (Contains center for vertical conjugate gaze) 	<ul style="list-style-type: none"> • Trigeminal nerve • Abducent nerve • (Contains center for horizontal gaze) • Facial nerve • Part of vestibulocochlear nerve 	<ul style="list-style-type: none"> • Part of vestibulocochlear nerve • Glossopharyngeal nerve • Vagus • Accessory nerve • Hypoglossal nerve

- Rostral interstitial nucleus of the medial longitudinal fasciculus and the interstitial nucleus of Cajal, both of which are involved in the control of vertical and torsional gaze
- PPRF—For horizontal gaze.

New SARP Series Anatomy



MEDULLA OBLONGATA

External Features

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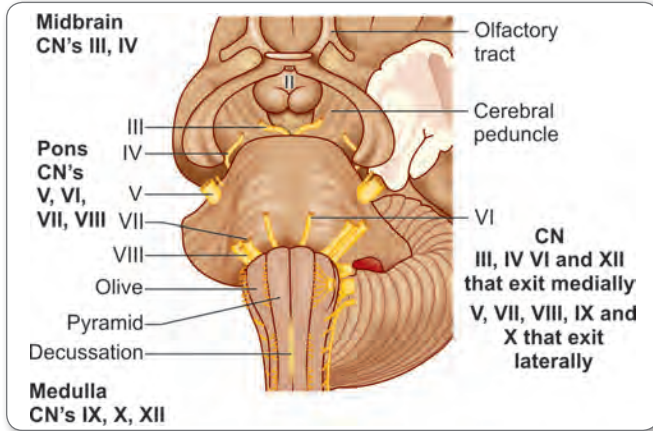


Fig. 43: External features of brain

- Lower part of brain stem extending from foramen magnum to lower border of pons
- Contains vital centers like cardiac center, respiratory center and vasomotor center
- **Pyramids**—elevation produced corticospinal fibers
- **Olive**—oval mass due to underlying inferior olivary nucleus
- **Hypoglossal nerve emerges** between pyramid and olive
- Inferior cerebellar peduncle lying posterolateral to olive
- Rootlets of IX, X, XI emerge between olive and inferior cerebellar peduncle.

Internal Features

Great Motor Decussation Occurs at Lower Level of Medulla

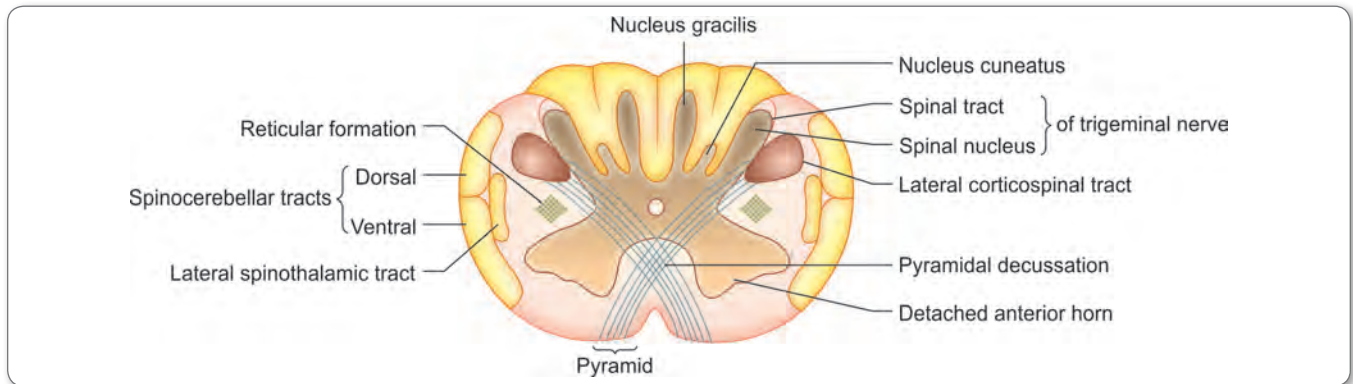


Fig. 44: Transverse section through the lower closed part of the medulla oblongata at the level of pyramidal decussation

- 75% of fibers cross to opposite side and continue as lateral corticospinal tract, 20% of fibers donot cross and continue as anterior corticospinal tracts and 5% of fibers uncrossed run in lateral white column of spinal cord.

Medulla at the Sensory Decussation

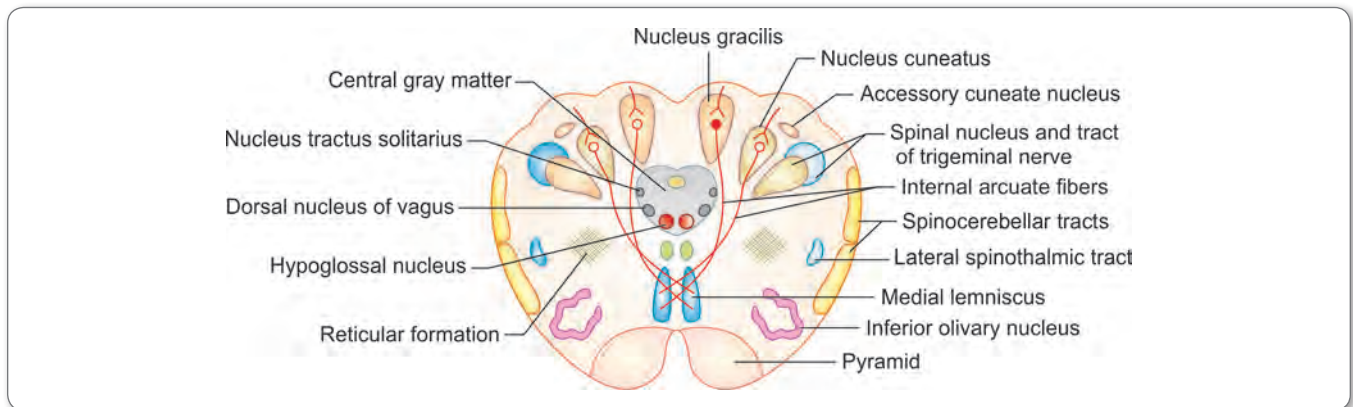


Fig. 45: Transverse section of the medulla at the sensory decussation



- Nucleus gracilis and cuneatus become more prominent
- **Great sensory decussation occurs at higher level of medulla** – fibers from gracile and cuneate nucleus decussate and form internal arcuate fibers and continue upward as medial lemniscus.
- Central gray matter contains **hypoglossal nucleus, dorsal nucleus of vagus and nucleus tractus solitarius**
- Lateral and anterior spinothalamic tracts are very close and form spinal lemniscus.

MEDULLA AT THE LEVEL OF OLIVES

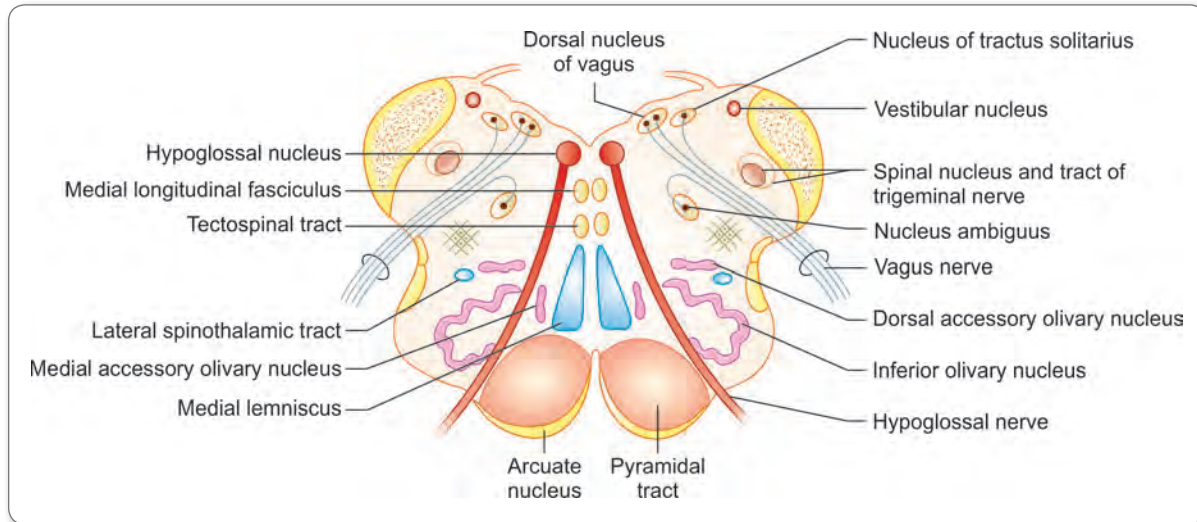
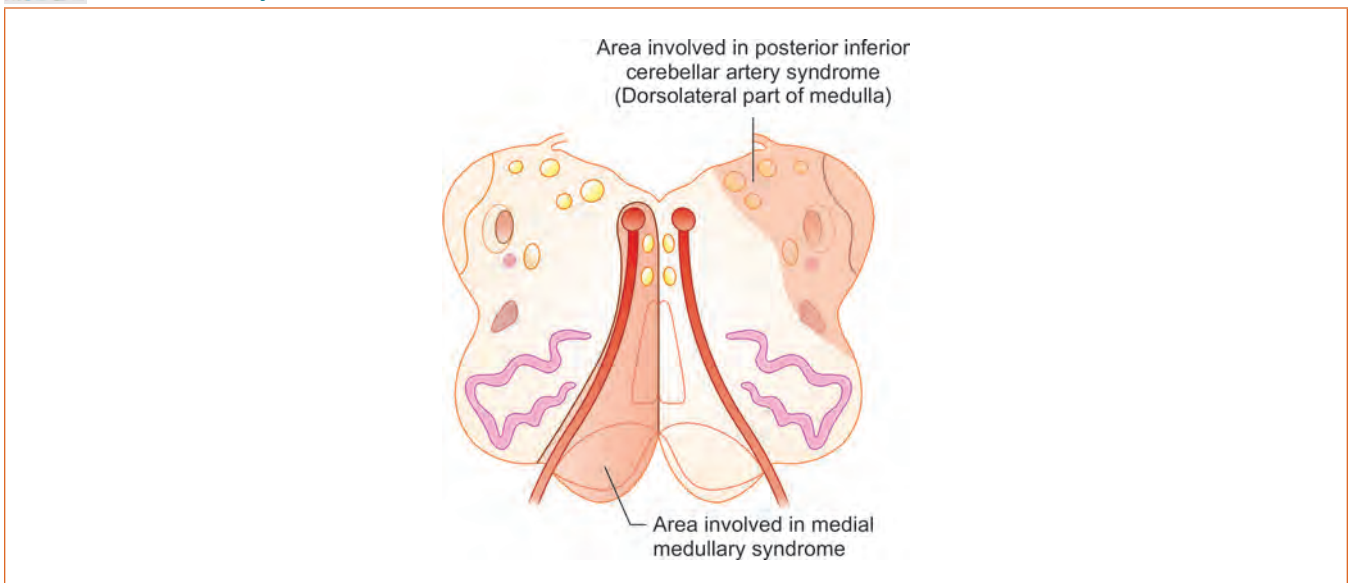


Fig. 46: Transverse section of the medulla at the level of olives

- Central gray matter spread over the floor of the IV ventricle, **hypoglossal nucleus, nucleus interclatus, dorsal nucleus of vagus and vestibular nuclei from medial to lateral side**
- Nucleus tractus solitarius ventral to **vestibular nuclei**
- Nucleus ambiguus present
- Arcuate nuclei—inferiorly displaced pontine nucleus situated anteromedial to pyramids
- **Inferior olivary nucleus** is the largest gray matter and forms important feature in this section
- Inferior cerebellar peduncle.



Clinical Aspect



Contd...



Medial medullary syndrome

- Occlusion of anterior spinal artery or vertebral artery
- Contralateral hemiplegia due to damage of pyramid
- Ipsilateral paralysis/atrophy of half of tongue due to damage of hypoglossal nerve
- Contralateral loss of position sense and vibration due to damage of medial lemniscus

Lateral medullary syndrome (Wallenberg syndrome)

- Occlusion of **posterior inferior cerebellar artery**
- Contralateral loss of pain and temperature due to involvement of spinothalamic tract
- Ipsilateral loss of pain and temperature over the face due to involvement of spinal nucleus and tract of trigeminal nerve
- Ipsilateral paralysis of muscles of palate, pharynx and larynx due to involvement of nucleus ambiguus
- Ipsilateral ataxia: Due to involvement of inferior cerebellar peduncle
- Giddiness: Due to involvement of vestibular nuclei
- Horner's syndrome: Due to involvement of reticular formation of medulla.

PONS

Middle part of brain stem and connected to cerebellum by middle cerebellar peduncle.

Internal Structure of Pons

- Consists of ventral basilar part and dorsal tegmental part
- Ventral basilar part is same throughout the sections of pons and consists of:
 - Pontine nucleus longitudinal bundle (include corticopontine, corticonuclear, corticospinal) and transverse fibers arise in pontine nucleus and cross to opposite side. Pontine nucleus center for corticopontocerebellar pathway.

In the Lower Part of Pons–Tegmental Part

- Gray matter—abducent nuclei, facial nerve nucleus, vestibule and cochlear nucleus, spinal nucleus of trigeminal, salivatory nucleus and lacrimatory nucleus.
- White matter—**trapezoid body, facial colliculus and two-lemniscus (medial and spinal).**

Facial Colliculus

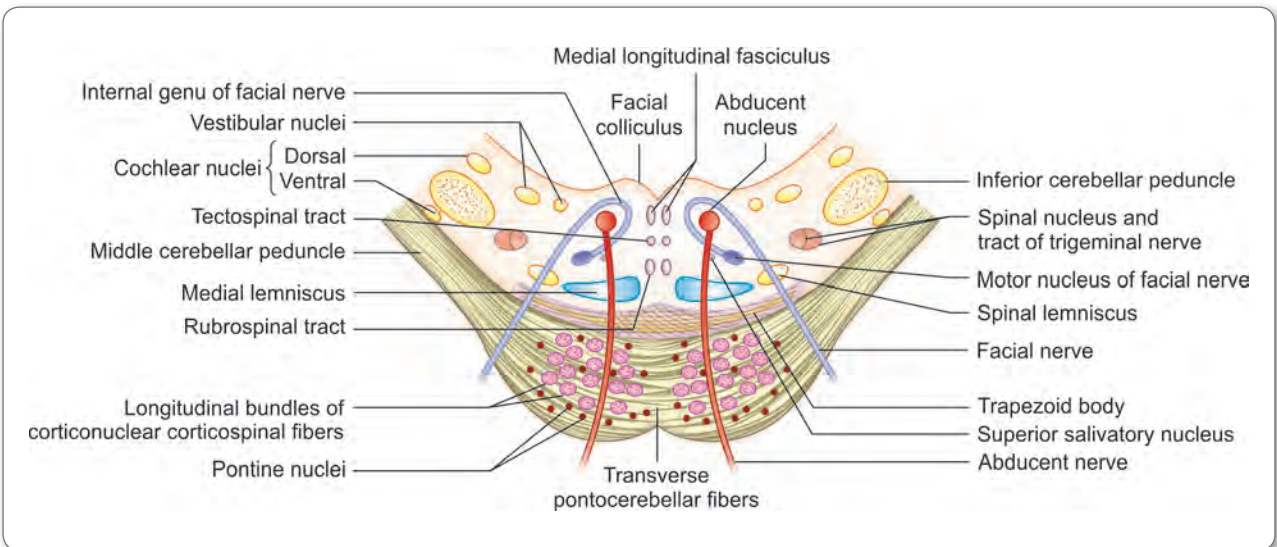


Fig. 47: Transverse section at facial colliculus

- Formed by fibers from facial nerve hooking around the abducent nucleus
- Motor component (facial nerve) migrates caudally and reach close to spinal nucleus of trigeminal nerve. Such migration of motor nucleus toward sensory nucleus to elicit quick reflex is called **neurobiotaxis**.



Trapezoid Body

Formed by transversely running fibers from cochlear nucleus of both the sides.

In the Upper Part of Pons

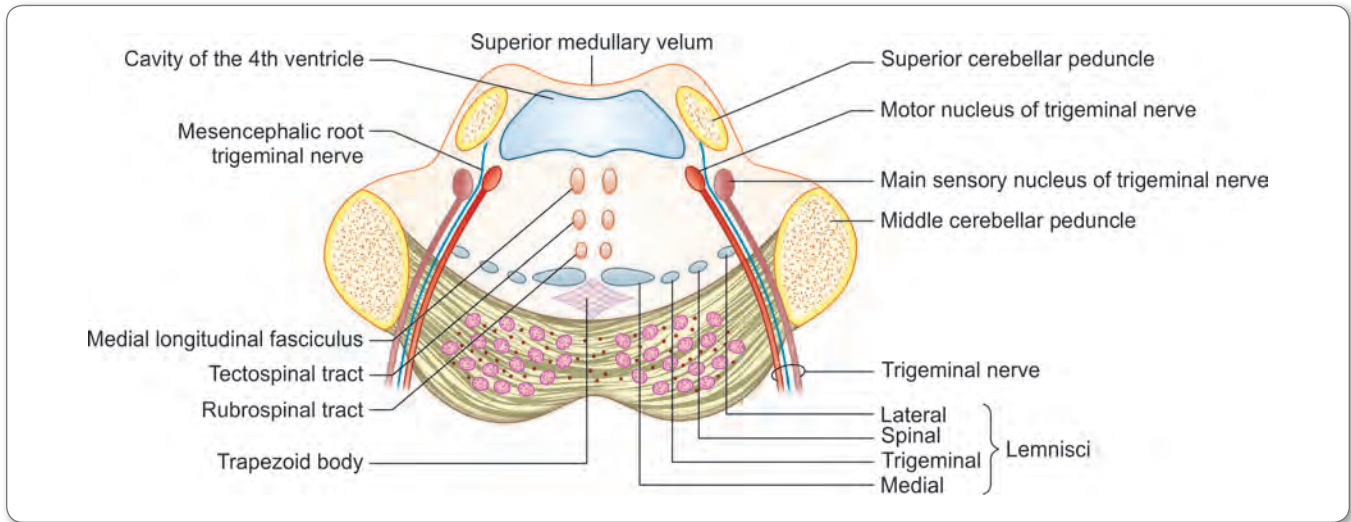
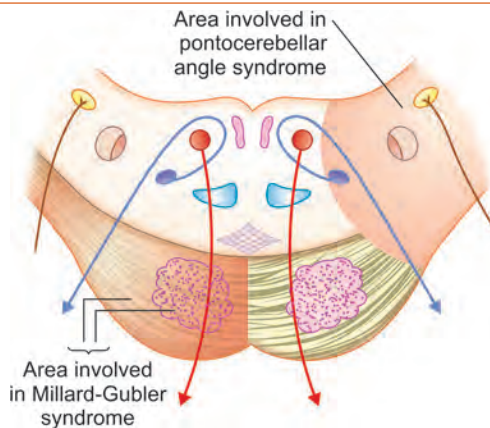


Fig. 48: Transverse section at upper part of pons

- Gray matter: Motor and sensory nucleus of trigeminal nerve.
- White matter: Medial longitudinal bundle, 4 lemniscus (medial, trigeminal, spinal and lateral lemniscus), trapezoid body.



Clinical Aspect



Millard–Gubler syndrome

- Medial inferior pontine syndrome
- Lesion in the lower part of pons
- Ipsilateral medial squint (due to involvement of abducent nerve)
- Ipsilateral facial palsy due to involvement of facial nerve fibers
- Contralateral hemiplegia due to involvement of corticospinal tract

Pontocerebellar angle syndrome

- Anatomical structures located in the pontocerebellar angle include VII, VIII, flocculus of cerebellum and choroid plexus of IV lower case
- Tinnitus, deafness and vertigo due to involvement of VIII nerve
- Ipsilateral ataxia and gait due to involvement of cerebellum
- Ipsilateral lower motor neuron of facial palsy due to involvement of facial nerve
- Ipsilateral loss of pain and temperature in face due to involvement of spinal nucleus of trigeminal nerve



MIDBRAIN

Internal Structure of Midbrain

- Consists of posterior part tectum and large anterior part cerebral peduncle
- Cerebral peduncle divided into tegmentum, substantia nigra, and crus cerebri
- Substantia nigra and crus cerebri remain same throughout the sections.

Crus Cerebri

- Corticonuclear and corticospinal fibers occupy medial two-thirds of crus.

- Frontopontine fibers occupy the medial one-third
- Temporopontine, parietopontine and occipitopontine fibers occupy the lateral one third of crus.

Substantia Nigra

- Pigmented band of gray matter between tegmentum and crus cerebri
- Large motor nucleus that extends throughout the length
- Divided into pars compacta and pars reticularis
- Contains deeply pigmented melanin (which is precursor of dopamine) and iron
- Synthesis dopamine which is carried by axons to corpus striatum.

Midbrain at the Level of Inferior Colliculus

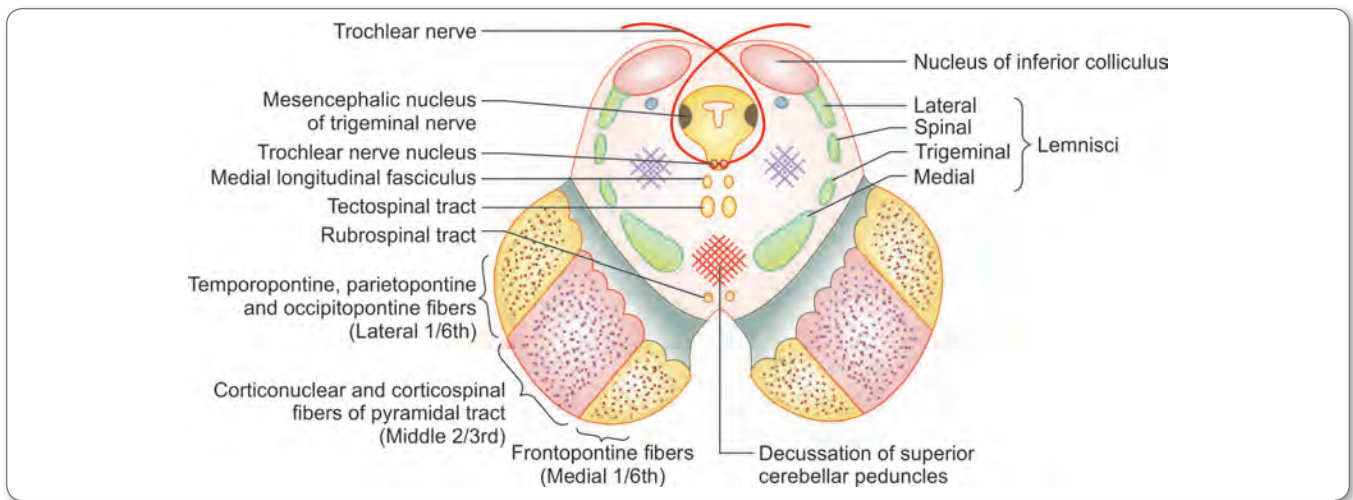


Fig. 49: Transverse section of midbrain at the level of inferior colliculus

- **Gray Matter**
 - Nucleus of trochlear nucleus, mesencephalic nucleus of trigeminal nerve and inferior colliculus.
- **White Mater**
 - Four lemnisci seen (medial, trigeminal, spinal and lateral). Lateral lemnisci ends in inferior colliculus.
 - Decussation of superior cerebellar peduncle

Midbrain at the Level of Superior Colliculus

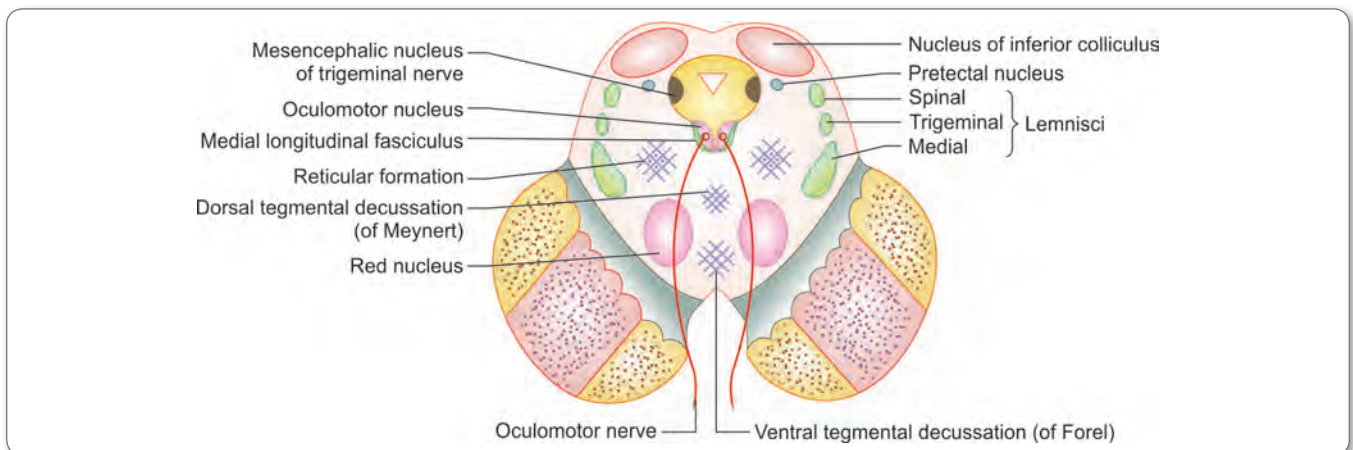


Fig. 50: Transverse section of midbrain at the level of superior colliculus



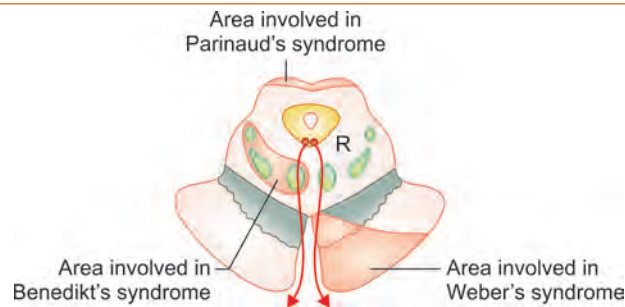
- **Gray matter**
 - Oculomotor nucleus, Edinger Westphal nucleus, mesencephalic nucleus of trigeminal nerve, superior colliculus, red nucleus and pretectal nucleus.
- **White matter**
 - Only three lemnisci seen—medial, trigeminal and spinal. **Lateral lemnisci is not seen.**
 - Red nucleus and fibers (rubrospinal) immediately decussate and form ventral tegmental decussation of Forel
 - Tectospinal fibers decussate and form dorsal tegmental decussation of Meynert.

Mnemonic

Superior colliculi control eye reflexes, superior colliculi—superior brachium—lateral geniculate body—optic (ocular) **Mn - SLOW**
 Inferior colliculi—in auditory pathway. Inferior colliculi—inferior brachium—medial geniculate body—auditory pathway.
Mn – Indian Medical Association.



Clinical Aspect



Weber's syndrome	<ul style="list-style-type: none"> ● Occlusion of posterior cerebral artery ● Ipsilateral lateral squint, ptosis—due to involvement of IIIrd nerve ● Contralateral hemiplegia—due to involvement of corticospinal tract ● Pupil is dilated and fixed—accommodation reflex lost—due to involvement of IIInd nerve ● Contralateral paralysis of lower part of face, tongue—due to involvement of corticobulbar tract
Benedikt's syndrome	<ul style="list-style-type: none"> ● Occlusion of paramedian branches of posterior cerebral artery ● Ipsilateral lateral squint, ptosis due to involvement of IIIrd nerve ● Contralateral loss of pain and temperature due to involvement of trigeminal and spinal lemnisci ● Contralateral loss of tactile, muscle, joint and vibration sense due to involvement of medial lemniscus ● Contralateral tremors and involuntary movements in limbs due to involvement of red nucleus
Perinaud's syndrome	<ul style="list-style-type: none"> ● Due to pineal gland tumor ● Loss of upward gaze due to involvement of superior colliculus ● Noncommunicating hydrocephalus aqueduct of sylvius compression

Note:

- Weber's syndrome—IIIrd nerve lesion with **hemiplegia** (due to pyramid involvement)
- Benedikt syndrome—IIIrd nerve lesion with **tremors** (due to involvement of red nucleus)

MEDIAL LONGITUDINAL FASCICULUS

- Heavily myelinated tract found in paramedian position throughout the brain stem
- Medial longitudinal fasciculus (MLF) consists of fibers arising from vestibular nuclei (also from interstitial nucleus of cajal—accessory oculomotor nucleus & fibers from lateral lemniscus)
- Fibers from MLF interconnect nuclei of III, IV, VI and spinal nucleus of accessory
- Function: To coordinate the movement of eye, head and neck in response to stimulation of VIII nerve.



Clinical Aspect

Intranuclear Ophthalmoplegia – MLF Syndrome

- Seen in multiple sclerosis
- Damage to MLF between abducent and oculomotor nuclei
- Results in medial rectus palsy on attempted lateral conjugate gaze and monocular horizontal nystagmus in abducting the eye.

CEREBELLUM

Consists of two cerebellar hemisphere which united in the midline by worm like vermis.

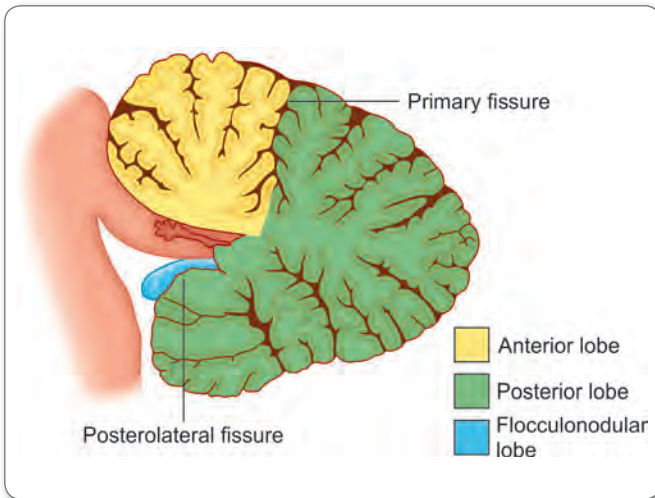


Fig. 51: Lobes of cerebellum

Fissures

- **Horizontal fissures:** Most conspicuous at the junction between superior and inferior surface of cerebellum.
- **Posterolateral surface:** Lies on the inferior surface of cerebellum and separates flocculonodular lobe from rest of the cerebellum
- **Primary fissure:** Lies at the junction of anterior two-thirds and posterior one third.

Subdivisions

Anatomical Subdivision

- **Anterior lobe:** Lies anterior to primary fissure
- **Posterior or middle lobe:** Lies between primary fissure and posterolateral fissure
- **Flocculonodular lobe:** The smallest and lies on the inferior surface in front of posterolateral surface.

Morphological Subdivisions

- Archicerebellum (vestibular cerebellum): Phylogenetically **oldest**. Consists of flocculonodular lobe. Concerned with maintenance of equilibrium, tone and posture of trunk muscles.

- Paleocerebellum (spinal): Phylogenetically next part consists of anterior lobe. Concerned with tone, posture and crude movements of the limbs.
- Neocerebellum (cerebral cerebellum): Most recent part and concerned with smooth performance of skilled motor activity.

Layers of Cerebellar Cortex

- **Outer molecular layer:** Basket and stellate cells and dendrites from Purkinje cell.
- **Intermediate purkinje layer:** Flask-shaped purkinje cell.
- **Inner granular layer:** Contains granule cell and few Golgi cells.

HIGH YIELD POINTS

All cells are inhibitory except granule.

MOSSY (constitute bulk) and climbing fibers are two main inputs to cerebellum

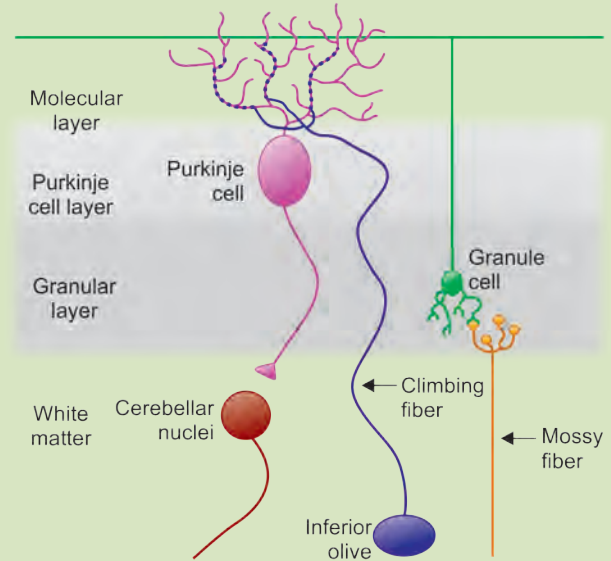
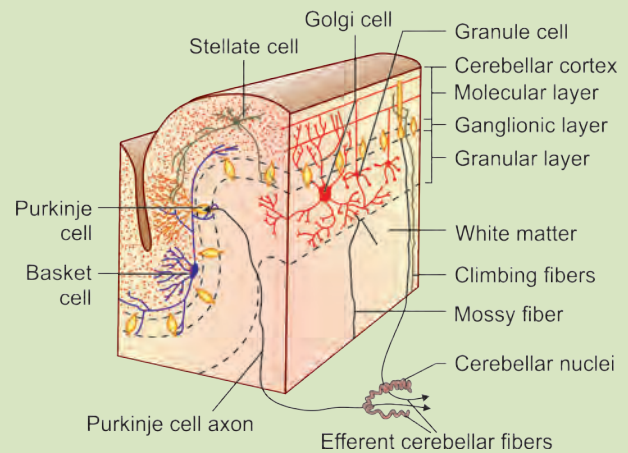


Fig. 52: Layers of cerebellum with their respective cell types



Cerebellar Pathway

- Afferents by climbing fibers and mossy fibers (both are excitatory)
- Climbing fibers originate from **inferior olivary nucleus** and synapse with **Purkinje cell**
- Mossy fibers form the bulk of the afferents and each fiber ends by dividing into 30–40 terminal rosette. Each rosette anastomoses with Golgi cell and granule cell. One granule cell synapse with thousands of purkinje, So are mossy fiber synapse with thousands and thousands of purkinje cell
- Axons of purkinje cells (inhibitory) end by synapsing with the neurons of intracerebellar nuclei
- Axons from these nuclei inturn project into contralateral thalamus and then into contralateral cerebrum
- Cerebrum in turn control the contralateral spinal cord via corticospinal tract
- Few purkinje neurons from flocculonodular lobe pass directly to vestibular nuclei.

Intracerebellar Nuclei

- Dentate laterally present
- Emboliform
- Fastigial: Most medial
- Globose

Cerebellar Peduncle

It connects cerebellum to brain stem.

- Superior cerebellar peduncle connects cerebellum to mid brain
- Middle cerebellar peduncle connects cerebellum to pons
- Inferior cerebellar peduncle connects cerebellum to medulla.

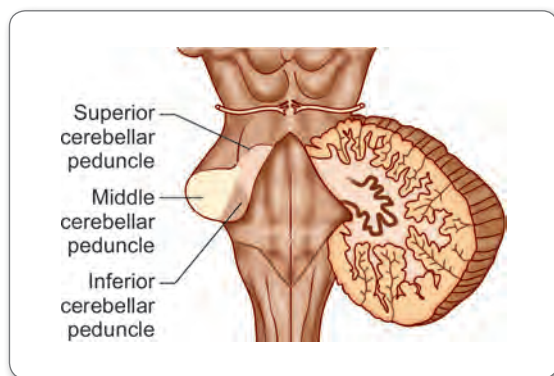


Fig. 53: Cerebellar peduncles

Table 18: Afferent and efferent nerves from various peduncles

Peduncle	Afferent	Efferent
Superior	<ul style="list-style-type: none"> • Anterior spinocerebellar • Tectocerebellar (Mn – AT) 	<ul style="list-style-type: none"> • Dentato olivary (Mn – DO) • Fastigioreticular (Mn FAST RETURN) • Cerebellorubral • Dentatothalami (Mn DENTAL and HEAD)

Contd...

Peduncle	Afferent	Efferent
Middle	Pontocerebellar	
Inferior	<ul style="list-style-type: none"> • Vestibulocerebellar • Cuneocerebellar • Spinocerebellar • Par olivocerebellar • Olivocerebellar • Reticulocerebellar • Trigemino-cerebellar 	<ul style="list-style-type: none"> • Cerebellovestibular • Cerebello-livary • Cerebelloreticular

Clinical Aspect

Signs of Cerebellar Dysfunction

- Archicerebellum lesion—truncal ataxia, staggering gait, nystagmus
- Paleocerebellum lesion— hypotonia of limb muscles
- Neocerebellum lesion—dysmetria, intentional tremors, dysarthria, dysdiadochokinesia and rebound phenomenon.

DIENCEPHALON

- Part of brain between cerebrum and brain stem.

DIVISIONS OF DIENCEPHALON

Table 19: Divisions of diencephalon

Pars dorsalis	Pars ventralis
<ul style="list-style-type: none"> • Thalamus • Metathalamus: Medial and lateral geniculate bodies • Epithalamus <ul style="list-style-type: none"> ▪ Pineal gland – acts as biological clock and secretes melatonin ▪ Habenular nucleus ▪ Habenular commissure ▪ Posterior commissure 	<ul style="list-style-type: none"> • Subthalamus—subthalamic nucleus • Hypothalamus

THALAMUS

- Large ovoid mass of gray matter situated above the midbrain
- The two thalami are situated on each side by slit-like cavity called third ventricle
- Each thalamus forms the lateral wall of third ventricle and floor of the central part of lateral ventricle
- Receives precortical input from all sensory systems except the olfactory system
- Projects primarily to cerebrum, basal ganglia and hypothalamus
- Plays important role in sensory and motor system integration.



Thalamic Nuclei and their Connection

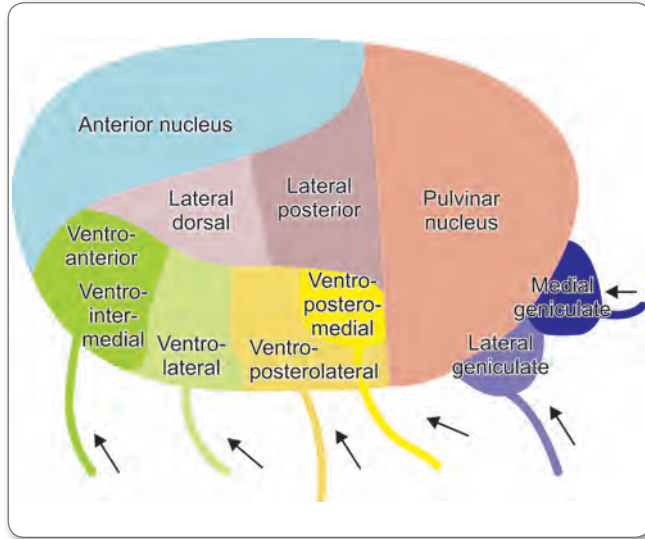


Fig. 54: Thalamic nuclei

- Anterior nucleus
 - Via mammillothalamic tract it receives from hypothalamic mammillary nuclei
 - Via fornix it receives input from hippocampus
 - Fibers inturn project to cingulate gyrus
- Dorsomedial nucleus
 - Part of limbic system
 - Lesion of this part results in memory loss (Wernicke-Korsakoff syndrome)
- Intralaminar nuclei
 - Receives input from reticular formation
 - Fibers inturn project to neocortex
 - Sends fibers to other thalamic nuclei (whereas other thalamic nucleus sends fibers to different areas of cortex)
- Dorsal tier nucleus
 - Lateral dorsal nucleus—posterior extension of anterior nucleus
 - Pulvinar
 - Largest thalamic nucleus
 - Receives input from lateral and medial geniculate body
 - Concerned with integration of visual and auditory input
- Ventral tier nucleus
 - Ventral anterior
 - ◆ Receives input from globus palidus and substantia nigra
 - ◆ Fibers project to motor cortex
 - Ventral posterior: Contains three subnuclei
 - Ventral posterolateral: Receives input from spinothalamic tracts and medial lemniscus
 - Ventral posteromedial: Receives trigeminothalamic tracts
 - Ventral posterior inferior: Receives fibers from vestibular nuclei.

METATHALAMUS

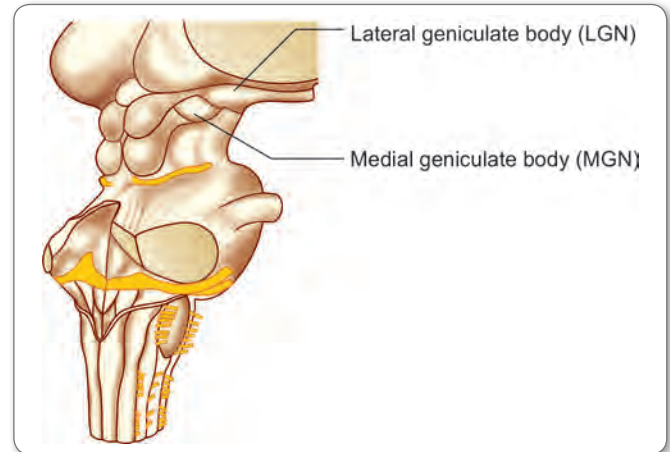


Fig. 55: Metathalamus

- Contains medial and lateral geniculate body
- **Medial geniculate body**
 - Auditory relay nucleus
 - Receives auditory input from inferior colliculus
 - Project to primary visual cortex
- **Lateral geniculate body**
 - Visual relay nucleus
 - Receives input from optic tract
 - Project to visual cortex.

EPITHALAMUS

It consists of:

- Pineal gland
 - Biological clock for physiological and behavioural control
 - Secretes melatonin, which inhibits the secretion of gonadotrophins GnRH from hypothalamus
 - Neuroendocrine activity in regulation of pituitary and other endocrine organs
 - Neural pathway for pineal secretion
- Habenular nucleus—situated above the superior colliculus and medial to pulvinar. Part of limbic system
- Habenular commissure—connects habenular nucleus of two sides
- Posterior commissure: Connects interstitial nuclei, superior colliculi, pretectal nuclei of two sides.

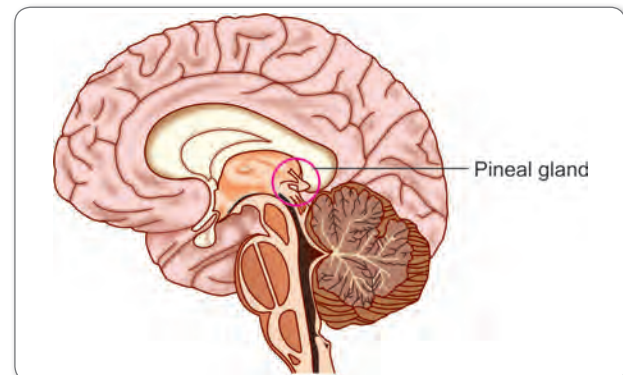


Fig. 56: Pineal gland



Hypothalamus

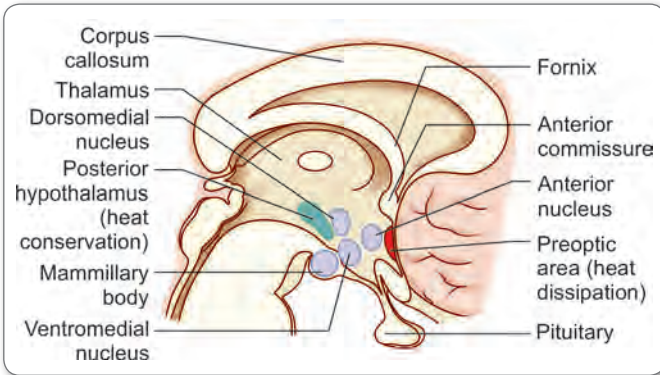


Fig. 57: Hypothalamus

- Part of diencephalon situated below the thalamus
- Forms floor and lower part of lateral wall of third ventricle.

Table 20: Hypothalamus nuclei and their functions

Nucleus	Functions
Preoptic	Regulates the release of gonadotrophic hormones
Supraoptic and paraventricular	Regulates antidiuretic hormone and oxytocin
Anterior nucleus	Regulates body temperature and stimulates parasympathetic system
Posterior	Regulates body temperature by conservation of heat (shivering center) Stimulates sympathetic system
Ventromedial	Satiety center
Arcuate	Produce hypothalamic releasing factors
Dorsomedial nucleus	Stimulation causes obesity and causes savage behavior
Mammillary nuclei	Receives input from hippocampal formation
Lateral nucleus	Feeding center



Clinical Aspect

Pituitary Adenoma

- Constitutes 15% of intracranial tumors
- Pressure on optic chiasm results in bitemporal hemianopia
- Pressure on hypothalamus results in hypothalamic syndrome

Wernicke Encephalopathy

- Results from thiamine deficiency
- Lesions are found in hypothalamus and in periaqueductal gray mater of mid brain
- Characterized by the triad ocular palsy, ataxic gait and mental confusion

CEREBRUM

- Largest part of human brain and occupies most of the cranial cavity.
- Consists of two cerebral hemispheres which are connected in middle by corpus callosum.
- It encloses cavity called lateral ventricle.

FEATURES OF CEREBRUM

Three Poles

- Frontal pole: Anterior end of hemisphere.
- Occipital pole: Posterior end of hemisphere.
- Temporal pole: Anterior end of temporal lobe.

Three Surfaces

- Superolateral surface: Most convex and most extensive.
- Medial surface: Flat and vertical.
- Inferior surface: Irregular and divided into orbital area and tentorial area.

Borders

- Superomedial border: Separates superolateral surface from medial surface.
- Superciliary border: Junction of superolateral and orbital surface.
- Inferolateral border: Separates superolateral surface from tentorial surface.
- Medial orbital border: Separates medial surface from orbital surface.
- Medial occipital border: Separates medial surface from tentorial surface.

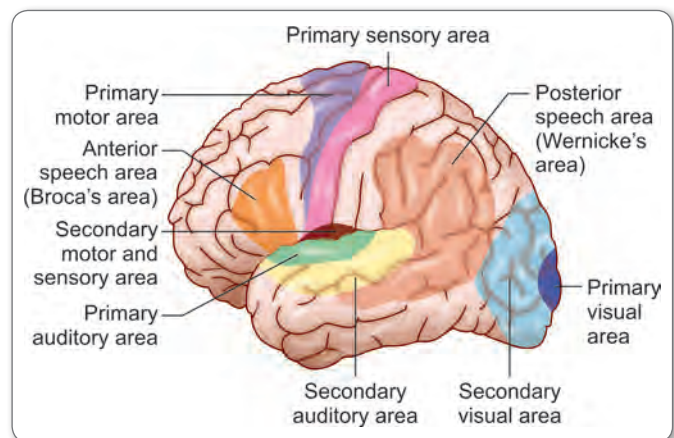


Fig. 58: Cerebrum

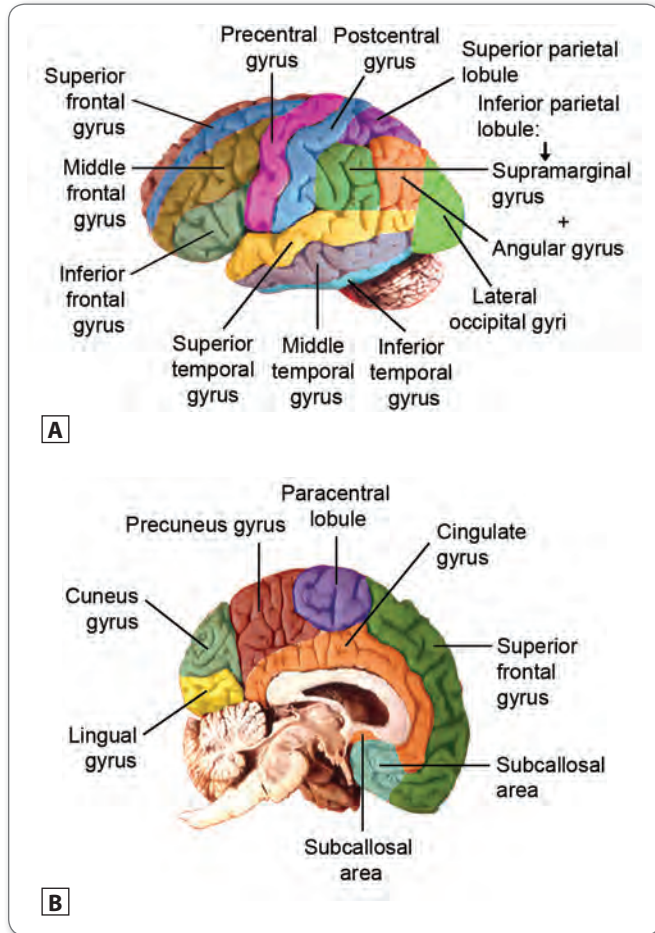
Sulci and Gyri

To accommodate the extensive cerebral hemisphere in the limited space, cerebrum is thrown into numerous convolutions separated by fissures. These convolutions are called gyri and fissures are called sulci.



Functionally, sulci are divided into:

- Axial sulcus: Formed in long axis of homogenous area, e.g. postcalcarine sulcus in the striate cortex.
- Limiting sulcus: Separates functionally different areas, e.g. central sulcus of Rolando.
- Operculated sulcus: Separates functionally different areas but the lip contains third area, e.g. lunate sulcus.
- Complete sulcus: Produce elevation in lateral ventricle, e.g. collateral sulcus, calcarine sulcus.



Figs 59A and B: Left brain. (A) Lateral view; (B) Mid-sagittal view

BRODMANN AREAS

Brodman divided the cerebral cortex into 47 areas and indicated each of them by a number.

Types of Cortical Areas

- Sensory cortex: Primarily concerned with sensory functions and receive afferents fibers from thalamus.
- Motor cortex: Primarily concerned with motor function and gives origin to corticospinal and corticonuclear tracts.
- Association areas: Not concerned with primary motor or sensory functions but have more important associative, integrative and cognitive functions.

Functional Area in Cerebrum

Frontal Lobe

Table 21: Functional areas in the frontal lobe

Functional areas	Brodmann number	Location
Primary motor area (does the movement)	4	Precentral gyrus
Pre motor area (plans movement)	6	Superior, middle and inferior frontal gyri
Frontal eye field (conjugate deviation of the eye to the opposite side)	8	Middle frontal gyrus
Broca speech area Motor area of speech	44, 45	Inferior frontal gyrus

Parietal Lobe

Table 22: Functional area in parietal lobe

Functional area	Brodmann number	Location
Primary sensory area (receives input from ventral Posterior nucleus of thalamus)	3, 1, 2	Postcentral gyrus
Sensory association area	5, 7	Superior parietal lobe

Temporal Lobe

Table 23: Functional areas in temporal lobe

Functional area	Brodmann number	Location
Auditory area	41, 42	Anterior part of superior temporal gyrus
Wernicke speech area Sensory area of speech	22	Posterior part of superior temporal gyrus

Occipital Lobe

Table 24: Functional areas in occipital lobe

Functional area	Brodmann number	Location
Primary visual area	17	Posterior part of calcarine sulcus (occipital lobe)
Secondary visual area	18, 19	Surrounds the primary visual area



Other Cortical Areas

Table 25: Functional areas in other cortical areas

Functional area	Brodman number	Location
Taste area	43	Parietal operculum and para insular cortex.
Olfactory area	28	Para hippocampal gyrus And uncus

INVERTED HOMUNCULUS

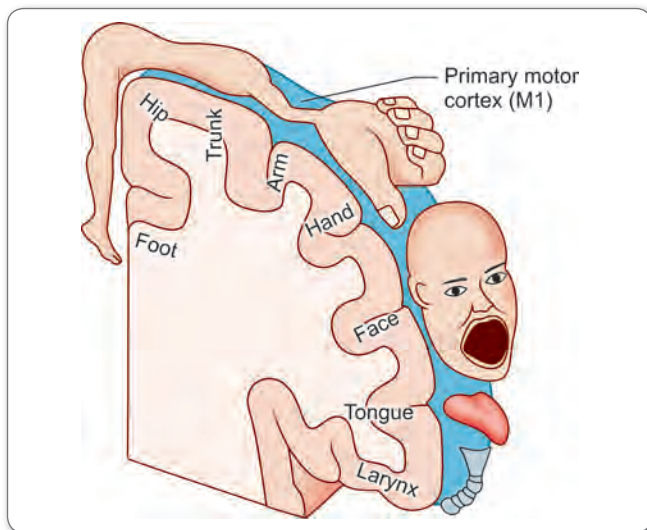


Fig. 60: Inverted homunculus

- Human body is represented in a upside down manner in the precentral gyrus (inverted homunculus)
- The pharyngeal region, tongue are represented in the lower most part, followed by face, hand, trunk and thigh
- The legs, feet and perineum are represented on the medial surface of the hemisphere in the paracentral lobule
- Area of the cortex controlling the particular movement is proportional to the skill involved in performing that movement and not to the size.

DOMINANT HEMISPHERE

- Responsible for propositional language, syntax and semantics
- Also responsible for speech and calculation
- Left side is dominant in most of the cases
- Lesion in the dominant hemisphere Parietal Lobe leads to Gerstmann Syndrome, which has the following features:
 - Right – left confusion
 - Finger agnosia
 - Agraphia
 - Dyscalculia

NONDOMINANT HEMISPHERE

- Responsible for three-dimensional perception and nonverbal ideation

- Lesion in the nondominant hemisphere Parietal Lobe leads to
 - Contralateral loss of sensory discrimination
 - Contralateral side neglect

Table 26: Blood supply to the major cortical areas and features of vascular lesions

Anterior cerebral artery	<ul style="list-style-type: none"> • Supplies the medial aspect of hemisphere • Occlusion: Affected areas and deficits <ul style="list-style-type: none"> ■ Paracentral lobule – contralateral somatosensory loss in the lower extremity and perineum, contralateral weakness and hyper reflexia in the lower extremity, urinary incontinence
Middle cerebral artery	<ul style="list-style-type: none"> • Supplies lateral surface • Occlusion: Affected areas and deficits <ul style="list-style-type: none"> ■ Frontal lobe: Contralateral facial weakness and weakness in upper limb, conjugate deviation of the eye to the affected side, broca aphasia ■ Temporal lobe: Deafness, Wernicke apahasia, auditory hallucinations ■ Parietal lobe: Gerstmann syndrome (dominant hemisphere lesion), hemi neglect syndrome (nondominant hemisphere)
Posterior cerebral artery	<ul style="list-style-type: none"> • Supplies the occipital lobe, inferior aspect of temporal lobe and splenium of corpus callosum • Occlusion: Affected areas and deficits <ul style="list-style-type: none"> ■ Occipital lobe: Contralateral homonymous hemianopia with macular sparing ■ Temporal: Incapacity to create and store new memory



Clinical Aspect

Aphasia—Inability to Understand or Produce Speech

- Broca (motor) aphasia
 - Lesion in motor area of speech
 - Fluency affected
 - Comprehension—not affected
 - Repetition—poor
- Wernicke (sensory) aphasia
 - Lesion in sensory area of speech
 - Fluency not affected
 - Comprehension—affected
 - Repetition—poor
- Conduction aphasia
 - Lesion in arcuate fasciculus (interconnects broca and Wernicke area)
 - Fluency not affected
 - Comprehension: Not affected
 - Repetition: Poor

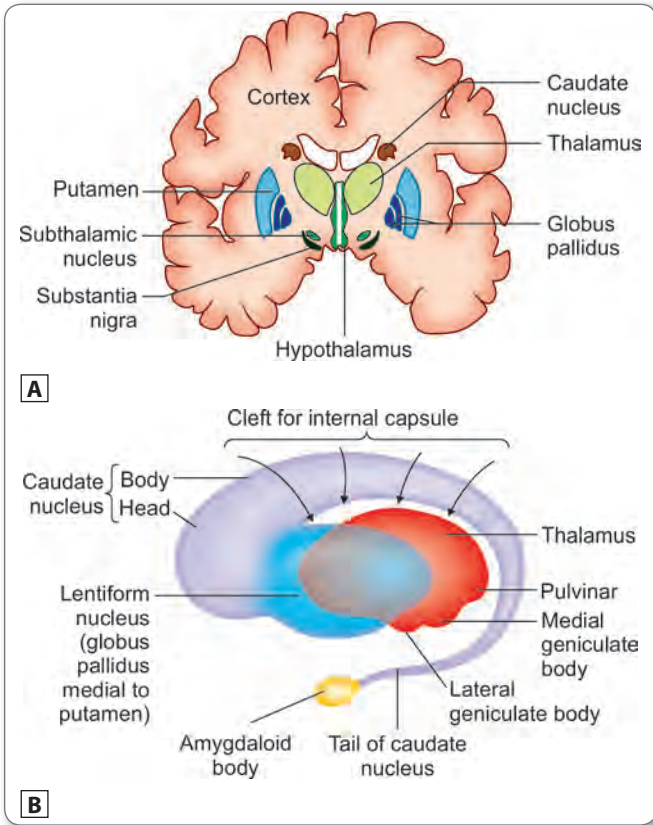
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- Transcortical motor aphasia
 - Fluency affected
 - Comprehension: Affected
 - Repetition: Good
- Transcortical sensory aphasia
 - Fluency not affected
 - Comprehension: Affected
 - Repetition: Good
- **Global aphasia:** Combines the system of Broca and Wernicke aphasia

Aphasia	Comprehension	Repetition	Fluency
Broca's motor	Preserved	Affected	Decreased
Wernicke's sensory	Affected	Affected	Maintained or increased
Global aphasia	Affected	Affected	Decreased
Conduction aphasia	Maintained	Affected	Maintained

BASAL GANGLIA (MASS OF GRAY MATTER IN CEREBRAL HEMISPHERE)



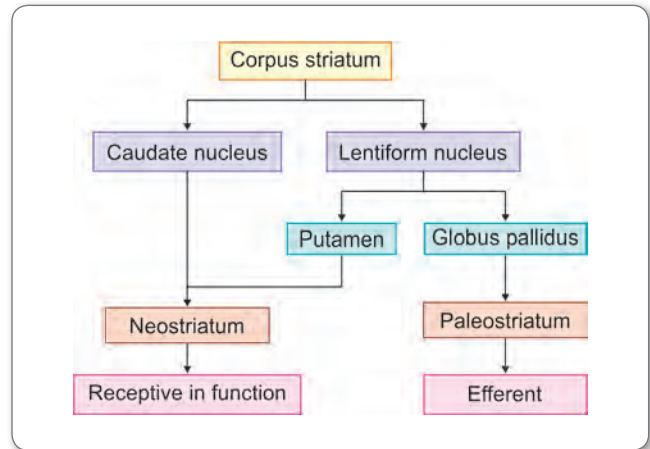
Figs 61A and B: Basal ganglia

- Corpus striatum: Structural component, derived from telencephalon.
- Subthalamus: Functional component, derived from diencephalon.
- Substantia nigra: Functional component, derived from mesencephalon.

Table 27: Structural and functional components of basal ganglia

Structural components (derived from telencephalon)	Functional components
Corpus striatum <ul style="list-style-type: none"> • Caudate nucleus • Lentiform nucleus <ul style="list-style-type: none"> ■ Putamen ■ Globus pallidus 	<ul style="list-style-type: none"> • Subthalamus—derived from diencephalon • Substantia nigra—derived from mesencephalon

- Neostriatum: Caudate nucleus and putamen together called as neostriatum.
- Paleostriatum: Pallidum.

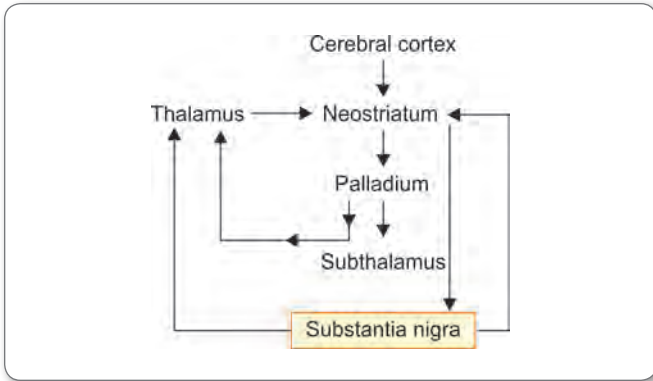


Functionally also Consists of

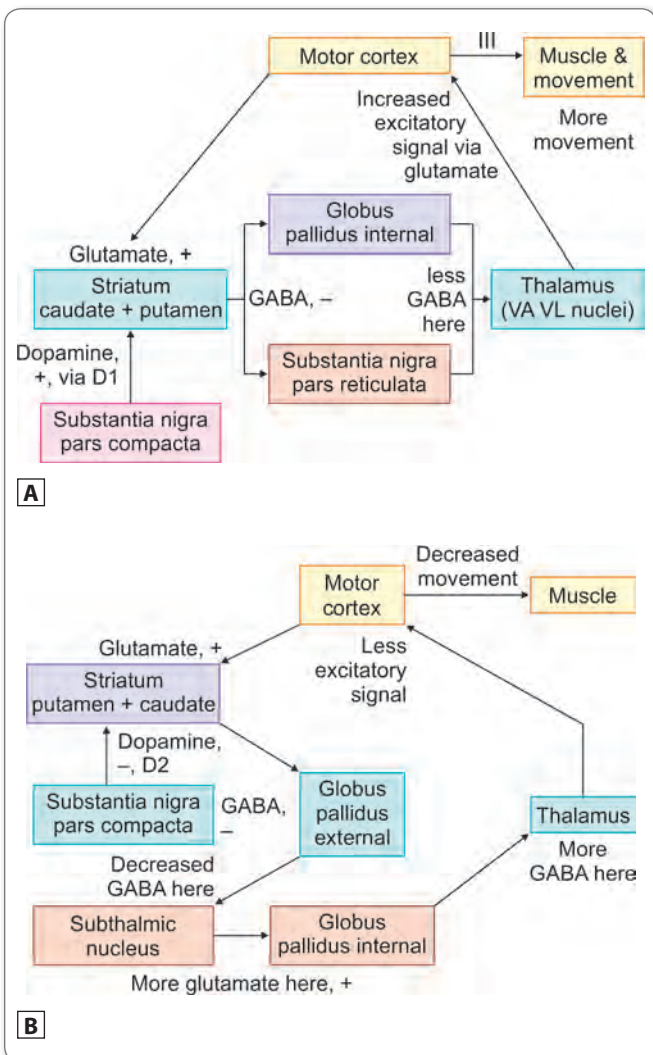
- Substantia nigra
- Subthalamus
- Red nucleus (some workers included this under basal ganglia).

Internal Circuit of Basal Ganglia

- Neostriatum receives input from three source—cerebral cortex, thalamus and substantia nigra
- Caudate nucleus and putamen are the receptive part and pallidum is the efferent part
- Neostriatum efferent fibers pass to pallidum and substantia nigra
- Efferent from pallidum pass to subthalamus and thalamus
- Thalamus receives input from pallidum and substantia nigra.



Direct and Indirect Pathways of Basal Ganglia



Figs 62A and B: Pathways of basal ganglia: (A) Direct; (B) Indirect

Clinical Aspect

Lesion site	Disorder	Features
Subthalamic nucleus	Hemiballismus	Violent burst of irregular movements
Substantia nigra	Parkinsonism (Paralysis agitans)	<ul style="list-style-type: none"> Resting tremors, cog-wheel rigidity, pill rolling Movement, mask like face, hypokinesia Depletion of dopamine in caudate nucleus and putamen
Caudate nucleus and Putamen (MN – C C)	Chorea	<ul style="list-style-type: none"> Flicking movements in hand and face Huntington's chorea is an autosomal dominant disorder with severe degeneration of cholinergic and GABAergic neurons in caudate and putamen
Lentiform nucleus	Wilson's disease	<ul style="list-style-type: none"> Also known as hepatolenticular degeneration Autosomal recessive disorder owing to defect in metabolism of copper Tremor, rigidity and Purposeless involuntary movements Copper deposited in cornea (kayser—fleischer ring), liver, lentiform nuclei sunflower cataract. Treated with copper chelating agent—d penicillamine and pyridoxine for anemia
Globus pallidus	Athetosis	<ul style="list-style-type: none"> Slow, sinuous and writhing movements of hand and arm

Note: Other choreiform dyskinesia

- Sydenham chorea (St. Vitus dance)—most common chorea, sequelae to rheumatic fever due to microemboli in corpus striatum.
- Chorea gravidarum—usually occurs during the second trimester of pregnancy.
- Red nucleus is one of the brainstem nuclei situated in the tegmentum of midbrain and is a part of extrapyramidal system. Its lesion could cause resting tremors, dystonia, and choreoathetoid movements.



WHITE MATTER OF CEREBRUM

Consists of 3 types of fibers: Association fibers, commissural fibers and projection fibers.

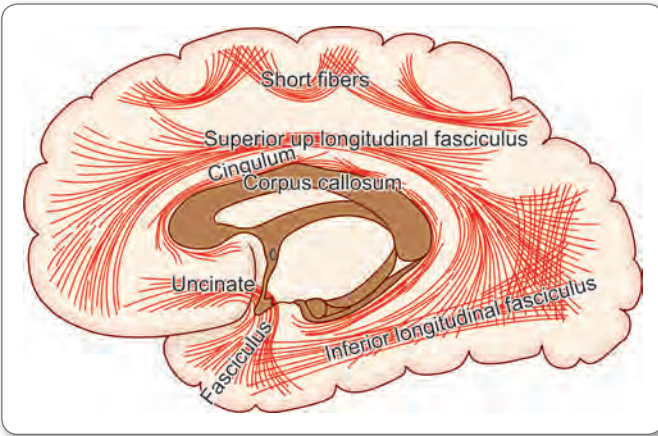


Fig. 63: White matter of cerebrum

Table 28: Examples of fibers white matter

Types of fiber	Example
Association fibers	Interconnect the different regions of cortex in the same hemisphere <ul style="list-style-type: none"> • Short association fibers • Long association fibers • Uncinate fasciculus • Cingulum • Superior longitudinal bundle • Inferior longitudinal bundle • Frontooccipital bundle

Contd...

Types of fiber	Example
Commissural fibers	Interconnect the identical areas of opposite cortex; corpus callosum <ul style="list-style-type: none"> • Anterior commissure • Posterior commissure • Habenular commissure • Commissure of fornix
Projection fibers	Connect cortex to subcortical areas <ul style="list-style-type: none"> • Internal capsule • Fornix

CORPUS CALLOSUM

- Largest commissural fibers
- Connects all parts of cerebral cortex except for lower and anterior part of temporal lobe.

Relations

- Forms roof of lateral ventricle
- Superiorly—indusium griseum
- Inferiorly—septum pellucidum

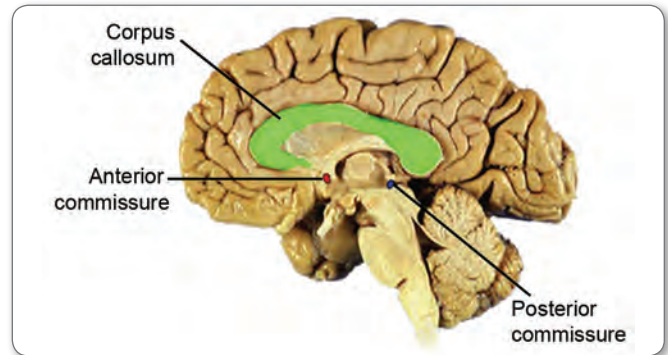


Fig. 64: Corpus callosum

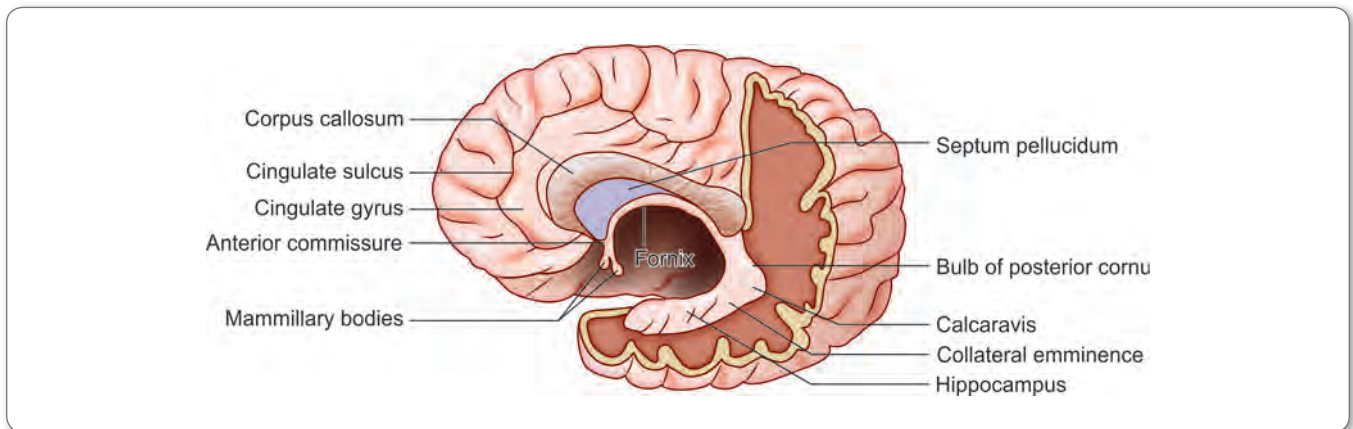


Fig. 65: Relations of corpus callosum



Parts of Corpus Callosum

- Genu—curved anterior end. Forms the anterior boundary of the anterior horn of lateral ventricle. Fibers project into frontal lobe as forceps minor
- Rostrum—extension of genu in downwards and forward direction. Forms the floor of the anterior horn of lateral ventricle. Fibers extend inferiorly to connect the orbital surfaces of the 2 frontal lobes.
- Body – middle part present between genu and splenium. Forms the roof of the central part of lateral ventricle
- Splenium – massive posterior end. Fibers project into occipital lobe as forceps major.



Clinical Aspect

Split Brain Syndrome

- Corpus callosum congenitally absent or surgically sectioned.
- Each hemisphere isolated.
- Patient responds if he/she has two brains.
- Anterior commissure: Connects anterior and lower part of temporal lobe and olfactory regions.
- Posterior commissure: Connects superior colliculi, pretectal nucleus and interstitial nucleus.

INTERNAL CAPSULE

V-shaped projection fiber—angled laterally, present between thalamus and caudate nucleus medially and lentiform nucleus laterally.

Parts of Internal Capsule

- Anterior limb: Between caudate nucleus medially and lentiform nucleus laterally.
- Posterior limb: Between thalamus medially and lentiform nucleus laterally.
- Genu—between anterior and posterior limb
- Sublentiform—present below the lentiform
- Reterolentiform—present behind lentiform.

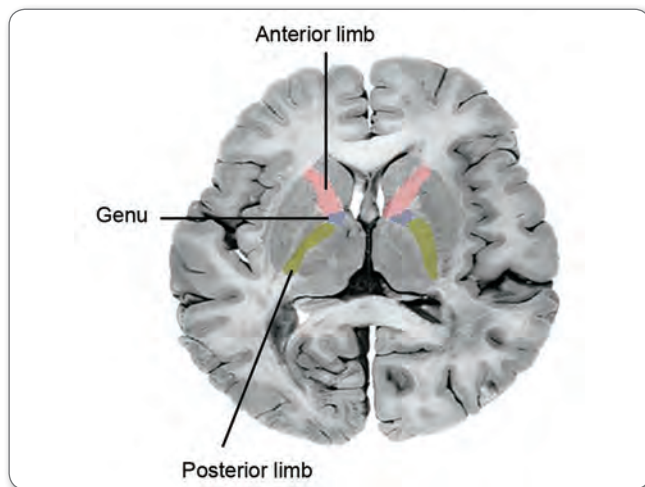


Fig. 66: Internal capsule

Table 29: Constituent motor and sensory fibers in different parts of internal capsule

Parts	Motor fibers	Sensory fibers
Anterior limb	Frontopontine fibers	Anterior thalamic radiation
Genu	Corticonuclear fibers	Few superior thalamic radiation
Posterior limb	• Corticospinal fibers • Extrapyrmidal fibers	Superior thalamic radiation
Sublentiform	• Parietopontine and • Temporopontine fibers	Auditory radiation
Retrolentiform	• Parietopontine and • Occipitopontine fibers	Optic radiation

Mnemonic

Mn – SARO (Sublentiform – Auditory radiation, Retrolentiform – Optic radiation, Occipitopontine fiber)



Clinical Aspect

Lesion of Internal Capsule

- Occurs due to hemorrhage leads to spastic paralysis (due to involvement of pyramidal and extrapyramidal fibers for the upper limb, trunk and lower limb) and loss of sensations in the opposite half of the body
- Most commonly involved artery – Charcot’s artery of cerebral hemorrhage (striate branches from middle cerebral artery)
- Lesions in the sublentiform and retrolentiform parts of internal capsule leads to visual loss and auditory defects.

LIMBIC SYSTEM

- Limbic system: Ring (limbic) like structures around the upper end of the brain stem.
- Cortical and subcortical structures.
- Plays role in fighting, feeding, feeling and mating.

Cortical Structure

- Limbic lobe: Cingulated gyrus (satisfaction center), isthmus, parahippocampal gyrus and uncus.
- **Hippocampal formation:** Hippocampus, dentate gyrus, gyrus fasciolaris and indusium griseum.

Subcortical Structures

- Amygdaloid nuclear complex
- Septal region and nuclei
- Olfactory areas
- Hypothalamus
- Anterior nucleus of thalamus.
- Functions – controls emotions, mood, recent memory, behavior, etc:



Amygdaloid Nucleus

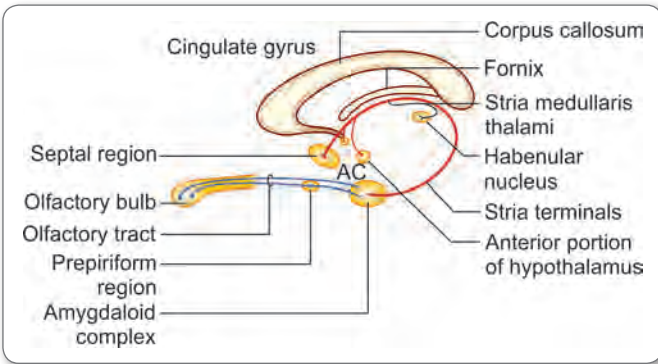


Fig. 67: Main afferent and efferent connections of the amygdaloid complex

- Almond shaped gray matter posteriorly continuous with tail of the caudate nucleus
- Connection
- Afferents—from primary olfactory regions
 - Efferents—stria terminalis. These fibers terminate in septal nuclei and anterior portion of hypothalamus. Some fibers join the anterior commissure. And run caudally to reach the habenular nucleus through stria medullaris thalami
- Plays an important role in controlling the somatic responses to internal needs, drives or instincts. Believed to play in smell-mediated sexual behavior
- Bilateral damage results in reducing the fear and increases the sexual activity.

Septal Region

- Situated in front of lamina terminalis, beneath the genu and rostrum of corpus callosum
- Includes paraterminal and parolfactory gyrus.

HIPPOCAMPUS

It has Has rolled in the floor of inferior horn of lateral ventricle.

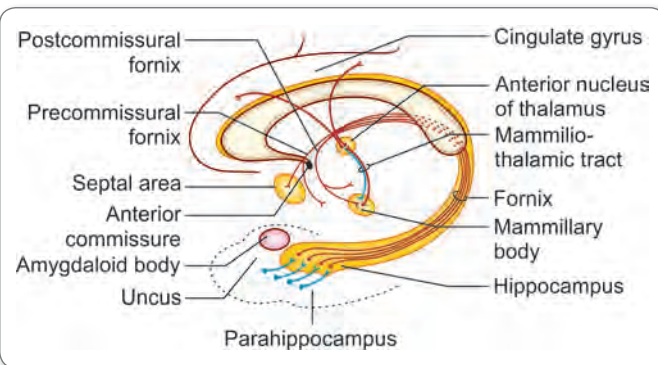


Fig. 68: Hippocampus

- Anterior extremity expanded and bears grooves and resembles animal paw termed as pes hippocampus
- Traced posteriorly, hippocampus narrows and ends beneath splenium of corpus callosum

- Ventricular surface is covered with thin layer of white matter called alveus
- These fibers converge to form fimbria
 - Afferent—entorhinal cortex
 - Efferent—fornix
- Plays an important role in **recent memory**.

Fornix

- Projection fiber connecting hippocampus with mammillary body
- Fimbria becomes rounded and forms crux of fornix
- Two crura, converge and unite to form the body of fornix
- Body divides into two columns
- Each column curves posteriorly and end in mammillary body.

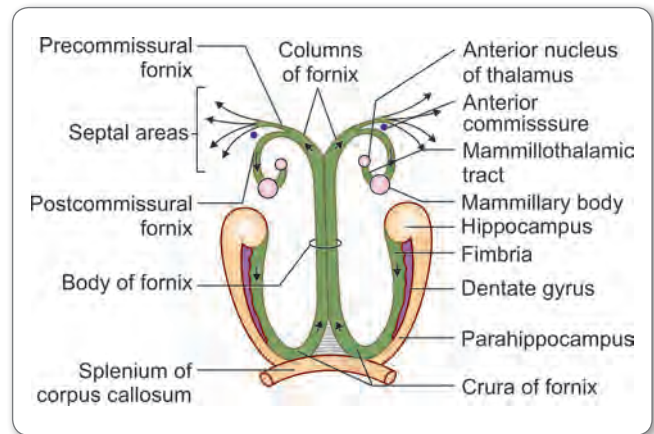


Fig. 69: Schematic diagram showing parts of fornix and its connections

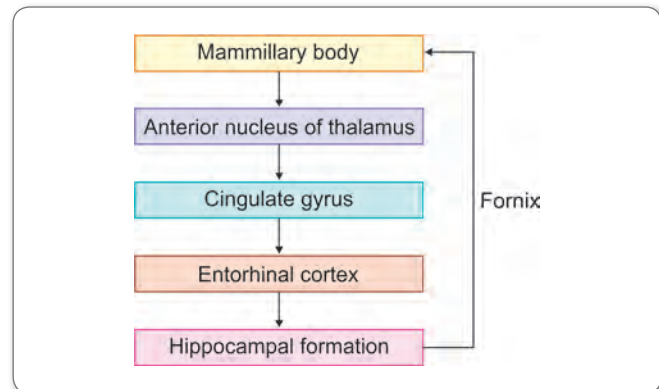


Fig. 70: Papez circuit

Clinical Aspect

Kluver–Bucy syndrome

- Results from ablation of amygdalae, hippocampal formation and anterior temporal neocortex
- Characterized by hyper sexuality, hyperphagia and psychic blindness (visual agnosia).



RETICULAR FORMATION

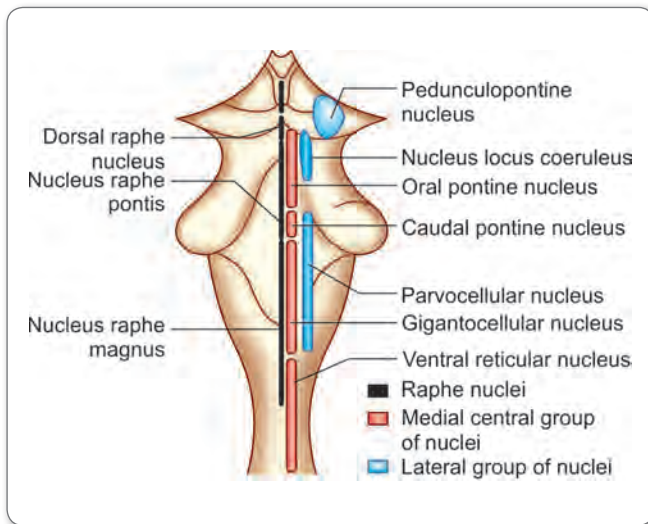


Fig. 71: Reticular nuclei in the brainstem

- Diffuse ill-defined mass of intermingled neurons and nerve fibers occupying the entire core of brain stem.
- Damage to reticular activating system leads to progressive loss of consciousness followed by stupor, coma and death.
- Extends cranially from diencephalon to spinal cord in the cervical region.
- Median column: Lies in the midline and consists of intermediate sized neurons. The nucleus of this column termed as raphe nuclei.
- Medial column: Made up of large sized neurons and termed as magno cellular column.
- Lateral column: Small neurons and referred as parvocellular column.
- Functional divisions of reticular system
 - Ascending reticular system
 - Descending reticular system.

Table 30: Functional division of reticular system

Ascending reticular activating system	<ul style="list-style-type: none"> • Most of the ascending tracts spinothalamic, trigeminal lemniscus, lateral lemniscus while passing through brain stem give collaterals to lateral part of reticular formation which inturn project to intralaminar and reticular nuclei of thalamus. • Responsible for maintaining a state of alertness and consciousness
Descending reticular activating system	<ul style="list-style-type: none"> • Descending pathway from reticular formation to autonomic centers in the brain stem and lateral horn cells of spinal cord • Plays important role in controlling the respiratory and cardiac rhythms and other vital functions

SENSORY SYSTEM

VISUAL PATHWAY

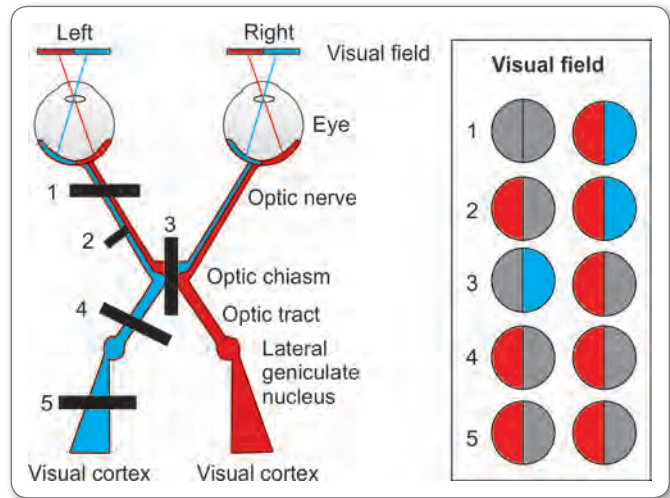


Fig. 72: Visual pathway

- **Visual system transmits visual impulse from retina to lateral geniculate body and then to primary visual cortex**
- The following systems are included in the visual system. They are:
 - Retina
 - Optic nerve
 - Optic chiasma
 - Optic tract
 - Lateral geniculate body
 - Optic radiation
 - Visual cortex
- **Retina:** Ganglion cells of retina are multipolar neurons. The axons of ganglion cells form optic nerve
- **Optic nerve:** Pass through optic canal and joins with the fellow of the opposite side to form optic chiasma above the roof of the pituitary fossa.

Note:

- Fibers from the optic nerve arise in the nasal half of retina enter the optic tract of the opposite side after crossing in the optic chiasma.
- Fibers from temporal half of each retina enter the optic tract of the same side
- Compression results in optic atrophy
- **Optic tract:** Posteriorly optic chiasma divides into two optic tracts and end in lateral geniculate body of the same side.



Clinical Aspect

- Optic tract consists of temporal fibers of same side and nasal fibers of opposite side
- Damage of central part of optic chiasma results in bitemporal hemianopia
- Damage to bilateral part of optic chiasma results in binasal hemianopia
- Transection of optic tract results in contralateral homonymous hemianopia.



- Lateral geniculate body—thalamic relay nucleus for vision. Receives fibers from ipsilateral temporal hemiretina, contralateral nasal hemiretina
 - Transection of lateral geniculate body results in contralateral homonymous hemianopia
- Geniculocalcarine tract extends from lateral geniculate body to banks of calcarine sulcus, the visual cortex. It has two division
 - Upper division: Projects to upper banks of the calcarine sulcus. Transection results in contralateral lower homonymous quadrantopia.
 - Lower division: Forms Meyers loop and terminate in the lower banks of calcarine sulcus. Transection results in contralateral upper homonymous quadrantopia.
- Visual cortex: Receives retinal input via ipsilateral lateral geniculate body.



Clinical Aspect

Lesion of visual cortex due to involvement of posterior cerebral artery results in contralateral homonymous hemianopia with macular sparing (branch of middle cerebral artery also supplies this area)

VISUAL REFLEXES

Light Reflexes

- When the light is shown to one eye, normally the pupils of both eyes constrict.
- Direct reflex: Constriction of pupil in the stimulated eye.
- Indirect or consensual reflex -constriction of pupil on the unstimulated eye.

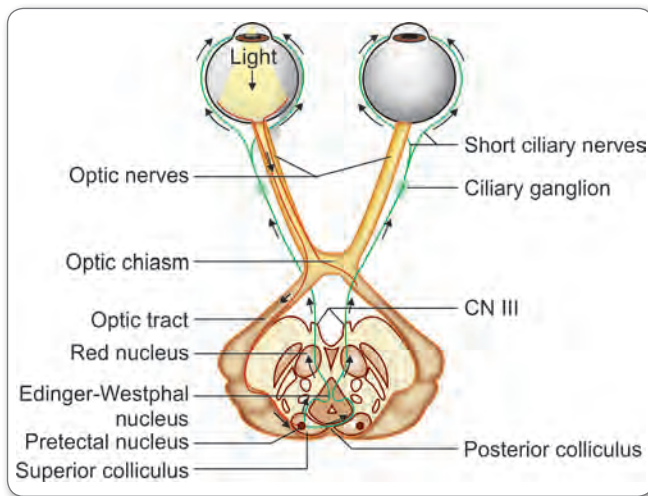


Fig. 73: Light reflex

Pathway

- **Afferent limb:** Visual impulse from optic nerve, optic chiasma and optic tract to terminate in the pretectal nucleus. Then the impulse pass to parasympathetic Edinger-Westphal nuclei of cranial nerve III of both sides.

- **Efferent limb:** Impulse from Edinger-westphal nucleus pass to IIIrd nerve to ciliary ganglion. Postganglionic fibers pass along short ciliary nerve to supply sphincter pupillae and ciliaris muscle.

Note: Postganglionic sympathetic fibers from superior cervical ganglion supplies dilator pupillae and also muller's muscle.

Accommodation Reflex

- When the eyes are focused from distant object to near object, three reactions takes place. All these actions are mediated by IIIrd nerve
- Constriction of pupil is due to **sphincter pupillae** to increase the depth of field and depth of focus
- Thickening of lens is due to **contraction of ciliary muscle** to increase the refractive index of the lens
- Convergence of both the eyeballs is due to contraction of **medial rectus**, to focus the near point

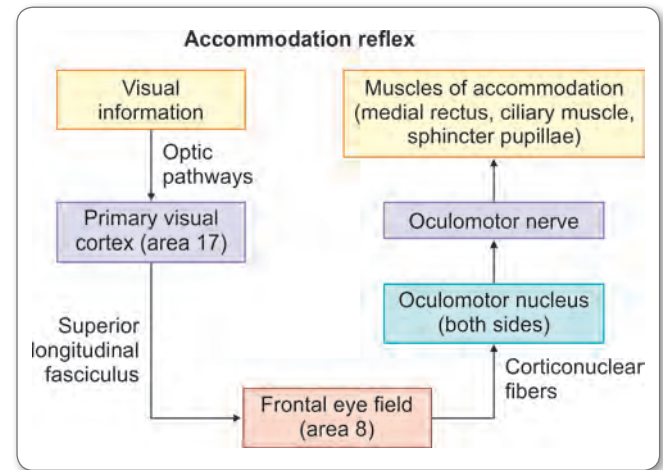


Fig. 74: Accommodation reflex



Clinical Aspect

- **Anisocoria:** Two pupils not equal. Seen in Horner's syndrome, third nerve palsy
- **Argyll Robertson pupil:** Absence of constriction of pupil in light reflex, with preservation of miotic reaction to accommodation reflex. Seen in lupus erythematosus, diabetes, syphilis
- **Marcus Gunn pupil** (consensual stimulation of constrictor pupillae is much greater than direct stimulation through defective optic nerve):
 - Diagnosed by swinging flashlight reflex
 - Light is thrown into normal eye results in pupillary constriction in both normal and affected eye (consensual rection)
 - Light is immediately thrown into affected eye, which results in dilatation of afferent pupil.
 - Seen in retrobulbar neuritis
- **Ptosis:** Drooping of eyelids
 - Oculomotor ptosis: Paralysis of levator palpebrae
 - Sympathetic ptosis: Due to involvement of muller's muscle as seen in Horner's syndrome
 - Myasthenic ptosis: Seen in myasthenia gravis. Improves by injecting cholinesterase inhibitor.



AUDITORY PATHWAY

- Cell bodies of first order neuron located in spiral ganglion (cochlear ganglion – bipolar cells)
- Central process continues as cochlear nerve whereas peripheral nerve innervates the organ of Corti
- Cochlear nerve enters the brain stem at the pontomedullary junction and bifurcate into dorsal and ventral cochlear nerve
- Second order neurons arise from cochlear nuclei and end in dorsal nucleus of trapezoid body and superior olivary nucleus of same side as well as opposite side
- Third order neuron arise from trapezoid body and superior olivary nucleus of both sides and ascend as lateral lemniscus
- Very few fibers relay in inferior colliculus and send axons to medial geniculate body. But majority of the fibers pass directly to medial geniculate body without being relayed in inferior colliculus
- Medial geniculate body is the final relay station. Fibers arising from medial geniculate body form the auditory radiations and project into auditory area in the superior temporal gyrus.

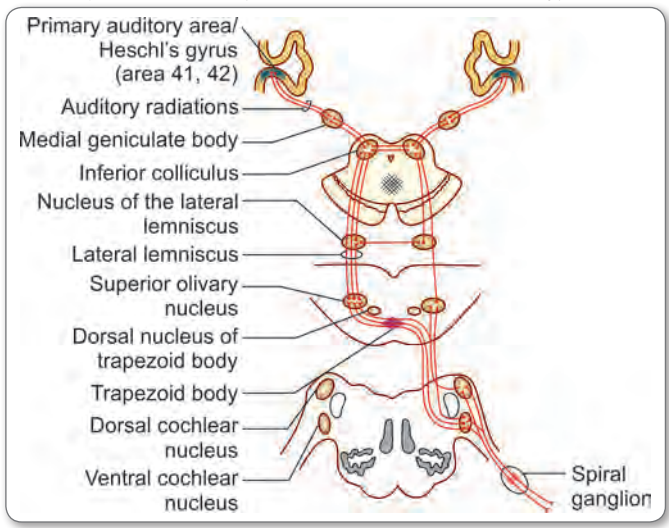


Fig. 75: Auditory pathway

Trapezoid body is related to auditory pathway.

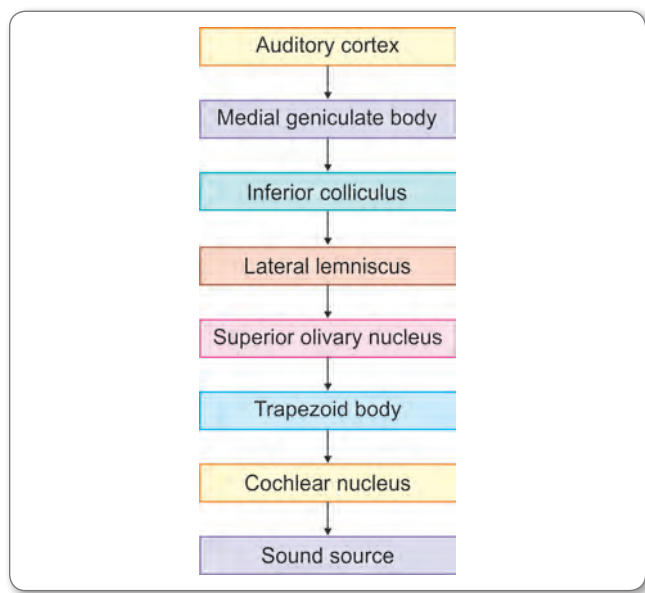


Fig. 76: Auditory pathway

Clinical Aspect

Hearing Defects

- **Conductive deafness:** Due to interruption in transmission of sound waves through external ear or middle ear. Includes:
 - Obstruction by wax
 - Otosclerosis
 - Otitis media
- **Nerve deafness:** Due to disease of cochlea, cochlear nerve or auditory pathway. Occurs in:
 - Acoustic neuroma
 - Ototoxic drugs
 - Rubella infection

Tuning Fork Tests

Weber Test

- Performed by placing vibrating tuning fork on the vertex
- Sound hears equally in both ears in normal subjects
- In unilateral conductive deafness: Lateralization sound in affected ear
- In unilateral nerve deafness: Lateralization of sound in normal ear

RINNE Test

- Compares bone conduction and air conduction
- Vibrating tuning fork placed on mastoid process until it is no longer heard and then placed in front of ear
- In unilateral conductive deafness: Bone conduction > air conduction
- In unilateral nerve deafness – AC > BC

Table 31: Findings in Weber and Rinne test

Findings	Weber	Rinne
Normal ear	No lateralization	AC > BC on both ears
Conductive deafness left ear	Lateralization to left ear	BC > AC on left AC > BC on right
Nerve deafness	Lateralization to right	AC > BC on both ears

NEURAL PATHWAY FOR BALANCE

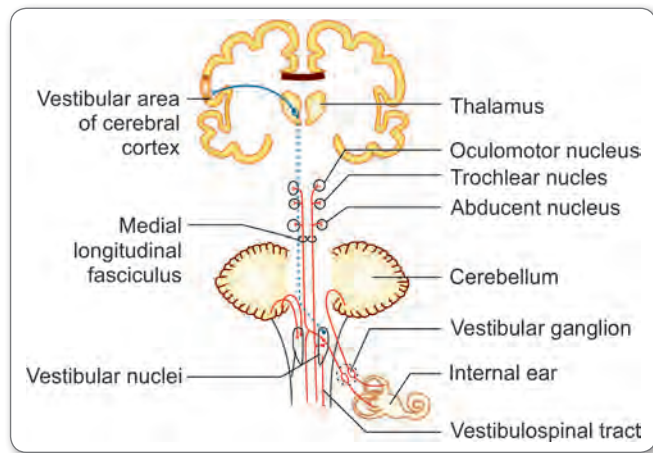


Fig. 77: Neural pathway for balance



- Cell bodies of first order neuron located in vestibular ganglion. Central process form the vestibular nerve and peripheral process innervate macula and cristae.
- Vestibular nerve relay in vestibular nuclei and flocculonodular lobe of the cerebellum.
- Second order neurons from vestibular nuclei project to flocculonodular lobe of the cerebellum, to motor nuclei of III, IV, VI cranial nerve through medial longitudinal fasciculus (MLF) and to anterior horn of spinal cord.
- Fibers from vestibular nuclei also project to posteroventral nucleus of thalamus.
- Third order sensory neurons from thalamus project to vestibular area of cerebral cortex.



Clinical Aspect

Ocular Reflex in Comatose Patient

- The external auditory meatus is irrigated with cold water. If the brain stem is intact, eyes deviate towards the irrigated side.
- If MLF transected, eyes deviate to the side of abducted eye only.
- With lower brain stem damage, eyes do not deviate from midline.

Acoustic Reflex

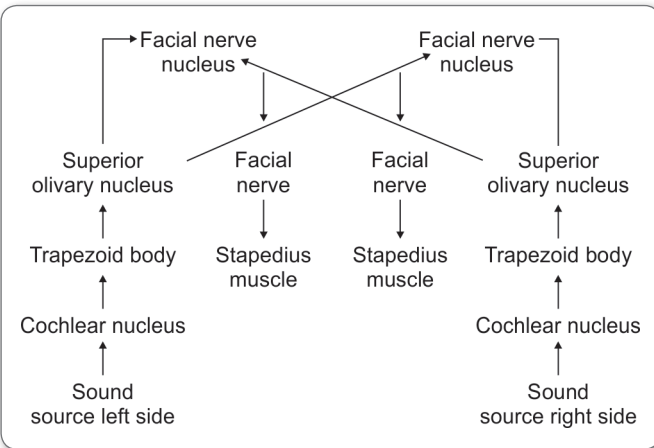


Fig. 78: Acoustic reflex

OLFACTORY PATHWAY

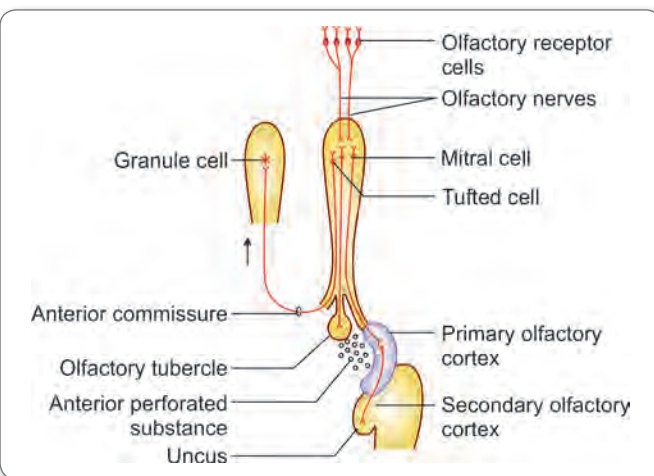


Fig. 79: Olfactory pathway

- Olfactory receptor cell form the first order neuron.
- The axons arising from these receptor cells form the bundles of olfactory nerve which pierce the cribriform plate of ethmoid and enter the olfactory bulb where they terminate in olfactory glomeruli.
- Glomeruli: Axons of receptor cells and dendrites of mitral cell and tufted cell.
- Most of the axons from mitral cell form the lateral olfactory striae and end in primary olfactory cortex.
- Most of the axons of tufted cell run in medial olfactory striae and cross the midline and synapse with granule cells in the opposite olfactory bulb.

Note: Olfactory impulses are directly transmitted to cerebrum without relay in thalamus.



Clinical Aspect

- Olfactory nerves damaged in fracture of cribriform plate, meningitis, meningiomas
- Foster-Kennedy syndrome
 - Meningioma of the olfactory groove which compress the olfactory tract and optic nerve
 - Features—**ipsilateral** anosmia, optic atrophy and **contralateral** papilledema.

NEURAL PATHWAY FOR TASTE

- Cell bodies of first order sensory neurons carrying taste sensation from taste buds located in geniculate ganglion of facial nerve, superior petrosal ganglion of glossopharyngeal nerve, ganglion nodosum of vagus nerve
- Peripheral process innervates the taste buds and central process ends in nucleus tractus solitarius
- Second order neuron arises from nucleus tractus solitaries cross the middle and then proceed upward and joins with medial lemniscus and terminate in posteroventral nucleus of thalamus
- Third order neuron from thalamus project into taste area of cortex.

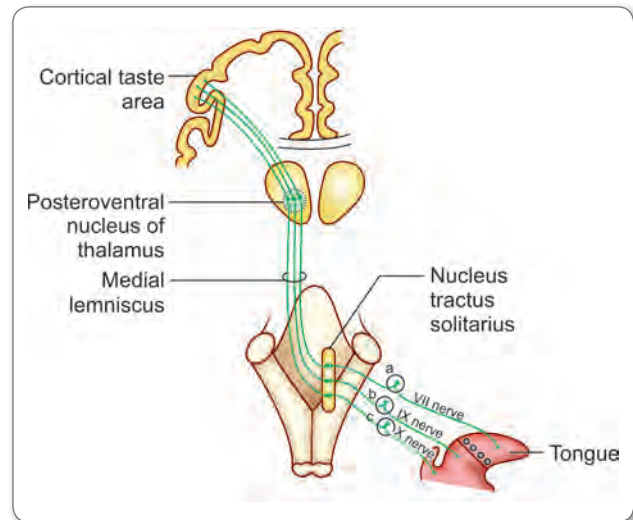


Fig. 80: Neural pathway for taste



AUTONOMIC NERVOUS SYSTEM

- It has three subdivisions: Sympathetic, parasympathetic and enteric
- ANS carries general visceral afferent and general visceral efferent fibers that control and regulates smooth muscle, cardiac muscle and glands
- Projection neurons are two types preganglionic and postganglionic

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SYMPATHETIC DIVISION

- Adrenergic system
- Thoracolumbar flow
- Neurotransmitters: Norepinephrine, epinephrine
- sympathetic trunks are ganglionated chains—paravertebral in position.
- Ganglions are cervical (3 in number), thoracic (10–12), lumbar (4) and sacral (4–5)
- These ganglions connected to spinal nerve by white and gray rami communicantes.
- Cervical ganglions and its chain situated posterior to carotid sheath

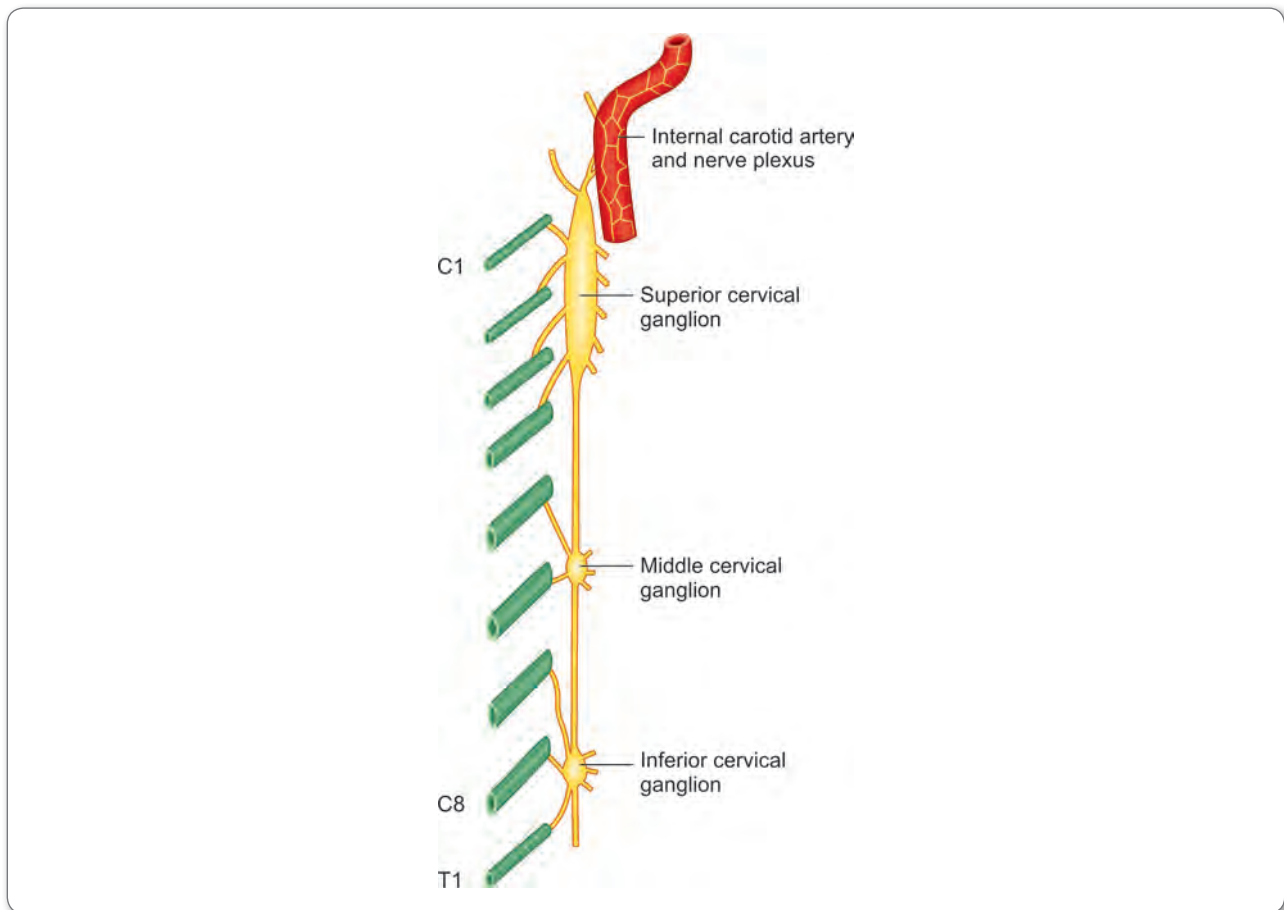


Fig. 81: Sympathetic division of autonomic nerve system

- Internal carotid nerve – accompanies the internal carotid artery & nerve is continuation of sympathetic trunk from cranial pole of superior ganglion
- In thorax, chains situated anterior to head of the rib
- Enters the abdomen through crux of the diaphragm
- In abdomen, it is situated anterolateral to bodies of lumbar vertebra
- In pelvis, it is situated anterior—medial to sacral foramina
- Preganglionic neurons—located in T1–L2. Project the fibers to anterior root of the spinal nerve and white rami communicans to the sympathetic trunk or via splanchnic nerves to prevertebral ganglia.



- Postganglionic neurons: Located in sympathetic trunk and in prevertebral ganglia. Connected to spinal nerve via gray rami communicantes. And then innervates blood vessels, sweat glands and arrector pili muscles.
- **Inter neurons:** Situated in sympathetic ganglia. These are dopaminergic (inhibitory).

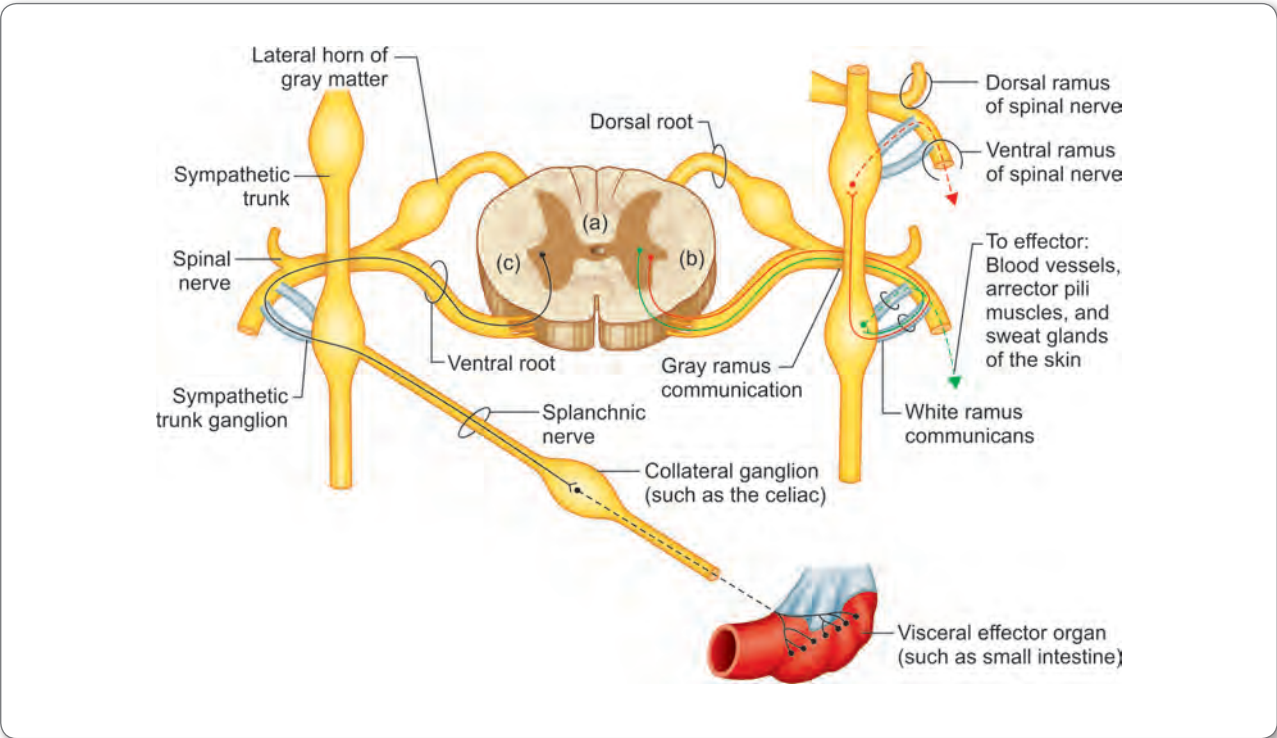


Fig. 82:

- White rami communicantes—connected to spinal nerves T1–L2
 - Preganglionic fibers
 - Contains GVE myelinated and GVA fibers whose cell bodies are located in lateral horns of spinal cord and dorsal root ganglia respectively
- Gray rami communicantes:
 - Postganglionic fibers
 - Contains GVE unmyelinated fibers supplying the sweat glands and blood vessels, etc.

PARASYMPATHETIC PATHWAY

- Cranial sacral flow
- Cholinergic system
- Cranial division
 - Four cranial nerves are associated with parasympathetic function 3, 7, 9, 10
 - Oculomotor nerve
 - Accessory oculomotor nucleus – carries preganglionic fibers to ciliary ganglion
 - Ciliary ganglion—parasympathetic ganglion supplies ciliaris muscle and sphincter pupillae
 - Facial nerve
 - Superior salivatory nucleus –connected to pterygopalatine ganglion and submandibular ganglion
 - Pterygopalatine ganglion supplies lacrimal gland, nasal glands and palatal glands
 - Submandibular ganglion supplies submandibular gland and sublingual gland
 - Glossopharyngeal nerve
 - Inferior salivatory nucleus connected to otic ganglion
 - Otic ganglion supplies parotid gland
 - Vagus nerve
 - Dorsal nucleus of vagus gives preganglionic fibers to viscera
 - Nucleus ambiguus gives preganglionic fibers to SA node, AV node.
 - ◆ Largest distribution. Longest extra cranial course. Supply upto mid gut.



Clinical Aspect

Oculosympathetic Pathway – Horner’s Syndrome

- First order neuron situated in hypothalamus
- Second order neuron situated in intermediolateral cell column T1 of spinal cord
- Third order neuron situated in superior cervical ganglion
- Postganglionic fibers from these ganglia supply the dilator pupillae, tarsal muscle
- Lesion in this pathway leads to Horner’s Syndrome
- Features of Horner’s syndrome
 - Partial ptosis: Due to involvement of muller’s muscle.
 - Miosis: Due to involvement of dilator pupillae
 - Enophthalmos: Due to involvement of orbitalis muscle.
 - Anhidrosis: Lack of sweating.
 - Heterochromia iridis: Seen in congenital cases (iris pigmentation is under sympathetic control and it is completed by 2 years of age).



- Sacral division
 - S2–S4—pelvic splanchnic nerve—only splanchnic nerve which carries parasympathetic fibres.
 - Postganglionic neurons located near the viscera
 - Supply hind gut and involved in micturition, defecation and sexual function.

Table 32: Comparison of parasympathetic and sympathetic nervous system

	Parasympathetic	Sympathetic
Preganglionic neuron	Located in midbrain, pons and medulla oblongata and pass through III, VII, IX, X cranial nerves and also along S2–S4 segments of spinal cord	Located in lateral horn of spinal cord from Th 1–12 and L 1–2 segments
Preganglionic fibers	Longer	Shorter
Relay of impulses	Occurs in neurons close to viscera	Occurs in neurons little away from the viscera they supply
Postganglionic fibers	Short	Long
Neurotransmitters	Both at preganglionic endings and postganglionic endings, acetylcholine is released	At preganglionic endings, acetylcholine is released. At postganglionic endings, adrenaline is released, except in cases of sweat glands where acetylcholine is released
Number of synapses	Preganglionic neuron makes synapses with much smaller number of neurons. Impulses are localized	Preganglionic neuron makes connection with large number of postganglionic nerve cells and impulses are widespread
Postganglionic supply	Only the viscera are supplied by postganglionic fibers. These do not supply blood vessels of skeletal muscles	All the viscera are supplied by postganglionic fibers. The only exception is suprarenal gland, which is supplied by the preganglionic fibers
Functions	These activities are discrete as well as isolated and conserve the body energies	These activities are mass reactions, widely diffuse in their action. These reactions are catabolic in nature and are used in fright, flight or fight. Sudomotor, pilomotor and vasomotor
Action of skin	Nil	Sudomotor, pilomotor and vasomotor
Effect on blood vessels	Blood vessels to the glands of gastrointestinal tract are dilated	Blood vessels to skeletal muscles (cholinergic), heart and brain are dilated.
Effect on gastrointestinal system	Secretory to the glands, motor to the smooth muscles and inhibitory to the sphincters of gut	Decreases the secretory activity of glands, including the peristalsis of gut. It is motor to the sphincters
Effect on pupil	Pupil is constricted, lens curvature is increased as in reading	Dilates the pupil.
Heart	Slows the pulse, maintains normal blood pressure	Tachycardia, rise in blood pressure. Dilates the coronaries
Lungs	Increase the secretions of glands of lungs and is bronchoconstrictor	Decreases the secretions, is bronchodilator Adrenaline-like drugs are given in asthma
Urinary bladder	Both filling and emptying of urinary bladder are controlled by parasympathetic	Supplies only blood vessels of bladder, sphincter vesicae is contracted by sympathetic action during ejaculation

Table 33: Effects of autonomic nervous system on various structures

Structure	Parasympathetic	Sympathetic
Eye	Constriction of pupil	Dilation of pupil
Salivary glands	Watery secretion	Mucoid secretion
Bronchial smooth muscle	Contraction	Relaxation
Heart	Decreases the heart rate	Increases the heart rate
Gastrointestinal tract	Increases the peristalsis and relaxes the sphincters	Decreases the peristalsis and Constricts the sphincter
Penis	Erection	Ejaculation
Sweat glands	No effect	Produce sweating

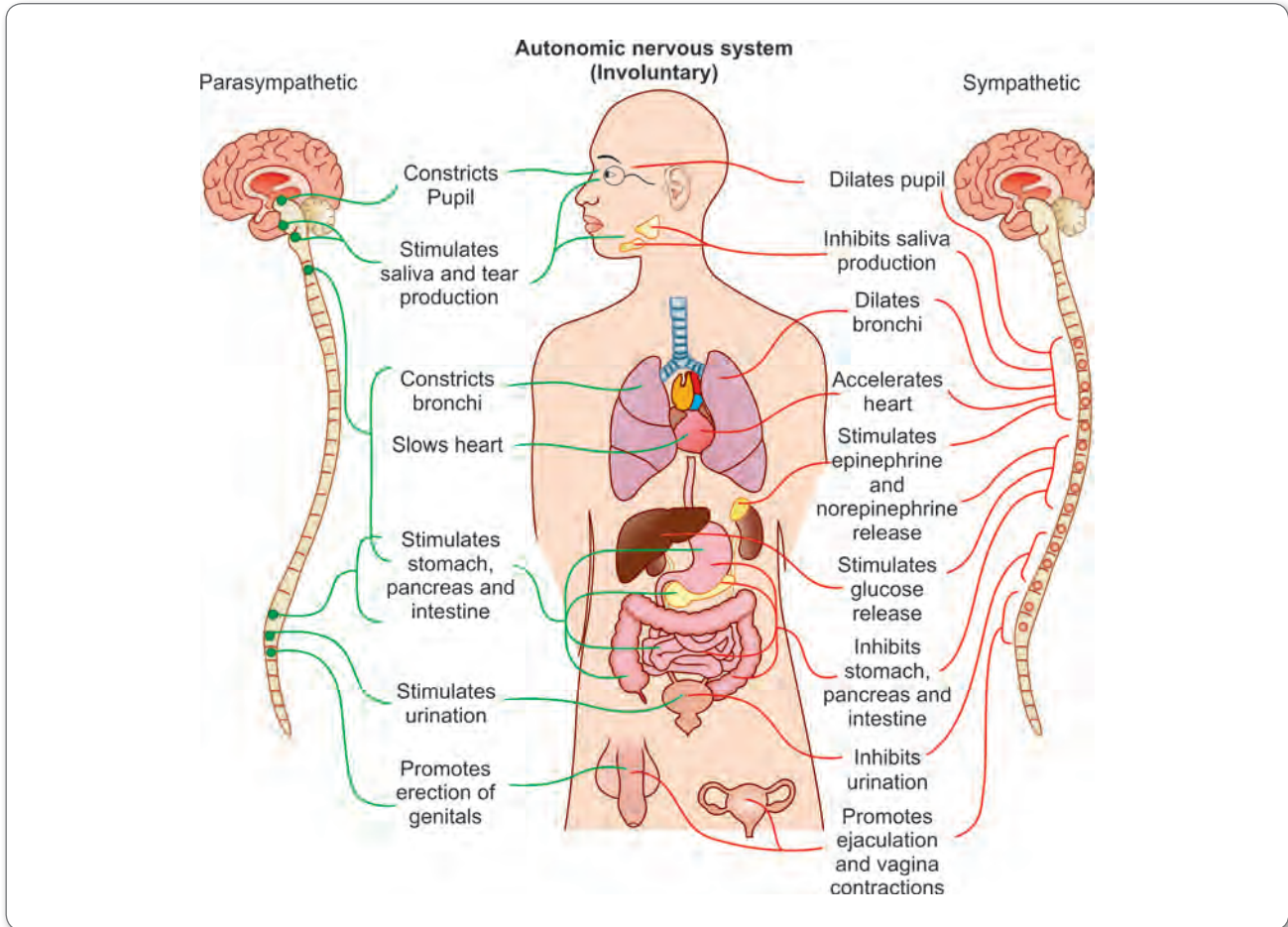


Fig. 83: Autonomic nervous system

ENTERIC DIVISION

Enteric Nervous System and Intrinsic Neurons

- Many peripheral autonomic ganglia contain neurons that are anatomically distinct from sympathetic and parasympathetic neurons.
- Complex interactions occur between the enteric and sympathetic & parasympathetic nervous systems,
- This enteric nervous system is capable of sustaining local reflex activity independent of the CNS.
- This enteric system consists of neurons and glial cells which lying in the wall of the gastrointestinal tract and form myenteric and submucous plexi that extend from the oesophagus to the anal sphincter
- This plexus control the contractions of the muscular coats of the alimentary tract, secretion of gastric acid, intestinal transport of water and electrolytes and the regulation of blood flow.



Clinical Aspect

Injury to medial longitudinal fasciculus (MLF) can affect → **Horizontal gaze centers in the pons to oculomotor nucleus.**

Lesions of vertical gaze centers

- Lesions affecting posterior commissure → **Upward gaze affected**
- Lesions affecting interstitial nucleus of Cajal → **Downward gaze affected**
- Occlusion of calcarine artery produces → **Contralateral homonymous hemianopia**
- **Carotid siphon** is produced by → S-shaped curves /bends of internal carotid artery

Contd...



Lesions of cortical speech areas (Aphasia)

- Lesions of Broca's area → **Motor aphasia (Expressive/non-fluent aphasia)**
 - Lesions of area 22 → **Fluent aphasia (word deafness)**
 - Lesions of area 39 → **Word blindness**
 - Lesions of area 40 → **Tactile agnosia**
 - Lesions of arcuate fasciculus → **Conduction aphasia**
- Anatomical structure most common affected in intraventricular bleed → **Caudate nucleus**.
Hippocampal formation is also known as Ram's horn or Ammon's horn.

Brown-Séquard syndrome

The signs and symptoms are due to injury to one-half of the spinal cord. Following are at the level of injury:

- Ipsilateral upper motor neuron paralysis
- Ipsilateral loss of conscious proprioception
- Contralateral loss of pain and temperature

Following are due to injury to various tracts below the level of injury:

- Ipsilateral lower motor neuron paralysis
- Ipsilateral loss of sensation over the cranial dermatome

Syringomyelia

There are cavities around the central canal. There is bilateral loss of spinothalamic fibers. Lateral spinothalamic tracts cross at once while anterior spinothalamic first ascend and then cross. There is a loss of pain and temperature at one level and loss of touch and pressure at another level. So it is called "dissociated sensory loss".

Tabes Dorsalis

Tabes dorsalis affects the posterior white column of spinal cord. It leads to bilateral loss of proprioceptive sensations and tactile discrimination below the side of lesion. The finger nose test is past pointing with eyes closed.

Weber's Syndrome

Weber's syndrome involves corticospinal tract and 3rd nerve nucleus. There is lateral squint on same side and hemiplegia on the opposite side of body.

Subarachnoid Hemorrhage

Subarachnoid hemorrhage is the collection of blood in the subarachnoid space at the base of brain. These are also called the cisterns. The circle of Willis lies in the interpeduncular cistern. At small branch usually due to persistent hypertension, may rupture to give rise to subarachnoid hemorrhage.

Babinski's sign

In case of lesion of corticospinal tract there is dorsiflexion of big toe and fanning of other toes in response to scratching the skin on the lateral side of sole. This sign is positive in case of upper motor neuron lesion.

MUSCLES OF BACK

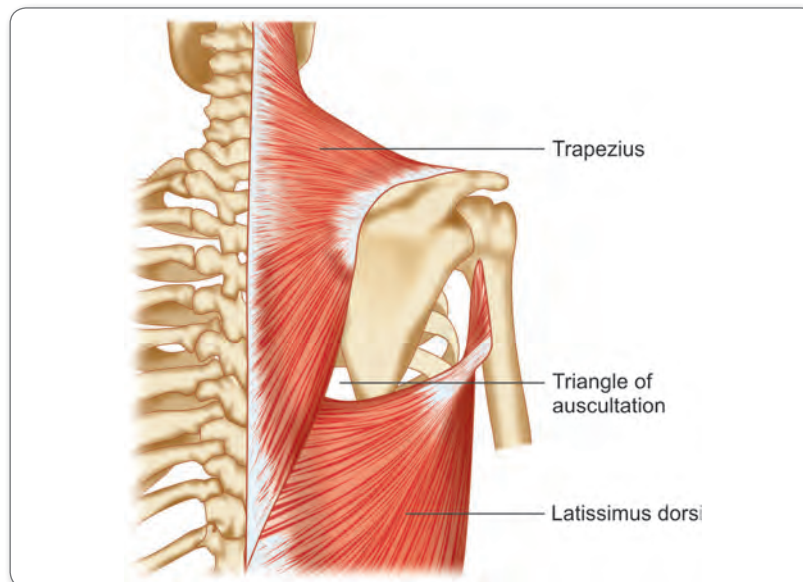


Fig. 84: Muscles of back



Table 34: Muscles of back: Their origin, insertion, nerve supply and action

Muscles	Origin	Insertion	Nerve supply	Action
Trapezius	<ul style="list-style-type: none"> External occipital protuberance, Superior nuchal line, Ligamentum nuchae, from the spine of C7 to T12 spine 	<ul style="list-style-type: none"> Upper fibers—posterior border of lateral 1/3 clavicle Middle fibers—medial border of acromion Lower fibers—upper lip of crest of spine <p>(Note: Cutting of lower fibers results in winging of scapula)</p>	Spinal part of accessory, Proprioceptive from kuh– C3, C4	<ul style="list-style-type: none"> Elevation of scapula Retraction of scapula Over head abduction
Latissimus dorsi (climbers muscle)	<ul style="list-style-type: none"> Lower 6 thoracic spines Outer lip of iliac crest Lower 4 ribs Inferior angle of scapula 	Floor of bicipital groove	Thoracodorsal nerve	<ul style="list-style-type: none"> Extension Adduction Medial rotation of shoulder joint

HIGH YIELD POINTS

- Latissimus dorsi is anatomically muscle of upper limb but is migrated to trunk for functional reasons.

Features of Vertebra

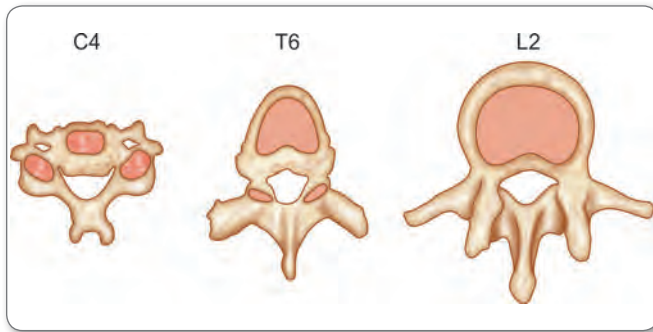
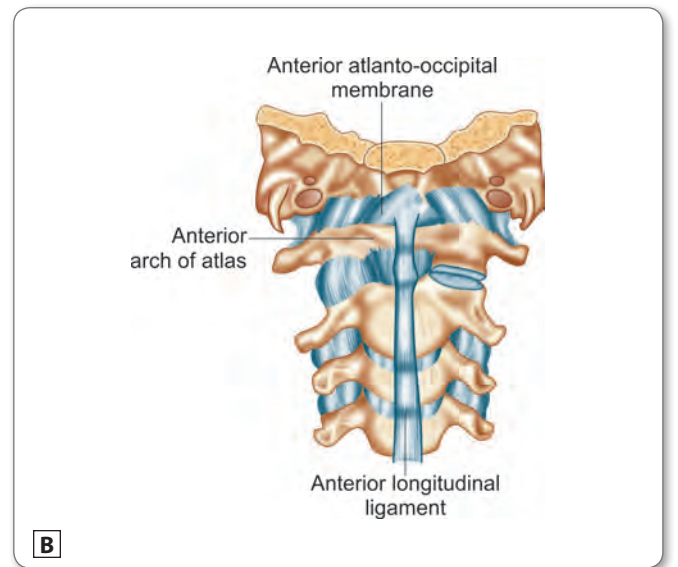
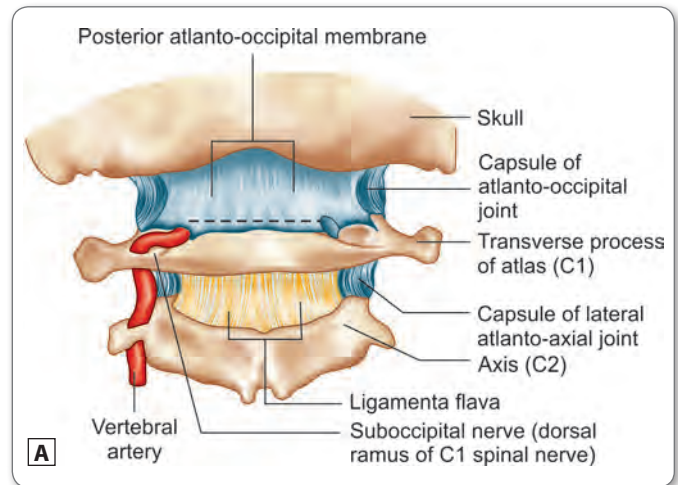


Fig. 85: Features of vertebra

Features	Cervical vertebra	Thoracic vertebra	Lumbar vertebra
Number	7	12	5
Identifying feature	Foramen transversarium	Costal demifacets	Large kidney shaped body
Vertebral foramen	Triangular	Circular	Triangular
Vertebral body	Small	Heart-shaped	Kidney-shaped
Spinous process	Bifid	Incline downward	Quadrangular shape and incline backward
Superior articulating facet	Backwards and upwards	Backwards and laterally	medially
Inferior articulating facet	Downwards and forwards	Forwards and medially	Laterally

Craniovertebral Joints

Atlanto-occipital between skull and C1



Figs. 86A and B: Atlanto-occipital membrane (A) Posterior; (B) Anterior



- Synovial type of ellipsoid > condylar
- **Articular surface:** Occipital condyles and superior articular surface of atlas

- Lateral flexion—rectus capitis lateralis, semispinalis capitis, splenius capitis.

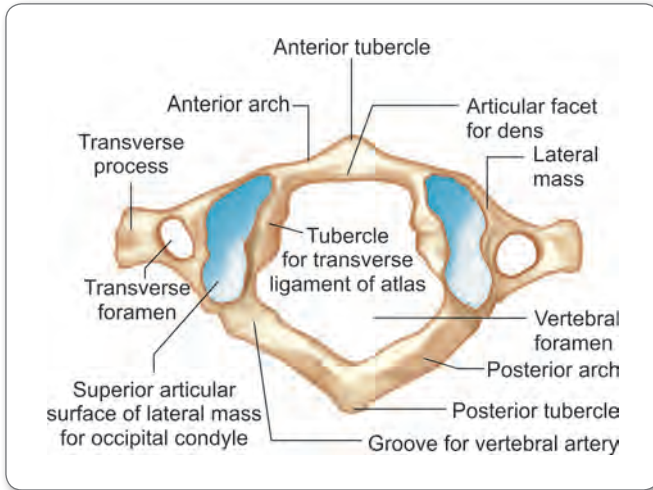


Fig. 87: Superior view of articular surface of atlas

- Ligaments—fibrous capsule. Accessory ligaments are anterior and posterior atlanto-occipital membrane.
- Permits nodding of head (YES movement)
- Muscles produce flexion—longus capitis, rectus capitis anterior
- Muscle produce extension—rectus capitis posterior major and minor, oblique capitis superior, semispinalis capitis, splenius capitis

Atlanto-axial Joint

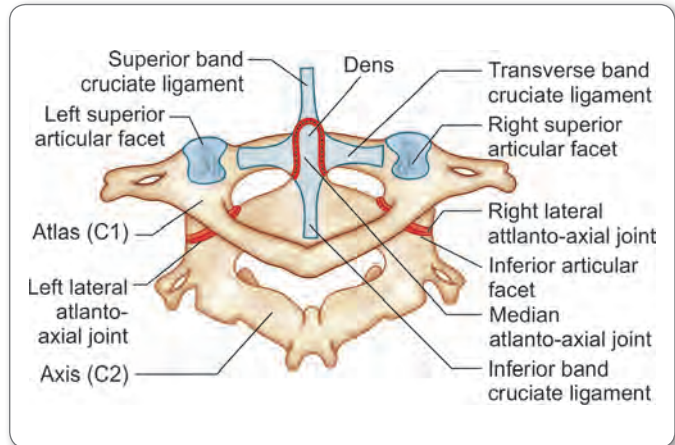
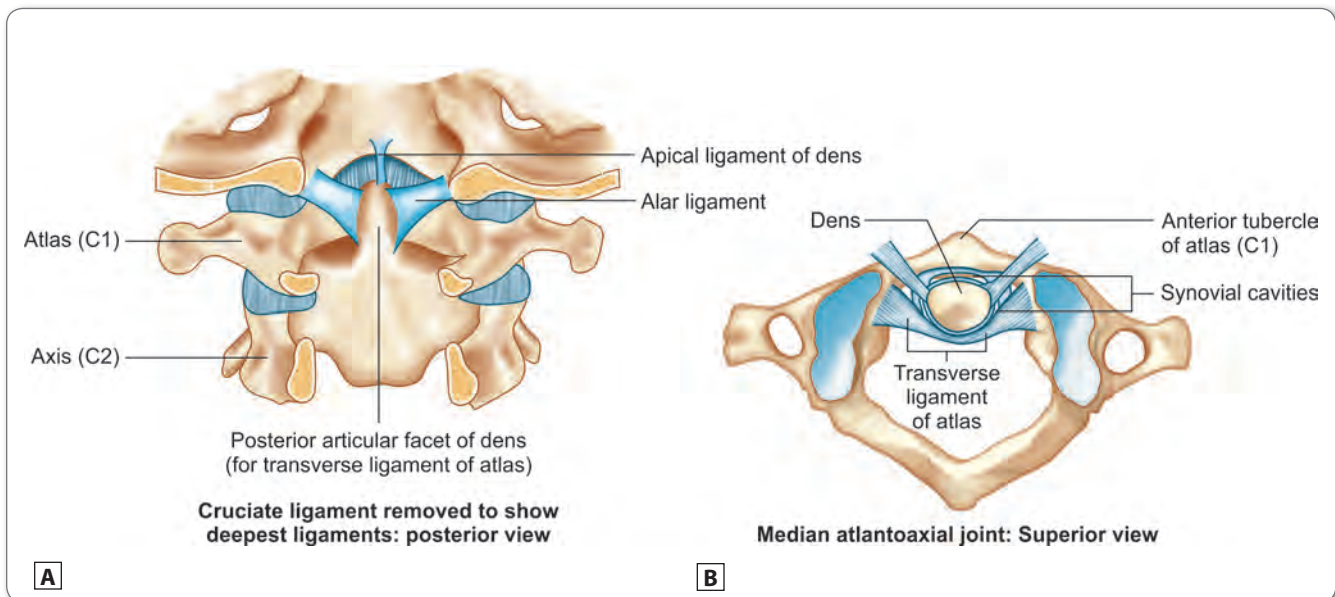


Fig. 88: Atlanto-axial joint

- Median atlanto-axial—Pivot type of synovial. Lateral Atlanto axial joint – plane type of synovial.
- Articulating surface –
 - Medial atlanto-axial joint—odontoid process of axis, Anterior arch & transverse ligament of atlas
 - Lateral atlanto-axial joint—inferior facet on lateral mass of atlas, superior articular facet on axis.

Internal Craniocervical Ligaments



Figs. 89A and B: Internal craniocervical ligaments

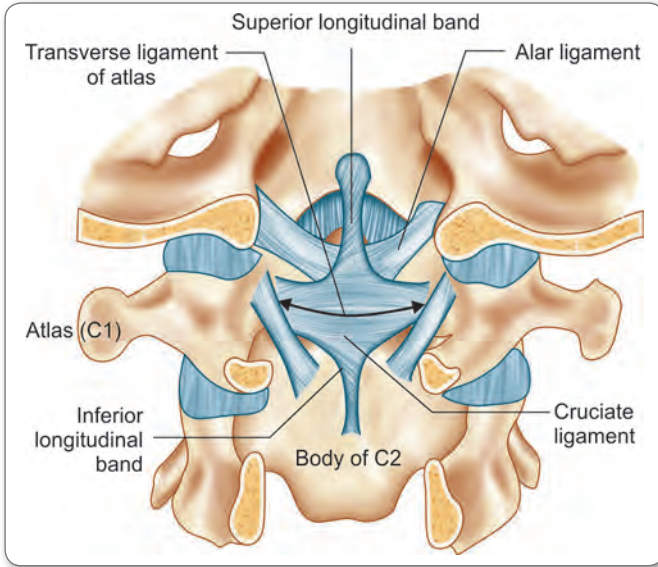


Fig. 90: Transverse ligament of atlas

- Permits head to be turned from side to side (No movement)
- Ligaments—alar ligament (from apex on dens to tubercle on the occipital condyle), apical ligament (apex of the dens to anterior aspect of foramen magnum), tectorial ligament (**continuation of posterior longitudinal ligament**), cruciform ligaments (transverse and longitudinal ligaments).

Movements of Vertebra

Vertebra	Movements
Cervical spine produce	Maximum flexion
Lumbar spine produce	Maximum extension
Cervical and lumbar spine	Maximum lateral bending
Thoracic spine produce	Maximum rotation
Lumbar spine	Least rotation
Sacrum and coccyx	No movement

Spinal Curvatures

Primary curvatures	Secondary curvatures
Present since birth	Acquired after birth
Thoracic and Sacral curvatures	Cervical and lumbar curvatures
Concave Anteriorly (kyphosis)	Concave posteriorly (lordosis)
MN – PT - SAC	

Cranial Nerve Reflex

Cranial nerve	Afferent	Efferent
Corneal reflex	Ophthalmic branch of trigeminal	Facial nerve
Gag reflex	Glossopharyngeal nerve	Vagus nerve
Light reflex	Optic nerve	Occulomotor nerve
Jaw/Massetric reflex	Mesencephalic nucleus of trigeminal nerve	Motor nucleus of trigeminal nerve

REFLEXES

Deep Reflex and their Root Value

Deep reflex	Root value
Ankle (Achilles tendon reflex)	S1, 2
Knee (patellar reflex)	L3, 4
Inverse supinator/supinator (biceps, brachioradialis)	C5, 6
Triceps	C7, 8

Inverse Supinator Reflex

Supinator reflex lost at lesion of C₅ and C₆, if supinator reflex is tested, instead of supination at elbow and brisk flexion of finger is seen.

Superficial Reflex

Superficial reflex	Root value
Cremasteric reflex	L1
Plantar (Babinski) reflex	L5, S1
Bulbocavernous reflex	S2-4
Anal reflex	S4, 5
Abdominal reflex	T6-12



Chapter at a Glance

- Features of Horner's syndrome: Anhydrosis, miosis, ptosis and enophthalmous. **Heterochromia iridis** feature of Horner's syndrome in **babies less than two years**
- Brown sequard syndrome: Hemisection of spinal cord, ipsilateral loss of vibration, contralateral loss of crude touch and pressure, ipsilateral loss of flaccid paralysis below the lesion
- Cerebellum most lateral nucleus is dentate and most medial is fastigial and it is phylogenetically oldest
- General visceral fibers supply the smooth, cardiac muscles and glands
- Special visceral efferent supply the pharyngeal arches
- General somatic afferent supply the skeletal muscles
- Lateral medullary syndrome: Wallenberg's syndrome— involvement of posterior inferior cerebellar artery—so lesion in spinothalamic tract, spinal tract of trigeminal nerve, nucleus ambiguus and cerebellum
- Medial medullary syndrome: Involvement of vertebral artery— lesion in corticospinal tract, medial lemniscus and hypoglossal nerve
- Medial longitudinal fasciculus interconnect the nuclei of III, IV, V, VI and spinal nucleus of accessory nucleus with vestibule cochlear nerve
- Argyll Robertson pupil: Light reflex lost, but accommodation reflex remains intact
- Arnold-Chiari's malformation is congenital anomaly characterized by herniation of cerebellar tonsils
- Medial, trigeminal and spinal lemniscus projected into thalamus not lateral
- Superior colliculi: Lateral geniculate body—optic
- Inferior colliculi: Medial geniculate body—auditory
- Corpora quadrigemina consists of two superior and two inferior colliculus
- Posterior cerebral artery mainly supply the occipital lobe and also thalamus, mid brain, temporal lobe and medial geniculate body
- Hippocampus formation: Hippocampus, dentate gyrus, gyrus fasciolaris and indusium griseum
- Cingulate gyrus satisfaction center for food/sex
- Limbic system control the mood, emotion, eating behavior, sexual behavior and memory
- Fornix connects hippocampus to mammillary body.



Multiple Choice Questions

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CNS Development

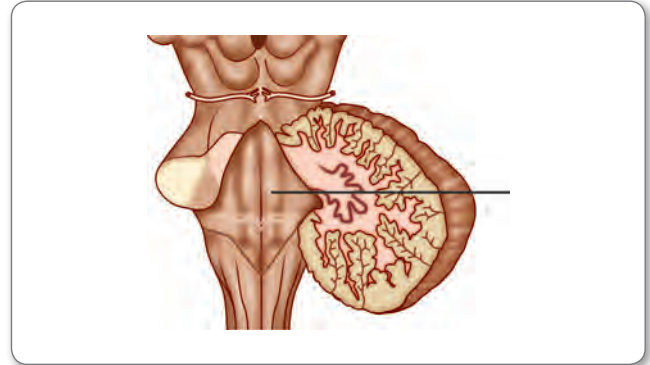
- Closure of the neural tube begins at which of the following levels:** (DNB 2010, AI 2009)
 - Cervical region
 - Thoracic region
 - Cephalic end
 - Caudal end
- Structures derived from the neural crest are:** (DNB 2003)
 - Pia
 - Dental papillae
 - Adrenal medulla
 - Schwann cells
 - All of the above
- Failure of migration of neural crest cells is seen in:** (DNB 2001)
 - Albinism
 - Congenital megacolon
 - Odontomes
 - Adrenal tumor
- All the followings are the derivatives of the neural crest except** (AI 2002)
 - Melanocyte
 - Adrenal medulla
 - Sympathetic ganglia
 - Cauda equine
- Central nervous system develops from:**
 - Ectoderm
 - Endoderm
 - Mesoderm
 - None
- Medulla arises from:** (Recent Question 2015)
 - Prosencephalon
 - Mesencephalon
 - Rhombencephalon
 - None
- Which of the brain stem nuclei is not derived from alar plate:** (AIIMS Nov. 2008)
 - Inferior olivary
 - Substantia nigra
 - Dentate
 - Hypoglossal
- Mesodermal in origin:** (Recent Question 2012)
 - Astrocytes
 - Oligodendrocytes
 - Ependymal cells
 - Microglial cells
- All of these arises from neuroepithelial cells, except:** (Recent Question 2013)
 - Neuron
 - Oligodendrocyte
 - Microglial cells
 - Ependymal cells
- Caudal neuropore closes at day:**
 - 20
 - 25
 - 28
 - 30
- Alpha-fetoprotein levels are elevated in all, except:**
 - Anencephaly
 - Myeloschisis
 - Omphalocele
 - Down syndrome
- Spinal cord develops from:** (Recent Question 2014)
 - Neural tube
 - Mesencephalon
 - Rhombencephalon
 - Prosencephalon
- The retina is an outgrowth of the:** (Recent Question 2014)
 - Mesencephalon
 - Diencephalon
 - Telencephalon
 - Pons
- First commissure to develop:** (Recent Question 2013)
 - Corpus callosum
 - Anterior commissure
 - Hippocampus
 - None of the above

Nuclear Columns

- All of the following cranial nerve contain somatic efferents except:** (DNB 2014, AI 2008)
 - VII Nerve
 - III Nerve
 - IV Nerve
 - VI Nerve
 - Special visceral efferent doesn't involve** (Neet 2018)
 - Nucleus ambiguus
 - Motor nuclei of 5th cranial nerve
 - Motor nuclei of 7th cranial nerve
 - Dorsal nucleus of 10th cranial nerve
 - All the following statements about vagus nerve are true except** (AIIMS Nov 2005)
 - Supplies heart and lung
 - Carries postganglionic parasympathetic fibres
 - Innervates up to right two third of transverse colon
 - Stimulates peristalsis and relaxes sphincters
 - Special visceral efferents fibers supply:** (Recent Question 2014)
 - Striated muscles of limb
 - Muscles of mastication
 - Extrinsic muscles of limb
 - Musculature of the iris
 - Nucleus in brain common to IX, X, XI cranial nerves:** (DNB 2005)
 - Nucleus solitaries
 - Nucleus ambiguus
 - Dentate nucleus
 - Red nucleus
 - Nucleus ambiguus doesn't include:** (NBE Based NEET 2012-13)
 - 7th nerve nucleus
 - 9th nerve nucleus
 - 11th nerve nucleus
 - 10th nerve nucleus
 - NOT a somatic efferent nerve:** (AIPG 2008)
 - IIIrd
 - IVth
 - Vth
 - XIIth
 - All of the following nerves have general visceral efferent fibers except:** (AIIMS 2015)
 - Olfactory
 - Oculomotor
 - Facial
 - Glossopharyngeal
 - Which of the following nuclei belongs to the general visceral efferent column?** (AIIMS 2004)
 - Facial nerve nucleus
 - Trigeminal nerve nucleus
 - Dorsal nucleus of vagus
 - Nucleus ambiguus
- ### CSF and Meninges
- True about cerebrospinal fluid:** (PGI 2004)
 - Produced by choroid plexus
 - Travels from subarachnoid space to fourth ventricle
 - Absorbed by arachnoid villi
 - Drains into dural venous sinuses
 - Aqueductal stenosis dilates 4th ventricle



25. Cranial nerve emerging between pyramid and olive (JIPMER Nov 2017)
- 6th nerve
 - 7th nerve
 - 11th nerve
 - 12th nerve
26. The arachnoid villi responsible for cerebrospinal fluid absorption protrude mainly in the: (DNB 2006)
- Superior sagittal sinus
 - Inferior sagittal sinus
 - Straight sinus
 - Transverse sinus
27. Biondi Ring Tangles (BRT) are found in: (AI 2008)
- Choroidal plexus cells
 - Golgi type 2 cells
 - Basket cells
 - Piamatter
28. All are seen in the floor of 3rd ventricle except: (AIIMS May 2013, Recent Question 2013, AI 2011)
- Infundibulum
 - Occulomotor nerve
 - Mammillary body
 - Optic chiasma
29. True regarding cavity of diencephalon: (PGI Nov. 2009)
- Septum pellucidum forms partition
 - Septum pellucidum cavity opens superiorly
 - Lateral wall is lamina terminalis
 - Interthalamic adhesions joins lateral walls
 - Lamina terminalis contain anterior communicating artery
30. True about 4th ventricle:
- Rhomboid fossa forms the floor
 - Choroid plexus lies at its floor
 - Connection between two cerebral hemispheres
 - Lies inferior to inferior cerebellar peduncle
31. Which nucleus is not found in the floor of the fourth ventricle: (DNB 1999)
- Abducent nerve
 - Dorsal nucleus of vagus
 - Hypoglossal nerve
 - None
32. CSF escapes the fourth ventricle through: (PGIC 2000)
- Foramen of monro
 - Aqueduct of sylvius
 - Luschka foramen
 - Magendie foramen
 - Arachnoid granulations
33. Diencephalon cavity (Recent Question 2012)
- Lateral ventricle
 - 3rd ventricle
 - 4th ventricle
 - Aqueduct of sylvius
34. Cavity of mesencephalon: (Recent Question 2013)
- Lateral ventricle
 - Third ventricle
 - Cerebral aqueduct
 - Fourth ventricle
35. Ventricles of brain are lined by: (Recent Question 2015)
- Ependymocytes
 - Astrocytes
 - Oligodendrocytes
 - Podocytes
36. Anterior horn of lateral ventricles is closed anteriorly by: (Recent Question 2013)
- Thalamus
 - Septum pellucidum
 - Lamin terminalis
 - Corpus callosum
37. Pineal gland forms: (Recent Question 2013)
- Floor of third ventricle
 - Anterior wall of third ventricle
 - Posterior wall of third ventricle
 - Roof of third ventricle
38. All are seen in the floor of the fourth ventricle, except:
- Vagal triangle
 - Hypoglossal triangle
 - Vestibular area
 - Stria terminalis
39. Floor of 4th ventricle has: (Recent Question 2015)
- Infundibulum
 - Vagal triangle
 - Mammillary body
 - Optic chiasma
40. Which cranial nerve nucleus lies under the facial colliculus? (AIIMS 2014, 2015)
- Fifth
 - Sixth
 - Seventh
 - Eighth
41. Damage to the structure producing the elevation marked leads to paralysis of which of the following muscles? (AIIMS 2016)



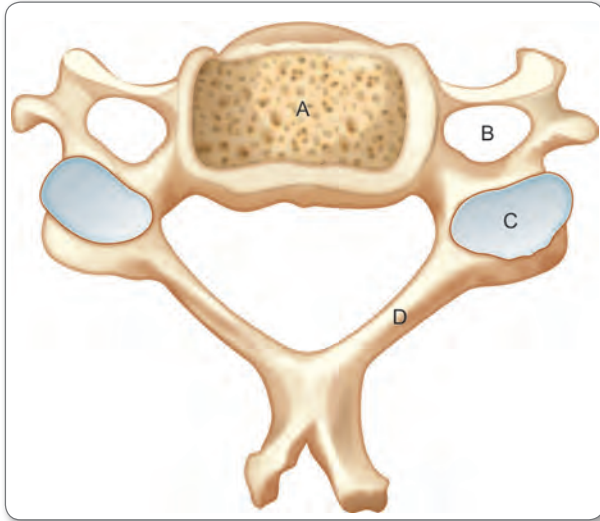
- Lateral rectus
 - Risorius
 - Levator palpebrae superioris
 - Superior oblique
42. Dura is supplied by all cranial nerves, except: (DNB 2008)
- 12
 - 10
 - 5
 - 4
43. True about falx cerebri: (Recent Question 2015)
- Separates cerebellum from occipital lobe
 - Contains straight sinus
 - Separates two cerebellar hemispheres
 - Contains occipital sinus
44. All the following branches of 5th nerve supply the duramater, except: (DNB 2002)
- Anterior ethmoidal
 - Posterior ethmoidal
 - Auriculotemporal
 - Mandibular
45. Which is not true about cranial duramater? (AIIMS May 2014)
- It has endosteal layer and meningeal layer
 - It is supplied by 5th cranial nerve
 - outer layer – endosteal layer
 - Venous sinuses present inner to meningeal layer

Blood Supply

46. Charcot's artery is: (Recent Question 2015)
- Medial striate branch of anterior cerebral artery
 - Striate branch of middle cerebral artery
 - Fronto- polar artery
 - Calloso- marginal artery



47. Different parts of cervical vertebra are shown in the figure. Identify the part which is related to vertebral artery (AIIMS May 2017)



- a. A
- b. B
- c. C
- d. D

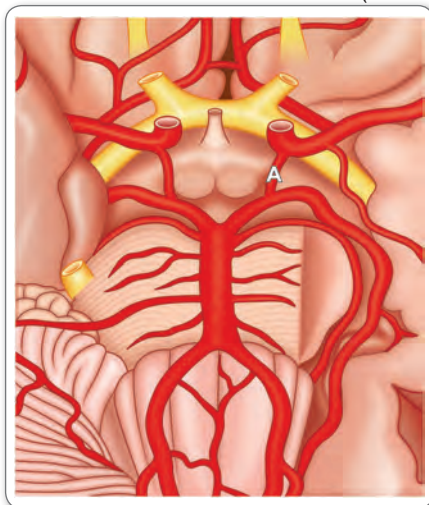
48. A patient sustains head trauma. Clinical findings and imaging are suggestive of extra Dural hemorrhage along with fracture of pterion. Which of the following vessel is likely to be involved? (JIPMER Nov 2016)

- a. Accessory middle meningeal artery
- b. Middle cerebral artery
- c. Middle meningeal artery
- d. Superficial temporal artery

49. Cranial nerve lies between superior cerebellar artery and posterior cerebral artery (JIPMER May 2017)

- a. Oculomotor nerve
- b. Optic nerve
- c. Abducent nerve
- d. Trigeminal nerve

50. Identify the marked vessels in the given diagram. (AIIMS May 2016)



- a. Posterior cerebral arteries
- b. Middle cerebral artery
- c. Posterior communicating artery
- d. Anterior cerebral artery

51. Occlusion of posterior cerebral artery supplying visual cortex results in

- a. Ipsilateral homonymous hemianopia
- b. Contralateral homonymous hemianopia
- c. Ipsilateral homonymous hemianopia with macular sparing
- d. Contralateral homonymous hemianopia with macular sparing

52. A 40 year-old female graduate student had an excruciating headache. When she looked in the mirror, she noticed that her eyelids was drooping; when she lifted the eyelid, she saw that her eyeball was looking down and out and her pupil was huge. She complained of both blurred and double vision. An magnetic resonance angiogram scan showed an aneurysm of the cerebral arterial circle. Which artery gives rise to the offending aneurysm?

- a. Anterior choroidal
- b. Anterior communicating
- c. Charcot-Bouchard's
- d. Posterior communicating

53. A 15 year-old boy is hit on the temple with a baseball and becomes unconscious. After about 10 minutes, he regains consciousness, but he soon becomes lethargic, and over the next 2 hours, he becomes stuporous. His pupils are unequal. Intracranial hemorrhage is suspected. Which of the following arteries is most likely to be the source of hemorrhage?

- a. Anterior cerebral
- b. Anterior communicating
- c. Basilar
- d. Middle meningeal

54. Major supply of medial surface of cerebral hemisphere: (Recent Question 2015)

- a. Anterior cerebral artery
- b. Posterior cerebral artery
- c. Middle cerebral artery
- d. Posterior inferior cerebral artery

55. No. of branches of internal carotid artery in the neck:

- a. 1
- b. 2
- c. 3
- d. None

56. Ophthalmic artery is the branch of the which part of internal carotid: (DNB 2004)

- a. Intercavernous
- b. Intrapetrosal
- c. Intracerebral
- d. Extracranial

57. All the following are branches of intracavernous part of internal carotid artery, except: (AIIMS May 2008, AI 2007)

- a. Hypophyseal branches
- b. Ophthalmic artery
- c. Branch to trigeminal ganglion
- d. Meningeal artery

58. Medulla is supplied by all, except:

(DNB 2008, AI 2006, AIIMS 1991)

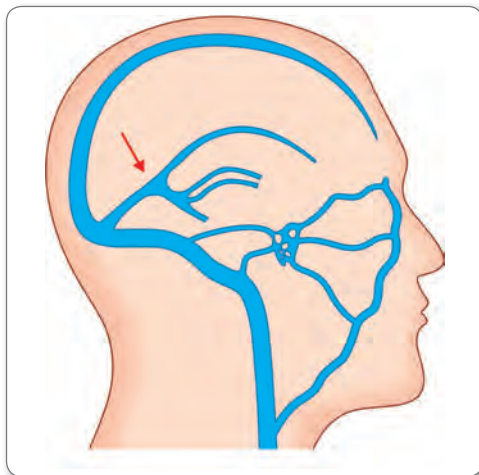
- a. Anterior spinal artery
- b. Basilar artery
- c. Bulbar artery
- d. Posterior inferior cerebellar artery

59. Branch of basilar artery include: (PGI 2002)

- a. Posterior inferior cerebellar artery
- b. Posterior cerebral artery
- c. Middle cerebral artery
- d. Posterior communicating artery
- e. Anterior cerebral artery



- 60. Majority of Visual cortex is supplied by:** (DNB 1999, PGI 1997)
- Posterior cerebral artery
 - Middle cerebral artery
 - Middle and posterior cerebral artery
 - Anterior cerebral artery
- 61. True about vertebral artery:** (PGI Nov. 2009)
- Enters skull through condylar canal
 - Branch of internal carotid
 - Branch of subclavian artery
 - Accompany sympathetic ganglion
 - Passes through foramen transversarium of cervical vertebra
- 62. Vertebral artery traverses all the following, except:** (AIIMS Nov. 2005)
- Foramen magnum
 - Subarachnoid space
 - Intervertebral foramen
 - Foramen transversarium
- 63. Posterior cerebral artery supplies A/E:** (AIIMS Nov. 2010, AI 2010)
- Pons
 - Midbrain
 - Thalamus
 - Striate Cortex
- 64. Posterior communicating artery connects:** (CET Pattern Nov. 2012)
- Two posterior cerebral arteries
 - Posterior cerebral artery with middle carotid artery
 - Posterior cerebral artery with internal carotid artery
 - Anterior cerebral artery with middle cerebral artery
- 65. Two internal cerebral veins fuse to form:** (NEET Pattern 2012)
- Middle cerebral vein
 - Anterior cerebral vein
 - Great cerebral vein
 - Inferior cerebral vein
- 66. Vein of galen drains into:** (Recent Question 2015)
- Internal Juglar Vein
 - External Juglar Vein
 - Straight Sinus
 - Superior Sagittal sinus
- 67. Superior cerebral veins drains into:** (Recent Question 2014)
- Great cerebral vein
 - Vein of galen
 - Superior sagittal sinus
 - Inferior sagittal sinus
- 68. Arrow mark in figure indicates which sinus of brain:** (Recent Question 2016-17)



- Sigmoid sinus
- Transverse sinus
- Internal jugular vein
- Straight sinus

- 69. Most commonly lesioned nerve in intracranial aneurysms is:** (AIPG 2007)
- Optic
 - Oculomotor
 - Trochlear
 - Abducent
- 70. Berry aneurysms of the posterior communicating artery causes compression of:** (AIIMS 2008)
- Optic nerve
 - Oculomotor nerve
 - Trochlear nerve
 - Hypophysis cerebri
- 71. All is true about branches of internal carotid artery except:**
- Anterior choroidal artery is given in cerebral part
 - Ophthalmic artery is given in cerebral part
 - Posterior communicating artery is given in petrous part
 - Caroticotympanic artery is given in petrous part
- 72. Vertebral arteries of both sides unite to form:** (Recent Question 2015)
- Anterior spinal artery
 - Posterior spinal artery
 - Medullary artery
 - Basilar artery
- 73. Visual area cortex is supplied by:** (PGIC 2008)
- Anterior cerebral artery
 - Middle cerebral artery
 - Posterior cerebral artery
 - Posterior inferior cerebellar artery
 - Posterior choroidal artery
- 74. Blood supply of putamen includes all, except:** (Recent Question 2015)
- Medial striate arteries
 - Lateral striate arteries
 - Anterior choroidal artery
 - Posterior communicating artery
- 75. All are pain sensitive area of brain, except:** (AIPG 2009)
- Dural sheath surrounding vascular sinuses
 - Middle meningeal artery
 - Falx cerebri
 - Choroid plexus

Spinal Cord

- 76. All of the following statements regarding the spinal cord are true, except:** (AI 2012)
- Central canal lies in the white matter
 - Efferents leave from anterior horn
 - Spinal cord ends at the lower border of L1 in adults
 - Denticulate ligaments suspend spinal medulla in the subarachnoid space
- 77. Not correct about the termination of the following structures**
- Spinal cord terminates at transpyloric plane
 - Dura mater terminates at S2
 - Pia mater terminates at coccyx
 - Arachnoid terminates at S2
- 78. All are features of LMN lesion except:** (NIMHANS 2017)
- Plantar flexion
 - Absent DTR
 - Hypertonia
 - Hypotonia



79. Which is not found in brown sequard syndrome

(Recent Question 2018)

- a. Hemi section of spinal cord
- b. Ipsilateral loss of vibrations
- c. Ipsilateral loss of crude touch
- d. Ipsilateral spastic paralysis below the lesion

80. All of the following descending tracts anterior in position, except:

- a. Reticulospinal
- b. Rubrospinal
- c. Vestibulospinal
- d. Tectospinal

81. Spinal cord in infants ends at the level of: (AI 1995)

- a. L1
- b. L2
- c. L3
- d. L4

82. Subarachnoid space ends at: (DNB 2004)

- a. L1
- b. L2
- c. L5
- d. S2

83. The inability to perceive the texture and shape of an object occurs in the lesion of: (DNB 2002, AIIMS 1996)

- a. Lateral spinothalamic tract
- b. Nucleus gracilis
- c. Spino reticular tract
- d. Nucleus cuneatus

84. An anterolateral corodotomy relieves pain in right leg is effective because it interrupts: (AIIMS Nov. 2005)

- a. Left dorsal column
- b. Left ventral spinothalamic tract
- c. Left lateral spinothalamic tract
- d. Right lateral spinothalamic tract

85. In epidural puncture, all the structures are pierced except: (DNB 2004, AIIMS 1999)

- a. Posterior longitudinal ligament
- b. Ligamentum flavum
- c. Interspinous ligament
- d. Supraspinous ligament

86. Popping sensation felt on doing LP is while piercing: (AIIMS 2015)

- a. Ligamentum flavum
- b. Supraspinous ligament
- c. Interspinous ligament
- d. Dura

87. In adults, the spinal cord normally ends at: (Recent Question 2015)

- a. Lower border of L1
- b. Lower border of L3
- c. Lower border of S1
- d. Lower border of L5

88. Ligamentum denticulatum has two many pair of teeth like projection: (Recent Question 2016)

- a. 19
- b. 21
- c. 28
- d. 3

89. These ventral spinal rootlets are more prone to injury during decompressive operations because they are shorter and exit in a more horizontal direction: (AIIMS 2002)

- a. C5
- b. C6
- c. C7
- d. T1

90. Which of the following is NOT carried by posterior column tract? (AIIMS 2014)

- a. Position sense
- b. Pain
- c. Touch
- d. Vibration

91. Which of the following pathway is involved in the ability to recognize an unseen familiar object placed in the hand?

(AIPG)

- a. Dorsal spinocerebellar tract
- b. Anterior soinothalamic tract
- c. Posterior spinothalamic tract
- d. Dorsal column

92. All true about conus syndrome, except: (AIPG 2008)

- a. Begins at the level of lower 3 sacral and coccygeal segment
- b. Absent knee and ankle jerks
- c. Flexor planter reflex
- d. Saddle anaesthesia

93. Which of the following is concerned with pain and temperature? (AIPG 2008)

- a. Pyramidal tract
- b. Anterior spinothalamic tract
- c. Lateral spinothalamic tract
- d. Dorsal spinothalami tract

Brain Stem

94. Fibers passing through crus cerebri are: (DNB 2002)

- a. Corticonuclear and corticospinal fibers
- b. Medial leminiscus
- c. Spinothalamic
- d. All

95. Interpeduncular fossa contains all, except: (DNB 2003, 2001)

- a. Mammillary bodies
- b. Posterior perforated substance
- c. Oculomotor nerve
- d. Ophthalmic nerve

96. Olive is seen in which part of brain: (Recent Question June 2014)

- a. Medulla
- b. Cerebellum
- c. Midbrain
- d. Pons

97. Internal arcuate fibers of medulla comes from: (Recent Question July 2015)

- a. Dorsal nucleus of vagus
- b. Hypoglossal nucleus
- c. Nucleus of tractus solitarius
- d. Nucleus gracilis and cuneatus

98. Area that lies immediately lateral to the anterior perforating substance is: (DNB 2007)

- a. Orbital gyrus
- b. Uncus
- c. Optic chiasma
- d. Limeninsulae

99. Facial colliculus is seen in: (AI 2008)

- a. Midbrain
- b. Pons
- c. Medulla
- d. Interpeduncular fossa

100. Efferents from cochlear nucleus arise for: (Recent Question 2003)

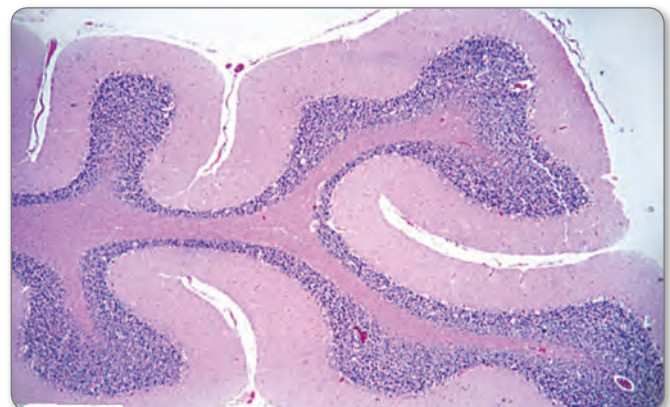
- a. Superior olivary nucleus
- b. Inferior colliculus
- c. Medial geniculate body
- d. Lateral leminiscus

101. Which of the following is not concerned with auditory pathway? (DNB 2001)

- a. Trapezoid body
- b. Medial geniculate body
- c. Genu of internal capsule
- d. Lateral lemniscus



- 102. Which of the following tract of fibers is primarily involved in correlating movements of the eyes with signals from vestibular nuclei?** (Recent Question 2016-17)
- Medial lemniscus
 - Lateral lemniscus
 - Medial longitudinal fasciculus
 - Dorsal longitudinal fasciculus
- 103. Chemoreceptor Trigger Zone is related to:** (Recent Question 2016-17)
- Medulla oblongata
 - Pons
 - Mid brain
 - Spinal cord
- 104. Which nerve does not arise from the medulla:** (Recent Question 2014)
- Facial
 - Glossopharyngeal
 - Vagus
 - Accessory
- 105. Position of nucleus ambiguus is:** (Recent Question 2014)
- Anteromedial to olive
 - Anterolateral to olive
 - Posteromedial to olive
 - Posterolateral to olive
- 106. A 68-year-old woman presents in the emergency room with dizziness and nystagmus. Examination reveals a loss of pain and temperature sensation over the right side of the face and the left side of the body. The patient exhibits ataxia and intention tremor on the right in the both the upper and lower extremities and is unable to perform either the finger-to-nose or heel to-shin tasks on the right. In addition, she is hoarse and demonstrates papillary constriction and drooping of the eyelid on the right. Finally, the right side of her face is drier than the left. Which of the following artery block would explain the patient's condition?** (AIIMS 2016)
- Right posterior inferior cerebellar artery
 - Left posterior inferior cerebellar artery
 - Right anterior inferior cerebellar artery
 - Basilar artery
- 107. All are contents of interpeduncular fossa, except:** (Recent Question 2012)
- Trochlear nerve
 - Tuber cinereum
 - Infundibular stalk
 - Posterior perforated substance
- 108. The final common pathway for horizontal gaze is nucleus:** (AIPG 2008)
- Abducent
 - Occulomotor
 - Pre-motor cortex
 - Primary somato-sensory cortex
- 109. Purkinje cells from the cerebellum end in:** (DNB 2007)
- Extrapyramidal system
 - Cranial nerve nuclei
 - Cerebellar nuclei
 - Cerebral cortex
- 110. All tracts pass through superior cerebellar peduncle, except:**
- Tectocerebellar
 - Dentatothalamic
 - Olivocerebellar
 - Cerebellorubral
- 111. Middle cerebellar peduncle transmits:** (DNB 2003)
- Pontocerebellar pathway
 - Tectospinal pathway
 - Spinocerebellar pathway
 - Middle cerebellar pathway
- 112. All of the following are seen in cerebellar lesions, except:** (AIIMS Nov. 2016)
- Nystagmus
 - Ataxia
 - Resting tremor
 - Past pointing
- 113. Fastigial nucleus correct statement is:** (Recent Question 2016-17)
- Phylogenetically oldest nucleus
 - Most lateral nucleus in cerebellum
 - Related to spinocerebellum
 - Related to vestibular system
- 114. Spherical shaped nucleus in cerebellum:** (Recent Question 2016-17)
- Nucleus ambiguus
 - Fastigii nucleus
 - Dentate nucleus
 - Globose nucleus
- 115. The climbing fiber of cerebellum is from:** (Recent Question 2016-17)
- Inferior olivary nucleus
 - Spinocerebellar tract
 - Tectocerebellar nucleus
 - Reticulocerebellar
- 116. Cells present in cerebellar cortex are all, except:** (AIIMS 2008)
- Bipolar
 - Purkinje
 - Golgi
 - Granule
- 117. Structures not passing through inferior cerebellar peduncle:** (PGIC 2007, 2008, 2009)
- Pontocerebellar
 - Cuneocerebellar
 - Anterior spinocerebellar
 - Posterior spinocerebellar
 - Vestibulocerebellar
- 118. Which is the lateral most cerebellar nuclei?**
- Dentate
 - Emboliform
 - Fatigi
 - Globose
- 119. Histology of given picture leads to which of the following speech disorder** (AIIMS Nov 2016)

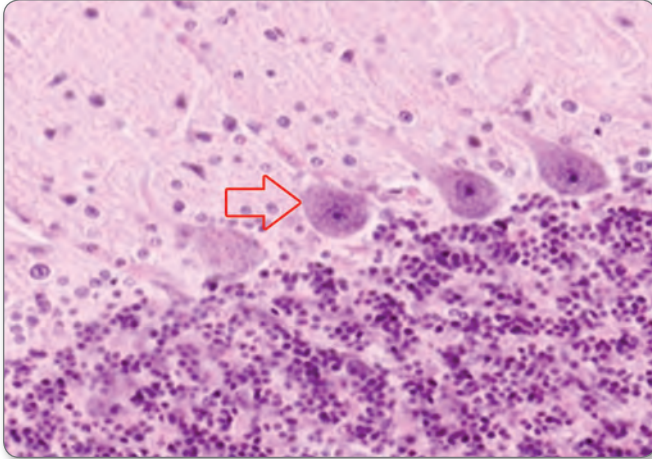


- Apraxia
- Aphasia
- Dysarthria
- Verbal dyspraxia

Cerebellum



120. The marked cell inhibits which of the following
(AIIMS May 2017)



- a. Golgi cell
- b. Basket cell
- c. Vestibular cell
- d. Deep cerebellar nuclei

Diencephalon

121. Which of the following is not a part of epithalamus:
(DNB 2003)

- a. Pineal body
- b. Posterior commissure
- c. Trigonum habenulae
- d. Geniculate body

122. Which of the following is projected to ventral posterior nucleus of thalamus?

- a. Lateral lemniscus
- b. Medial lemniscus
- c. Corticospinal tract
- d. Spinal lemniscus
- e. Trigeminal lemniscus

123. Which of the following thalamic nuclei does NOT project to neocortex?

- a. Intralaminar nuclei
- b. Reticular nuclei
- c. Pulvinar nuclei
- d. Anterior thalamic nuclei

124. All of the following pairs are correct for nuclei of hypothalamus, except:

- a. Ventero-medial: Hunger
- b. Supraoptic: Water conservation
- c. Posterior nucleus: Shivering center
- d. Supra-chiasmatic: Circadian rhythm

Cerebrum

125. Primary visual area is located in the walls of:

- a. Parieto occipital sulcus
- b. Superior temporal sulcus
- c. Posterior part of calcarine sulcus
- d. Central sulcus

126. Temporal lobe contains: (Recent Question 2015)

- a. Primary visual area
- b. Primary auditory area
- c. Broca's area
- d. Prefrontal area

127. Heschl's gyrus in brain is located in: (JIPMER 2016)

- a. Primary auditory cortex
- b. Medial frontal lobe
- c. Visual cortex
- d. Parietal association area

128. Speech in words and not in sentence occurs due to the lesion of:

- a. Wernicke's sensory speech area
- b. Broca's motor speech area
- c. Arcuate fasciculus
- d. Primary auditory atea

129. Motor area of Brodman's area: (DNB 1996)

- a. 1
- b. 4
- c. 5
- d. 7

130. Broca's area localized in: (AIIMS 1992)

- a. Superior temporal gyrus
- b. Parietal lobe
- c. Inferior frontal lobe
- d. Middle frontal lobe

131. Which of the following is a complete sulcus:
(NEET Pattern 2012)

- a. Lunate
- b. Calcarine
- c. Collateral
- d. Central

132. Which of the following is an operculated sulcus?
(NEET Pattern 2012)

- a. Calcarine
- b. Collateral
- c. Lunate
- d. Central

133. Temporal lobes contains: (Recent Question 2015)

- a. Primary visual area
- b. Primary auditory area
- c. Broca's area
- d. Prefrontal area

134. A man comes with aphasia, he is unable to name things and repetition is poor. However comprehension, fluency and articulation is unaffected. He is probably suffering from:
(AIIMS May 2015)

- a. Anomic aphasia
- b. Transcortical sensory aphasia
- c. Conduction aphasia
- d. Broca s aphasia

135. Cortical representation of body in cerebrum is:
(AIIMS May 2009)

- a. Horizontal
- b. Vertical
- c. Tandem
- d. Oblique

136. During treatment of meningioma, left paracentral lobule was injured. It would lead to paresis of: (AIIMS 2000)

- a. Right leg and perineum
- b. Left leg and perineum
- c. Right shoulder and trunk
- d. Left shoulder and trunk

137. Corticospinal fibers pass through which part of internal capsule:

- a. Posterior one-third of anterior limb
- b. Anterior two-thirds of posterior limb
- c. Posterior two-thirds of anterior limb
- d. Anterior two-thirds of anterior limb

138. Genu of internal capsule carries: (PGI June 2008, 1997)

- a. Optic radiation
- b. Corticospinal
- c. Corticonuclear
- d. Corticorubral

139. Association fibers are all except: (AIIMS Nov. 2014)

- a. Uncinate fasciculus
- b. Cingulum
- c. Superior longitudinal fasciculus
- d. Forceps major

140. True about corpus callosum: (PGI Nov. 2009)

- a. Unite far area of two side of brain
- b. Connects two frontal lobe
- c. Unite two hemisphere
- d. Superiorly related to indusium griseum
- e. Unite adjacent and wide spread separated gyri in the same lobe



141. The sulcus separating the cuneus from the lingual sulcus is:
(Recent Question 2016-17)

- a. Calcarine sulcus
- b. Rhinal sulcus
- c. Parieto-occipital sulcus
- d. Cuneal sulcus

142. Broca's speech area is located in:
(Recent Question 2016-17, DNB Dec 2009)

- a. Superior frontal gyrus
- b. Inferior frontal gyrus
- c. Insula
- d. Cingulate sulcus

143. Gustatory cortex is situated in: (Recent Question 2016-17)

- a. Superior parietal gyrus
- b. Inferior frontal gyrus
- c. Posterior ramus of lateral sulcus
- d. Inferior temporal gyrus

Basal Ganglia and Internal Capsule

144. All are nuclei of basal ganglia, except: (DNB 2004)

- a. Caudate nucleus
- b. Amygdaloid nucleus
- c. Lentiform nucleus
- d. Dentate nucleus

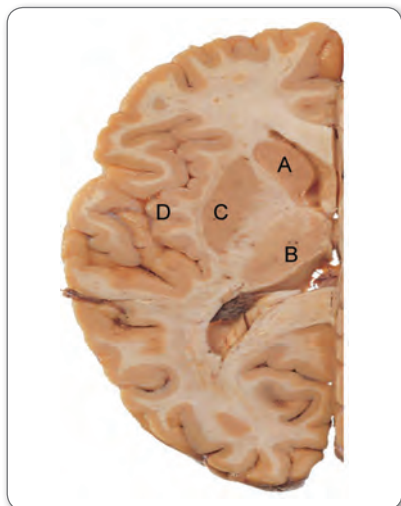
145. Basal ganglia consist of all of the following, except: (DNB 2002)

- a. Caudate nucleus
- b. Putamen
- c. Thalamus
- d. Globus pallidus

146. Functions of basal ganglia: (TN 2002, PGI 2001)

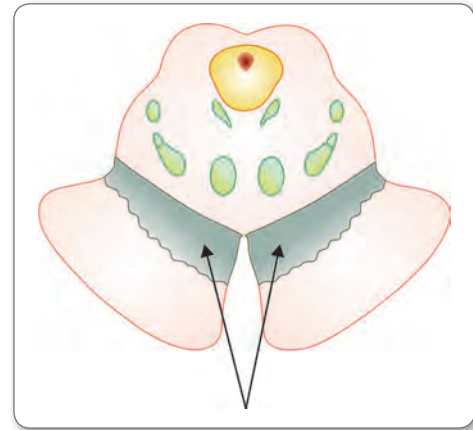
- a. Planning and programming of movements
- b. Sensory integration
- c. Recent memory
- d. Coordination of motor activity
- e. Pain reception

147. In the human brain given below the arrow that points to insula is (AIIMS May 2016)



- a. A
- b. B
- c. C
- d. D

148. Which of the following disease pathogenesis primarily involves the marked structure: (AIIMS May 2017)

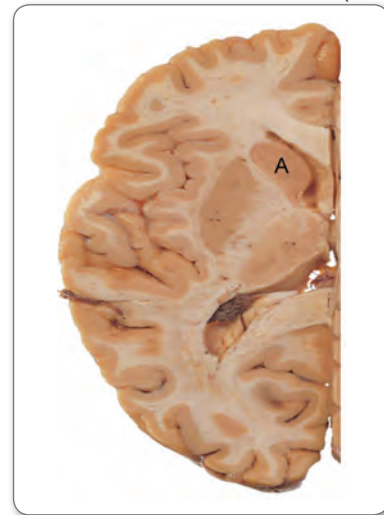


- a. Depression
- b. Alzheimer's
- c. Paralysis agitans
- d. Huntington's chorea

149. Charcot artery of cerebral hemorrhage belongs to (JIPMER Nov 2015)

- a. Lateral striate group
- b. Lenticulostriate group
- c. Posterior striate group
- d. Anterior striate group

150. In the image given below, the structure marked with the arrow is an important area related to motor function. All of the following gives afferent fibres to this structure except (AIIMS May 2016)



- a. Thalamus
- b. Cerebral cortex
- c. Substantia nigra
- d. Spinal cord

151. A 6-year-old girl has brief, irregular contractions in her feet; symptoms are suspected to be a result of an untreated strep infection. What is the diagnosis?

- a. Chorea gravidarum
- b. Chorea major
- c. Huntington chorea
- d. Sydenham chorea

**152. Relations of internal capsule**

- a. Thalamus medially, caudate nucleus and lentiform laterally
- b. Thalamus and caudate medially and lentiform laterally
- c. Thalamus and caudate laterally and lentiform medially
- d. Thalamus laterally, caudate nucleus and lentiform medially

153. Which of the following parts of internal capsule associated with optic radiation?

- a. Genu
- b. Posterior limb
- c. Retrolentiform
- d. Sublentiform

154. Which of the following artery do not supply the posterior limb of internal capsule?

- a. Middle cerebral artery
- b. Anterior cerebral artery
- c. Anterior choroidal artery
- d. Posterior cerebral artery

Limbic System**155. Hippocampal formation includes all, except:**

- a. Dentate gyrus
 - b. Subicular complex
 - c. Amygdaloid nucleus
 - d. Entorhinal cortex
- (AIPG 2009)*

156. In the papez circuit of the limbic system, between which combination is the hypothalamus placed on the basis of function?

- a. Cingulate cortex – Hippocampus
 - b. Hippocampus – Thalamus
 - c. Thalamus – Hippocampus
 - d. Parahippocampal gyrus – Thalamus
- (AIIMS Pattern 2007)*

Neural Pathways**157. Which of the following is the center for stapedial reflex:**

- a. Superior olivary complex
 - b. Medial geniculate body
 - c. Lateral lemniscus
 - d. Superior colliculus
- (AIIMS Nov. 2016)*

158. A transaction made at the lower end of medulla through the pyramids would cause all, except:

- a. In coordination
 - b. Involuntary movements
 - c. Spasticity
 - d. Increased tendon reflexes
- (DNB 2003)*

ANS**159. Parasympathetic nervous system includes?**

- a. Cranial nerve 3, 5, 7, 9 and sacral plexus
 - b. Cranial nerve 3, 5, 9, 10 and S1 and S4 of sacral plexus
 - c. Cranial nerve 3, 7, 9, 10 and sacral plexus
 - d. All cranial nerve 3, 7, 9, 10 and plexus
- (AIIMS Nov. 2016)*

160. General visceral fibers do not supply:

- a. Smooth muscles
 - b. Skeletal muscles
 - c. Cardiac muscles
 - d. Glands
- (Recent Question 2013)*

161. Intraocular muscle supplied by Edinger-Westphal nucleus is:

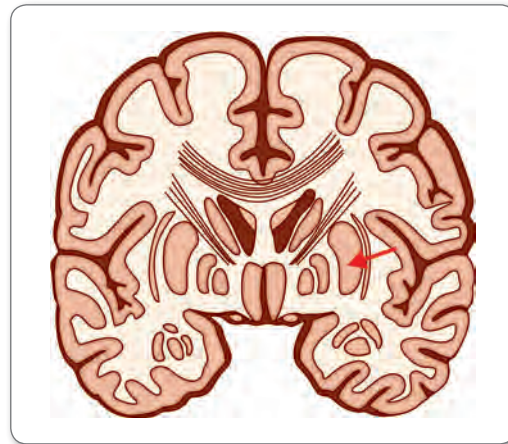
- a. Superior oblique
 - b. Ciliary muscle
 - c. Lateral rectus
 - d. Medial rectus
- (Recent Question 2014)*

162. All are seen in Horner's syndrome, except:

- a. Heterochromia iridis
 - b. Ptosis
 - c. Miosis
 - d. Apparent exophthalmos
- (AIIMS 2008)*

163. Which of the following is not a sign of stellate ganglion block?

- a. Meiosis
 - b. Exophthalmos
 - c. Nasal congestion
 - d. Conjunctival redness
- (AIPG 2006)*

164. Marked structure in the image below indicates:*(Recent Question 2016-17)*

- a. Caudate
- b. Putamen
- c. Globus pallidus
- d. Hypothalamus

165. Spinal cord ends at what level in adults?

- a. T12
 - b. L1
 - c. L2
 - d. L3
- (AIIMS May 2018)*

166. Which of the following sensation is not perceived by spinal nucleus of trigeminal nerve?

- a. Pain
 - b. Touch
 - c. Temperature
 - d. Proprioception
- (AIIMS May 2018)*

167. Purkinje fibers from the cerebellum end in:*(AIIMS May 2018)*

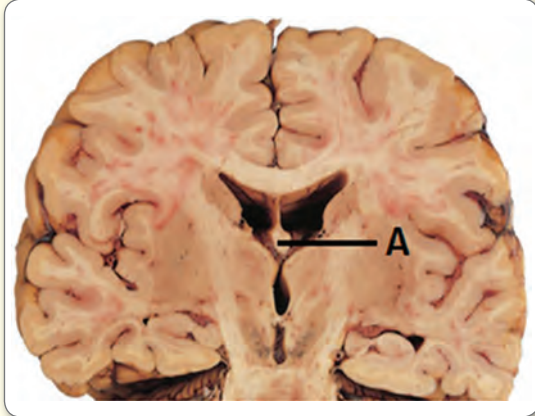
- a. Dentate nucleus
- b. Amygdala
- c. Caudate nucleus
- d. VLN thalamus



168. Which of the following is false regarding blood supply of dura mater? (AIIMS May 2018)

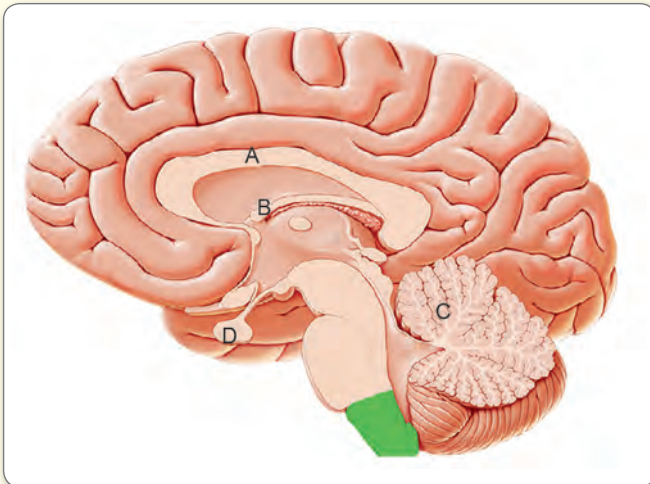
- a. Meningeal branch of ICA in posterior cranial fossa
- b. Accessory meningeal artery
- c. Meningeal branch of anterior and posterior ethmoidal artery
- d. Middle meningeal artery

169. In the given section of brain, the marked part arises from (AIIMS May 2018)



- a. Hippocampus
- b. Mammillary body
- c. Caudate nucleus
- d. Amygdala

170. Which of the following is not correctly marked? (AIIMS May 2018)

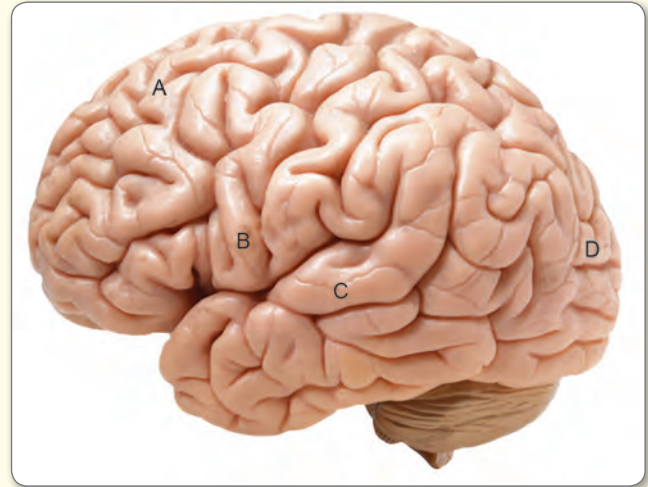


- a. Corpus callosum
- b. Fornix
- c. Cerebellum
- d. Hypothalamus

171. Nucleus of upward gaze (AIIMS May 2018)

- a. PPRF
- b. Nucleus of raphae magnus
- c. Cuneiform nucleus
- d. Interstitial nucleus of Cajal

172. Patient knows what he wants to speak but he cannot. Which of the following area marked in the given image of cerebrum affected? (AIIMS May 2018)



- a. A
- b. B
- c. C
- d. D

173. Which of the following cranial nerve not associated with olfaction? (AIIMS Nov 2018)

- a. XII
- b. IX
- c. V
- d. X

174. Occlusion of the artery supply marked area will cause all except: (AIIMS Nov 2018)



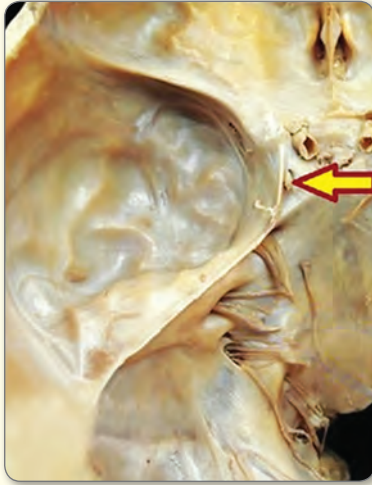
- a. Urinary incontinence
- b. Rectal incontinence
- c. Apraxia
- d. Perianal anesthesia

175. Patient with syphilis develops imbalance on walking with eyes closed and has to lift up foot and stamp on ground to walk. Name the tract involved in given condition? (AIIMS Nov 2018)

- a. Spinocerebellar tract
- b. Dorsal column tract
- c. Lateral spinothalamic tract
- d. Vestibulospinal tract



176. Identify the arrow marked nerve in the given section of cranial cavity? (AIIMS Nov 2018)



- a. Trochlear
- b. Trigeminal
- c. Oculomotor
- d. Abducent

177. Fibers from which of the following reach Purkinje cell directly (AIIMS Nov 2018)

- a. Vestibular nucleus
- b. Inferior olivary nucleus
- c. Raphae nucleus
- d. Locus coeruleus

178. Neuronal migration completed at which month?

(JIPMER Nov 2018)

- a. 4th month
- b. 5th month
- c. 6th month
- d. 7th month

179. Which nucleus of cerebellum for saccades?

(JIPMER Nov 2018)

- a. Dentate nucleus
- b. Emboliform
- c. Fastigial nucleus
- d. Globose nucleus

180. Which of the following Broadman area involved in Broca's motor aphasia? (Recent Question June 2018)

- a. 44, 45
- b. 22
- c. 17 18 19
- d. 4, 6

181. Spinal cord end in newborn: (Recent Question June 2018)

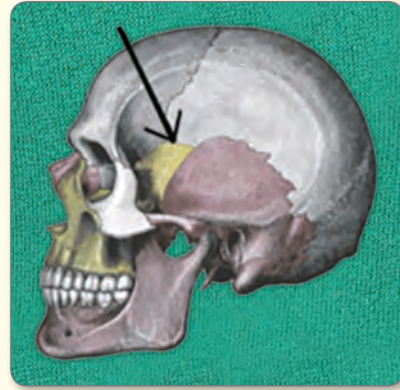
- a. L1
- b. L2
- c. L3
- d. L4

182. Structure developed from ectoderm:

(Recent Question June 2018)

- a. CNS
- b. Thyroid
- c. Respiratory epithelium
- d. Gut epithelium

183. Artery lies beneath the arrow: (Recent Question June 2018)



- a. Middle meningeal artery
- b. Middle cerebral
- c. Deep temporal
- d. Anterior cerebral

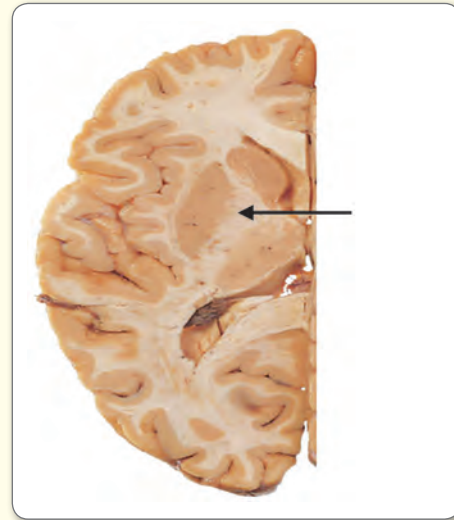
184. Hand eye coordination is mediated by which lobe?

(Recent Question June 2018)

- a. Middle frontal cortex
- b. Inferior parietal cortex
- c. Superior temporal gyrus
- d. Occipital cortex

185. Identify the type of fibre marked in the given diagram?

(Recent Question)



- a. Long association fibres
- b. Short association fibres
- c. Projection fibres
- d. Commissural fibres

186. PICA is involved in:

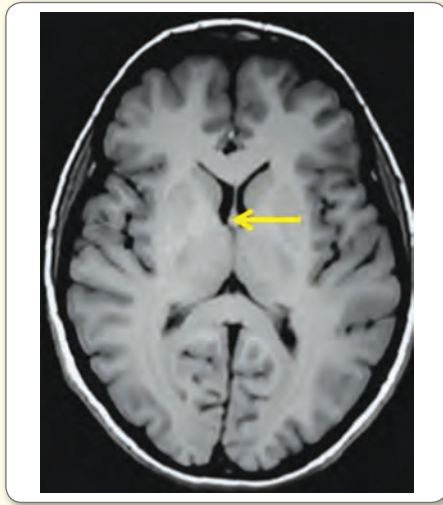
(Recent Question)

- a. Medial medullary syndrome
- b. Wallenberg syndrome
- c. Weber
- d. Benedict syndrome



187. Identify the marked structure:

(Recent Question)



- a. Fornix
- b. Pineal gland
- c. Pituitary gland
- d. Insula

188. Identify the marked structure in the given image:

(Recent Question)



- a. Cerebellum
- b. Cerebrum
- c. Brain stem
- d. Corpus callosum

189. Lesion in right medial lemniscus leads to:

(Recent Question)

- a. Loss of pain, crude touch, temperature on right side
- b. Loss of temperature, pain, crude touch on left side
- c. Loss of stereognosis, proprioception, on right side
- d. Loss of stereognosis, proprioception, on left side

190. Contralateral loss of pain and temperature is due to injury of

(Recent Question)

- a. Anterior spinothalamic
- b. Lateral spinothalamic
- c. Fasciculus gracilis
- d. Fasciculus cuneatus

191. Blood supply of optic chiasma

(PGI Nov 2018; Recent Question 2018)

- a. Anterior cerebral
- b. Middle cerebral
- c. Posterior cerebral
- d. Internal carotid
- e. Posterior communicating artery



Answers with Explanations

600

1. Ans. a. Cervical region

[Ref: Langman's Embryology 12/E]

Neurulation Conversion of Neural Plate to Neural Tube

- Fusion begins in the cervical region and proceeds cranially and caudally.
- Until fusion is complete, the cephalic and caudal ends of the neural tube communicate with the amniotic cavity by cranial and caudal neuropores, respectively.

2. Ans. e. All of the above

[Ref: Langman's Embryology 12/E]

3. Ans. b. Congenital megacolon

- Congenital megacolon (hirschsprung disease) due to failure of migration of neural crest to distal part of the tube
- So, absence of parasympathetic myenteric auerbach s ganglia.
- Diseased segment is constricted and the segment proximal is dilated due to faecal retention.

4. Ans. d. Cauda equine

[Ref: Langman's Embryology 12th edition]

Cauda equina is developed from the neural tube.

5. Ans. a. Ectoderm

Neural tube develops from ectoderm

6. Ans. c. Rhombencephalon

[Ref: Langman's s Embryology 10th edition pg 299]

Medulla develops from rhomencephalon

7. Ans. d. Hypoglossal

[Ref: Gray's Anatomy 40th edition pg 376-378]

Hypoglossal nucleus – motor nucleus - develops from ventral basal lamina

8. Ans. d. Microglial cells

- During hematopoiesis, some of the stem cells differentiate into monocytes and travel from the bone marrow to the brain, where they settle and further differentiate into miceoglia
- Microglia cells are derived from neuroectoderm and include: Astrocytes, oligodendrocytes, ependymal cells, Schwann cells.

9. Ans. c. Microglial cells

- Microglia cells are mesenchymal in origin
- During hematopoiesis, some of the stem cells differentiate into monocytes and travel from the bone marrow to the

brain, where they settle and further differentiate into microglia

10. Ans. c. 28

- Caudal (posterior) neuropore closes three days later (25+3) to cranial and caudal region (Langman's embryology)

11. Ans. d. Down syndrome

- In Down syndrome Alpha-fetoprotein levels are down

12. Ans. a. Neural tube

- Neural tube develops into brain and spinal cord
- Brain: Forebrain (prosencephalon); Midbrain (Mesencephalon); Hindbrain (Rhombencephalon)

13. Ans. b. Diencephalon

- Diencephalon extends into the eyeball to become retina and optic nerve
- Hypoglossal nerve – motor – derived from basal plate.

14. Ans. b. Anterior commissure

15. Ans. a. VII Nerve

[Ref: IB Singh 8th Edition E Pg 112]

Facial nerve not included in general somatic efferent.

16. Ans. d. dorsal nucleus of vagus

Dorsal nucleus of vagus – general visceral efferent

17. Ans. b. Carries postganglionic parasympathetic fibres

Vagus nerve carries preganglionic fibres not postganglionic

18. Ans. b. Muscles of mastication

[Ref: IB Singh 8th Edition Pg 113]

19. Ans. b. Nucleus ambiguus

[Ref: IB Singh 8th Edition Pg 112]

20. Ans. a. 7th nerve nucleus

[Ref: BDC 5th/e Volume 3 p. 338]

- Nucleus ambiguus include – 9, 10, 11 cranial nerve
- Nucleus tractus solitarius – 7, 9, 10 cranial nerve
- Cranial nerve with parasympathetic function – 3, 7, 9, 10

21. Ans. c. Vth

- Somatic efferent nerves supply all the skeletal muscles except the branchial arch musculature. Hence, Vth nerve is not a somatic efferent nerves as it supplies the muscles of mastication under the first branchial arch (It comes under special visceral efferent)
- Somatic efferent nerve are the IIIrd, IVth and Vth, which supply skeletal muscles of eyeball. XIIth nerve also belongs to somatic efferent column and controls the skeletal muscles of tongue

**22. Ans. a. Olfactory**

- Olfactory nerve belongs to SSA (Special Somatic Afferent) neural column
- Cranial nerve 1, 2 and 8 are under SSA. These nerve brings special sensations (smell, vision, hearing and balance) from the periphery
- GVE (General Visceral Efferent) neural column belongs to automatic nervous system and supplies the three effectors: Cardiac muscles, smooth muscles and glands
- Oculomotor nerve supplies two smooth muscles under this neural column
- Facial nerve has superior salivatory nucleus and lossophary nerve has inferior salivatory nucleus smooth muscles of glands under this column)

23. Ans. c. Dorsal nucleus of vagus

- GVE (General Visceral Efferent) neural column belongs to autonomic nervous system and supplies the three effectors: Cardiac muscles, smooth muscles and glands. Dorsal nucleus of vagus supplies the three effectors of ANS
- Salivatory (including lacrimatory) nuclei of facial nerve also belong to GVE column
- Trigeminal nerve nuclei do not have any GVE functionality
- Nucleus ambiguus belongs to special column and supplies the branchial arch muscles

24. Ans. a. Produced by choroid plexus, c. Absorbed by arachnoid villi, d. Drains into dural venous sinuses

[Ref: Gray's Anatomy 40th edition, pg 243]

- Travels from fourth ventricle to subarachnoid space
- Aqueductal stenosis dilates lateral and III ventricle. (Cerebral aqueduct of sylvius communicates CSF from III ventricle to IV ventricle).

25. Ans. d. 12th nerve

12th nerve present between pyramid and olive

26. Ans. a. Superior sagittal sinus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 332]

27. Ans. a. Choroidal plexus cells

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg]

- Biondi ring triangles – consists of lipid droplets surrounded by ring shaped bundle of filaments
- Intracellular inclusion bodies in choroidal epithelial cells of choroid plexus.
- Significant marker for Alzheimer's disease.

28. Ans. b. Oculomotor nerve

[Ref: IB Singh 8th Edition pg 204, 205]

29. Ans. d. Interthalamic adhesions joins lateral walls, e. Lamina terminalis contain anterior communicating artery

[Ref: Gray's Anatomy 40th edition, pg 243]

- Septum pellucidum present between corpus callosum and anterior columns of fornix and form medial relation to central part and anterior horn of lateral ventricle
- Lateral wall by thalamus and hypothalamus
- Lamina terminalis extends from rostrum of corpus callosum to optic chiasma. Lamina terminalis contain anterior communicating artery
- Lamina terminalis forms the anterior relation of IIIrd ventricle.

30. Ans. a. Rhomboid fossa forms the floor

[Ref: IB Singh 8th Edition Pg 207]

- Choroid plexus in the floor
- Cerebellar peduncle on the lateral wall.

31. Ans. d. None

[Ref: IB Singh 8th Edition Pg 207]

32. Ans. c. Luschka foramen; d. Magendie foramen

- CSF escapes the fourth ventricle into the sub-arachnoid space via three foramina: one midline magendie and two lateral Luschka

33. Ans. b. 3rd ventricle

- Third ventricle is the midline ventricle located in diencephalon

34. Ans. c. Cerebral aqueduct

- Cerebral aqueduct of sylvius is a cavity within the mesencephalon (midbrain), connects the third ventricle in the diencephalon to the fourth ventricle within the region of mesencephalon

35. Ans. a. Ependymocytes

- Ependymocytes are cuboidal or columnar in shape with tuft of cilia on their luminal surfaces and constitutes the majority of the ependymal cells that line the ventricles of the brain and central canal of the spinal cord

36. Ans. d. Corpus callosum

- The anterior horn of the lateral ventricle lies anterior to its central part, the two being separated by an imaginary vertical line drawn at the level of the of the interventricular foramen
- Anterior horn is closed anteriorly by the genu and rostrum of the corpus callosum

37. Ans. c. Posterior wall of third ventricle

- The posterior boundary of the ventricle is marked by a suprapineal recess, the habenular commissure, a pineal (epiphyseal) recess, which extends into the pineal stalk, and by the posterior commissure

38. Ans. d. Stria terminalis

- Abducent (6), vestibular (8), vagus (10), hypoglossal (12) nuclei are at the floor of 4th ventricle

39. Ans. b. Vagal triangle

- Floor of 4th ventricles has areas related to Abducent (6), vestibular (8), vagus (10), hypoglossal (12) nuclei



40. Ans. **b. Sixth**

- Facial colliculus is raised due to the axons of facial nerve winding around the abducent nucleus
- It is the facial nerve axons (and not the abducent nucleus) that arises the elevation called facial colliculus

41. Ans. **b. Risorius**

- Key – marked structure – facial colliculus. Facial colliculus is a rounded elevation formed by the axons of facial nerve (and not by the abducent nucleus deep to it)
- Damage to the facial nerve axons paralyzes muscles of facial expression like risorius

42. Ans. **d. 4**

[Ref: BD Chaurasia Human Anatomy 6Th Edition Vol 3 Pg 386]

43. Ans. **b. Contains straight sinus**

Contains superior, inferior sagittal sinus and straight sinus.

44. Ans. **c. Auriculotemporal**

[Ref: BD Chaurasia Human Anatomy 6Th Edition Vol 3 Pg 368, 369]

45. Ans. **d. Venous sinuses present inner to meningeal layer**

Venous sinuses present between the two layers.

46. Ans. **b. Striate branch of middle cerebral artery**

[Ref: Gray's 39th/e p. 300-310]

47. Ans. **b. B**

Vertebral artery related to foramen transversarium

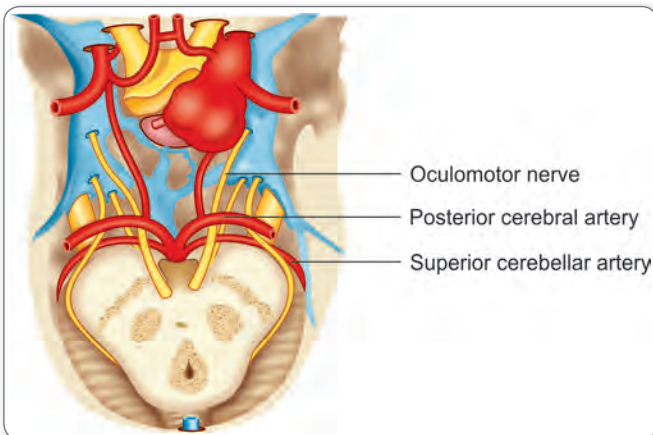
- A – body
- B – foramen transversarium
- C – superior articular facet
- D – lamina

48. Ans. **c. Middle meningeal artery**

Extradural haemorrhage – middle meningeal artery

49. Ans. **a. Oculomotor nerve**

Oculomotor nerve lies between superior cerebellar artery and posterior cerebral artery



50. Ans. **c. Posterior communicating artery**

51. Ans. **d. Contralateral homonymous hemianopia with macular sparing**

Lesion of posterior cerebral artery supplying leads to Contralateral homonymous hemianopia with macular sparing because middle cerebral artery supplies macula, that will be spared.

52. Ans. **d. Posterior communicating artery**

Features of IIIrd nerve injury given. IIIrd nerve affected in aneurysm of posterior communicating artery.

53. Ans. **d. Middle meningeal artery**

Lucid interval seen. Seen in extra dural hemorrhage – due to middle meningeal artery involvement.

54. Ans. **a. Anterior cerebral artery**

[Ref: BDC 5th/e Vol. 3 p. 461, 462]

55. Ans. **d. None**

56. Ans. **c. Intracerebral**

57. Ans. **b. Ophthalmic artery**

[Ref: Last anatomy 11th edition, pg 354-356]

Ophthalmic artery is branch of cerebral part of internal carotid artery

58. Ans. **c. Bulbar artery**

[Ref: Gray's Anatomy 40Th Ed 250-25]

Bulbar artery not supply the medulla

59. Ans. **b. Posterior cerebral artery**

[Ref: Snell's Neuroanatomy 7th edition pg 285]

- PICA – branch of vertebral artery
- Anterior and middle cerebral artery – internal carotid artery
- Posterior communicating artery – internal carotid artery

60. Ans. **a. Posterior cerebral artery**

[Ref: Snell's Neuroanatomy 6th edition pg 474]

61. Ans. **c. Branch of subclavian..., d. Accompany sympathetic..., e. Passes through foramen transversarium...**

[Ref: Snell Neuro Anatomy 6th edition pg 470-472]

- Enters skull through foramen magnum
- Branch of subclavian artery
- Passes through foramen transversarium from C6 to C1, foramen transversarium of C7 transmits only vertebral veins

62. Ans. **c. Intervertebral foramen**

[Ref: Snell Neuro Anatomy 6th edition pg 470-472]

Arteries present in sub arahnoid space
Veins in subdural space



Vertebral artery passes through foramen magnum, foramen transversarium

63. Ans. a. Pons

[Ref: Snells Neuroanatomy 7th edition 285]

Posterior cerebral artery supplies striate cortex, thalamus, midbrain, temporal lobe, lentiform nucleus, medial geniculate body.

64. Ans. c. Posterior cerebral artery with internal carotid artery

[Ref: BDC 6th edition volume 3 page 459]

65. Ans. c. Great cerebral vein

[Ref: Textbook of Neuroanatomy pg 189]

Great cerebral vein – joining of 2 internal cerebral veins

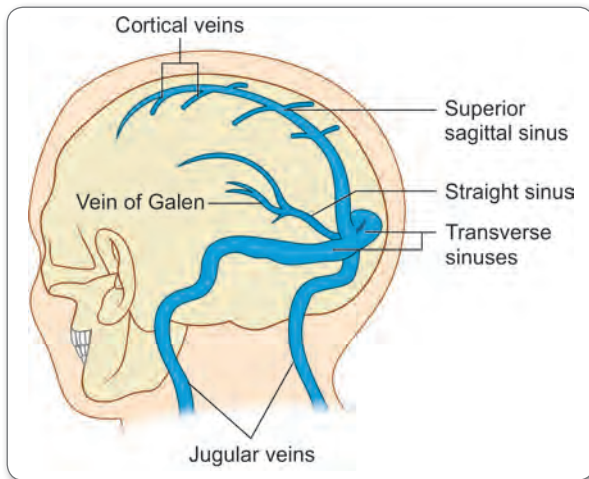
66. Ans. c. Straight sinus

Great cerebral vein drains into straight sinus

67. Ans. c. Superior sagittal sinus

68. Ans. d. Straight sinus

[Ref: BDC-III, 6th/e pg. 196]



69. Ans. b. Oculomotor

- Intracranial aneurysms may involve oculomotor, abducent and optic nerve in descending order
- Trochlear nerve involvement is highest in head trauma

70. Ans. b. Oculomotor nerve

- Berry aneurysms in the vicinity of posterior communicating artery can compress the third nerve and cause oculomotor nerve palsy
- Aneurysms of superior cerebellar artery or tip of the basilar artery can also compress the oculomotor nerve and produce it palsy
- Berry aneurysms on the internal carotid artery (near its termination) compress the lateral aspect of optic chiasma and hence damages the visual information from the ipsilateral nasal visual field

71. Ans. c. Posterior communicating artery is given in petrous part

- Posterior communicating artery is given in cerebral part

72. Ans. d. Basilar artery

- The two vertebral arteries enter the cranial cavity through foramen magnum and unite at the pontomedullary junction to form the basilar artery
- It ascends superiorly anterior to the pons and divides at the junction of pons and midbrain into two posterior cerebral arteries

73. Ans. b. Middle cerebral artery; c. Posterior cerebral artery

- The major artery to supply occipital cortex is posterior artery
- An additional branch to the macular area on the brain is given by the middle cerebral artery

74. Ans. d. Posterior communicating artery

- Basal ganglia components (including putamen) are supplied by the striate (medial and lateral) arteries, which are branches from the roots of the anterior and middle cerebral arteries
- The posteroinferior part of the lentiform complex is supplied by the thalamostriate branches of the posterior cerebral artery
- Additional contributions are from anterior choroidal artery (branch of internal carotid artery)

75. Ans. d. Choroid plexus

- Choroid plexus is not a pain producing structure, Much of the brain parenchyma, ventricular ependyma, pial veins and choroid plexus are not pain-producing structures
- Few cranial structures are pain producing: The scalp, middle meningeal artery, dural sinuses, falx cerebri and proximal segments of large pial arteries
- The structures involved in headache are few and the large intracranial vessels and dura mater innervated by the trigeminal nerve

76. Ans. a. Central canal lies in the white matter

- Ligamentum denticulatum are (modifications of pia mater) 21 tooth like process on each side midway between dorsal and ventral spinal roots. Suspends the spinal cord in subarachnoid space and stabilize it.
- Central canal in gray mater

77. Ans. d. Arachnoid terminates at S2

Dura converge at S2 and ends at coccyx

78. Ans. c. Hypertonia

Hypertonia is feature of UMN lesion

79. Ans. c. Ipsilateral loss of vibration

Contralateral loss of vibration seen in this brown sequard syndrome

80. Ans. b. Rubrospinal

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 347,348]



Rubrospinal tract, lateral corticospinal tract in lateral columns of spinal cord.

81. Ans. c. L3

82. Ans. d. S2

[Ref: IBS Neuro Anatomy 8th Edition Pg 32]

83. Ans. d. Nucleus cuneatus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 347, 348]

- Sterognosis—Determination of texture and size of an object carried by fasciculus gracilis and
- Nucleus gracilis—Carries sensation from coccygeal, sacral, lumbar and lower thoracic segments
- Nucleus cuneatus—carries sensation from upper thoracic and cervical segments. So this nucleus receives impulse from digits, palm, hand and forearm

84. Ans. c. Left lateral spinothalamic tract

[Ref: IB Singh Neuro Anatomy 6Th Edition 83]

- Lateral spinothalamic tract—carries pain and touch of the opposite side
- Anterior spinothalamic tract—carries crude touch, pressure of the opposite side
- So right leg pain—left lateral spinothalamic tract.

85. Ans. a. Posterior longitudinal ligament

- Posterior and anterior longitudinal ligament not pierced in Lumbar puncture

86. Ans. a. Ligamentum flavum

[Ref: 40th edition Gray's]

- Ligamentum flavum > dura
- Classic popping is due to piercing of ligamentum flavum.

87. Ans. a. Lower border of L1

- In adults the spinal cord normally ends at the lower border of the L1 vertebra
- In a neonate, spinal cord ends at the upper border of L3 vertebra
- Dural and the subarachnoid sheath end at the caudal (lower) border of the S2 vertebra

88. Ans. b. 21

- The pia mater of the spinal cord has a pair of denticulate ligaments (one on each side of the spinal cord) with 21 attachments which attach it to the arachnoid and dura mater.

89. Ans. a. C5

- In upper cervical region the spinal nerve roots are short and run almost horizontally and are more prone to injury during decompressive operations
- Roots of the lumbar and sacral nerves are long and run obliquely (almost vertically)

90. Ans. b. Pain

- Posterior (dorsal) column carries sensation like pressure, vibration, tactile discrimination, proprioception, stereognosis, conscious, proprioception
- Pain and temperature is carried by the lateral spinothalamic tract

91. Ans. d. Dorsal column

- Ability to recognize an unseen familiar object is known as stereognosis and is carried by the dorsal column

92. Ans. b. Absent knee and ankle jerks

- Since the spinal segment involved in knee and ankle jerks are at higher level than the level of lesion, they are preserved, and not lost
- Root value of knee reflex is L-2, 3 and 4 and for the ankle reflex is S-1
- Conus medullary syndrome is a lower motor neuron lesion and involves the lower 3 sacral and coccygeal segments
- Plantar reflex remains flexor in this syndrome, since its spinal arc is also above the level of lesion and is unaffected
- Root value of plantar reflex is S-1, 2
- Conus medullary syndrome produces saddle anaesthesia in the perineal region as per the dermatomal pattern

93. Ans. c. Lateral spinothalamic tract

- Pain and temperature is carried by the lateral spinothalamic tract, whereas, anterior spinothalamic tract carries the crude touch
- Pyramidal tract is a motor tract and is concerned with control of fine and skilled voluntary motor activity
- Dorsal spinocerebellar tract is concerned with unconscious proprioception, mainly from the lower limbs
- Upper limb proprioception is carried by the cuneocerebellar tract

94. Ans. a. Corticonuclear and corticospinal fibers

[Ref: IB Singh 8th Edition Pg 104]

95. Ans. d. Ophthalmic nerve

[Ref: IB Singh 8th Edition pg 159, 175]

96. Ans. a. Medulla

97. Ans. d. Nucleus gracilis and cuneatus

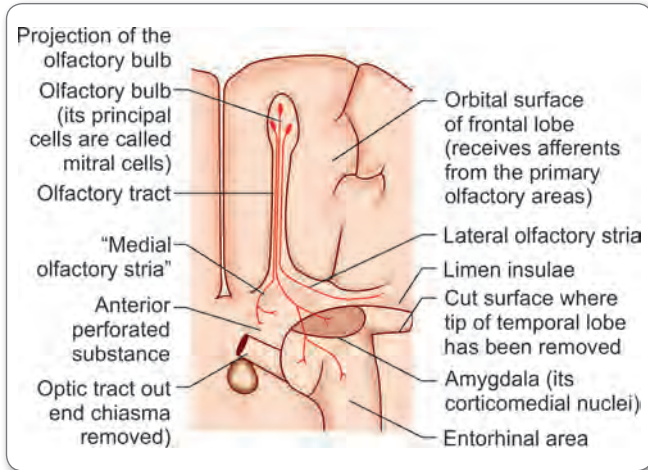
[Ref: BDC 6th edition volume 3]

- Nucleus gracilis and cuneatus gives rise to internal arcuate fibers.
- These fibers cross to opposite side and continue as medial lemniscus.

98. Ans. d. Limeninsulae

[Ref: IB Singh 8th edition pg 176]

Anterior perforated substance - Perforated by small blood vessels from middle cerebral artery in the base of brain.



Boundaries

Infront and medial	Medial olfactory striae
Infront and lateral	Lateral striae of olfactory tract
Behind and medial	Optic tract
Behind and lateral	Uncus
Lateral	Limen insulae
Medial	Optic tract and chiasma

Limen insulae lies in the lateral relation of anterior perforated substance

- Uncus lies in the postero-lateral relation of anterior perforated substance, optic chiasma is medial and 3rd ventricle lies posterosuperior to it
- Anterior perforated substance lies on the base of the brain situated between the olfactory trigone anteriorly and optic tract posteriorly bounded by the lateral and medial olfactory stria (of the olfactory pathway) on sides
- Limen insulae is a point at which the cortex of the insula is continuous, on the inferior surface of the parahippocampal gyrus cortex of the frontal lobe
- Uncus is the blunt end of the temporal lobe in inferior view. It is the medially curved anterior end of the cerebral hemisphere, with the observed on the inferior surface of the cerebral hemisphere
- Limen insulae, uncus and the entorhinal area (anterior part of parahippocampal gyrus) are collectively called as pyriform cortex and are connected to the olfactory pathway.

99. Ans. b. Pons

[Ref: IB Singh 8th Edition Pg 208]

100. Ans. a. superior olivary nucleus

[Ref: IB Singh 8th Edition pg 118]

101. Ans. c. Genu of internal capsule

[Ref: IB Singh 8th Edition Pg 11]

102. Ans. c. Medial longitudinal fasciculus

[Ref: BDC-III 6th/e pg. 391]

- Medial longitudinal fasciculus – coordinate the movements of eye, head and neck in response to VIII cranial nerve
- Heavily myelinated tract in paramedian position of brain stem
- MLF – interconnect –III, IV, VI, Spinal part of XI with VIII

103. Ans. a. Medulla oblongata

- Chemoreceptor trigger zone – in medulla
- In the floor of IV ventricle, lower part is formed by medulla. In that vagal triangle is divided by funiculus separans. Small area between gracile tubercle and funiculus above is area postrema – vomiting zone

104. Ans. a. Facial

- Facial nerve nuclei are present in the pons and the nerve exist at the pontomedullary junction
- Nuclei of cranial nerve 9, 10, 11 and 12 are present in the medulla oblongata and their fibers arise from the medulla.

105. Ans. c. Posteromedial to olive

- Nucleus ambiguus is a motor nucleus located in upper medulla oblongata, posteromedial to olive

106. Ans. a. Right posterior inferior cerebellar artery

- This is a case of right sided wallenberg syndrome due to occlusion in the right posterior inferior cerebellar artery, leading to lateral medullary ischaemia and lesion of certain nuclei and tracts
- The patient has alternating hemi-anaesthesia: ipsilateral loss of pain and temperature on face and contralateral loss of pain and temperature on the body. It occurs due to lesion of lateral spinothalamic tract and spinal sensory nucleus of trigeminal
- Ataxia and intentions tremors indicate injury to spinocerebellar tract in the lateral medulla
- There is hoarseness of voice which indicates lesion of nucleus ambiguus (which controls muscles of larynx)
- Patient also has features of right sided Horner syndrome due to lesion of the hypothalamo-spinal pathway in the lateral medulla.

107. Ans. a. Trochlear nerve

- Trochlear nerve is not a content of interpeduncular fossa

108. Ans. a. Abducent

- Subcortical center for horizontal conjugate gaze lies in the abducent nucleus in pons
- It receives input from the contralateral frontal eye field and controls ipsilateral lateral rectus and contralateral medial rectus muscle via projections of medial longitudinal fasciculus (MLF)
- MLF connects the nuclei controlling eyeball muscles and mediates nystagmus and lateral conjugate gaze
- Its fibers originate in vestibular nucleus and terminate in abducent, trochlear and oculomotor nuclei
- It coordinates eyeball movements with the head. Trochlear nucleus is mainly concerned with vertical gaze movements.

**109. Ans. c. Cerebellar nuclei**

[Ref: IB Singh 8th Edition E Pg 138]

Purkinje axons sole output from cerebellar cortex and these fibers end in intracerebellar nuclei.

110. Ans. c. Olivocerebellar

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 405]

111. Ans. a. Pontocerebellar pathway

[Ref: Bd Chaurasia Human Anatomy 6th Edition Vol 3 Pg 405]

112. Ans. c. Resting tremor

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 432]

Cerebellar Lesion Signs

- Ataxia
- Decomposition of movement
- Dysarthria
- Dysdiadochokinesia
- Scanning speech
- Dysmetria
- Hypotonia
- Hypotonia
- Intentional tremors
- Key-Resting tremors are features of Parkinson's disease

113. Ans. a. Phylogenitacally oldest nuclei

[Ref: BDC vol 1 6th edition pg.405]

Oldest and medial most cerebellar deep nuclei – fastigial
Latest in evolution – lateral most – dentate nucleus

114. Ans. d. Globose – nucleus

[Ref: BDC Vol. III 5th/e p. 406]

Dentate – crumpled bag
Emboliform – oval in shape

115. Ans. a. Inferior olivary nucleus

[Ref: BDC vol 1 6th edition pg.405]

- Climbing fibers originate in inferior olivary nucleus
- Make monosynaptic contact with Purkinje cell
- But bulk of the afferent is by mossy fibers.

116. Ans. a. Bipolar

- Cerebellar cortex has five cell types and bipolar cells are not among them
- Bipolar cells can be seen in the cerebral cortex and retina
- Cerebellar cortex has 3 layers: Outermost molecular layer – 2 cells (Stellate and basket); middle layer – Purkinje cells and inner (deeper/granular) layer – 2 cells (granule and Golgi)

117. Ans. a. Pontocerebellar, c. Anterior spinocerebellar

- Pontocerebellar tract passes through the middle cerebellar peduncle and anterior spinocerebellar tract passes through the superior peduncle.

118. Ans. a. Dentate

- Evolution wise, the latest and the lateral-most nucleus is dentate and the oldest and medial most is fastigial nucleus.

119. Ans. c. Dysarthria

- Key given slide is cerebellum
- Cerebellum lesion cause – dysarthria

120. Ans. d. Deep cerebellar nuclei

- Marked cell – Purkinje cell
- Axons from Purkinje cell inhibit the cerebellar nuclei

121. Ans. d. Geniculate body

[Ref: IB Singh 8th Edition E Pg 164]

122. Ans. b. Medial lemniscus

- Thalamus has a ventral posterior (VP) nucleus, which has two parts: medial and lateral
- VPM (Ventero-Posterior-Medial) nucleus receive sensory input from 'head' region, whereas VPL (Ventero-Posterior-Lateral) nucleus receive sensory input from the 'body'
- Trigeminal nerve (first order neuron) carries information from the head region continues in the trigeminal lemniscus (second order neurone in brainstem) and synapses on VPM nucleus of thalamus
- Thalamus has third order neurons, which in turn project on to the parietal sensory cortex (1, 2, 3)
- Spinothalamic tract-spinal lemniscal system (pain,temperature) and dorsal column-medial lemniscal system (tactile discrimination,vibration etc.) carry information from the 'body' region to synapse on VPL nucleus of thalamus, which further project the information to area 1, 2, 3
- Lateral lemniscus carries auditory pathway and synapses with medial geniculate body (meta thalamus)

123. Ans. b. Reticular nuclei

- Reticular nuclei have intrathalamic connections and do not project to the cortex
- Reticular nuclei lie between the external medullary lamina and the internal capsule
- They use the neurotransmitter GABA and have inhibitory control over thalamic nuclei
- They play important role in normal ECG readings
- Most of the thalamic nuclei project to the neocortex, including intralaminar, plvinar and anterior thalamus

124. Ans. a. Ventero Medial: Hunger

- Venteromedial nucleus is the center for satiety (not hunger)
- Anterior hypothalamus has osmoreceptors and centers like supra-optic nucleus secrete vasopressin (ADH) for water conservation
- Posterior nucleus works for heat conservation (shivering center)
- Supra-chiasmatic regulates the circulation rhythm

125. Ans. c. Posterior part of the calcarine sulcus

- Primary auditory area. Posterior part of calcarine sulcus
- Primary visual area (Brodmann area 17) is located at the posterior part of the calcarine sulcus
- This area shows lines (stria) of Gennari and is also called as striate cortex



- It is supplied by posterior cerebral artery and additionally by middle cerebral artery

126. Ans. b. Primary auditory area

- Primary auditory area (41, 42) is present temporal gyrus (Heschl's)

127. Ans. a. Primary auditory cortex

- Heschl's gyrus is the transverse temporal gyrus in the area of primary auditory cortex buried within the lateral sulcus occupying
- Brodmann areas 41 and 42

128. Ans: b. Broca's motor speech area

- Speech in words and not in sentences is a feature suggesting hesitant speech, which occurs Broca's motor aphasia

129. Ans. b. 4

[Ref: IB Singh 8th Edition Pg 183]

130. Ans. c. Inferior frontal lobe

[Ref: Vishram Singh's Neuroanatomy 2nd Edition Pg150]

131. Ans. c. Collateral > calcarine

[Ref: Essentials of neuroanatomy pg 41]

Complete sulcus—collateral sulcus and anterior part of calcarine sulcus not entire calcarine sulcus.

132. Ans. c. Lunate

Operculated—lunate sulcus

133. Ans. b. Primary auditory area

[Ref: BDC 6th Edition Volume 3, Pg 421]

Temporal lobe contains primary auditory and auditory association area.

134. Ans. c. Conduction aphasia

Conduction aphasia – lesion in arcuate fasciculus

Aphasia	Comprehension	Repetition	Naming	Fluency
Broca's motor	Preserved	Affected	Affected	Decreased
Wernicke's sensory	Affected	Affected	Affected	Maintained or increased
Global aphasia	Affected	Affected	Affected	Decreased
Conduction aphasia	Maintained	Affected	Affected	Maintained
Anomic aphasia	Maintained	Maintained	Affected	Preserved
Alexia	Affected only for reading	Maintained	Maintained	Maintained

135. Ans. b. Vertical

[Ref: Vishram Singh's Neuroanatomy 2nd Edition pg 148-149]

Cortical representation of body is upside down (vertical) in inverted direction—inverted homunculus. Representation depends on the skill not the size of the organ.

136. Ans. a. Right leg and perineum

[Ref: Vishram Singh's Neuroanatomy 2nd edition pg145, 148-149]

- Paracentral lobule is present on the medial side of brain and contains both precentral (motor) and postcentral gyrus (sensory).
- Cerebral cortex controls the contralateral side of the body
- Inverted homunculus representation—(from below upwards) pharyngeal region, tongue, face, hand, trunk and thigh. The remaining leg, feet and perineum are represented in paracentral lobule
- So paracentral lobule is the prime center for micturation and defaecation.

137. Ans. b. Anterior two-third of posterior limb

- Corticospinal fibers pass through the anterior two-third of the posterior limb of internal capsule
- Posterior 1/3rd of posterior limb carries sensory fibers (including audio-visual pathways)

138. Ans. c. Cortico nuclear

[Ref: Grays 40th edition 357]

139. Ans. d. Forceps major

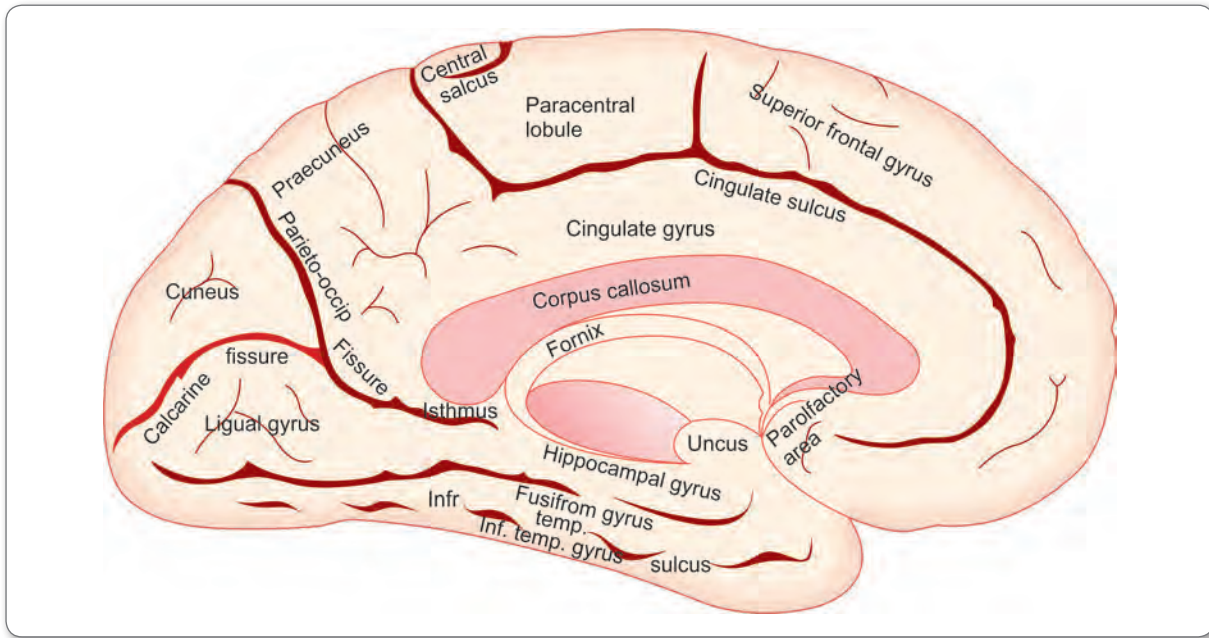
140. Ans. a. Unite far area of two side of brain, b. Connects two frontal lobe, c. Unite two hemisphere, d. Superiorly related to indusium griseum

[Ref: Gray's 40th Edition 354-356]

Connects two sides of opposite hemisphere not within the same lobe.

141. Ans. a. Calcarine sulcus

Calcarine sulcus—separates cuneus and lingual gyrus.



142. Ans. b. Inferior frontal gyrus

[Ref: BDC-III 6th/e pg. 421]

- Broca's area – motor area of speech – 44, 45 – inferior frontal gyrus
- Wernicke's area – sensory area of speech – 39, 40 – posterior part of superior temporal gyrus
- Auditory area – 41, 42, 22 – anterior part of superior temporal gyrus
- Visual area – 17, 18, 19 – occipital cortex
- Frontal eye field – 8 – middle frontal gyrus
- Gustatory cortex – 43 – posterior ramus of lateral sulcus or inferior parietal lobule

143. Ans. c. Posterior ramus of lateral sulcus

[Ref: BDC-III, 6th/e pg. 423]

144. Ans. d. Dentate nucleus

145. Ans. c. Thalamus

[Ref: BD Chaurasia Human Anatomy 6th Edition Vol 3 Pg 432]

146. Ans. a. Planning and programming of ...

[Ref: Snell's Neuroanatomy 6th edition pg 310- 333]

- Sensory integration function of thalamus
- Recent memory – hippocampus
- Coordination of motor activity – cerebellum
- Pain reception – fine nerve ending.

147. Ans. d. D

- A – Caudate nucleus
- B – thalamus
- C – lentiform nucleus
- D – insula

148. Ans. c. Paralysis agitans

- Marked structure – substantia nigra – lesion causes parkinsons (paralysis agitans)

149. Ans. a. Lateral striate artery

Lateral striate artery – from middle cerebral artery – artery of charcot cerebral haemorrhage

150. Ans. d. Spinal cord

Marked structure – caudate nucleus – neo striatum which receives afferent from cerebrum, thalamus and substantia nigra

151. Ans. d. Sydenham chorea

Sydenham chorea due to untreated streptococcal infection

152. Ans. b. Thalamus and caudate medially and lentiform laterally

Internal capsule between thalamus and caudate nucleus medially and lentiform nucleus laterally

153. Ans. c. Retrolentiform

- Optic radiations – retrolentiform
- Auditory radiations – sub lentiform

154. Ans. c. Anterior cerebral artery

- Superior part of posterior limb of internal capsule supplied by middle cerebral artery
- Inferior part is supplied by anterior choroidal artery
- According to some others Posterior limb also supplied by posterior cerebral artery

155. Ans. c. Amygdaloid nucleus

- Amygdaloid nucleus is a part of limbic system/basal ganglia, located deep and medially within the temporal lobes and



has a primary role in the processing of memory, decision-making, and emotional reactions

- Hippocampal formation is a compound structure in the medial temporal lobe of the brain which includes the dentate gyrus, the hippocampus proper, the subiculum and entorhinal cortex. It plays a role in memory, spatial navigation and control of attention

156. Ans. b. Hippocampus - Thalamus

- The sequence of connection is Hippocampus->Mammillary body->Thalamus. (Mnemonic: HMT)

Note: Mammillary body is a component of hypothalamus

157. Ans. a. Superior olivary complex

158. Ans. b. Involuntary movements

[Ref: IB Singh 8th Edition Pg 99]

Incoordination is feature of cerebellar lesion, but in UMN lesion some amount of incoordination is due to spastic paralysis
Involuntary movements only due to extra pyramidal tract.

159. Ans. c. Cranial nerve 3, 7, 9, 10 and sacral plexus

160. Ans. b. Skeletal muscles

- General visceral efferent (GVE) includes the fibers under autonomic nervous system, which control three effectors: Cardiac muscle, smooth muscles and glands
- General somatic efferent (GSE) neural column controls skeletal muscles

161. Ans. b. Ciliary muscle

- Edinger westphal nucleus sends the Preganglionic parasympathetic fibers through oculomotor nerve to ciliary ganglion, which further supply two smooth muscle of the eyeball: ciliaris and sphincter pupillae

162. Ans. d. Apparent exophthalmos

- Horner syndrome presents with enophthalmos (and not exophthalmos)
- This is due to paralysis of ciliaris muscle which normally protrude the eyeball out of the socket. It is paralysis leads to eyeball staying back in the orbit, giving the appearance of sunken eyeball (enophthalmos)
- Heterochromia iridis may be present if the lesion occurred in a child younger than 2 years (Congenital Horner's syndrome)

163. Ans. b. Exophthalmos

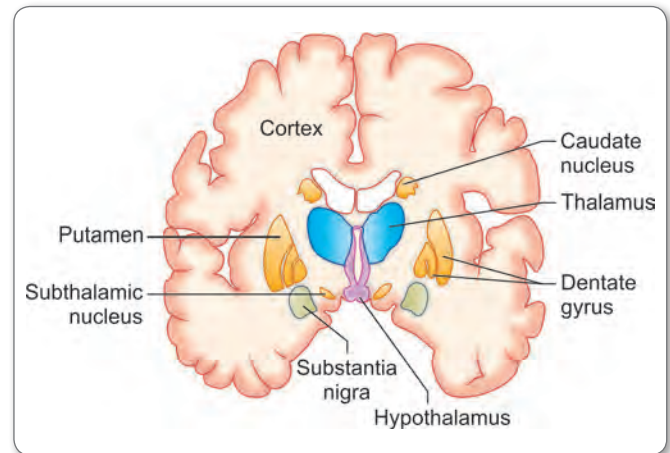
[Ref. BDC-III, 6th/e pg.418]

- Stellate ganglion block produces enophthalmos (not exophthalmos), due to the paralysis of ciliaris muscle (supplied by T1)
- Stellate ganglion has the sympathetic fibers and with root value T-1 and it supplies the head and neck region like skin over the face muscle of the iris-dilator pupillae etc.
- Stellate ganglion block produces the symptomology of Horner's syndrome i.e., loss of papillary dilation –meiosis loss of sympathetic vasoconstrictive tone resulting in dilated vessels-conjunctival redness. Loss of vasoconstrictive tone

leads to dilation of blood vessels in the nose region also and thus increasing nasal secretions – nasal congestion

164. Ans. b. Putamen

[Ref. BDC-III 6th edition pg.-437; BDC-III, 6th/e pg. 147]



165. Ans. b. L1

(Ref: Gray's Anatomy, 41st ed., Pg 762-763)

- Spinal cord in adults terminates at the level of L1
- In new born at the level of L3

166. Ans. d. Proprioception

(Ref: Barr's The Human Nervous System, 10th ed., Pg. 127 and Snell's Neuroanatomy 7th ed., Pg. 342-343)

- Proprioception carried by mesencephalic nucleus of trigeminal
- Mesencephalic nucleus of trigeminal
 - Contains unipolar neurons
 - Situated in mid brain
 - Centre for jaw jerk

167. Ans. a. Dentate nucleus

(Ref: Barr's The Human Nervous System 10th ed., Pg 164 and Snell's Neuroanatomy, 7th ed., Pg 235)

- Purkinje – sole efferent of cerebellum
Axons of purkinje end in cerebellar nuclei
Cerebellar nuclei (from lateral to medial)
- Dentate
 - Emboliform
 - Globose
 - Fastigial

168. Ans. a Meningeal branches of internal carotid artery in posterior cranial fossa

(Ref: Gray's Anatomy, 41st ed., Pg. 439 and Snell's Neuroanatomy, 7th ed, Pg 475-477)

Meningeal branch of internal carotid supplies the middle cranial fossa

Blood supply of meninges concerns blood supply of outer layer of dura rather than inner layer of dura, arachnoid, pia which do not require large blood supply.



Anterior cranial fossa supplied by:

- Anterior ethmoidal artery
- Posterior ethmoidal artery
- Ophthalmic artery

Middle cranial fossa supplied by:

- Middle meningeal artery
- Accessory middle meningeal artery
- Meningeal branch of internal carotid artery

Posterior cranial fossa supplied by vertebral and occipital artery

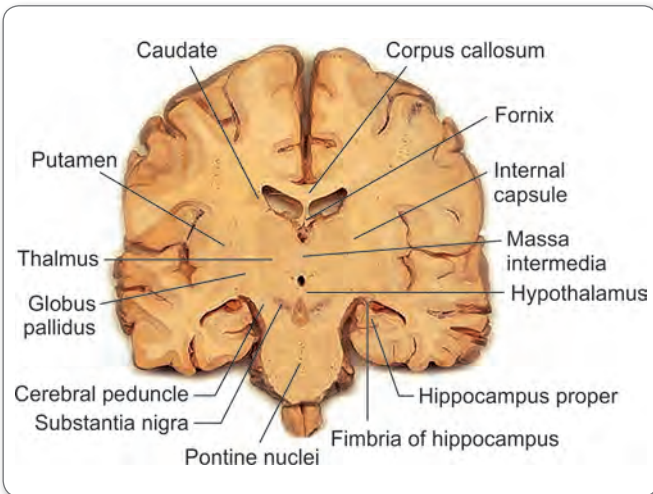
169. Ans. a. Hippocampus

(Ref: Gray's Anatomy, 41st ed., Pg. 439, Snell's Neuroanatomy, 7th ed., Pg. 310, Barr's Neuroanatomy, 10th ed., Pg 273)

The marked part is fornix – example of

Projection fibre

Fornix arises from hippocampus & extends up to mamillary body.



170. Ans. d. Hypothalamus

- D is pituitary gland not hypothalamus
- All other options correct

171. Ans. d. Interstitial nucleus of Cajal

(Ref: Gray's 41th edition – Book lines)

- Rostral interstitial nucleus of the medial longitudinal fasciculus and the interstitial nucleus of Cajal, both of which are involved in the control of vertical and torsional gaze
- PPRF – For horizontal gaze

172. Ans. b. B

- A – superior frontal gyrus – motor association area - 6
- B – inferior frontal gyrus – Broca's area (motor) – 44, 45
- C – superior temporal gyrus – auditory area 41, 42
- D – occipital gyrus – visual cortex – 17, 18, 19
- Wernicke's area – sensory speech area – 22 – posterior part of superior temporal gyrus
- Broca and Wernicke's aphasia – due to involvement of middle cerebral artery

- Broca's aphasia—fluency & repetition affected, comprehension normal
- Wernicke's aphasia—comprehension and repetition affected, fluency normal

173. Ans. a. XII

XII nerve is purely motor. Not involved in olfaction.

174. Ans. c. Apraxia

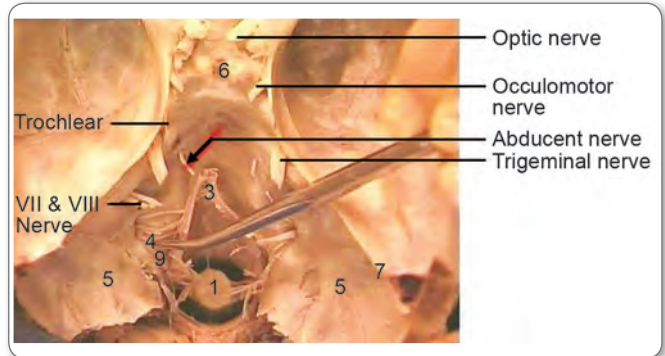
Key

- Paracentral lobule is marked
- Perineum and lower limb represented in this lobe
- It is the highest centre for micturition and defecation

175. Ans. b. Dorsal column tract

- Given sign is Romberg sign
- Due to involvement of posterior column

176. Ans. c. Oculomotor nerve



177. Ans. b. Inferior olivary nucleus

- Afferents by climbing fibres and mossy fibres
- Climbing fibres originate from inferior olivary nucleus & synapse directly with one Purkinje cell
- Mossy fibres form the bulk of the afferents and each fibre ends by dividing into 30–40 terminal rosette. Each rosette anastomoses with golgi cell and granule cell.
- One granule cell synapse with thousands of purkinje, So are mossy fibre synapse with thousands and thousands of purkinje cell

178. Ans. d. 7th month

- Neuronal migration peaks at 12-20 weeks
- By 28th week – migration completed

179. Ans. c. Fastigial nucleus

- Saccade related parts of cerebellum – oculomotor vermis
- And caudal part of fastigial nucleus

180. Ans. a. 44, 45

- Motor area of speech – Broca's area – inferior frontal gyrus – 44,45
- Sensory area of speech – Wernicke's area – posterior part of superior temporal gyrus – 22

**181. Ans. c. L3**

- Spinal cord in adult ends at the level L1
- Spinal cord in new born ends at the level of L3

182. Ans. a. CNS

- CNS developed from ectoderm
- Thyroid gland—endodermal derivative
- Respiratory epithelium—endoderm derivative
- Gut epithelium—endodermal derivative

183. Ans. a. Middle meningeal artery

Marked part is pterion

It is the place where four bones meet

- Parietal bone
- Squamous part of temporal bone
- Frontal bone
- Great wing of sphenoid
 - Anterior division of middle meningeal artery overlies it

184. Ans. b. Inferior parietal cortex

- Single unit recording has revealed both hand and eye movement related activity in parietal cortex.

185. Ans. c. Projection fibres

- Marked structure is internal capsule
- Projection fibres – connect cortex to sub cortical structures
- Examples -
 - Internal capsule
 - Fornix

186. Ans. b. Wallenberg syndrome

- PICA – artery involved in lateral medullary syndrome

187. Ans. a. Fornix

Marked structure is fornix.

188. Ans. a. Cerebellum**189. Ans. d. Loss of stereognosis, proprioception, on left side**

- Fibers from nucleus gracilis and cuneatus cross and continue as medial lemniscus
- So, lesion in medial lemniscus leads to contralateral loss of proprioception, stereognosis.

190. Ans. b. Lateral spinothalamic tract

- Lateral spinothalamic tract controls pain and temperature
- Anterior spinothalamic tract controls crude touch, pressure

191. Ans. a. Anterior cerebral; d Internal carotid

- Optic chiasma supplied by ant cerebral and median zone by internal carotid
- Optic tract—anterior choroidal artery and posterior communicating artery
- Optic radiation—middle cerebral and posterior cerebral artery

NOTES

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Spatters



Head and Neck

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HEAD AND NECK

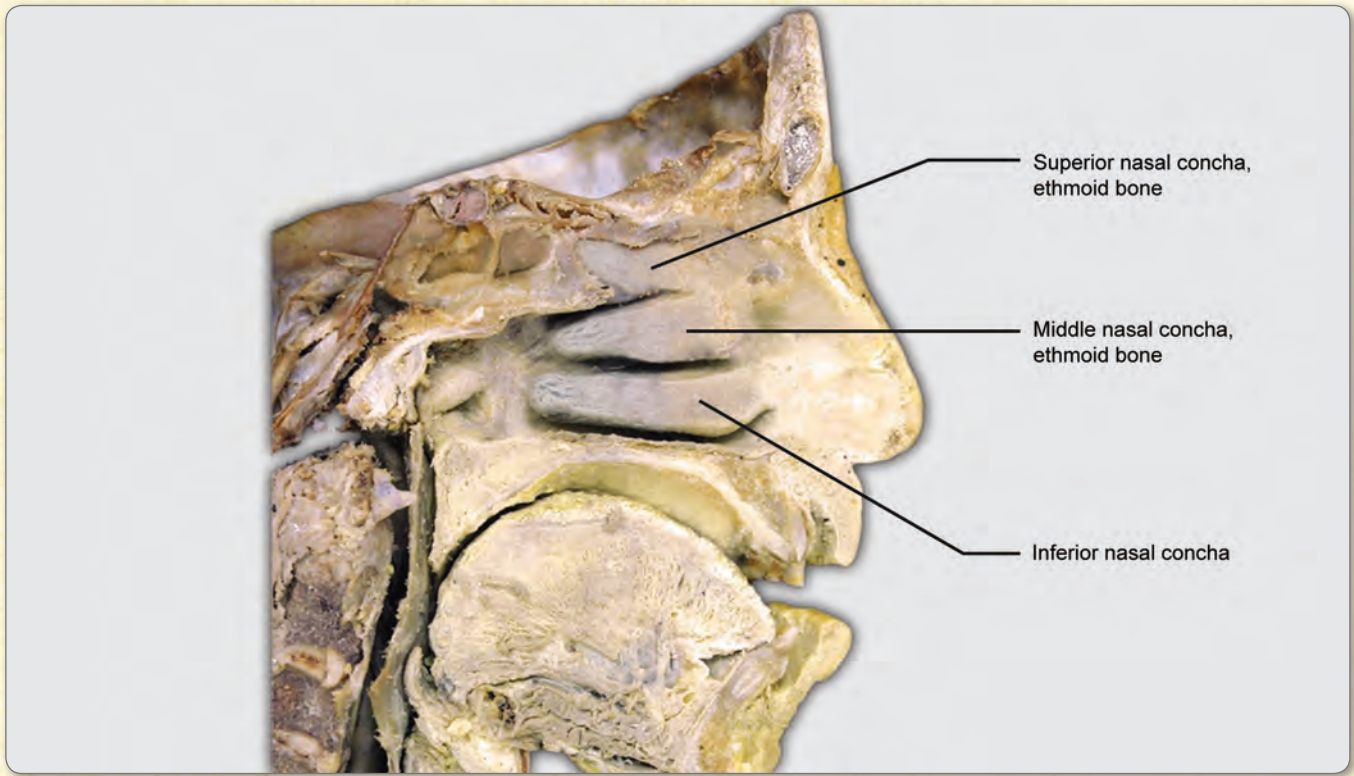


Fig. 1: Nasal cavity

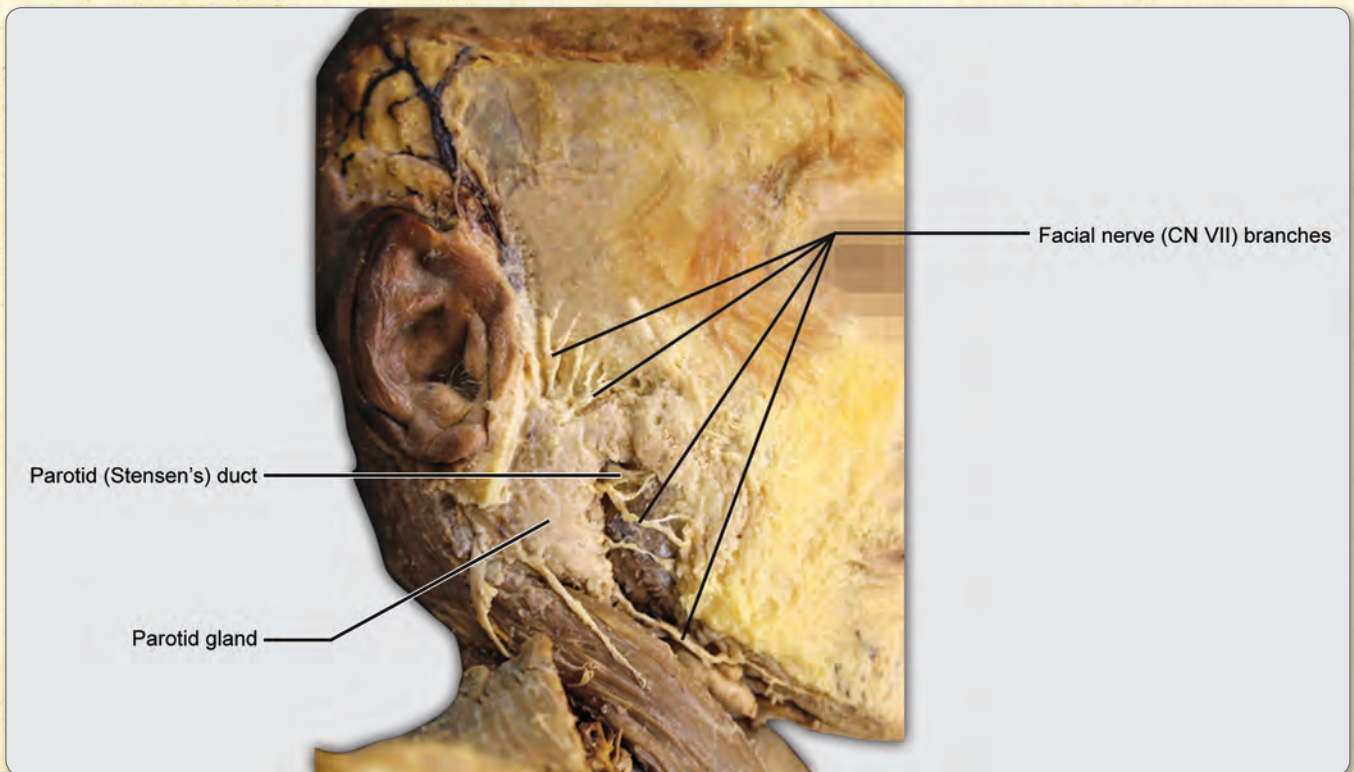


Fig. 2: Parotid gland

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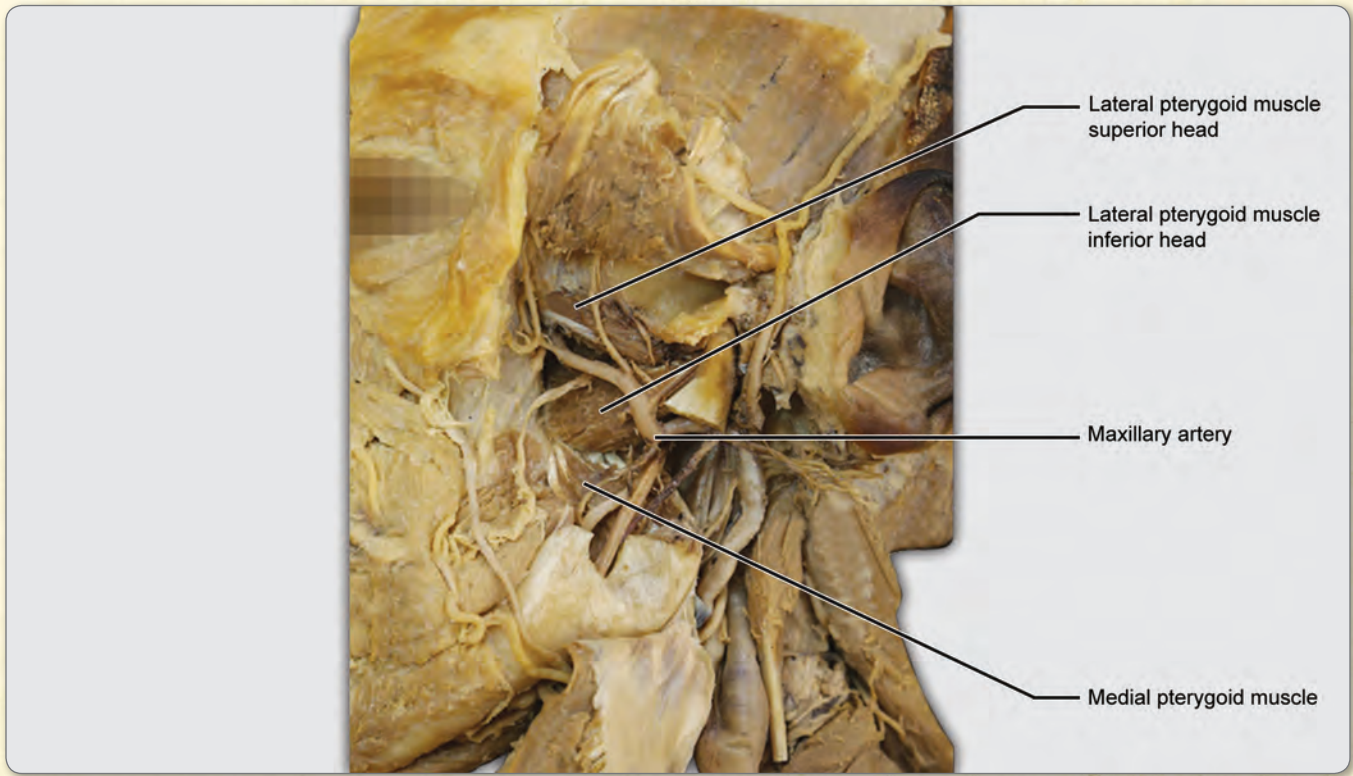


Fig. 3: Pterygoid muscles

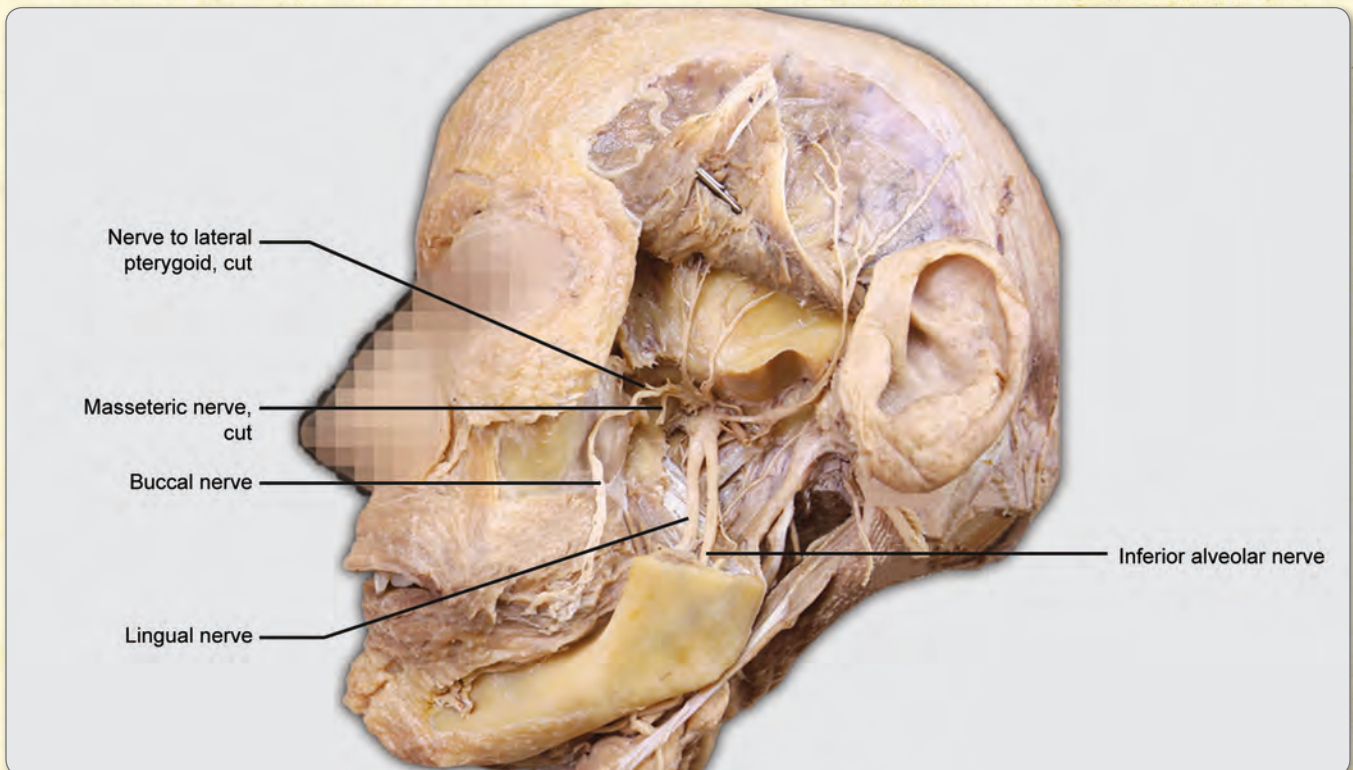


Fig. 4: Branches of mandibular nerve

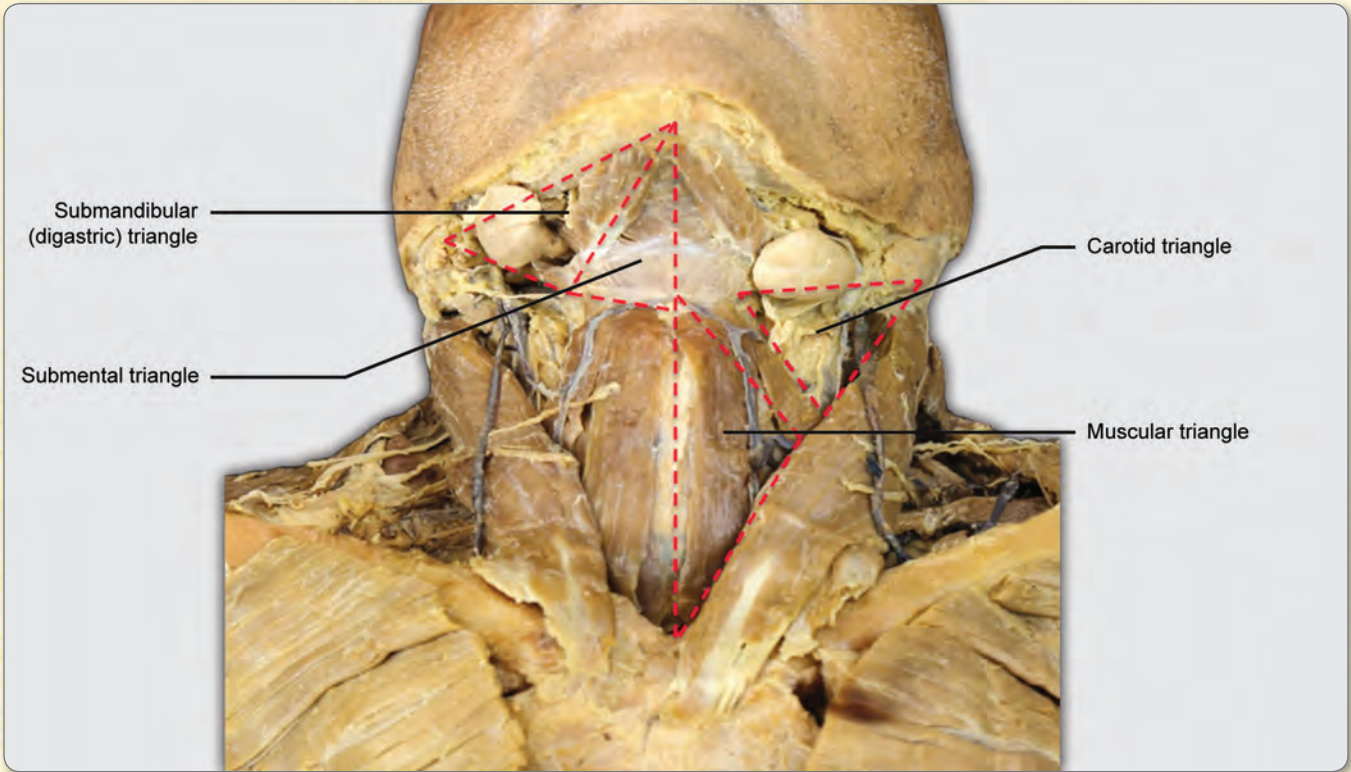


Fig. 5: Anterior triangles of neck

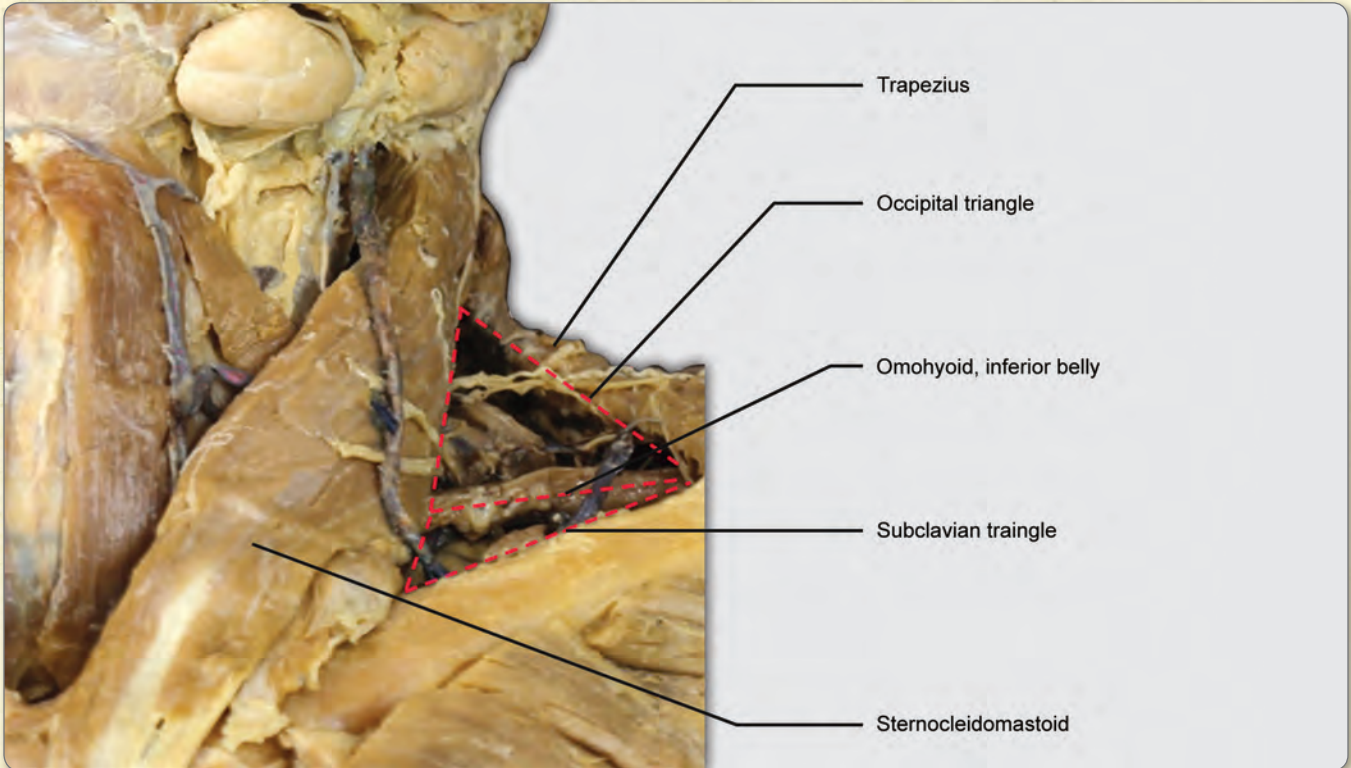


Fig. 6: Posterior triangle of neck

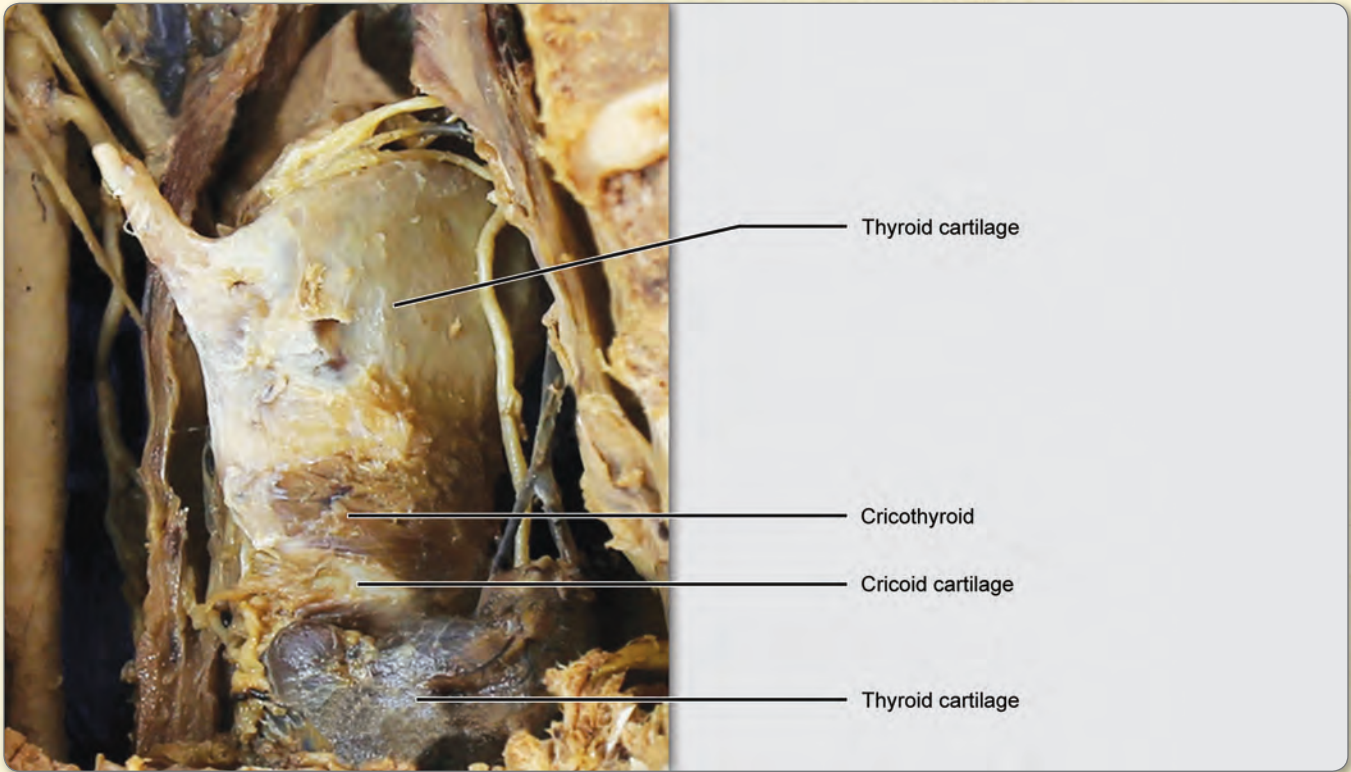


Fig. 7: Lateral view of larynx

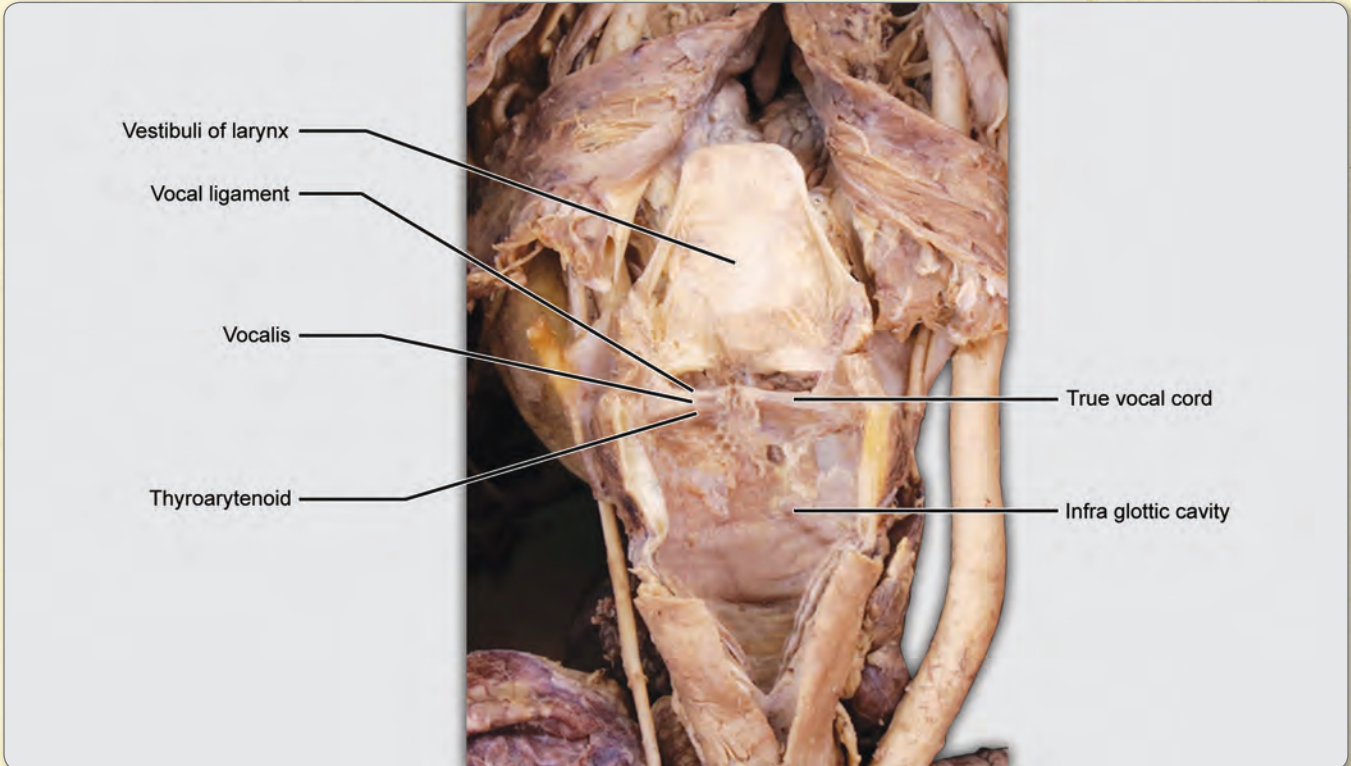


Fig. 8: Interior view of larynx

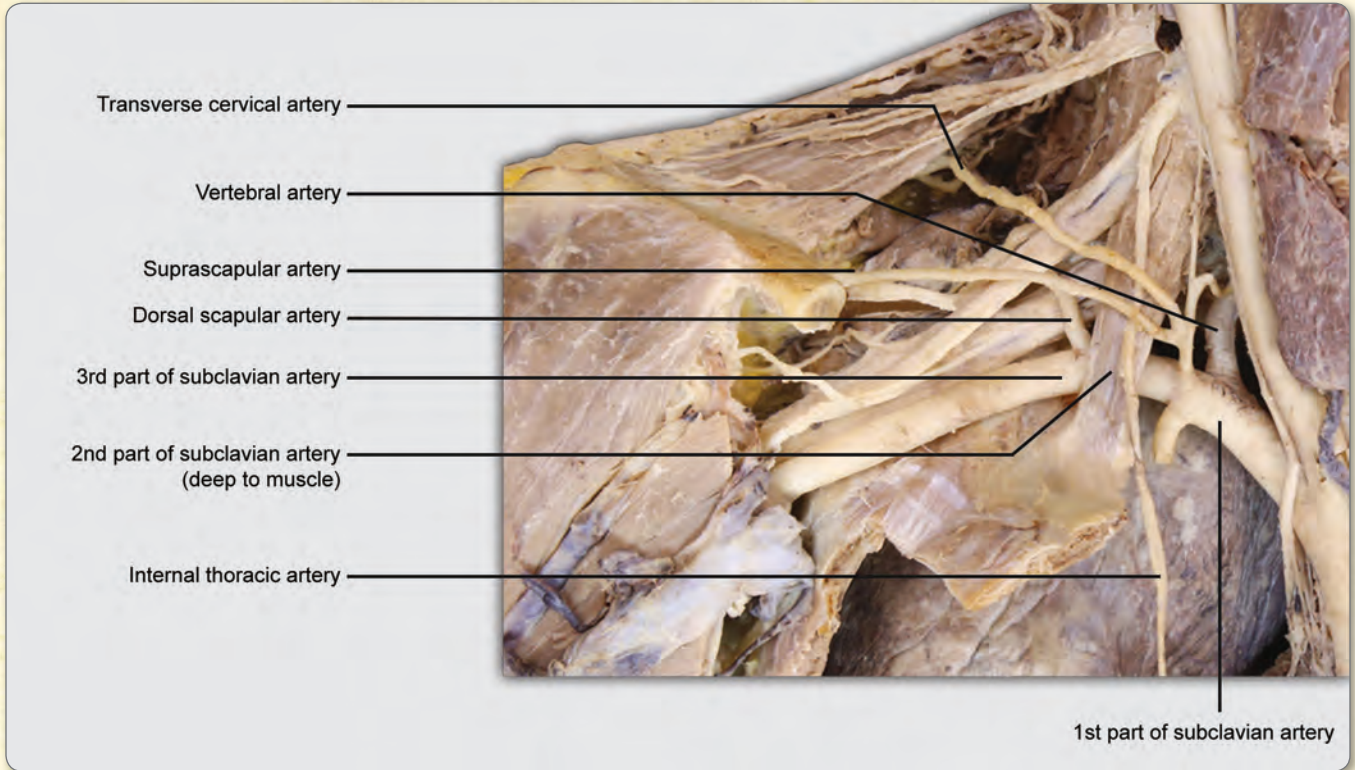


Fig. 9: Subclavian artery and its branches

Thorax

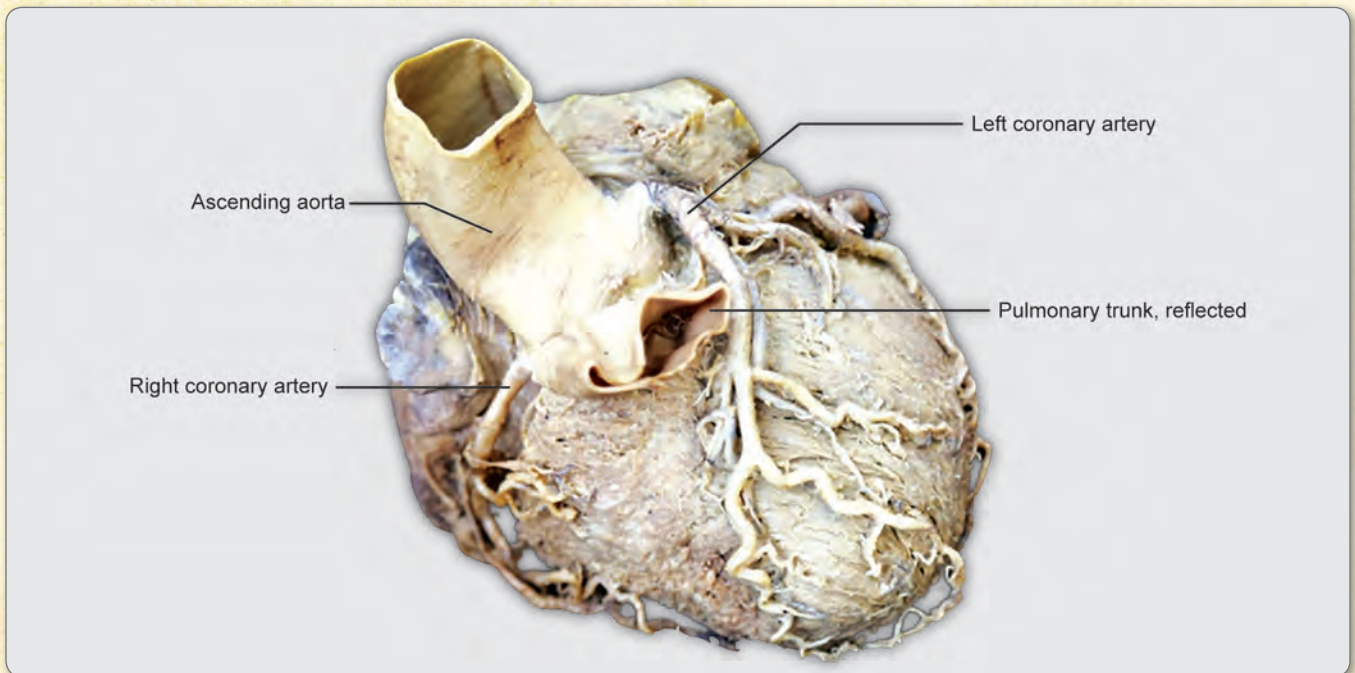


Fig. 10: The heart

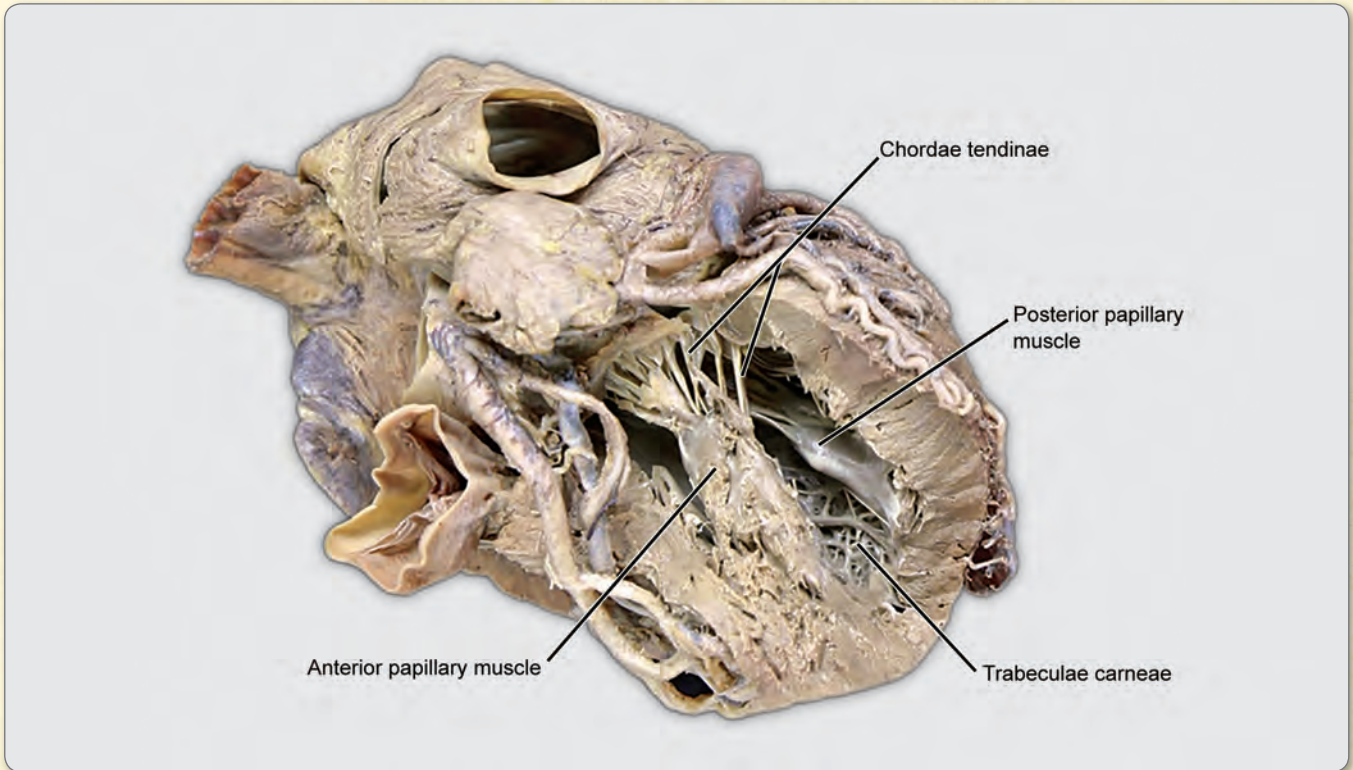


Fig. 11: Internal anatomy of heart

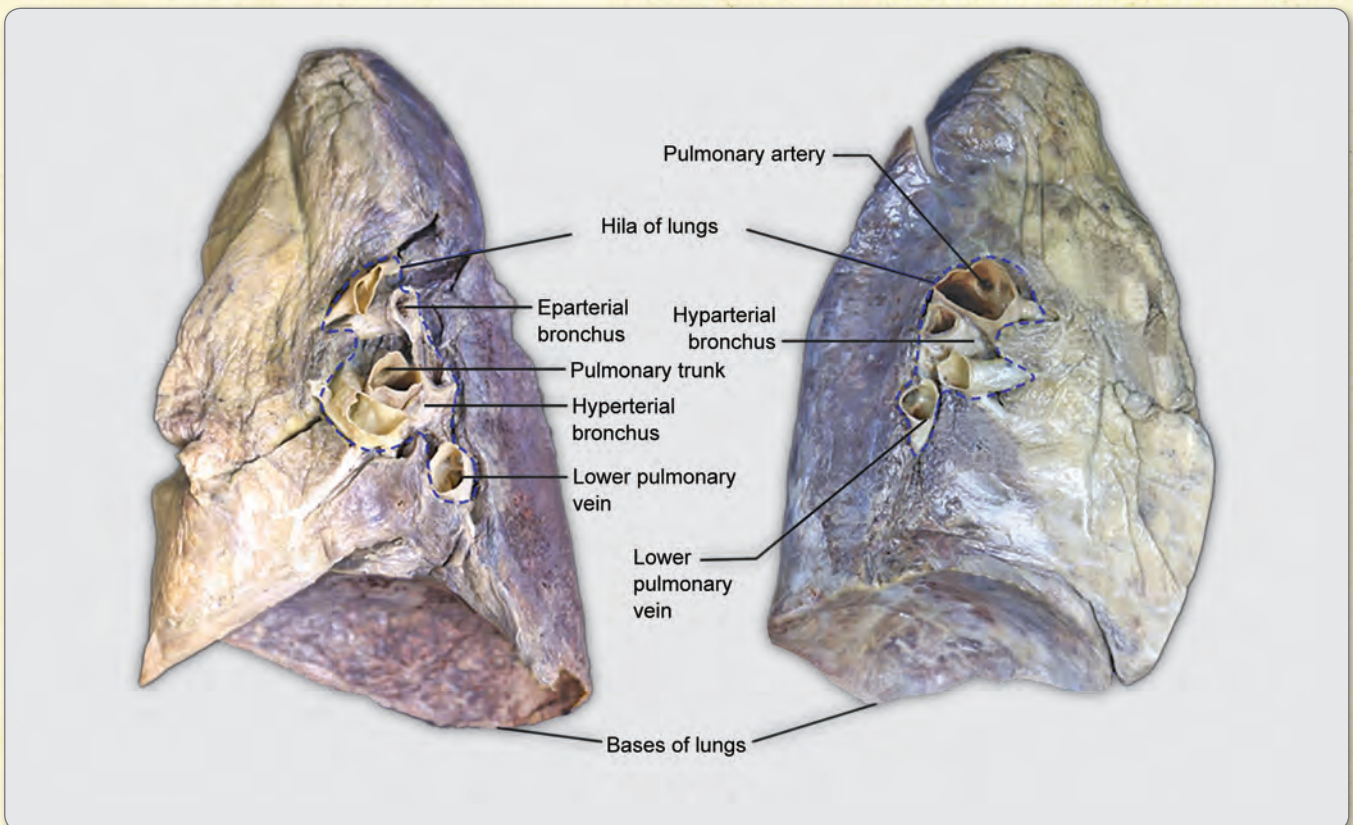


Fig. 12: Medial surface of lungs

Abdomen and Pelvis

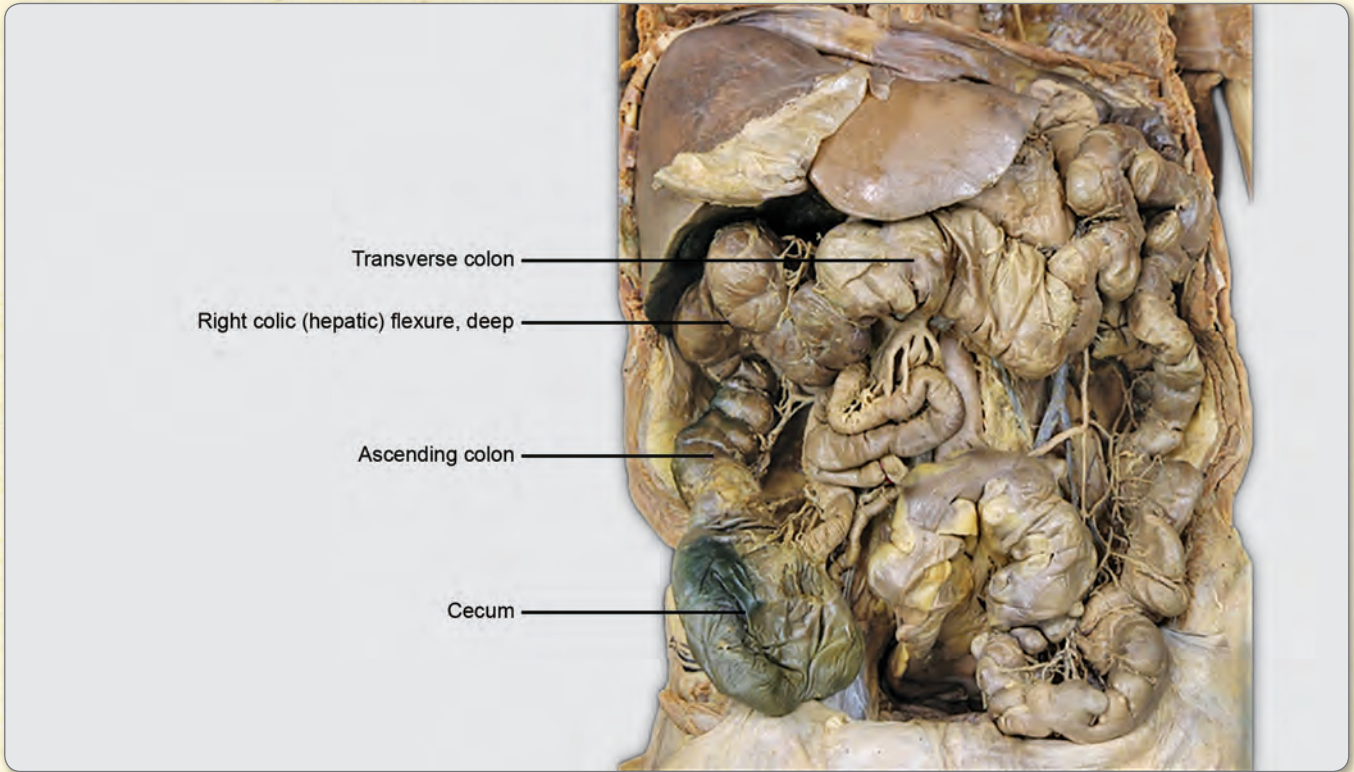


Fig. 13: Anatomy of colon

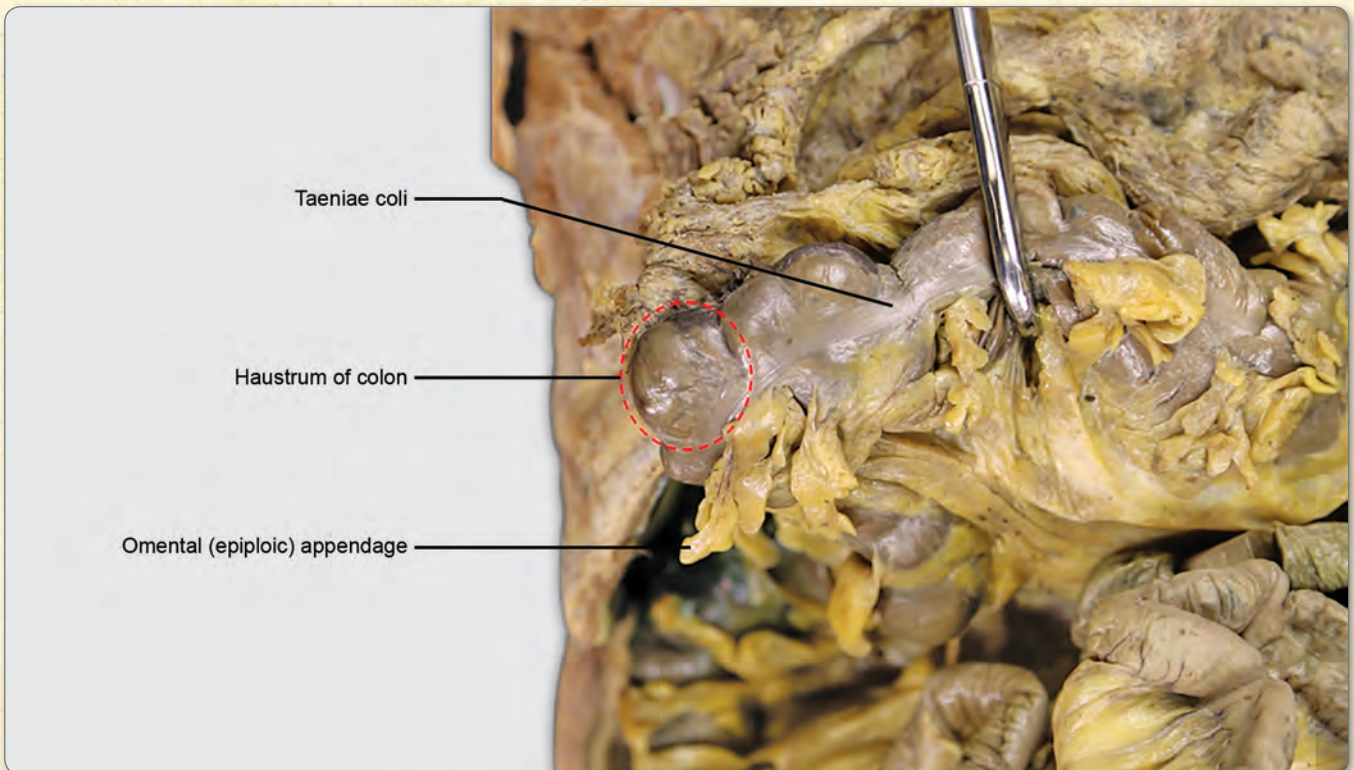


Fig. 14: Features of large intestine

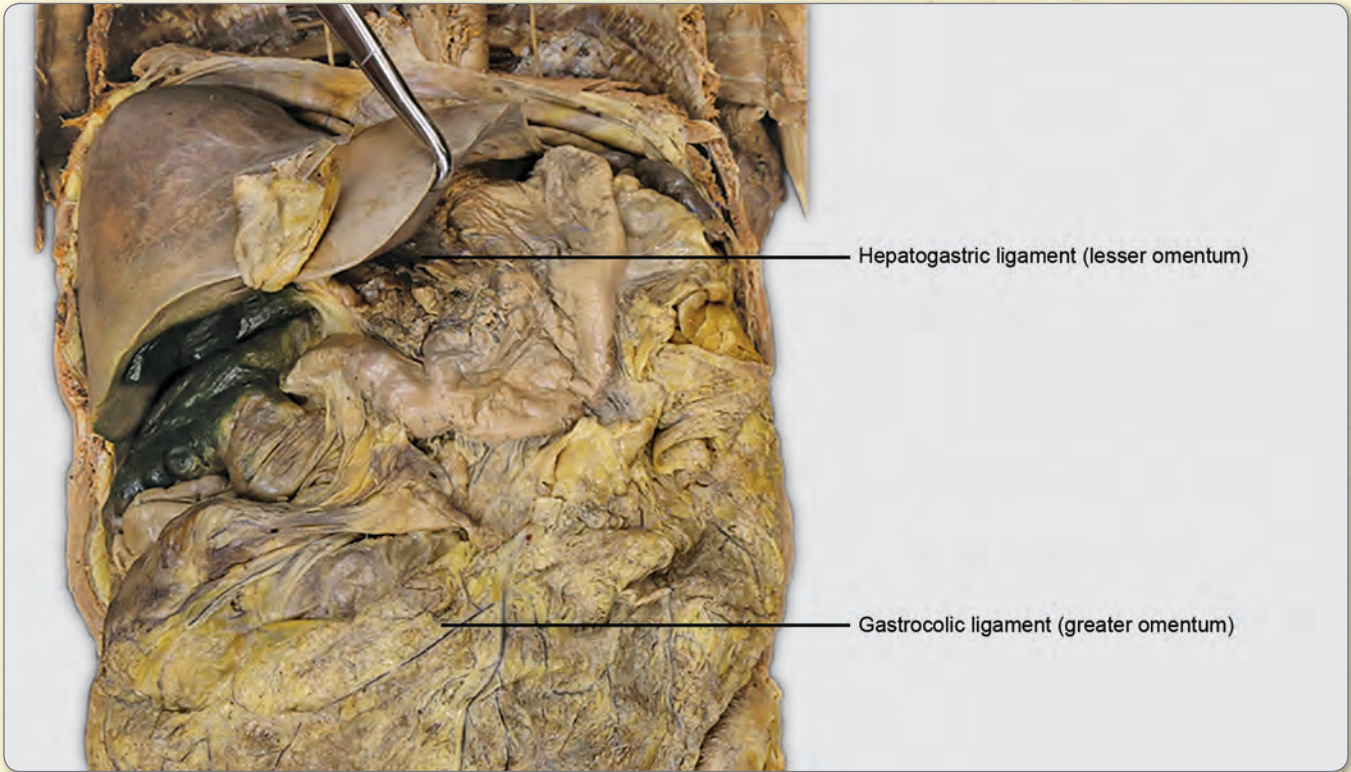


Fig. 15: Lesser omentum

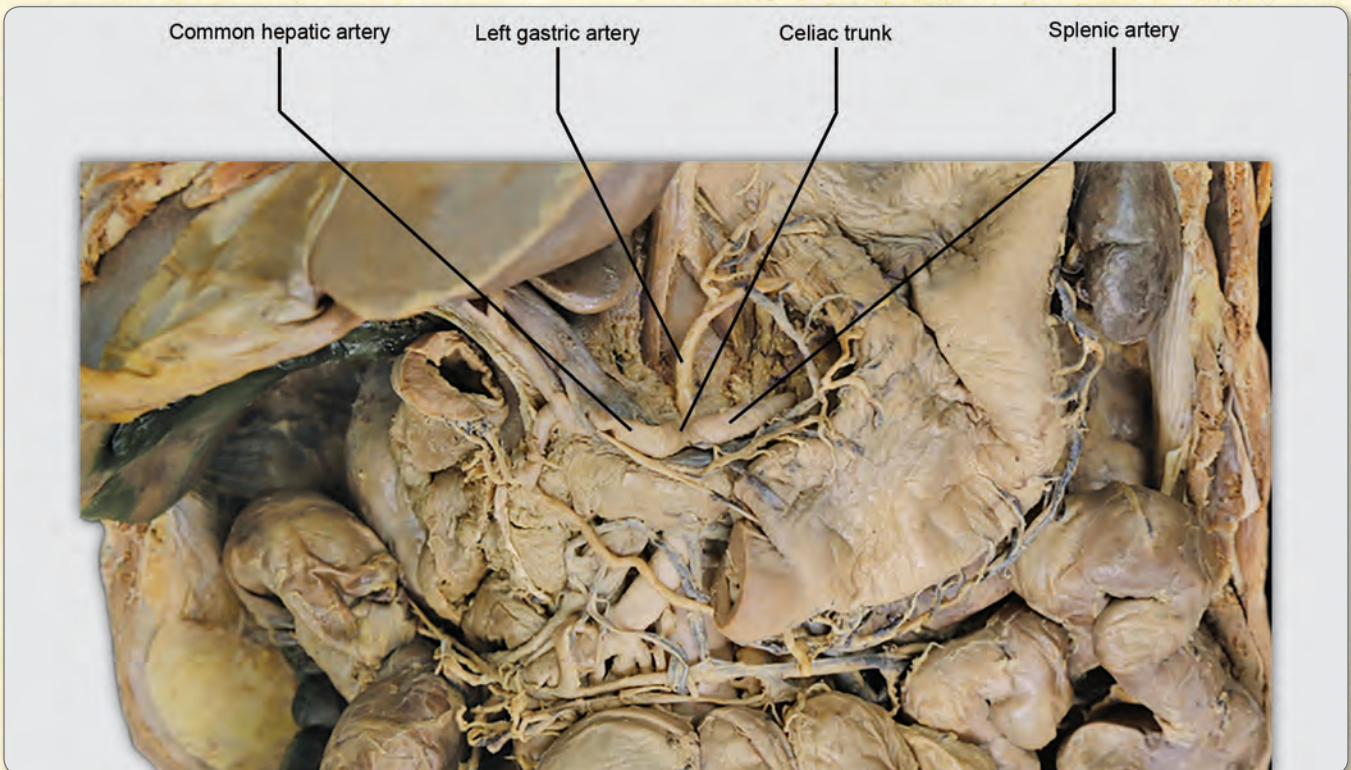


Fig. 16: Celiac trunk

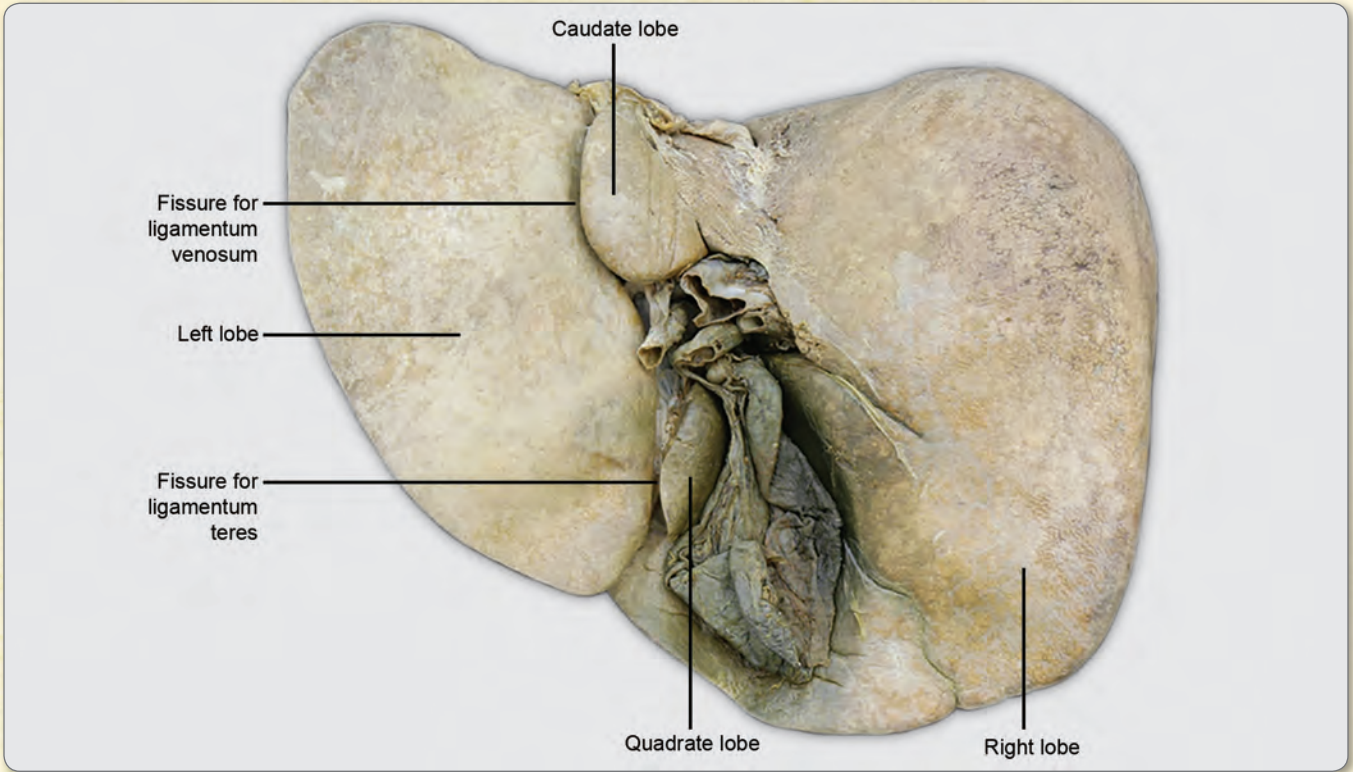


Fig. 17: Visceral surface of liver

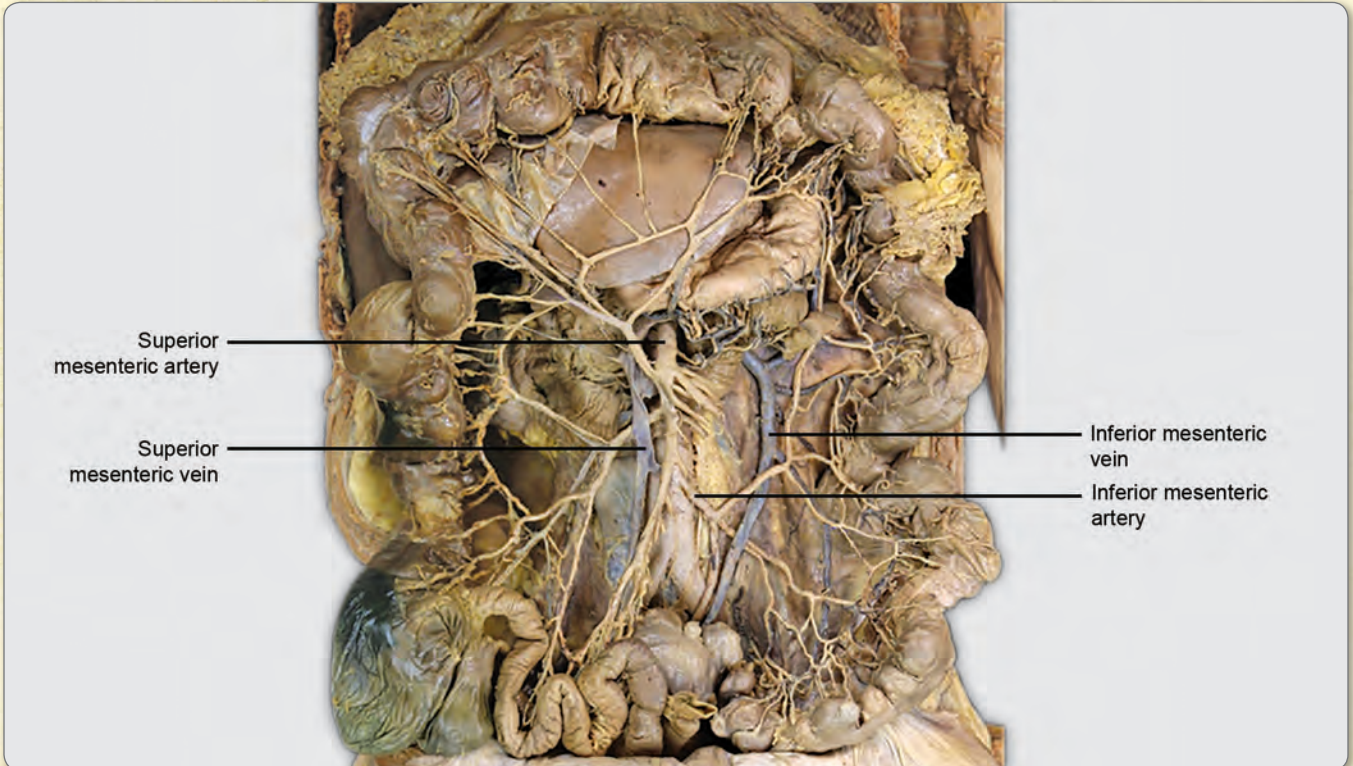


Fig. 18: Superior and inferior mesenteric artery

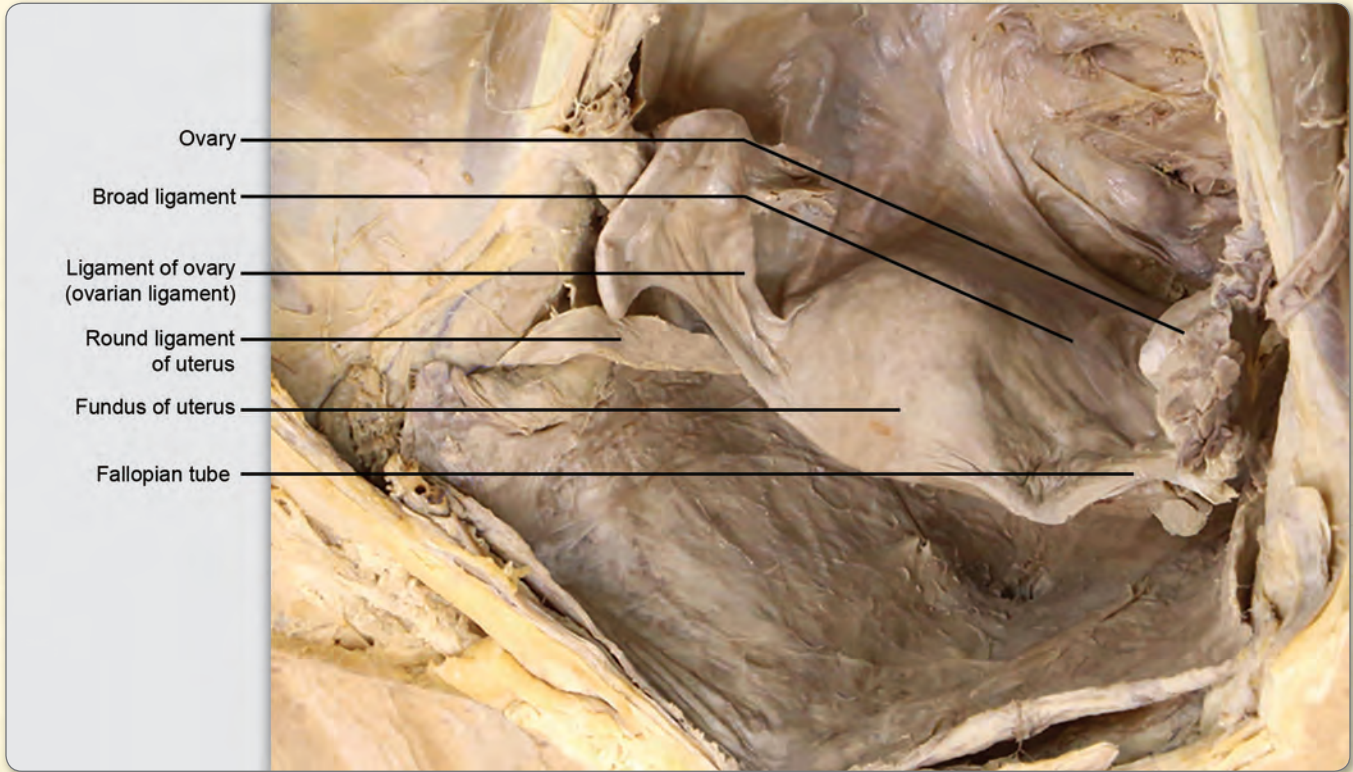


Fig. 19: Female reproductive organs



Fig. 20: Sagittal section of female pelvis

Upper Limb

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UPPER LIMB

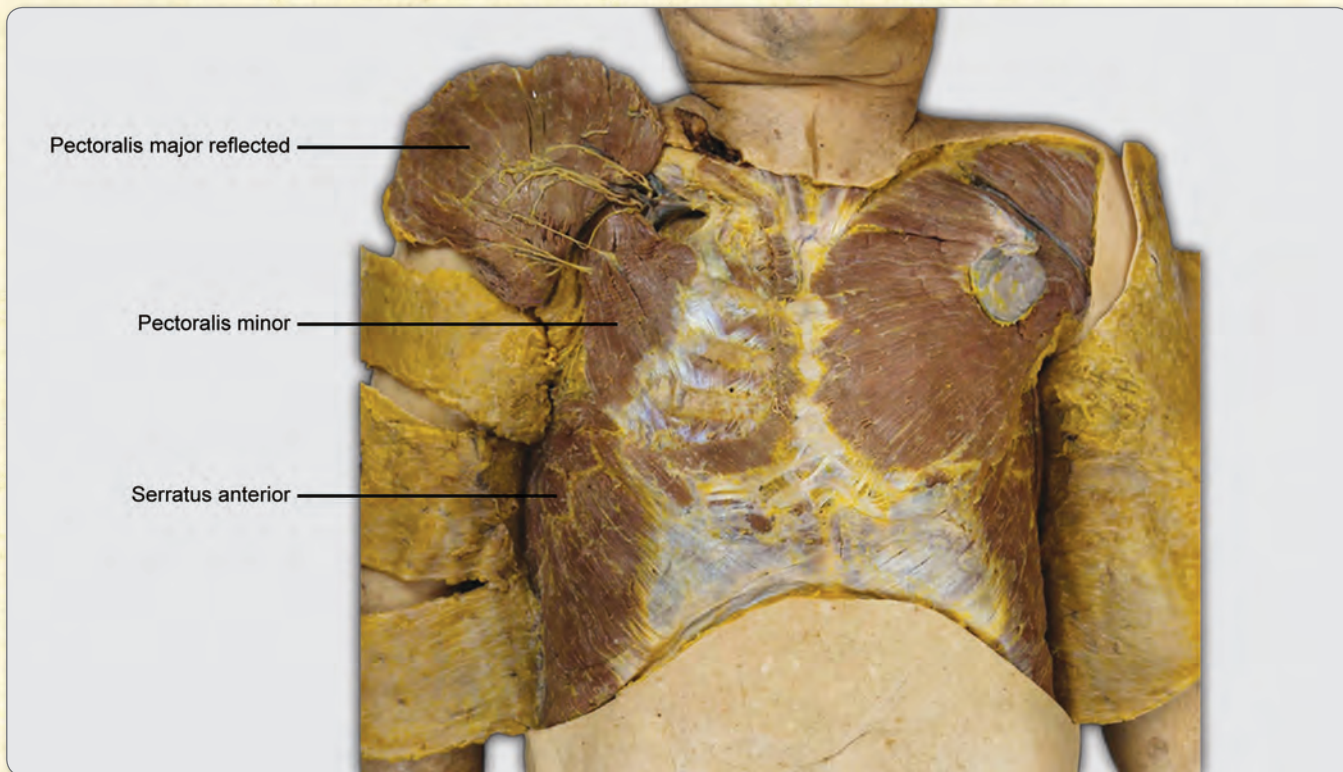


Fig. 21: Pectoral region

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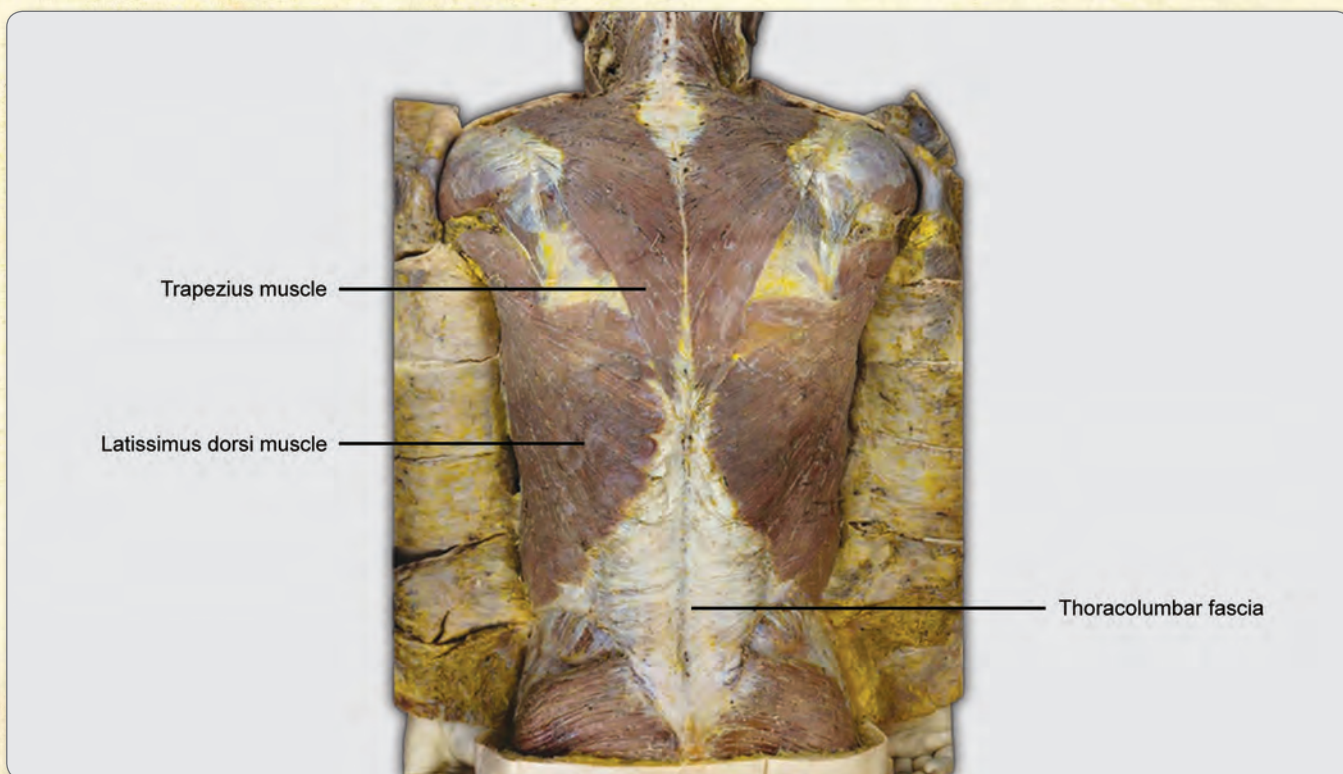


Fig. 22: Muscles of back: trapezius and latissimus dorsi

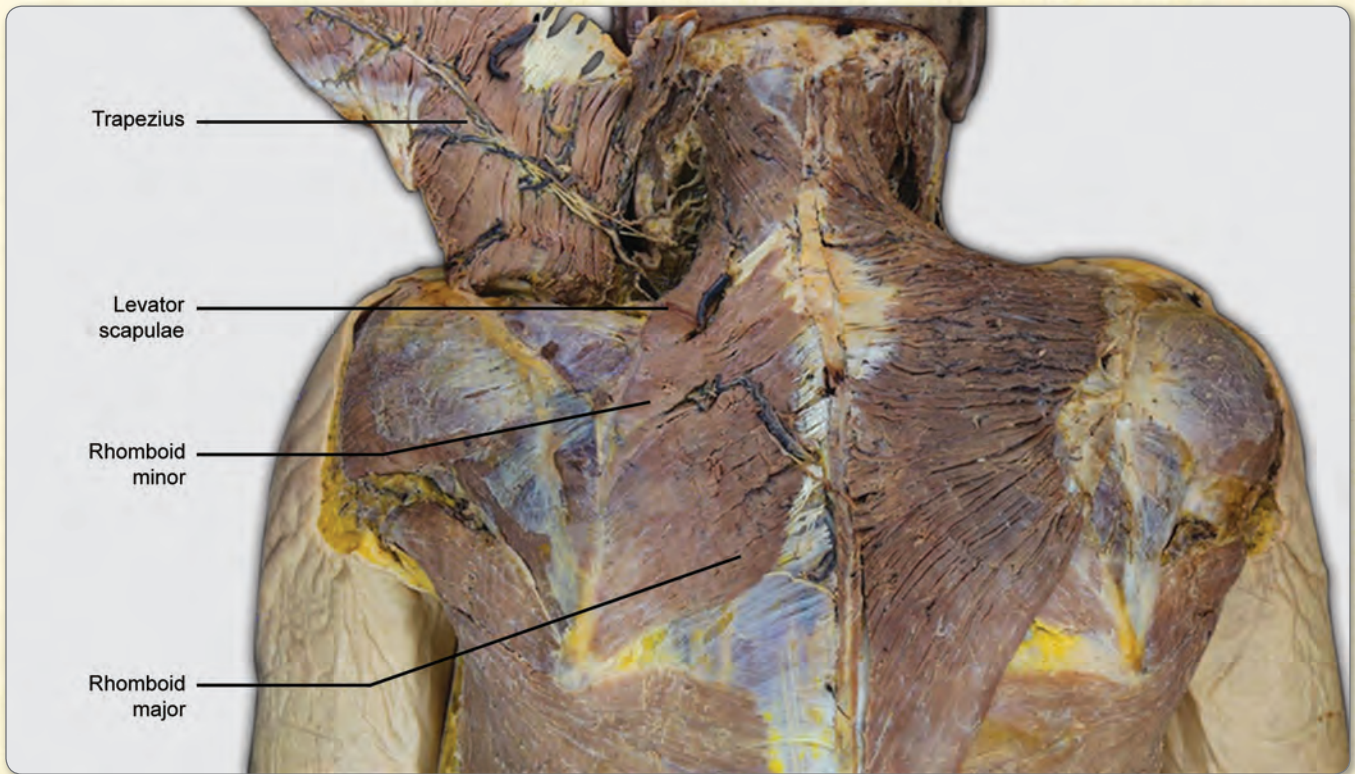


Fig. 23: Muscles of back: levator scapulae and rhomboids

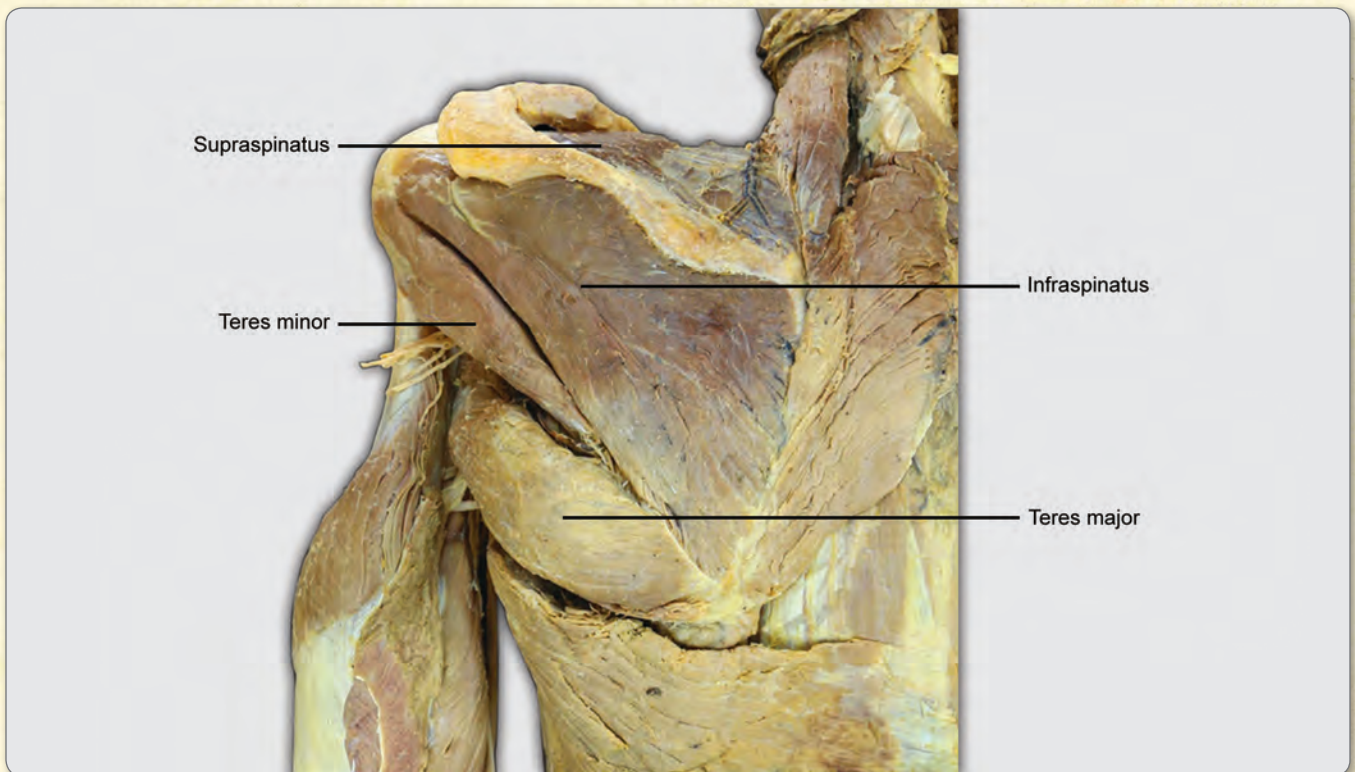


Fig. 24: Muscles of back: teres major and minor, supraspinatus

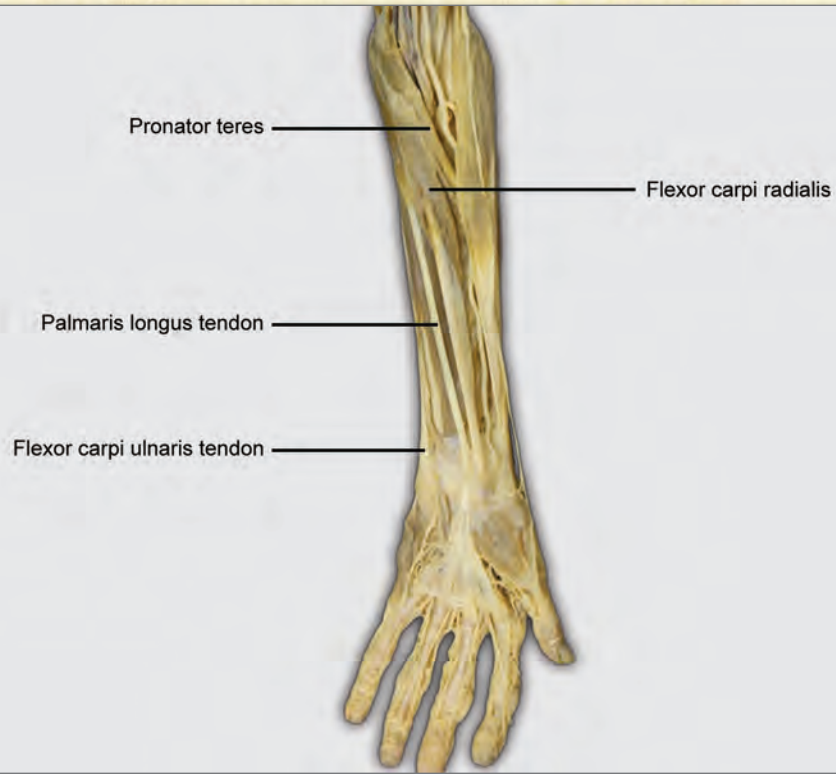


Fig. 25: Anterior of forearm

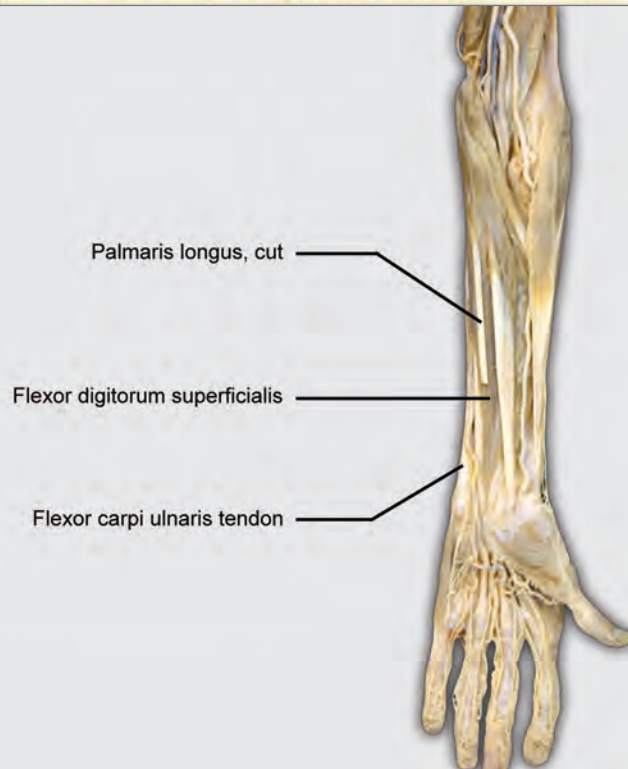


Fig. 26: Anterior of forearm: intermediate layer of muscles

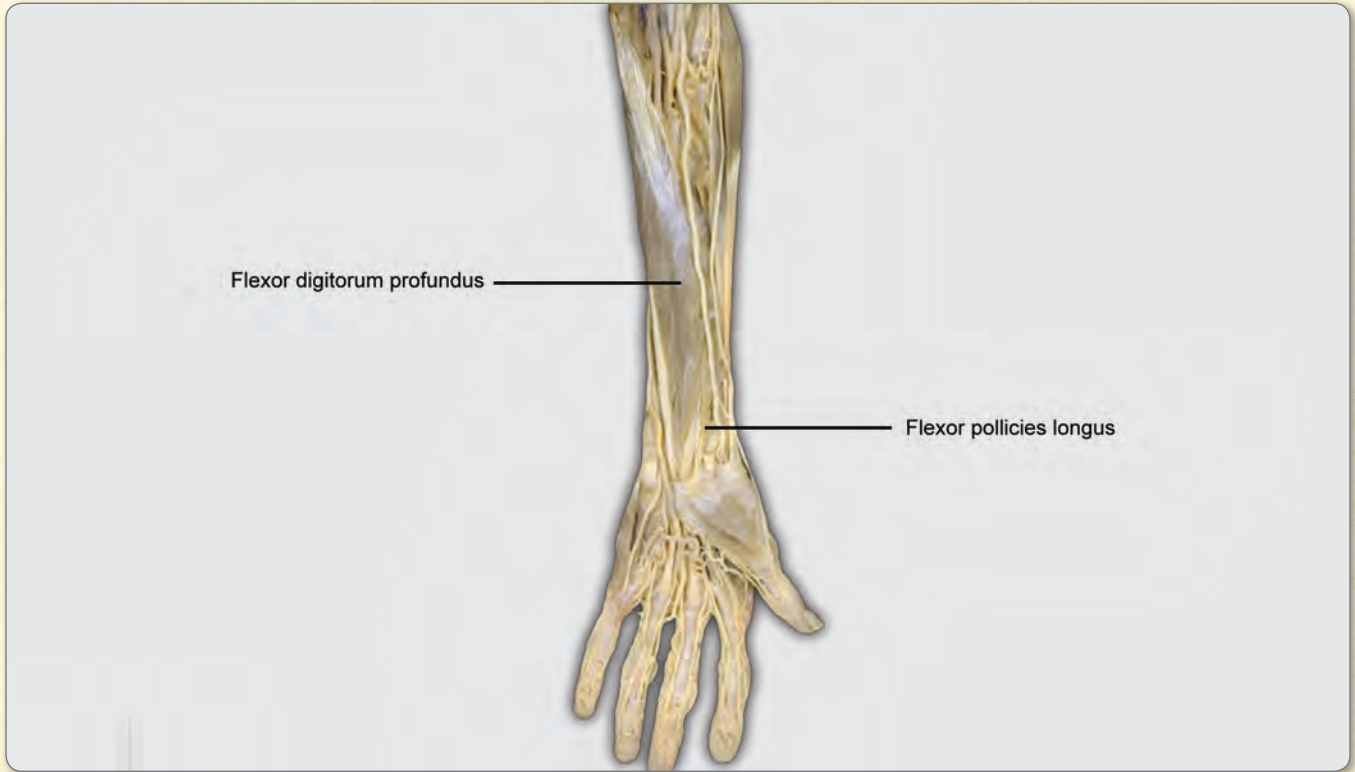


Fig. 27: Anterior of forearm: deep larger of muscles

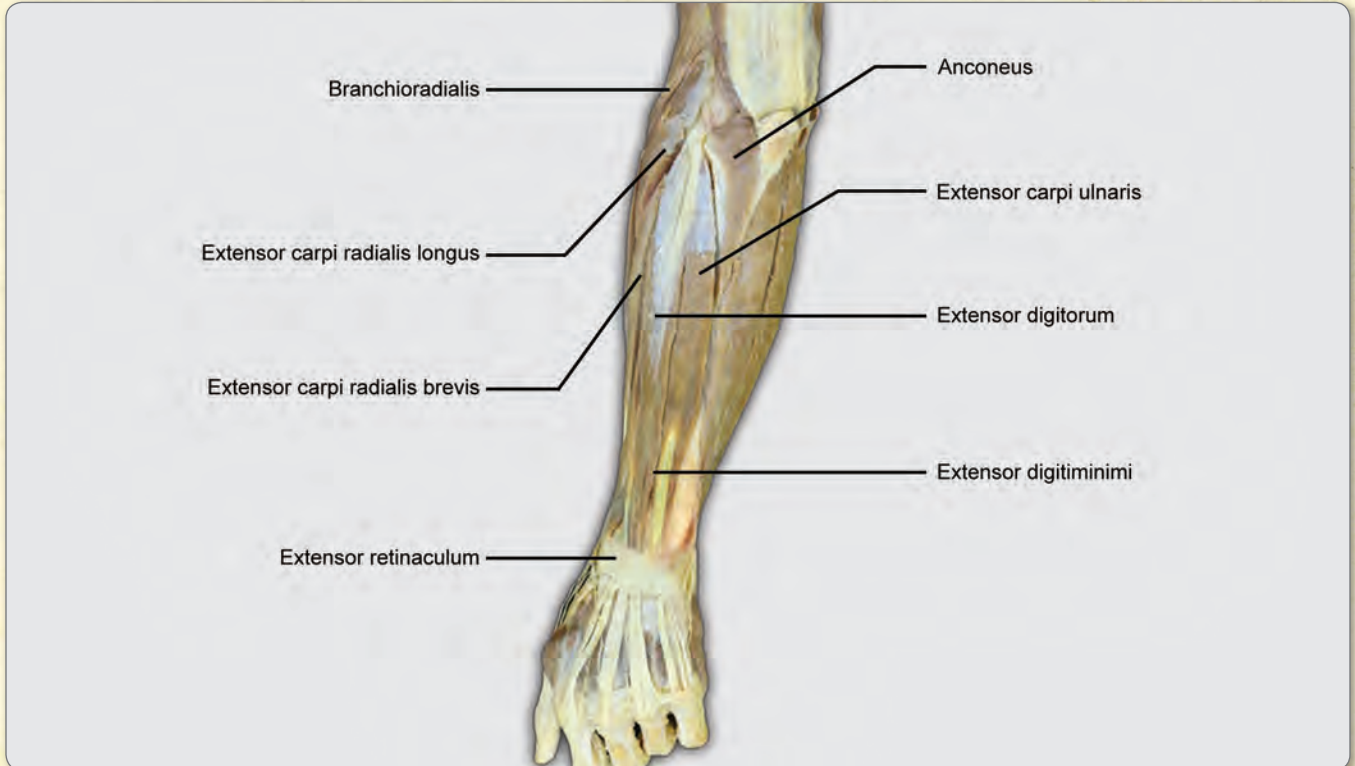


Fig. 28: Superficial compartment of muscles in forearm posterior

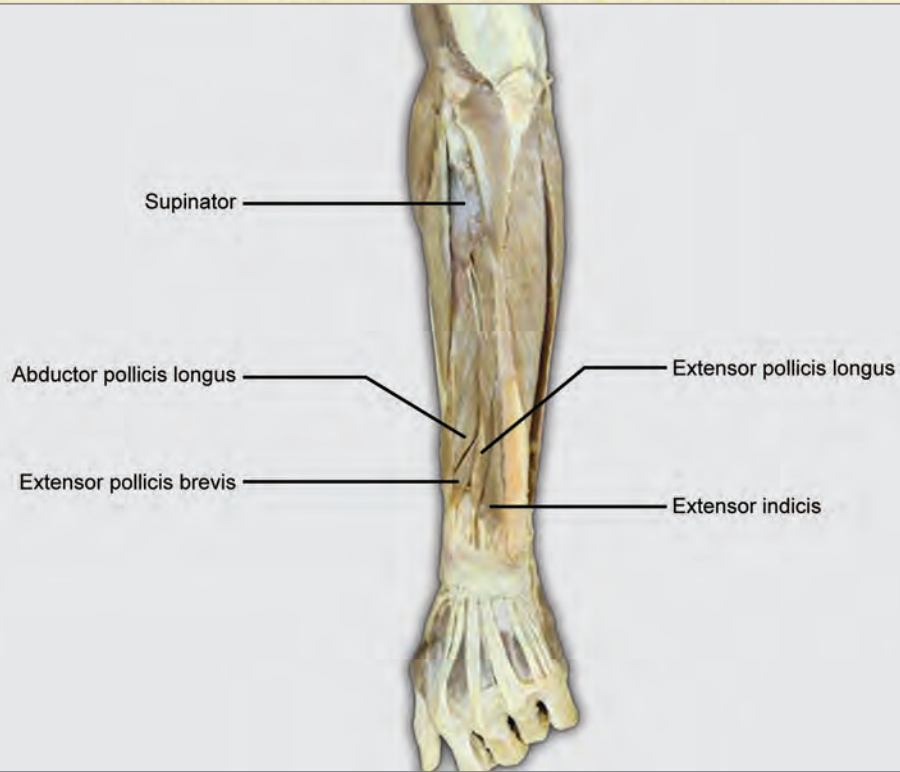


Fig. 29: Deep compartment of muscles in forearm posterior

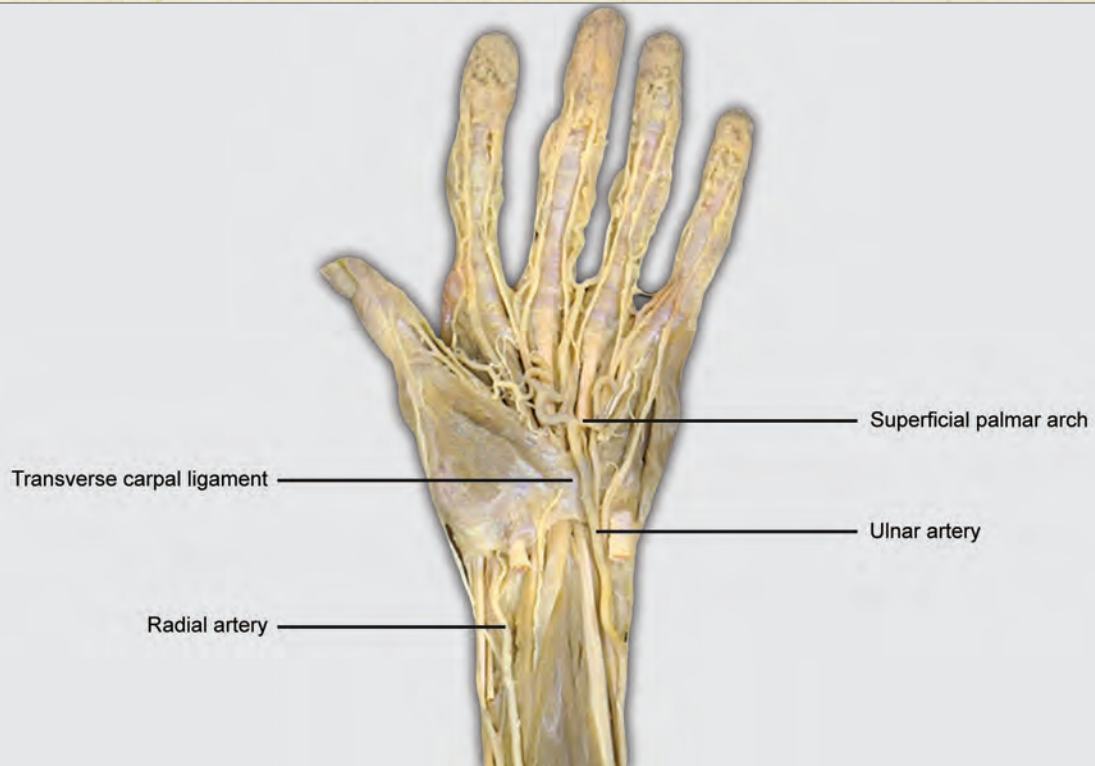


Fig. 30: Flexor retinaculum

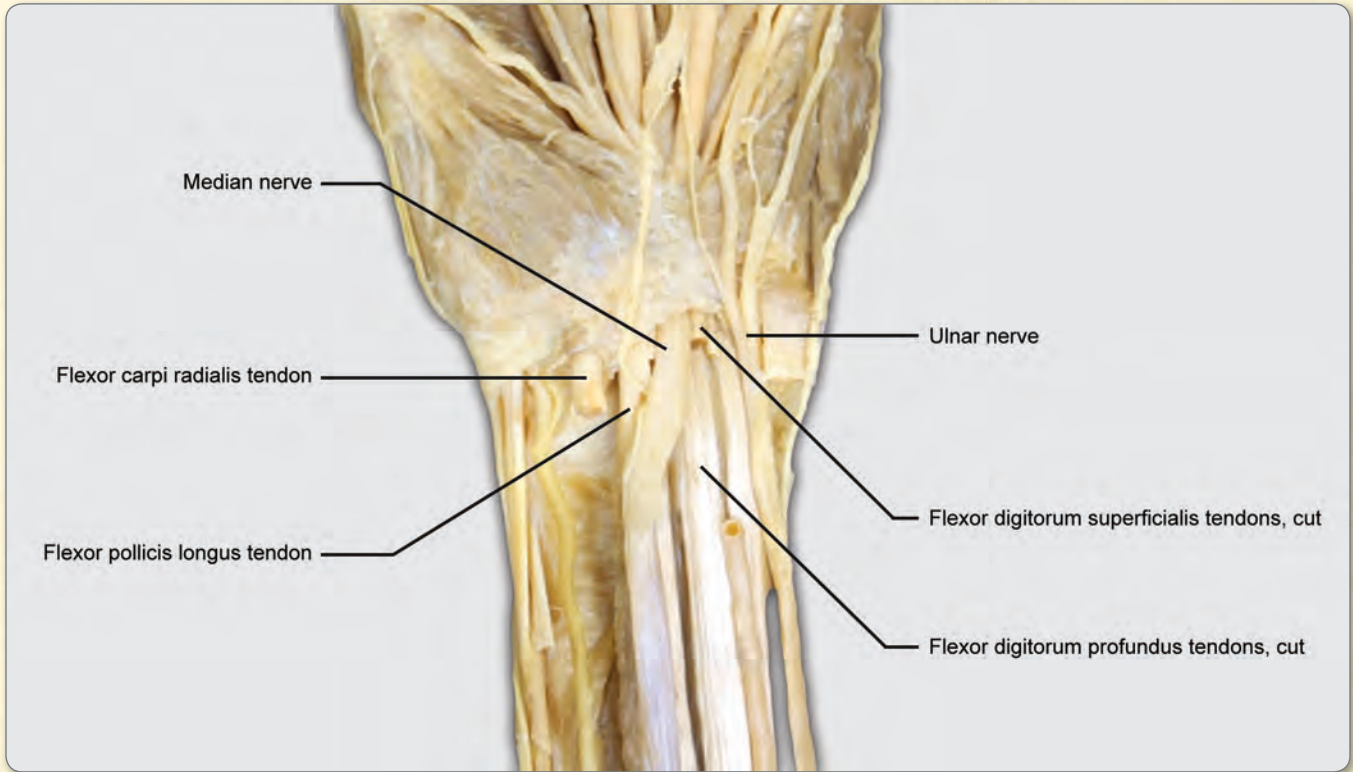


Fig. 31: Structures in relation to flexor retinaculum

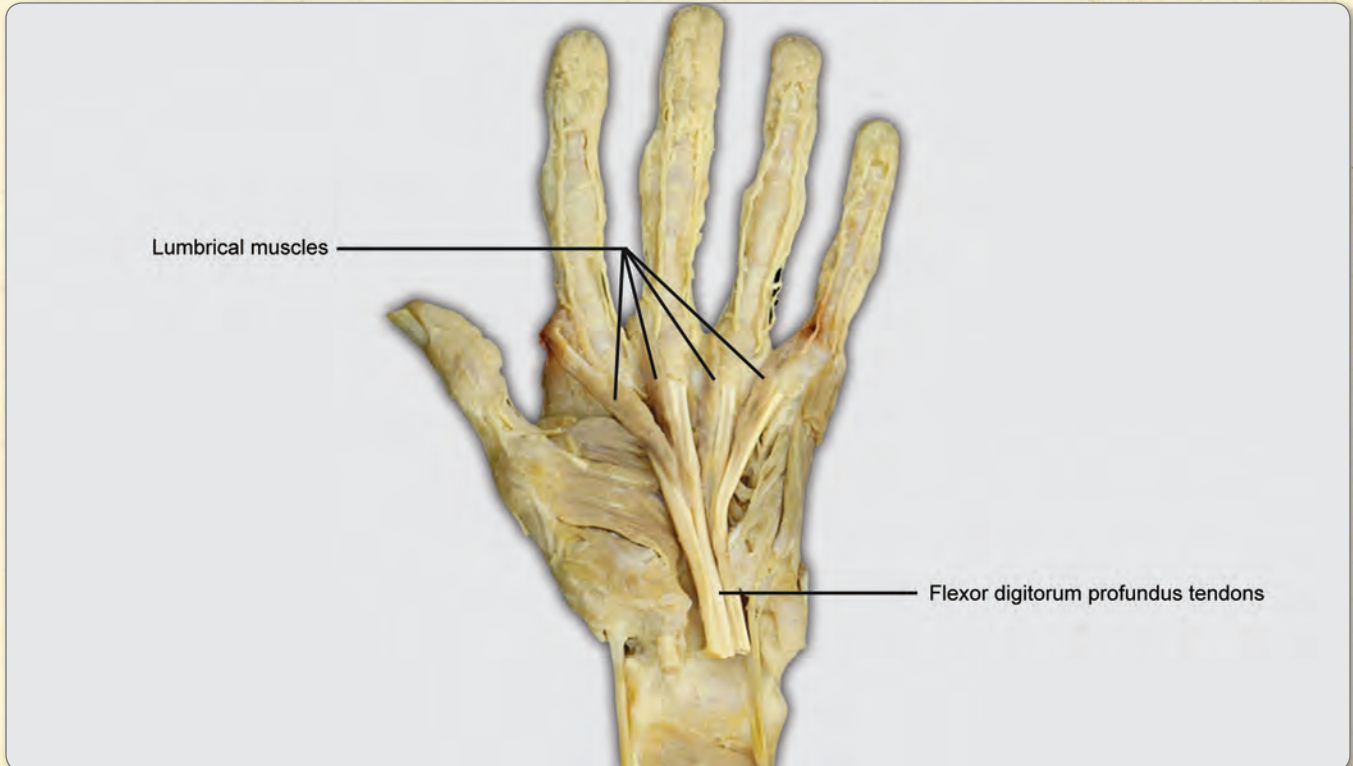


Fig. 32: Lumbricals

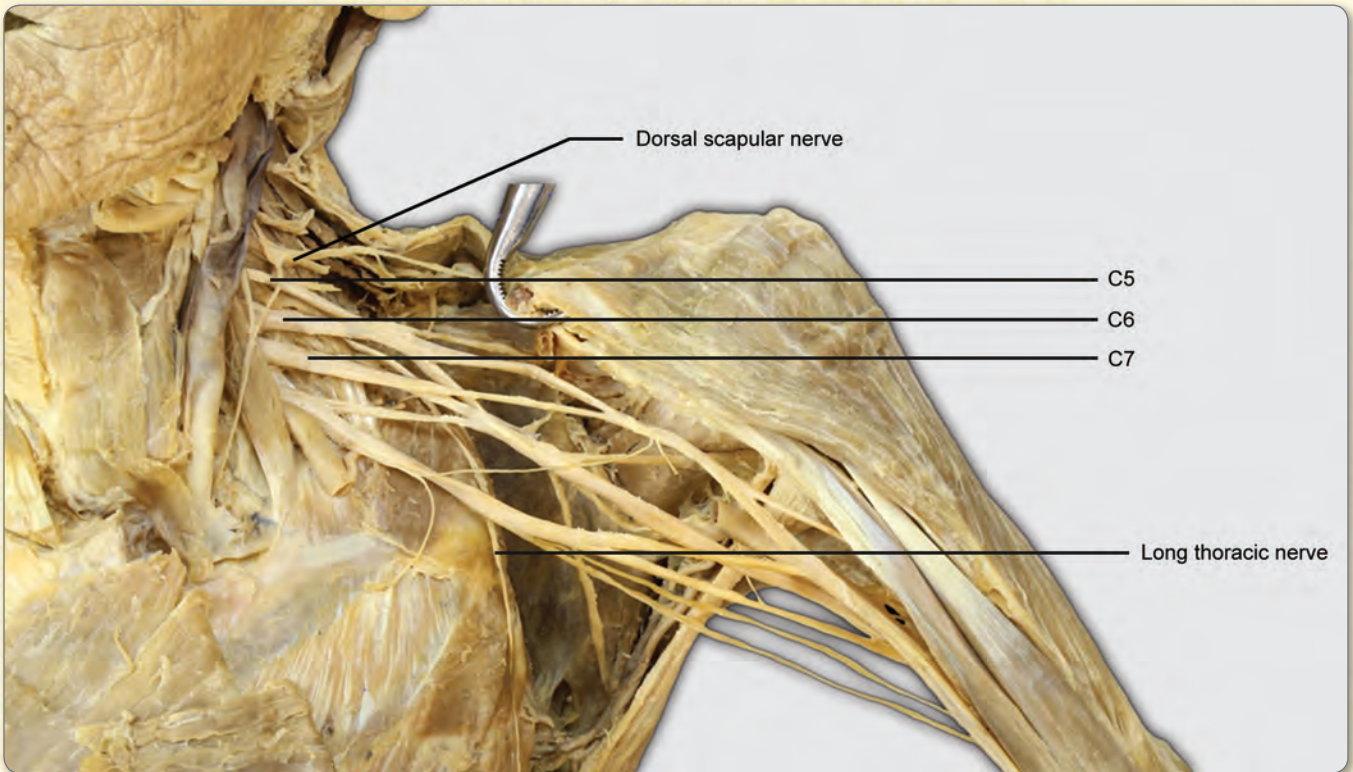


Fig. 33: Brachial plexus

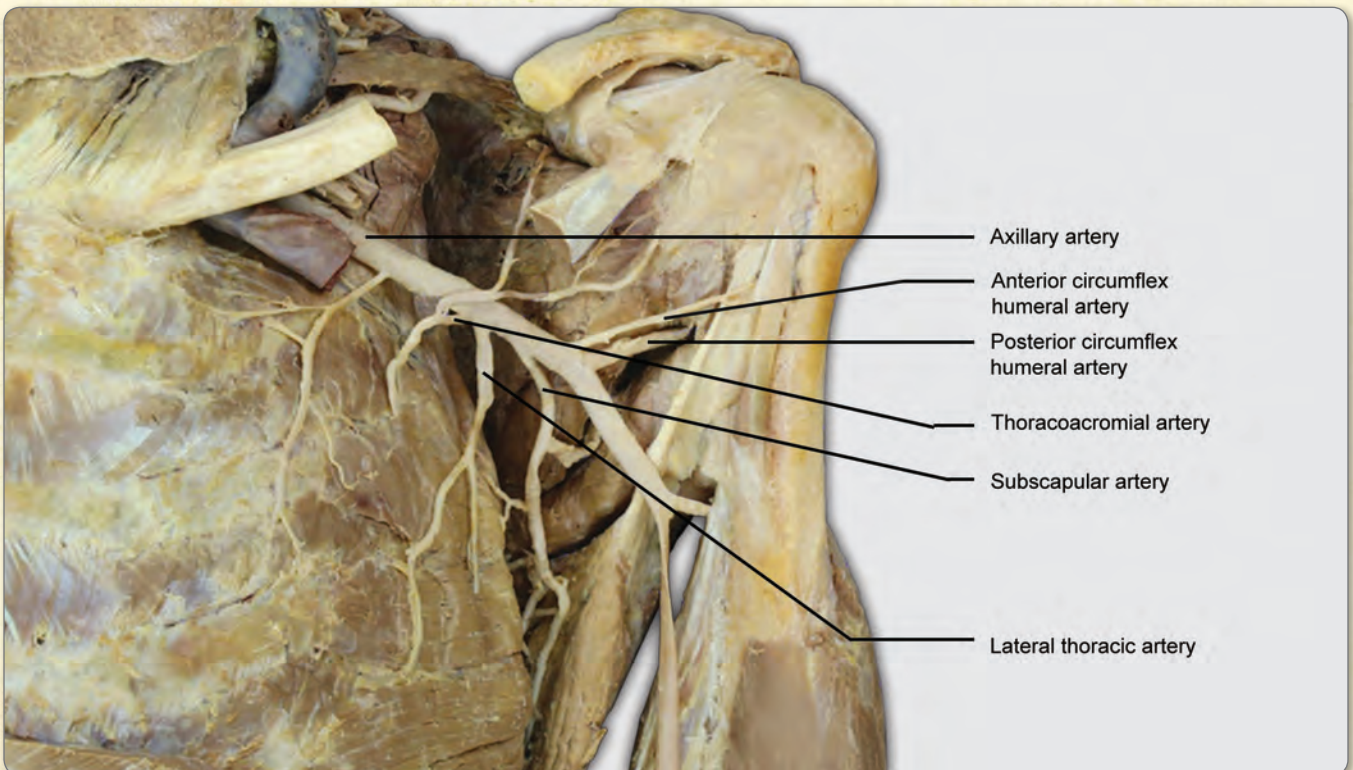


Fig. 34: Branches of axillary artery

Lower Limb

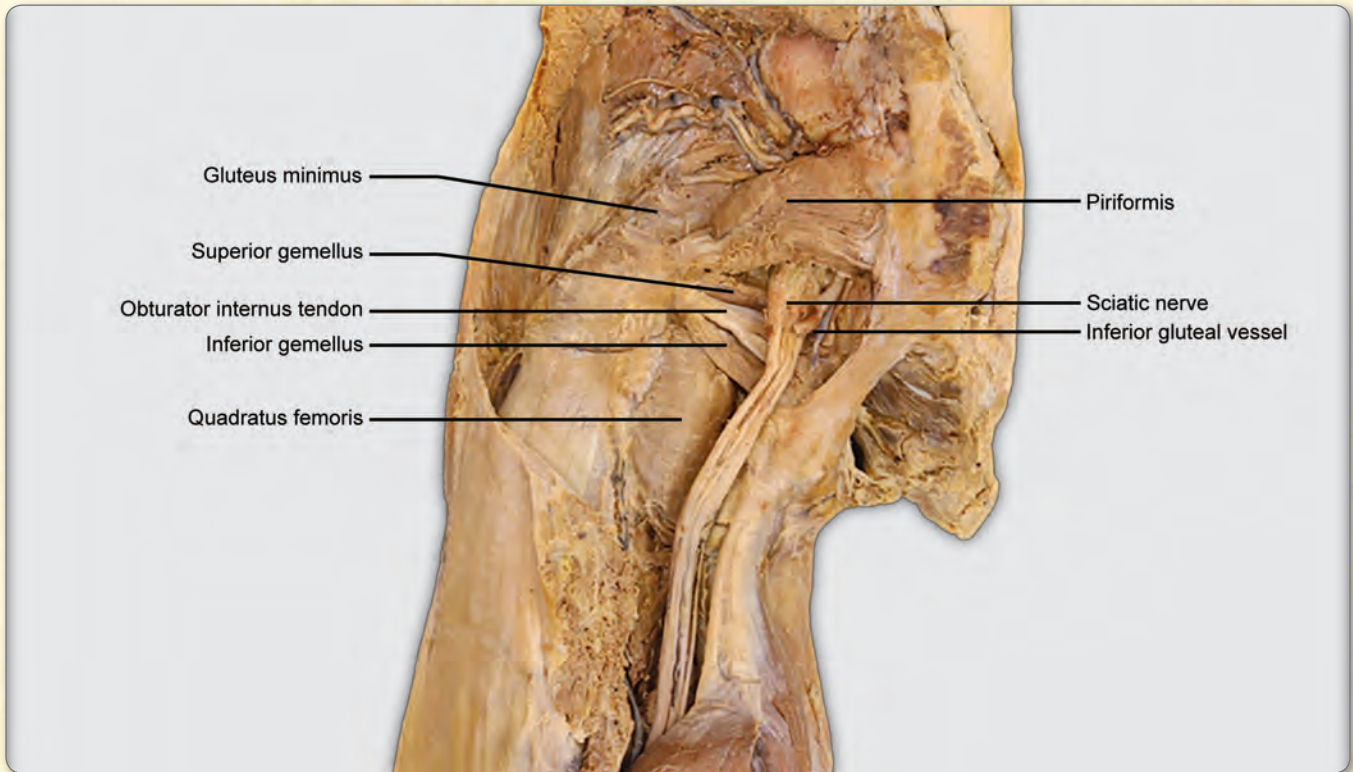


Fig. 35: Gluteal region

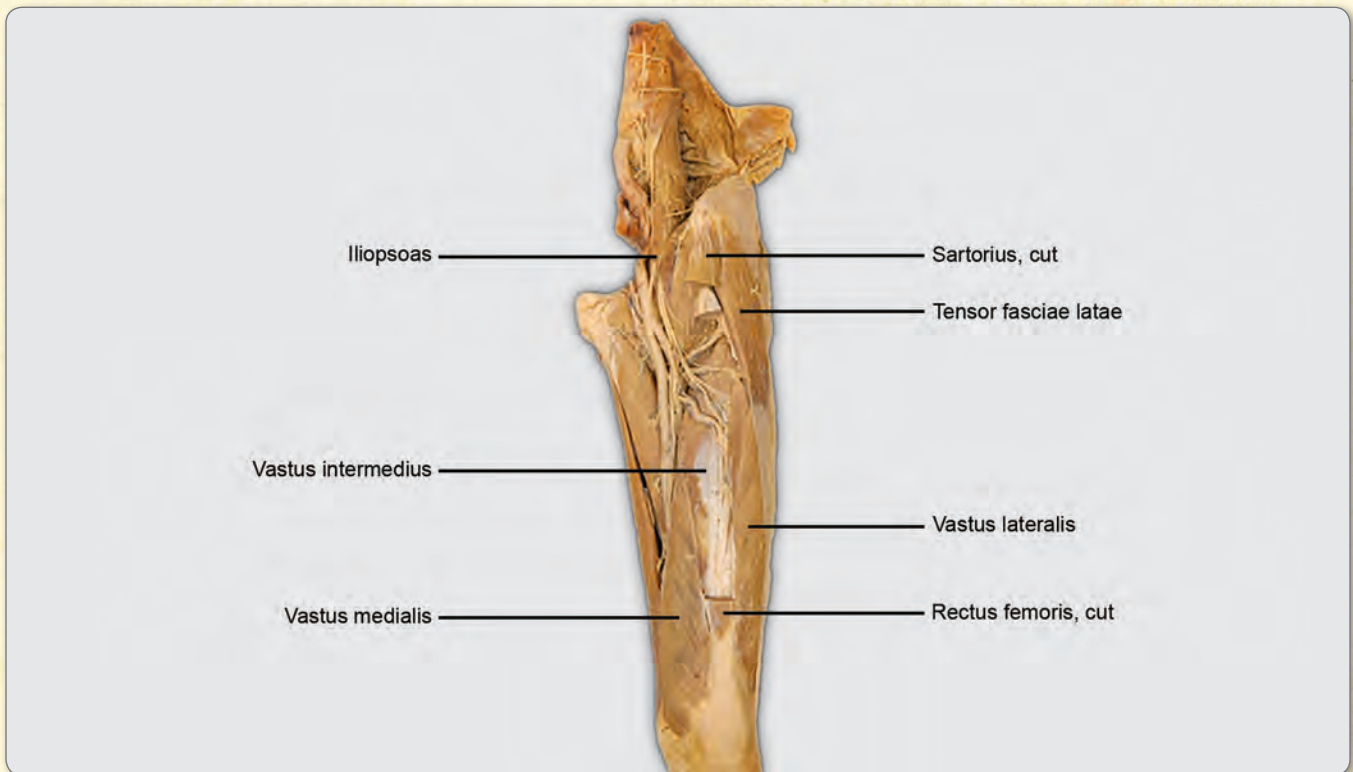


Fig. 36: Front of thigh



Fig. 37: Medial compartment of thigh



Fig. 38: Deep muscles in medial compartment of thigh

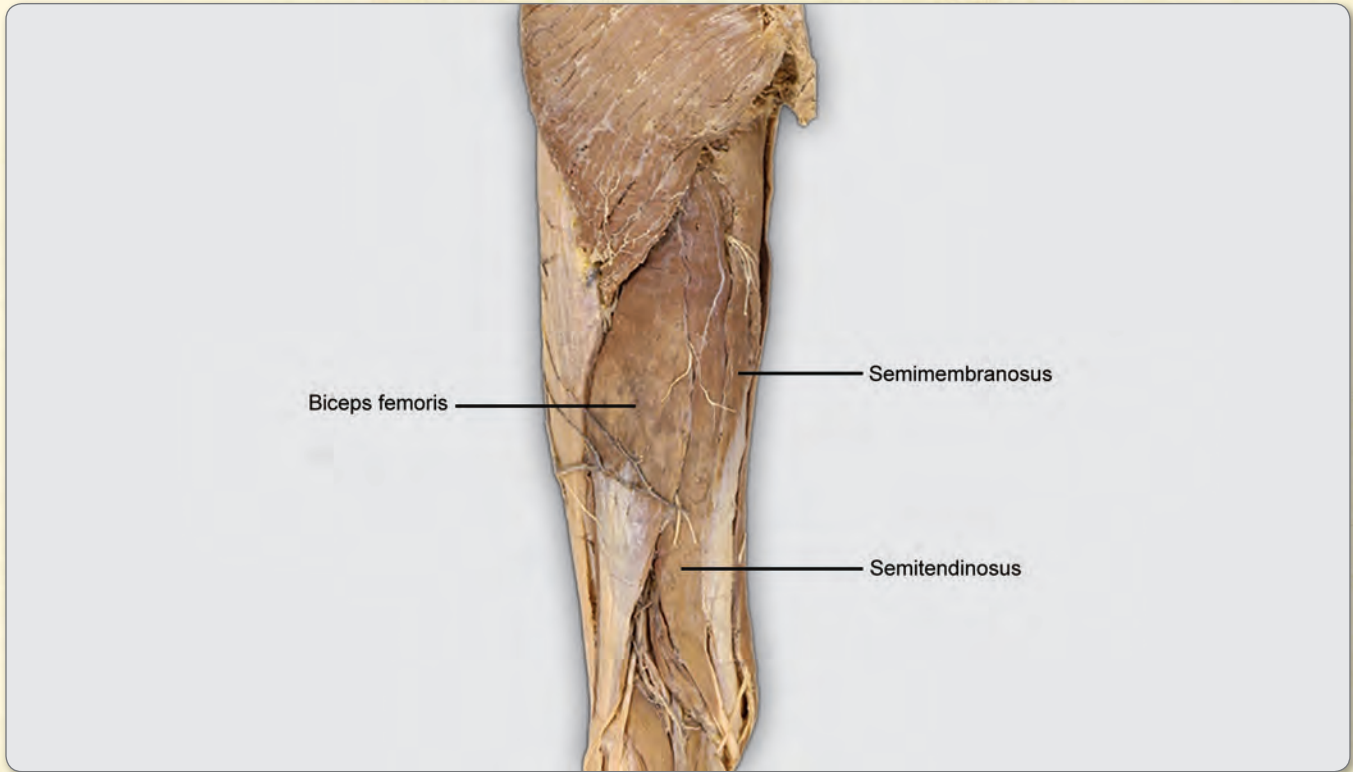


Fig. 39: Hamstring muscles

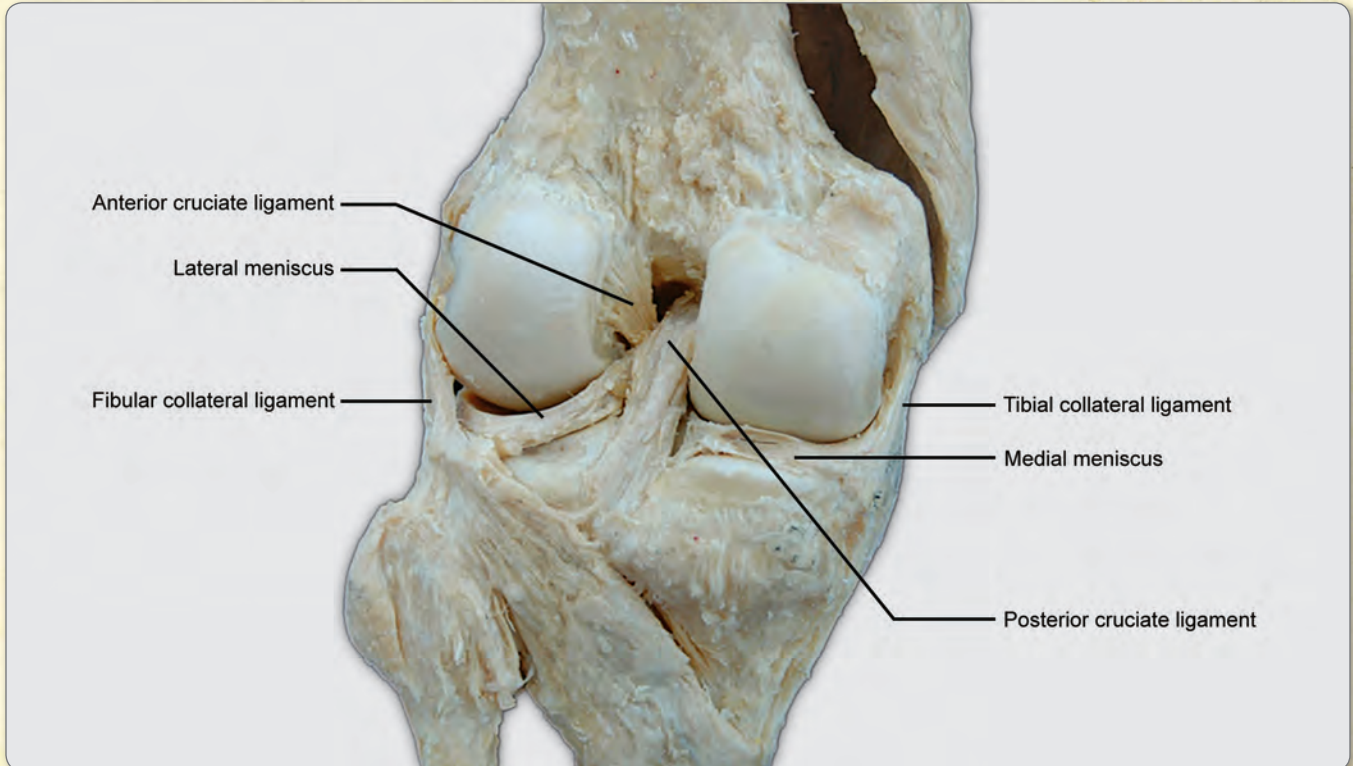


Fig. 40: Ligaments of knee joint

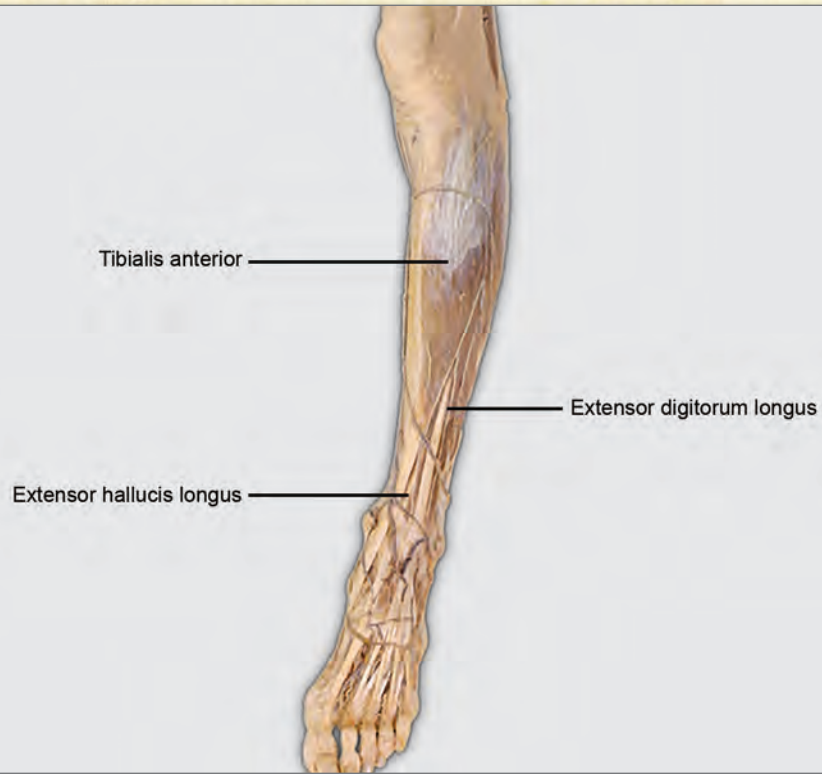


Fig. 41: Anterior compartment of leg

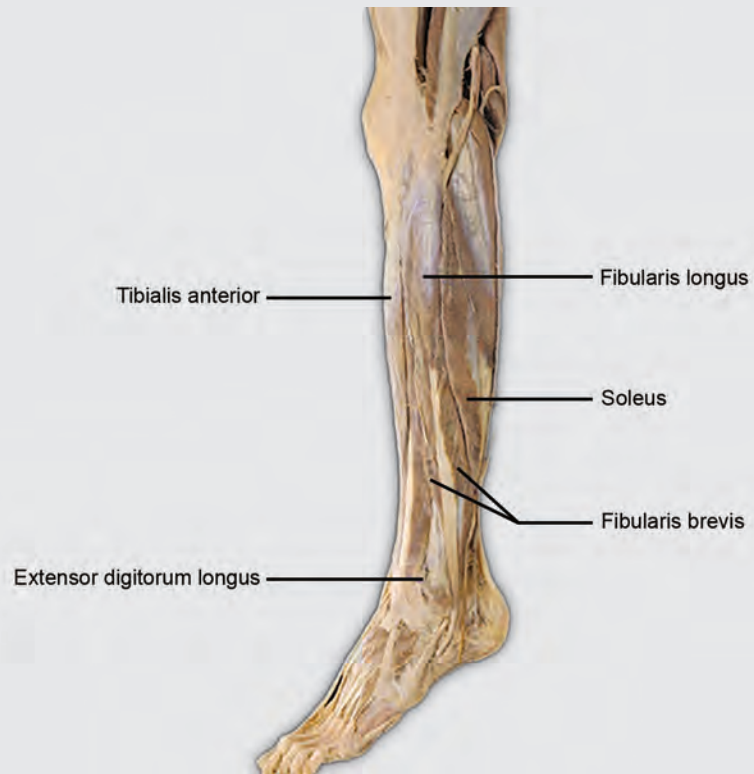


Fig. 42: Lateral compartment of leg

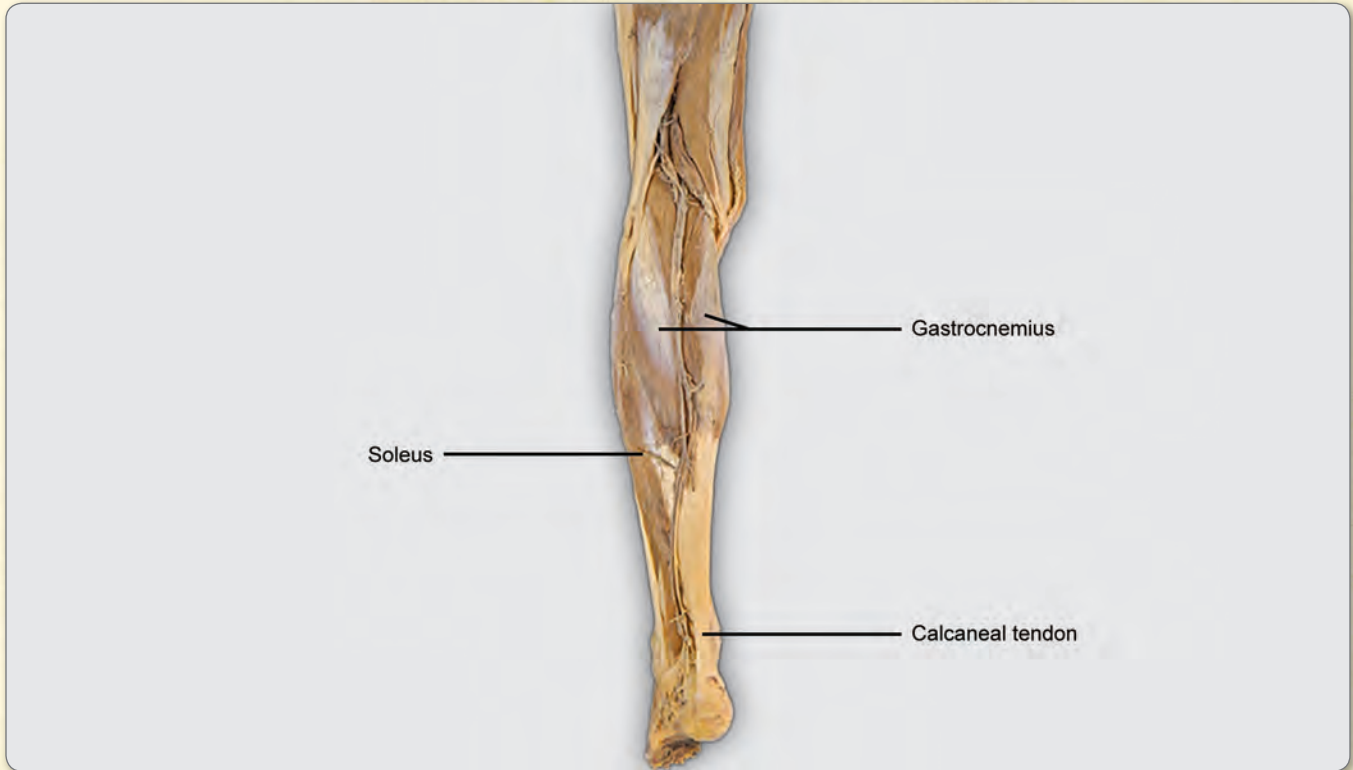


Fig. 43: Posterior compartment of leg

Neuroanatomy

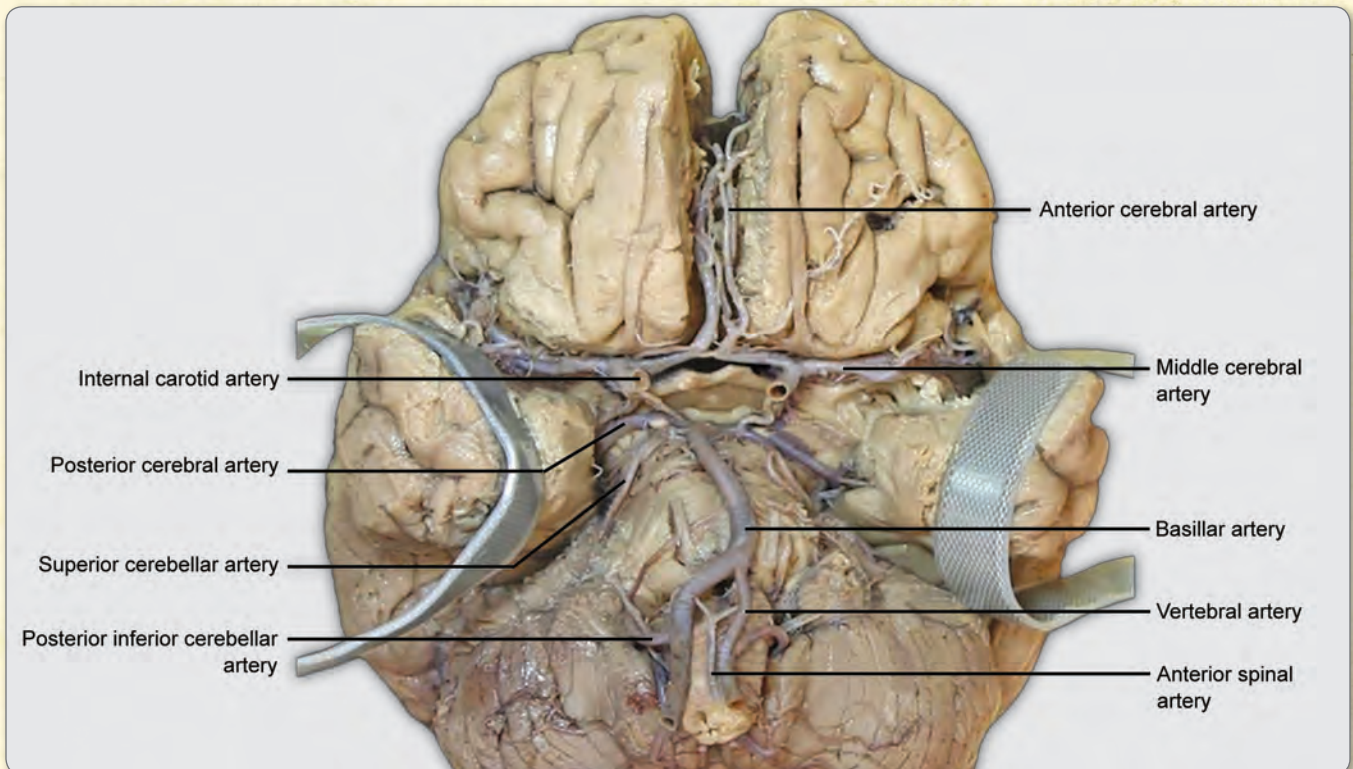


Fig. 44: Circle of willis

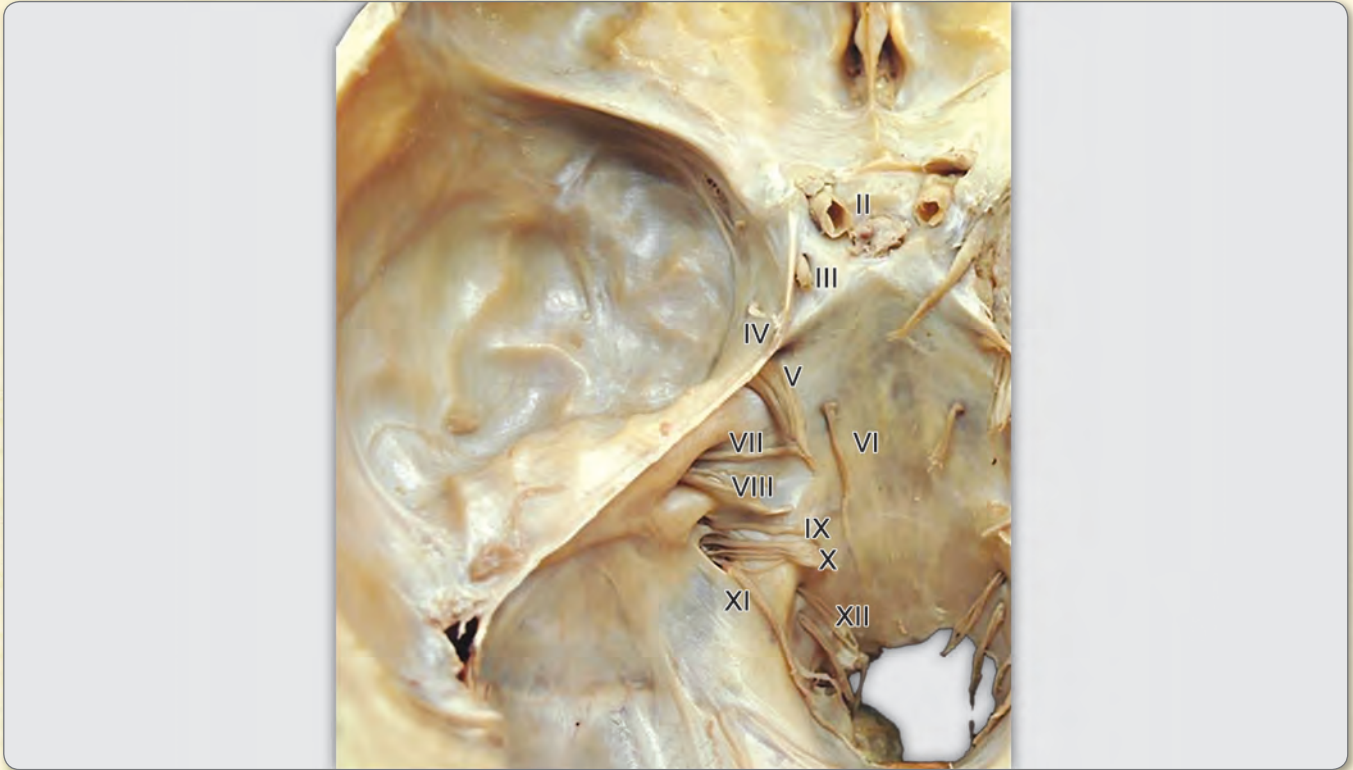


Fig. 45: Cranial nerves



Fig. 46: Lateral view of brain

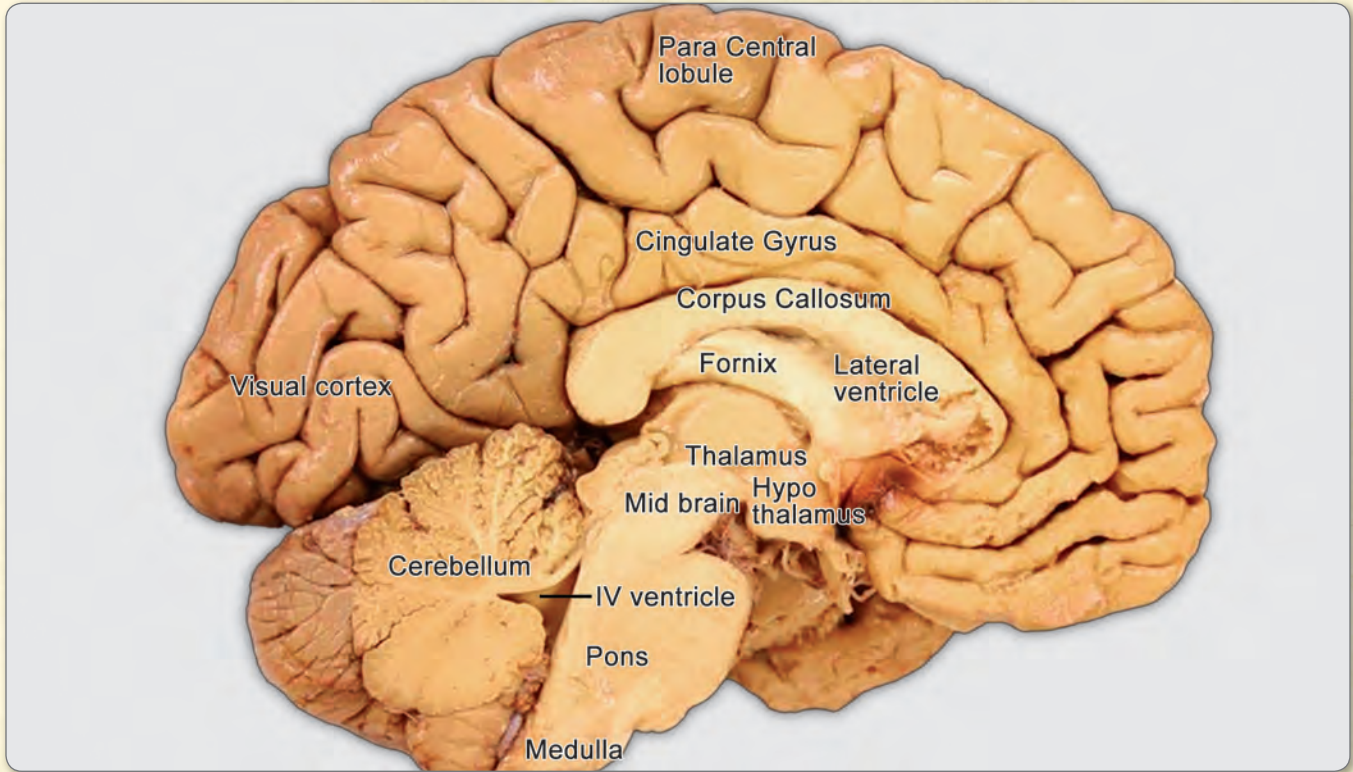


Fig. 47: Medial view of cerebrum

NOTES

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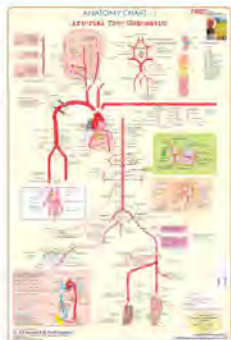
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- 400+ High Yield, Remember and Mnemonics boxes given as extra tools for remembering the most important information from examination perspective
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- Spotters section on dissection images has been included for a better understanding of anatomy of respective structures.

About the Authors

K Raviraj, MBBS, MD (Anatomy), who is a young and dynamic anatomist, completed his graduation from Government Stanley Medical College, Chennai, Tamil Nadu and postgraduation from PESIMSR, Kuppam, Andhra Pradesh. He has been mentoring the medical aspirants in various cities across the nation for the last 4 years. His flawless knowledge and grasp on the subject makes him the best faculty of Anatomy. He is popular amongst the students for his vivacious delivery of lecture. His approach makes anatomy extremely simple to understand. Students in the medical fraternity admire him for his approach and he is always a source of inspiration for them. He is also a successful author of several books, like FMGE Fire Aid Anatomy Manual and KONCPT-20.

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What I liked most was the colourful design and diagrams and the amazing flowcharts that help with revision also. Contains all topics required for the NEET exams from the point of anatomy. Helped me to reduce my tension too!

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