

ZOE DIANA DRAELOS AND MATTHEW MICHAEL DRAELOS

COSMETICS IN DERMATOLOGY

A Problem-Based Approach

FOURTH EDITION



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Cosmetics in Dermatology

Cosmetics for skin, hair, and nails play a vital part in the management and treatment of many dermatological conditions; unfortunately, they may also at times be the cause of some dermatological problems. Dermatologists need to have a working knowledge of over-the-counter products to answer patient questions, make product recommendations to prevent disease recurrence, select products useful in disease maintenance, and enhance appearance. This text bridges the worlds of skin, hair, and nail care formulation, chemistry, ingredients, function, and utility for the physician.



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Cosmetics in Dermatology

A Problem-Based Approach

Fourth edition

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I dedicate this book to everyone who has touched my life during my dermatology career, especially my husband, Michael, who has provided endless encouragement and insight as a fellow physician. I also dedicate this book to my two sons, Mark and Matthew, who allowed me to be part of their medical education, re-learning, re-thinking, and re-discovering many things that were unknown during my years in medical school. I am especially honored to have Matthew, as a budding fellow dermatologist, share his perspectives and insights as a co-author for the fourth edition. This text represents the culmination of my knowledge to date based on 30 years' experience designing, testing, and envisioning products for the skin care industry.

Zoe Diana Draelos



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Section I

Facial Cosmetic Dermatology

Introduction

Facial skin receives the most attention in the realm of cosmetic dermatology because it is our outer expressive conduit to the world. It ages more rapidly than the rest of the skin due to its almost constant exposure to the sun. Decoration of the facial skin is a time-honored tradition among many of the world's peoples. Most modern cosmetics are used to highlight facial features and camouflage facial defects. The earliest cosmetic designed to cover facial blemishes was the beauty patch. These patches became popular in the 1600s because they were used to cover the permanent scars left behind on the faces of people who survived smallpox epidemics in Europe. These patches were black silk or velvet pieces shaped like stars, moons, and hearts that were carefully placed on the face. Patch boxes—shallow metal boxes with a mirror in the cover—were carried everywhere to keep replacements handy should a patch fall off in public. Modern facial cosmetics were developed from the decorative patches (1).

The concept of covering the face with a pigmented cream originated in the theater with a product known as “French White,” which consisted of face powder incorporated into a liquid vehicle (2). This was considered a novel improvement over simply powdering the skin due to its superior adherence. Later, “grease paints” were developed as thick, oily pigmented pastes, but they were not appropriate for wear outside the theater. The first major breakthrough in facial foundations for the average woman came when Max Factor developed cake make-up, which he patented in 1936 (3). This product camouflaged the underlying skin, providing a velvety texture with subtle color.

However, the face is not only adorned with cosmetics, but it is also cleansed and moisturized. Cosmetics are used for hygiene purposes and also to maintain and enhance skin beauty. Harley Procter developed the first widely marketed American facial cleansing soap in 1878 when he decided that his father's soap and candle factory should produce a delicately scented, creamy white soap to compete with imported European products. He accomplished this feat with the help of his cousin James Gamble, a chemist, who made a richly lathering product called White Soap. By accident, they discovered that whipping air into the soap solution before molding resulted in a floating soap that could not be lost in the stream or bathtub (4). This resulted in a product known as Ivory soap, which is still manufactured today.

The excellent sebum removal afforded by the first soaps created the need for moisturizers to compensate for the flaking and dryness experienced. It is surprising that the very first American moisturizer is still in use and known as Vaseline, as named by Robert A. Chesebrough, who manufactured and patented the concoction in 1872. Chesebrough originally recommended petrolatum as a

chemical to treat leather; however, its value was soon recognized as a remedy for chapped hands and as a hair pomade. Later, petrolatum was adopted by the pharmaceutical industry as a vehicle instead of lard. It offered the benefit of preservative-free stability because lard frequently turned rancid.

Facial skin care has a rich history, but the modern formulations are clearly superior and better able to meet skin needs. This section of the text examines facial skin care from a disease-oriented approach. It examines the needs of the oily skin of acne, the dry skin of eczema, and the sensitive skin of rosacea. Cleansing, moisturizing, and the use of facial foundations are examined for these basic prototype groups. The discussion then turns to the large category of aging facial skin to additionally encompass the realm of cosmeceuticals. Finally, the section focuses on the special needs areas of the face, specifically the eyes and lips. It is hoped that at the end of this section, the dermatologist will understand how these over-the-counter products fit into the medical armamentarium.

Skin physiology

A brief discussion of skin physiology is presented to understand the challenge in creating healthy, normal facial skin for patients of all skin colors, complexion types, and ages. This is particularly challenging when the constituents of “normal” skin have not been defined; rather, there is a range of normal skins among all peoples of the world. The skin is the largest organ of the body. It possesses a regularly irregular surface composed of skin scales with intervening hairs, sweat ducts, and oil glands that reflect light to the eye, which is perceived as beauty. Unfortunately, with the passage of time, the beauty of the skin fades, even though it may be considered “normal.” Sun, smoking, stress, disease, scarring, and aging alter the structure of the skin and degrade its pristine appearance at birth.

Skin structure

The skin is composed of two layers, the epidermis and the dermis, each with distinct functions (Figure 1.1). The outer epidermis forms a barrier to the world, keeping out water, sunlight, insects, bacteria, toxins, and allergens. It acts as a beautiful barrier between the body and the environment and is responsible for all the variations in skin appearance. Below the epidermis lies the dermis, accounting for more than 90% of skin mass and providing physical strength to the skin. The dermis is composed of the papillary dermis and the reticular dermis, with the papillary dermis lying in direct contact with the epidermis. It is composed of collagen and elastin fibers containing blood vessels and lymphatic

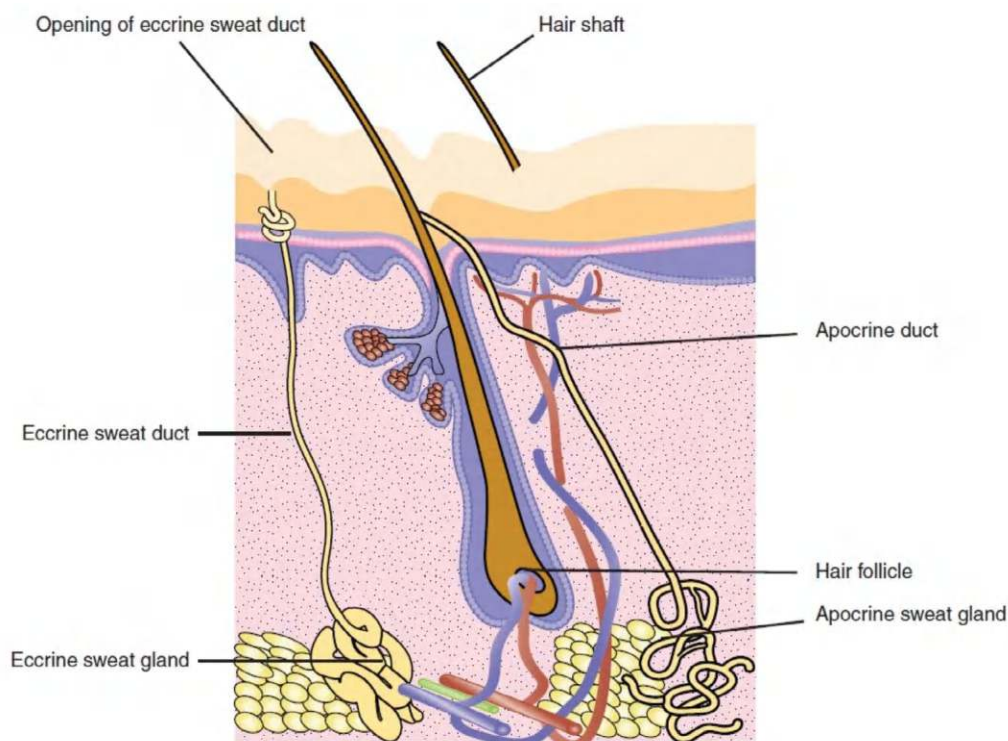


FIGURE I.1 The skin is composed of the epidermis and the dermis, with a thin nonliving layer known as the stratum corneum. All cosmetic products impact the stratum corneum, which is the basis for the visual beauty of the skin.

channels. In addition, there are connective tissue cells and glycosaminoglycans, which are responsible for holding water in the dermis and maintaining skin hydration. Under the papillary dermis lies the reticular dermis, possessing fewer cells, relatively few blood vessels, dense collagen bundles, and coarse elastin fibers. The papillary dermis provides physical strength to the skin and is the location of the eccrine and apocrine sweat glands, sebaceous glands, and hair follicles.

Stratum corneum

Perhaps the most important layer of the skin, from a cosmetic standpoint, is the stratum corneum, also known as the horny layer. This outermost layer of the epidermis is impacted by cleansing, moisturization, and other skin care treatments to the greatest degree. It is the layer assessed by the eye to arrive at the impression of lovely skin, but is only 15 to 150 μm thick. The rest of the chapter will address this layer from a cosmetic viewpoint.

The stratum corneum is composed of helical polypeptides, known as keratin protein, arranged into corneocytes. The corneocytes have been termed the bricks in the “brick and mortar” construction of the skin barrier. The mortar is composed of the intercellular lipids that form a waterproof covering of the body, to which cleansers, moisturizers, and cosmetics are applied. There are two types of lipids found in the skin: polar and nonpolar. The polar lipids possess an electrical charge and consist of phospholipids, glycolipids, and cholesterol. The uncharged nonpolar lipids are triglycerides, squalene, and waxes. The percentage breakdown of the intercellular lipids is given in [Table I.1](#).

Moisturizers attempt to mimic the effect of the intercellular lipids, but they can only create a barrier that reduces the

TABLE I.1: Intercellular Lipid Composition

Lipid	Quantity (%)
Triglycerides	12–25
Fatty acids	12–20
Waxes	6
Cholesterol, sphingolipids, ceramides	14–25

amount of water lost to the environment. Cleansers must allow these intercellular lipids to remain intact without producing irritation or premature desquamation of the corneocytes. Finally, colored cosmetics and cosmeceuticals must enhance the appearance of the stratum corneum on the face to create the optical sensation of beauty. With this introduction, our attention now turns to the incorporation of these concepts into a patient treatment regimen.

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Acne is the most common inflammatory condition treated by the dermatologist, using both prescription and over-the-counter (OTC) formulations. This chapter focuses on the OTC drugs and cosmetics that are used with prescription medication and in the maintenance phase of therapy. Consumers spend about \$100 million per year on OTC anti-acne products, which include cleansers, creams, and moisturizers (1).

OTC drug acne therapies

Acne products listing an active ingredient are regulated by the US Food and Drug Administration as OTC drugs. Only certain ingredients can be used in acne products, which are listed in the final United States Acne Monograph. Some of the ingredients approved for this use in the monograph are salicylic acid, sulfur, sulfur combined with resorcinol, and benzoyl peroxide (2). These ingredients can only be used singly and not in combination. Their utility in the treatment of acne in combination with skin care products is discussed in this chapter.

Benzoyl peroxide

The most effective and most commonly used active ingredient in OTC drug acne preparations is benzoyl peroxide. Eventually, all prescription benzoyl peroxide products will be available as OTC drugs. About 23% of people aged 13–27 years have used an OTC benzoyl peroxide product (3). It is a member of the organic peroxide family and consists of two benzoyl groups joined by a peroxide group. Benzoyl peroxide is prepared by treating benzoyl chloride with sodium peroxide to yield benzoyl peroxide and sodium chloride. It is a radical initiator, highly flammable, explosive, a possible tumor promoter, and a mutagen.

Benzoyl peroxide is the most effective acne treatment ingredient in the OTC market.

Benzoyl peroxide has many properties pertinent to acne, including antibacterial, anti-inflammatory, and comedolytic effects (4). When benzoyl peroxide touches the skin, it breaks down into benzoic acid and oxygen, neither of which is problematic. It has antimicrobial properties against *Cutibacterium acnes*, as demonstrated by a $2\log_{10}$ decrease in *C. acnes* concentration after two days of topical application of 5% benzoyl peroxide (5). This same antimicrobial effect was observed after applying 10% benzoyl peroxide cream for three days, which resulted in a mean $2\log_{10}$ decrease in the concentration of microbial organisms; however, after seven days, no further decline in *C. acnes* concentration was observed (6).

Benzoyl peroxide is an important antimicrobial agent that has a better potency against *C. acnes* than other topical antibiotics such as erythromycin or clindamycin. However, unlike topical antibiotics, benzoyl peroxide does not result in resistant organisms (7). Benzoyl peroxide also acts as an anti-inflammatory agent by reducing oxygen radicals. In addition, its ability to reduce

the *C. acnes* population also reduces inflammation due to fewer bacteria-induced monocytes producing tumor necrosis factor α , interleukin 1β , and interleukin 8 (8). This anti-inflammatory effect is perceived by the consumer as reduced redness and pain.

Finally, benzoyl peroxide is also a comedolytic and is capable of producing a 10% reduction in comedones (5). Comedolytics allow the plug in the pore to loosen from the surrounding follicle, restoring the normal flow of sebum to the skin surface. It was originally thought that higher concentration benzoyl peroxide preparations would provide superior comedolytic benefits; however, it now appears that even 2.5% benzoyl peroxide is effective. This is the strength most commonly found in products available in the consumer market. Higher concentrations benzoyl peroxide may only increase skin irritation, resulting in peeling and redness (9). In addition, benzoyl peroxide causes allergic contact dermatitis in 1–2.5% of consumers, resulting in redness, swelling, oozing, and pain (10).

In total, 2.5% benzoyl peroxide in small particulate size may be as effective as 5–10% benzoyl peroxide in acne treatment creams.

One of the major unresolved concerns regarding benzoyl peroxide is its safety. Benzoyl peroxide is a highly reactive molecule capable of causing explosions in concentrations of 20% or higher. The manufacture of benzoyl peroxide products requires a special facility, and stability problems are common in new formulations. Benzoyl peroxide is capable of producing DNA strand breaks, but rodent carcinogenicity studies have been negative (3). No correlation has been shown between benzoyl peroxide use and skin cancer in humans.

Current trends in benzoyl peroxide formulation have focused on the use of less irritating hydrogel formulations and smaller particle size benzoyl peroxide (11). Raw benzoyl peroxide is a particulate that must be solubilized into solution. It is only the benzoyl peroxide particles that touch the skin surface that are active in the killing of *C. acnes*. Although larger particles will yield higher concentrations in the formulation, most of the benzoyl peroxide particles will not touch the skin. A smaller particle size allows better skin coverage with less irritation because the concentration is reduced. It is possible to create a 2.5% benzoyl peroxide formulation with an efficacy equal to that of a 10% benzoyl peroxide formulation based on skin contact with the active ingredient. A careful, creative formulation can minimize tolerability issues associated with OTC benzoyl peroxide formulations (Figure 1.1).

Salicylic acid

Salicylic acid is another major comedolytic used as an active ingredient in OTC acne treatments in concentrations up to 2% (12). Salicylic acid is a colorless, crystalline, oil-soluble phenolic compound originally derived from the willow tree *Salix*. It is a β -hydroxy acid, where the OH group is located on the second

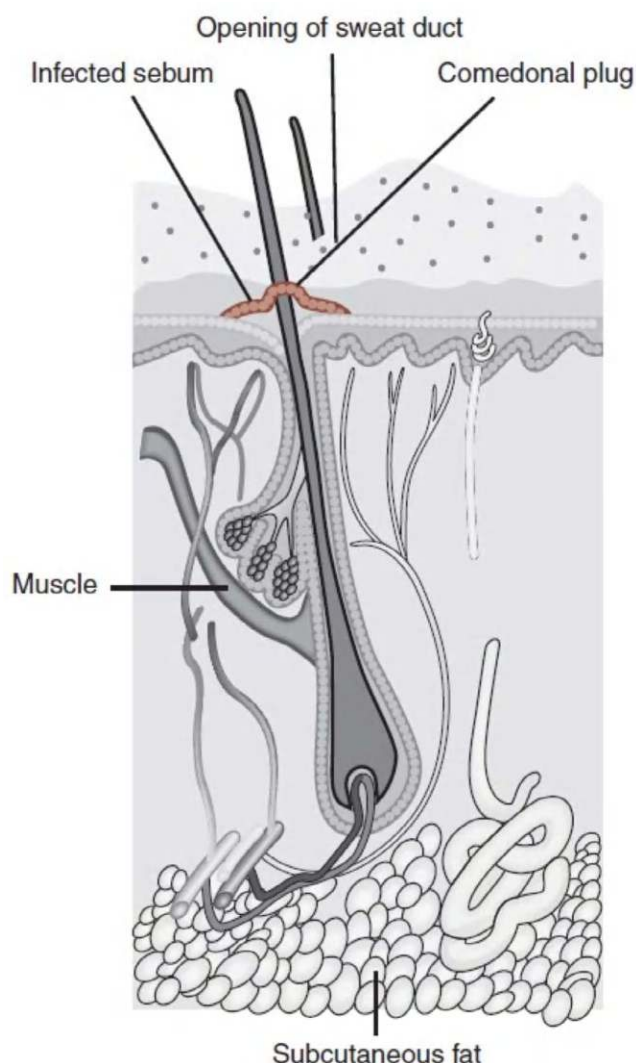


FIGURE 1.1 Benzoyl peroxide particles that contact the skin in and around the ostia provide a comedolytic and antibacterial effect by causing the skin to shed the comedonal “plug,” which seals the infected sebum and causes inflammation.

carbon of salicylic acid’s aromatic ring. The compound is synthesized by treating sodium phenolate, the sodium salt of phenol, with carbon dioxide at 100 atm pressure and 390 K temperature, followed by acidification with sulfuric acid.

Salicylic acid is able to exfoliate in the oily milieu of the pore.

Salicylic acid, also known as 2-hydroxybenzoic acid, has a rich history in medicine. It is used as an anti-inflammatory inhibiting arachidonic acid, a flavoring agent with the characteristic wintergreen taste because it is chemically related to aspirin, a liniment for sore muscles, and an acne treatment. Salicylic acid can penetrate the follicle and dislodge the comedonal plug from the follicular lining. It neither kills *C. acnes* nor does it prevent the development of antibiotic resistance.

Thus, salicylic acid may be less effective than benzoyl peroxide in acne treatment, but it is also less irritating and less allergenic. Some proprietary salicylic acid preparations have shown parity to 5% benzoyl peroxide (13). Salicylic acid is sometimes used in hypoallergenic acne treatments and acne treatments for mature individuals.

Salicylic acid can be applied to the skin in a variety of different formulations (14). It can be applied as a solution in an alcohol-detergent vehicle or in the form of an impregnated pad (15, 16). It can be formulated as a 2% salicylic acid scrub, with clinical data demonstrating a reduction in open comedones (17). Also, 10% and 20% salicylic acid peels are used to promote comedolysis.

Some individuals experience allergic reactions when salicylic acid is ingested; however, it is generally accepted as a safe ingredient. An overdose of salicylic acid can lead to salicylate intoxication, presenting as a state of metabolic acidosis with a compensatory respiratory alkalosis. This has not been reported with topical applications, and salicylic acid acne preparations are considered safe and effective, even during pregnancy.

Sulfur

The oldest treatment for acne predating benzoyl peroxide and salicylic acid is sulfur. Sulfur is a known bacteriostatic and anti-fungal agent (18). It is a yellow, nonmetallic element that has been used for centuries to treat various dermatologic conditions. The mechanism of action for sulfur is not totally understood, but it is thought to interact with cysteine in the stratum corneum, causing a reduction of sulfur to hydrogen sulfide. Hydrogen sulfide in turn degrades keratin, producing the keratolytic effect of sulfur (19). Sulfur has been labeled as a comedogen, but this is controversial (20). Sulfur is available in concentrations of 3–8% in OTC acne formulations. It has a characteristic foul odor and an unusual yellow color. It stains clothing and is typically formulated as a thick paste.

Sulfur is thought to interact with cysteine in the stratum corneum, causing a reduction in sulfur to hydrogen sulfide, which has a comedolytic effect beneficial in curing acne.

Cosmetic acne therapies

In addition to the monographed acne treatment ingredients of benzoyl peroxide, salicylic acid, and sulfur, other substances have been used in the cosmetic treatment of acne that are not monographed. These ingredients are found in cosmetic acne therapies and include hydroxy acids, retinol, triclosan, and tea tree oil.

Hydroxy acids

Hydroxy acids, such as glycolic acid, are used in the cosmetic treatment of acne as desquamating agents. Glycolic acid is the smallest alpha-hydroxy acid and appears as a colorless, odorless, hygroscopic crystalline solid. Although glycolic acid can be obtained from the fermentation of sugar cane, it is more commonly synthesized by reacting chloroacetic acid with sodium hydroxide, followed by re-acidification.

The efficacy of glycolic acid in treating acne is related to the free acid concentration (21). The free acid is able to dissolve the ionic bonds between the corneocytes forming the stratum corneum. This desquamation can remove the comedonal plugs;

however, the water-soluble glycolic acid cannot enter the oily milieu of the pore. For this reason, salicylic acid is a much better comedolytic.

Glycolic acid is an exfoliant used in acne washes.

Glycolic acid can be delivered to the skin in the form of a cleanser, moisturizer, or peel. The rinse-off cleanser is less effective in acne therapy than the leave-on moisturizer. Higher concentrations, such as 20–70% glycolic acid, can be delivered to the skin in the form of a peel that is left on for 3–5 minutes and rinsed off later. The peels can also be used to improve the dark scarring associated with acne, known as post-inflammatory hyperpigmentation (22).

OTC retinoids

Vitamin A derivatives, known as retinoids, are used in the treatment of acne. Three prescription acne treatment retinoids exist: adapalene, tretinoin, and tazarotene. A variety of OTC retinoids exist that may be helpful in acne treatment. These retinoids include retinol and retinaldehyde. Retinol can be absorbed by keratinocytes and reversibly oxidized into retinaldehyde. Retinaldehyde is irreversibly converted into all-trans retinoic acid, also known as tretinoin. Tretinoin is transported into the keratinocyte nucleus, modulating follicular keratinization. Large, multicenter, double-blind, placebo-controlled studies on the use of OTC retinoids in acne treatment are yet to be conducted. However, retinol has been shown to be 20 times less potent than topical tretinoin but exhibits greater penetration than tretinoin (23).

Retinol and retinaldehyde are used in some cosmetic acne treatment creams, but they do not have a similar effect on microcomedones like tretinoin.

Tea tree oil

Tea tree oil is the most common herbal essential oil used for acne treatment. Tea tree oil, obtained from the Australian tree *Melaleuca alternifolia*, contains several antimicrobial substances such as terpinen-4-ol, alpha-terpineol, and alpha-pinene (24). The oil has a pale golden color with a fresh camphoraceous odor. It is used for medicinal purposes as an antiseptic, antifungal, and antibacterial (25).

The antibacterial activity of 10% tea tree oil has been shown against *Staphylococcus aureus*, including methicillin-resistant *S. aureus*, without resistance (26). Lower concentrations, however, have demonstrated bacterial resistance. Tea tree oil has been found to be as effective in the treatment of acne as 5% benzoyl peroxide based on a reduction in comedones and inflammatory acne lesions; however, the onset of action is slower for tea tree oil (27). The tea tree oil group did experience fewer side effects than the benzoyl peroxide group. Another randomized, 60-subject, placebo-controlled study in subjects with mild to moderate acne found 5% topical tea tree oil produced a statistically significant reduction in total lesion count and acne severity index as compared to the placebo (28). Tea tree oil may also reduce the amount of inflammation present around acne lesions, thereby reducing the redness (29).

Tea tree oil is used as an antibacterial in some natural botanical cosmetic acne treatment products.

Tea tree oil is toxic when swallowed. It also has produced toxicity when applied topically in high concentrations to cats and other animals (30). Its use in low concentration topically for the treatment of acne has not produced toxicity problems. However, tea tree oil is a known cause of allergic contact dermatitis. An Italian study of 725 subjects patch tested with undiluted, 1%, and 0.1% tea tree oil found that 6% of the subjects experienced a positive reaction to undiluted tea tree oil, one subject experienced an allergic reaction to 1% tea tree oil, and none of them had any reaction to the 0.1% dilution (31). Thus, the incidence of allergic reactions to tea tree oil is concentration dependent.

Miscellaneous acne ingredients

An ingredient of some interest in acne treatment is zinc. It has been applied topically because zinc salts are bacteriostatic to *C. acnes* and orally ingested as a homeopathic acne therapy (32). A study by Dreno et al. demonstrated that zinc salts in the culture media of *C. acnes* prevented the development of organisms resistant to erythromycin. Because many *C. acnes* organisms are resistant to topical erythromycin, which has been largely replaced by topical clindamycin, this may be an important mechanism for preventing bacterial resistance (33). Zinc taken with nicotinamide orally for acne reduces inflammation. It is theorized that they reduce inflammation by inhibiting leukocyte chemotaxis, lysosomal enzyme release, and mast cell degranulation (34).

The value of topical nicotinamide in acne has been reported, along with its use orally (35, 36). A commercially available OTC vitamin preparation based on nicotinamide has been shown to produce acne improvement in eight weeks (37). Topically, nicotinamide 4% was shown to be comparable to clindamycin gel 1% in the treatment of moderate acne (38).

Skin care in acne patients

Beyond the acne treatments discussed earlier, skincare products and cosmetics can aid in acne therapy or contribute to disease worsening. These ancillary skin care products include cleansers, astringents, exfoliants, facial scrubs, epidermabrasion, textured cloths, mechanized skin care devices, and face masks.

Cleansers

Various cleansers are useful in removing sebum and normalizing the acne biofilm. Soaps are some of the major cleansers used in acne treatment. These include true soaps that are composed of long-chain fatty acid alkali salts with a pH of 9–10. Many of the milder acne soaps are composed of synthetic detergents, known as syndets. These cleansers contain less than 10% soap with a more neutral pH adjusted to 5.5–7.0 (39). Some of the most popular soaps for acne patients are combars composed of alkaline soaps to which surface-active agents with a pH of 9–10 have been added. These combars also contain benzalkonium chloride, a potent antibacterial that may be helpful in acne, discussed earlier.

Beyond traditional soaps that are used in acne treatment, specialized formulations known as facial scrubs are commonly used. Facial scrubs are mechanical exfoliants, as opposed to the glycolic acid chemical exfoliants previously discussed, and employ



FIGURE 1.2 Scrubs are used in OTC acne cleansers for increased exfoliation in and around the pore.

small granules in a cleansing base to enhance corneocyte desquamation. The scrubbing granules may be polyethylene beads, aluminum oxide, ground fruit pits, or sodium tetraborate decahydrate granules, which aid in the removal desquamating stratum corneum from the face (Figure 1.2) (40). Sibley et al. considered abrasive scrubbing creams effective in controlling excess sebum and removing desquamating tissue (41). However, they can cause epithelial damage if used too vigorously. This view is held by Mills and Kligman, who noted that the products produced peeling and erythema with no reduction in comedones. Aluminum oxide and ground fruit pits provide the most abrasive scrub due to their rough-edged particles, followed by polyethylene beads, which are smoother and produce less stratum corneum removal. Sodium tetraborate decahydrate granules become softer and dissolve during rubbing, providing the least abrasive scrub.

Acne scrub creams may contain polyethylene beads, aluminum oxide, ground fruit pits, or sodium tetraborate decahydrate granules.

A currently popular trend in facial exfoliant scrubs is the production of warmth. These products are labeled as “self-heating” scrubs. Heat is produced as part of an exothermic reaction. The heat does not increase the exfoliant efficacy, but is added for consumer comfort and marketing purposes. Sometimes these

heated exfoliant scrubs are preceded by a self-administered hydroxy acid peel, thus combining both chemical and physical exfoliation in one kit.

Astringents and exfoliants

Astringents and exfoliants are used in cosmetic acne treatment regimens marketed by many companies. Astringents are liquids applied to the face following cleansing and are used widely in cosmetic acne treatments. They comprise a broad category of formulations known by many terms: toners, clarifying lotions, controlling lotions, protection lotions, skin fresheners, toning lotions, T-zone tonics, etc. Originally, astringents were developed to remove alkaline soap scum from the face following cleansing with lye-based soaps and high-mineral-content well water. The development of synthetic detergents and public softened water systems greatly decreased the amount of post-washing residue. A new use for astringents was found when cleansing cream became a preferred method of removing facial cosmetics and environmental dirt. The astringent then became an effective product for removing the oily residue left behind following cleansing cream use.

Astringent formulations are presently available for all skin types (oily, normal, dry, sensitive, photoaged, etc.); with a variety of uses, their primary benefit is in oily skin afflicted with acne (42). Oily skin astringents contain a high concentration of alcohols, water, and fragrance, which functions to remove any sebum left behind after cleansing, to produce a clean feel, and possibly apply some treatment product to the face. For example, 2% salicylic acid or witch hazel may be added for a keratolytic and drying effect on the facial skin of acne patients. Clays, starches, or synthetic polymers may be added to absorb sebum and minimize the appearance of facial oil.

Cosmetic acne treatment astringents may contain 2% salicylic acid as the active ingredient.

Exfoliants are similar to astringents but are solutions, lotions, or creams applied to the face after cleansing and after the application of an exfoliant designed to hasten stratum corneum exfoliation and assist in comedolysis in the acne patient. Their exfoliant effect is based on the use of alpha-, poly-, or beta-hydroxy acids, thus inducing chemical exfoliation. The goal is to chemically loosen the retained comedonal plug from the lining of the pore. Many cosmetic acne treatment exfoliants use this theory to support claims and purport efficacy. Glycolic acid exfoliants based on alpha-hydroxy acids may be useful in patients with acne and photoaged skin to improve appearance; however, the salicylic beta-hydroxy acid exfoliants are more effective. This is due to their inherent oil solubility, which allows them to exfoliate in the oily milieu of the pore. Polyhydroxy acid exfoliants based on gluconolactone are also marketed with the main claim of reduced irritation. Their large molecular weight impedes skin penetration and reduces irritation.

Epidermabrasion and textured cloths

Epidermabrasion and textured clothes are used to induce mechanical exfoliation of comedonal plugs, as opposed to the exfoliants that induce chemical exfoliation. Durr and Orentreich termed mechanical exfoliation as epidermabrasion and examined the use of a nonwoven polyester fiber web sponge for the removal

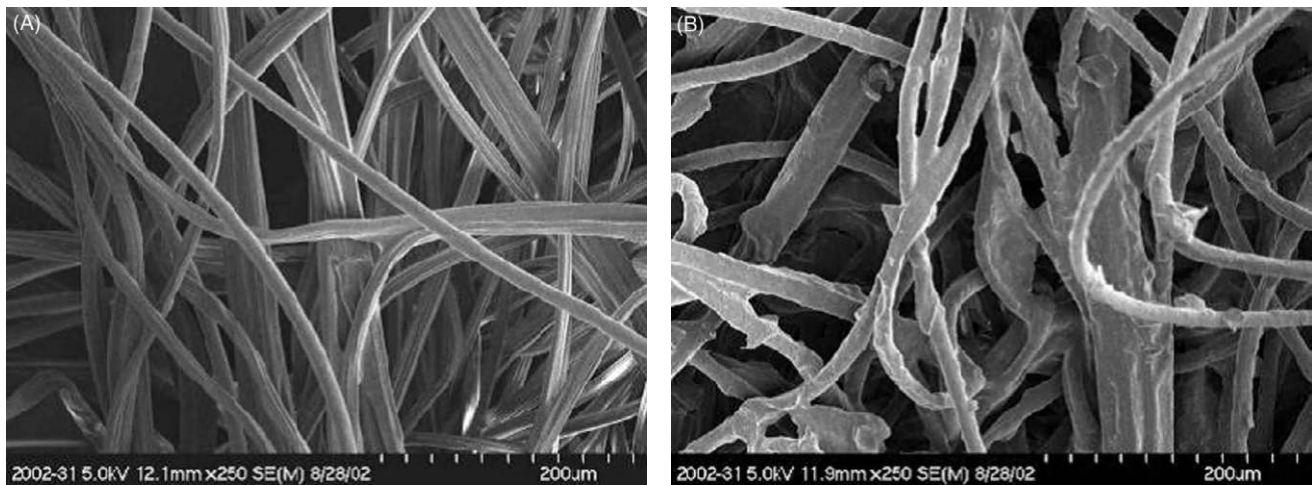


FIGURE 1.3 (A) A scanning electron microscopy image of a fiber cloth prior to cleansing, showing the entangled fibers compressed to form a continuous fabric. (B) A used cleansing cloth showing the skin scale and debris attached to the fibers prior to rinsing.

of keratin excrescences and trapped hairs in pilosebaceous ducts (43, 44). Other epidermabrasion implements include rubber puffs, sea sponges, and loofahs, and the most recent addition of textured fiber face cloths. The fiber face cloths have come to be a major segment of the current epidermabrasion marketplace and are discussed in detail.

Fiber cloths are extremely versatile dermatologic devices. They can be premoistened and impregnated with surfactants to cleanse the face or perfumed, containing volatile solvents to freshen the face. They can also be packaged dry with lipids and detergents to clean the face, and covered with a plastic film pouch that has microscopic holes to time-release an active acne ingredient onto the skin surface. In addition, they can be textured with patterns to physically exfoliate the skin. Although the use of facial fiber cloth as a cosmetic acne treatment is new, the cloth has been around for 30 years (Figure 1.3).

Fiber cloths are useful in cleansing the face of acne patients in and around the pores.

Modern fiber cloth technology focused on creating a soft wipe with excellent strength to prevent tearing. The fibers used are a combination of polyester, rayon, cotton, and cellulose fibers held together via heat through a technique known as thermobonding. Additional strength is imparted to the wipe by hydroentangling the fibers. This is achieved by entwining the individual rayon, polyester, and wood pulp fibers with high-pressure jets of water. Thermobonding and hydroentangling have eliminated the use of adhesive binders, thereby creating a soft, strong cloth suitable for facial use.

Face cloths are available both dry and moist. The dry packaged cloths are impregnated with a cleanser that foams modestly when the cloth is water moistened. The type of cleanser in the cloth can effect an aggressive sebum removal for oily skin and contains salicylic acid. Humectants and emollients can also be added to the cloth to decrease barrier damage or to smooth the xerotic skin scale common in acne patients who are on prescription therapy.

In addition to the composition of the ingredients preapplied to the dry cloth, the weave of the cloth will also determine its acne effect. Two types of fiber weaves are used in facial acne cloths: open weave and closed weave. Open weave cloths are so named because of the 2- to 3-mm windows in the cloth between the adjacent fiber bundles. These cloths are used in persons with dry and/or sensitive skin and acne to increase the softness of the cloth and decrease the surface area contact between the cloth and the skin, yielding a milder exfoliant effect. Closed-weave cloths, on the hand, are designed with a much tighter weave and are double-sided. One side of the closed-weave cloth is textured and impregnated with a synthetic detergent cleanser designed to optimize the removal of sebum, cosmetics, and environmental dirt while providing an exfoliant effect. The opposite side of the cloth is smooth and designed for rinsing the face and possibly applying skin conditioning or acne agents.

The texture of the cloth provides gentle mechanical exfoliation that may be valuable in the patient who cannot tolerate chemical exfoliation with hydroxy acids. The mechanical exfoliation can be achieved on the skin surface and around the follicular ostia due to the ability of the textured cloth to traverse the irregular topography of the skin more effectively than the hands or a washcloth. The degree of exfoliation achieved is dependent on the cloth weave, the pressure with which the cloth is stroked over the skin surface, and the length of time the cloth is applied. The cloth can aid in the removal of comedonal plugs.

Mechanized skin care devices

Mechanization of the epidermabrasion process is known as microdermabrasion. This is a procedure performed by estheticians and paramedical personnel, where small particulates, such as aluminum, silica, and baking soda, are sprayed against the skin surface and simultaneously removed with a vacuum. Microdermabrasion is simply another technique to induce stratum corneum exfoliation.

Mechanized cleansing devices can rotate, vibrate, or sonicate to aid in removal of skin scale and sebum.

Various devices are available to exfoliate the facial skin. These include rotary brushes that drag synthetic bristles across the skin surface to physically remove the stratum corneum. These devices are sold with a special cleanser to remove sebum and clean the bristles simultaneously. A variant of this technology used scrubbing pads of varied roughness to produce exfoliation. The scrubbing pads were held on the device head with adhesive and could be replaced when worn. These devices vibrated instead of rotating to remove skin scale.

A third type of facial cleansing device produces a sonicating motion, similar to that of sonicating electric toothbrushes. The hand-held device runs on a rechargeable battery that is attached to a miniaturized motor, creating an oscillatory motion of the brush head. This oscillatory sonic motion allows the brush bristles to traverse the dermatoglyphics, facial pores, and facial scars more adeptly than other mechanized cleansing methods. These devices may be useful for acne patients with facial scarring.

Face masks

Face masks are also used in the cosmetic treatment of acne. Typically, a face mask is applied on a weekly basis to provide a more aggressive type of acne treatment, but the medical benefits may be minimal. The masks that are used in acne treatment are earth based. Earth-based masks, also known as paste masks or mud packs, are formulated from absorbent clays such as bentonite, kaolin, or china clay. The clays produce an astringent effect on the skin, making this mask most appropriate for oily-complected patients. The astringent effect of the mask can be enhanced through the addition of other substances such as magnesium, zinc oxide, and salicylic acid. The masks can be applied as a cloth that is laid over the entire face, or as a paste that is scooped from a jar. The mask is left on the face for 15–30 minutes and then rinsed away with water.

Comedogenicity and skin care formulations

The issue of comedogenicity in relation to cosmetics arose in 1972 when Kligman and Mills described a low-grade acne characterized by closed comedones on the cheeks of women aged 20–25 years (45). They labeled this phenomenon “acne cosmetica.” Many of these women had not experienced adolescent acne. The authors proposed that substances present in cosmetic products induced the formation of closed comedones and, in some cases, a papulopustular eruption. This led to the concept that skin care products and cosmetics could cause acne.

Further research on cosmetic-induced acne led to the development of the rabbit ear comedogenicity model, which is still sometimes used by cosmetic companies to test products. The cosmetic is applied to the ears of New Zealand white albino rabbits. One ear serves as a control, while the other ear receives one-half mL of the test substance five days per week for two consecutive weeks. Visual observations of enlarged pores and hyperkeratosis are made daily. At the completion of the study, the skin is biopsied to look for hyperkeratosis of the sebaceous follicles (46).

Although this model was the standard test for comedogenicity for many years, it is currently out of favor as animal testing has been abandoned by many cosmetic companies and there are inherent problems with the model (47). First, some studies do not perform a biopsy and rely on the visual inspection of the rabbit ear, which is less sensitive than the microscopic examination. Microcomedones, now known to be important acne precursor lesions, can only be identified through microscopic examination. Second, some studies have confused follicular dilation with

comedone formation. Follicular dilation is a side effect of cutaneous irritation and is not necessarily the same as comedone formation. Third, the use of immature or aged rabbits may not yield accurate data because sebum production is reduced in rabbits not in their prime. Fourth, the rabbit ear may not accurately simulate the human face: many substances that produce comedones in the rabbit ear model produce pustules and inflammatory papules, not comedones, on the human face.

The follicular biopsy has become the standard technique for assessing comedogenicity in skin care formulations.

Due to the aforementioned limitations with the rabbit ear model, many cosmetic companies are now using the upper back of male and female volunteers for comedogenicity assessment (48). The volunteers are first checked for the ability to produce comedones by taking a follicular biopsy. This is done by placing a drop of cyanoacrylate glue on a microscope slide and letting it dry on the back of the subject. The microscope slide is then pulled from the skin, removing comedonal plugs that appear as waxy mountains when the slide is viewed with a dissecting 5× microscope. Occlusive patch tests are used to apply the material to the upper back for 30 days, with repeated daily changing. Follicular biopsies are repeated at the end of the test period, and the slides are examined for an increase in the presence of comedonal plugs (46). A negative no-treatment patch is applied, and a positive treatment patch containing coal tar is also used. This test for comedogenicity is also performed in addition to pre- and post-marketing surveillance.

The established lists of comedogenic substances, such as those shown in Table 1.1, are used by watchdog websites and some companies to show marketing advantages. These lists were generated many years ago by studying the material in concentrations of 100% in the rabbit ear assay, which may not be relevant to actual cosmetic formulations. Giving patients this list of comedogenic substances to avoid is not very useful because it is practically impossible to find formulations that possess none of these ingredients. The list contains some of the most effective emollients (octyl stearate, isocetyl stearate), detergents (sodium lauryl sulfate), occlusive moisturizers (mineral oil, petrolatum, sesame oil, cocoa butter), and emulsifiers found in the cosmetic industry (49). A product line that avoided all of these substances would not perform well on the skin and would possess a low cosmetic acceptability. Comedogenicity can only be evaluated in light of the patient's susceptibility to the formation of comedonal plugs. Some individuals have never developed a comedone in their life and use cocoa butter daily as a facial moisturizer. It is not yet understood why certain patients develop fewer comedones than others (50, 51).

Lists of comedogenic substances are not particularly helpful in selecting skin care product formulations for acne patients.

Acnegenicity and skin care formulations

Acnegenicity is a completely separate issue from comedogenicity. Substances that are comedogenic cause comedones, or blackheads, whereas substances that are acnegenic cause papules and pustules.

TABLE 1.1: A Standard List of Possible Comedogenic Substances

Butyl stearate
Cocoa butter
Corn oil
D&C red dyes
Decyl oleate
Isopropyl isostearate
Isopropyl myristate
Isostearyl neopentanoate
Isopropyl palmitate
Isocetyl stearate
Lanolin, acetylated
Laureth-4
Linseed oil
Mineral oil
Myristyl ether propionate
Myristyl lactate
Myristyl myristate
Methyl oleate
Oleic acid
Oleyl alcohol
Olive oil
Octyl palmitate
Octyl stearate
Peanut oil
Petrolatum
Propylene glycol stearate
Safflower oil
Sesame oil
Sodium lauryl sulfate
Stearic acid

Comedogenicity is due to follicular plugging, whereas acneogenicity is due to follicular irritation (52). Thus, comedogenic substances are not necessarily acneogenic and vice versa (Figure 1.4).

At first glance, acneogenicity also may seem rather simple. A list of substances that irritates the follicular ostia could be generated and then used to pick skin care products and cosmetics for patient use. Unfortunately, lists of acneogenic substances are useless because the interaction of ingredients, as well as their



FIGURE 1.4 It is impossible to determine whether a cosmetic is comedogenic or acneogenic based on its appearance or from the ingredient disclosure. Clinical testing is required.

concentration, is important. However, of more importance is the individual patient's susceptibility to acne formation. Cosmetics that are acneogenic in one patient are not necessarily acneogenic in another patient.

It is interesting to note that, in a general dermatologist's practice, the phenomenon of acneogenicity due to cosmetics is a more common occurrence than that of comedogenicity due to cosmetics. This makes acneogenicity a more important issue than comedogenicity. However, the incidence of comedone and acne formation due to cosmetics is rare, considering the number of persons who use such products daily.

Acne and the microbiome

Acne is basically a disease of the microbiome. However, the normal skin microbiome cannot be universally defined. The skin microbiome varies from person to person based on sex, age, body location, antimicrobial peptide presence, and immune function. It is not possible to change the microbiome for any individual permanently; however, small temporary changes can be achieved through the topical application of live bacterial materials or nutritional sources for the resident microflora. The normal skin microbiome is made up of largely gram-positive species. The skin surface is a rather harsh microbial environment, with the epidermal keratinocytes controlling the microbiome through the production of beta-defensins and cathelicidins.

The distinction between resident and transient microbial species is important and represents the basis for human hygiene. Resident microflora refer to species that reproduce on the skin with the capacity for sustained growth. Resident microflora include all species of *C. acnes*, *Staphylococcus epidermidis*, *Micrococci*, *Corynebacteria*, and *Acinetobacter*. Transient microflora refers to species that are contaminants with little or no capacity for sustained growth and reproduction. Examples of common transient microflora include *S. aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. However, the microbiome is extremely abundant and diverse, with more than 113 phylotypes identified.

Acne is characterized by the presence of *C. acnes*. The concept of putting "good bacteria" on the skin to get rid of the "bad *C. acnes* bacteria" to treat acne is compelling. There are a number of OTC acne formulations based on this principle; however, there is a problem in claim assessment. To make an OTC acne claim, products must contain one of the monographed ingredients, such as benzoyl peroxide or salicylic acid. Benzoyl peroxide will destroy any microbiome-based ingredients and cannot be used. Thus, salicylic acid is put in many of the microbiome-based products. It is impossible to tell whether the active agent is the salicylic acid or the microbiome-based ingredient. Usually, studies are not done to separately determine the additive benefit of the microbiome-based ingredient.

Nevertheless, there are a variety of microbiome products directed at acne improvement. There are probiotics, prebiotics, postbiotics, and synbiotics. Probiotic skin care products contain living bacteria designed to populate the skin surface with "good" bacteria. They must be preservative-free, or the bacteria would die, and therefore must be purchased cold out of a refrigerated case in the store. Most of these topical products contain the same bacteria found in yogurt, such as the dairy propionic acid bacteria (PAB) *Lactobacillus* and *Bifidobacterium*.

For a probiotic skin care product to be effective, the bacteria must demonstrate adhesion to the skin, transient colonization, resistance toward potential pathogens, and production of

antimicrobial substances. In vitro studies show PAB stratum corneum adhesion rates of 4–16%, so it is possible that probiotic skin care might hold some promise in acne. However, putting live bacteria in skin care products is challenging, so most probiotic skin care products contain ultrasound-inactivated bacterial extracts from PAB, which can exist in unrefrigerated, preservative-containing formulations. In addition, many probiotic skin care products contain bacterially fermented ingredients, not necessarily live bacteria inducing fermentation.

Prebiotics are nutrients that encourage the growth of microbome organisms. Inulin is sometimes used topically for this purpose.

Postbiotic skin care products contain non-viable bacterial products or metabolic byproducts from probiotic bacteria. Postbiotics are produced during the fermentation process of probiotic bacteria. Examples of postbiotics include enzymes, peptides, peptidoglycan-derived muropeptides, polysaccharides, cell surface proteins, and organic acids. Postbiotics are really nothing new to dermatology because many currently marketed skin care products contain bacterial fermentation products, such as lactic acid and glycerol. The therapeutic value of these ingredients has been well established.

If prebiotics and probiotics are combined in the same skin care formulation, the resulting product is known as a synbiotic. Synbiotics contain both the nutrients for bacterial growth and the bacteria. It should be recognized, however, that all traditional topical and oral antibiotic treatments for acne modulate the microbiome by killing *C. acnes*.

Summary

This chapter discussed the various ingredients and ancillary skin care products for acne treatment in the current marketplace. Astringents represent a broad category and may impart both cleansing and moisturizing effects to the skin, depending on the formulation and skin type. Exfoliants, which became popular when glycolic acid was introduced to the cosmetic acne treatment marketplace, can contain both chemical and physical exfoliating ingredients to enhance the desquamation of the stratum corneum. Physical exfoliating agents are commonly packaged as particulate facial scrubs, woven sponges, or textured cloths. Textured cloths are the most recent introduction and can function like disposable washcloths or may leave behind ingredients on the skin surface. Mechanized skin care devices attempt to deliver at-home microdermabrasion with rotary, vibrating, or sonicating motors. Finally, face masks deliver skin care benefits. These are popular acne ingredients and devices that should be understood by a dermatologist.

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The use of cosmetics in a rosacea patient is very important to minimize inflammation and camouflage facial redness. Rosacea patients form a subset of sensitive skin, making the selection of skin care products and cosmetics problematic. Ingredients that typically cause no difficulty in an average patient can cause severe stinging and burning in a rosacea patient. Sometimes the adverse reaction can be invisible; more typically, it is characterized by the rapid onset of facial flushing. For this reason, developing a methodology for product recommendations in a rosacea patient becomes important. This chapter discusses a rationale for the selection of cleansers, moisturizers, cosmeceuticals, and facial cosmetics for rosacea patients.

Many skin care and cosmetic products are labeled as appropriate for sensitive skin, including the rosacea patient, but this term does not have any scientific definition. Most manufacturers who make this claim will test sensitive skin care products on a population consisting of at least 30% rosacea sufferers. Of the entire population, approximately 40% consider themselves to possess the characteristics of sensitive skin (1). Sensitive skin can be defined in both subjective and objective terms. Subjective perceptions of sensitive skin are derived from patient observations regarding stinging, burning, pruritus, and tightness following various environmental stimuli. These symptoms may be noticed immediately following product application or delayed by minutes, hours, or days (2). Furthermore, the symptoms may only result following a cumulative product application or with concomitant products. Objective perceptions of sensitive skin include the onset of facial flushing and/or inflammatory papules following application. An adverse reaction to a cosmetic or skin care product may elicit subjective and/or objective signs in a rosacea patient.

Testing of facial products in rosacea patients

Skin care and cosmetic products designed for rosacea patients must be specially tested as appropriate for sensitive skin. One method of testing is simply to employ an in-use model by enrolling 40–60 subjects with mild to moderate rosacea and asking them to use the newly developed product for four weeks while recording their perceptions in a diary. A dermatologist investigator can also assess the state of the subject's rosacea at two-week intervals for improvement or worsening related to the study product. This is the most basic type of test that should be performed.

The facial sting test is useful for the testing of skin care and cosmetic products to find out whether they are appropriate for rosacea sufferers.

A more sophisticated testing method should be performed to evaluate subsets of rosacea patients who may have more sensitive skin and a higher incidence of cosmetic problems. This method of evaluating product appropriateness for rosacea is to use a modification of the lactic acid facial stinging test (3). This test provokes a flare of rosacea by exposing the

skin to an irritating chemical, accompanied by heat. The test is performed by placing the rosacea patient in a warm facial sauna for 15 minutes or until profuse sweating and redness appear, followed by an application of a 5% aqueous solution of lactic acid at room temperature to one randomized nasolabial fold using brisk rubbing strokes of a cotton-tipped applicator. The product in question is applied to the other nasolabial fold, and the subject is asked to rate the stinging of both application areas. The subject is blinded as to the identity of the applied products, so as not to bias the stinging response. The patient rates the stinging at 2.5 and 5 minutes after application on an ordinal four-point scale (0 = no stinging, 1 = slight stinging, 2 = moderate stinging, 3 = severe stinging) (4, 5). Even though this test is quite artificial, it appears to correlate well with skin care and cosmetic products that might cause difficulty in rosacea patients, but this remains controversial (6). This type of challenge testing can be adapted for use in the dermatology office.

The most important part of the product testing for rosacea patients is the need to expose the facial skin to the cosmetic during a rosacea flare when active inflammation is present. Vasodilation and inflammatory mediator release must be present to get an accurate assessment. Products that sting on the face of a rosacea patient may provoke a flare, which is undesirable, and they should not be marketed as appropriate for sensitive skin. In general, rosacea patients can use skin care and cosmetic products from reputable manufacturers that are labeled as appropriate for sensitive skin.

Facial cleansers

Proper skin care can enhance rosacea treatment or, in some cases, totally negate a positive effect. No skin care act is more important than cleansing. Because *Demodex* and *Cutibacterium acnes* may be contributory in some forms of rosacea, skin cleansing is the first step to restoring and maintaining a healthy biofilm. Thorough cleansing is also necessary to control the growth of *Pityrosporum* species in patients with the overlap syndrome of rosacea and seborrheic dermatitis. In short, the goals of cleansing in a rosacea patient are to remove excess sebum, environmental debris, desquamating corneocytes, unwanted organisms, and old skin care and cosmetic products while leaving the skin barrier untouched. This can be a challenge because cleansers cannot distinguish between sebum and intercellular lipids, meaning that products that clean too well may be problematic (Figure 2.1). This discussion focuses on the use of the cleansers in rosacea patients with a variety of skin needs to include oily, normal, and dry skin. Cosmetic removal, cleansing devices, and problematic products are also discussed.

Facial cleansing assumes great importance in rosacea to maintain a healthy biofilm without damaging the skin barrier.



FIGURE 2.1 The typical inflamed appearance of a rosacea patient with an excessive-cleansing-induced irritation from surfactant barrier damage.

Oily skin

Many rosacea patients with highly sebaceous skin produce abundant sebum. Even though the skin is oily, over-cleansing will result in shiny, flaky skin. This is due to the barrier disruption created by the removal of the intercellular lipids that causes premature corneocyte desquamation followed by the subsequent reaccumulation of sebum. The face becomes over-dry immediately after cleansing, but turns oily again two to four hours after cleansing. This is a challenging situation because cleansing does not reduce sebum production; it only removes the sebum present at the time of cleansing. This observation accounts for the ill-founded belief of some rosacea patients that skin cleansing produces redness and increased sebum.

The most basic cleanser for oily skin is soap, created as a reaction between a fat and an alkali, resulting in a fatty acid salt with detergent properties (7). Soap is composed of long-chain fatty acid alkali salts with a pH of 9–10 (8). The high pH thoroughly removes sebum but can also damage the intercellular lipids. For persons with extremely oily skin, this type of cleanser may be appropriate (Ivory, Procter & Gamble). Aggressive scrubbing with a washcloth or other implements should be avoided when trying to remove copious sebum because the manipulation of the skin may provoke a rosacea flare. A better solution is to wash the face twice, each time removing more sebum. Gentle massaging of the cleanser into the skin with the hands followed by lukewarm water rinsing is the best. It is important to avoid exposing the face to water temperature extremes, which could provoke flushing.

Normal skin

There is no definition of normal skin; however, for this discussion, the term will refer to patients without oily or dry skin. Soap may remove too much sebum in this population, making syndet cleansers the preferred choice. Syndets, also known as synthetic detergents, contain less than 10% soap with an adjusted pH of 5.5–7. The neutral pH, closer to the natural pH of the skin, produces less irritation. In general, all beauty bars, mild cleansing bars, and sensitive skin bars are of the syndet variety (Dove, Unilever). The most commonly used detergent is sodium cocoyl isethionate. These cleansers also possess excellent rinsability,

meaning that a soap scum film is not left behind on the skin when used with water of varying hardness. This is an important property in sensitive-skin rosacea patients, where the soap film might produce irritation.

For rosacea patients who are concerned about body odor and desire a “squeaky clean” skin feel, another type of cleanser, known as a combars, is available. Combars are produced by combining an alkaline soap with a syndet to produce less aggressive sebum removal than a soap but more aggressive sebum removal than a syndet. Most of the combars also add an antibacterial, such as benzalkonium chloride, to provide odor control properties. These cleansers are commonly labeled as deodorant soaps (Dial, Henkel) (9). For rosacea patients with abundant sebum production and difficult-to-control pustules, this type of cleanser may be beneficial.

Dry and/or sensitive skin

Many rosacea patients possess sensitive skin that must be gently cleaned due to limited sebum production. These patients are usually mature postmenopausal women. Lipid-free cleansers represent a cleansing alternative for this population. Lipid-free cleansers (Cetaphil Cleanser, Galderma; CeraVe Cleanser, L’Oreal) are liquids that clean without fats, a point that distinguishes them from soaps. The cleanser is applied to dry or moistened skin, rubbed to produce a slight lather, and rinsed or wiped away. These products may contain water, glycerin, cetyl alcohol, stearyl alcohol, sodium laurel sulfate, and occasionally propylene glycol. They leave behind a thin moisturizing film but do not possess strong antibacterial properties. For this reason, lipid-free cleansers are excellent for the dry face but are not recommended for cleansing the groin or armpits. They also are not good at removing excessive environmental dirt or sebum.

Cosmetic removal

Lipid-free cleansers may also be used to remove cosmetics in the rosacea patient. They can be applied dry and rubbed over the eyelids, cheeks, and lips to remove both water-removable and water-resistant cosmetics and rinsed off with lukewarm water. If necessary, another cleanser can be used for additional cleaning. Many of the commercially marketed cosmetic removers contain solvents that are volatile and damaging to intercellular lipids, thus provoking rosacea.

Lipid-free or low-foaming cleansers are excellent for makeup removal in rosacea patients.

Another product for cosmetic removal is the cleansing cream. A cleansing cream is composed of water, mineral oil, petrolatum, and waxes (Albolene) (10). The most common variant of the cleansing cream, known as cold cream, is created by adding borax to mineral oil and beeswax (Pond’s Cold Cream) (11). These products are popular among mature women as they do cosmetic removal and mild cleansing in one step.

Cleansing devices

Cleansing devices combine a cleanser with an implement for washing the skin. The most common cleansing device is a disposable cleansing cloth impregnated with a cleanser. The cloth can be of polyester, rayon, cotton, and cellulose fibers, which are heated to produce a thermobond. Additional strength is imparted to

the cloth by hydroentangling the fibers with high pressure jets of water, which eliminates the need for adhesive binders. This creates a soft, durable cloth. The cloth can be packaged dry or wet typically with a syndet cleanser. Dry clothes are wetted before use.

Open weave cleansing cloths can be used to gently but thoroughly cleanse the face of rosacea patients.

The amount of sebum removal achieved by the cloth can be varied based on the amount of cleanser and the type of cloth weave. There are two types of fiber weaves used in facial cloths: open weave and closed weave. Open-weave cloths possess 2- to 3-mm windows between adjacent fiber bundles. These cloths are used on dry or sensitive skin because it increases the softness of the cloth and decreases the cleansing surface area. Closed-weave cloths, on the other hand, are designed with a much tighter weave and provide a more thorough cleansing, but also induce exfoliation. The exfoliation is intended to remove desquamating corneocytes. Although this may be beneficial in some rosacea patients, it may be problematic in others. The degree of exfoliation achieved is dependent on the cloth weave, the pressure with which the cloth is stroked over the skin surface, and the length of time the cloth is applied. Individuals with sensitive skin may wish to consider using an open-weave cloth gently over the face once weekly for mild exfoliation.

Moisturizing cleansing cloths are also available and may be the preferable choice for rosacea patients. The cloth has two sides, which may be differently designed to deliver different benefits. Moisturizing cloths contain a cleanser on the textured side and a moisturizer on the smooth side. The cloth is dipped in water to wet it; the textured side of it is used first to clean and gently exfoliate the skin; then the cloth is rinsed. The cloth is then turned over, and the face is rinsed and moisturized simultaneously. This cloth technology can also be used for cosmetic removal in some patients.

A variant of the cleansing cloth is the cleansing pouch. Fusing two cleansing cloths around skin cleansing and conditioning ingredients creates the cleansing pouch. A plastic membrane is placed between two fiber cloths containing holes of various diameters to control the release of ingredients onto the skin surface. Many times the cleansing pouches contain a variety of botanicals, which may be problematic in rosacea patients.

Problematic cleansers and cleansing implements

Other cleansers and cleansing implements may also be problematic in rosacea patients. Products that induce aggressive exfoliation, such as abrasive scrubs, may provoke flushing. Abrasive scrubs incorporate polyethylene beads, aluminum oxide, ground fruit pits, or sodium tetraborate decahydrate granules to induce various degrees of exfoliation (12). The most aggressive exfoliation is produced by irregularly shaped aluminum oxide particles and ground fruit pits, which should be avoided by rosacea patients. Milder exfoliation is produced by polyethylene beads, which possess a smooth, rounded surface. The least aggressive exfoliation is produced by sodium tetraborate decahydrate granules, which soften and dissolve during use.

Aggressive facial cleansers and scrubbing implements should be avoided for rosacea patients.

Another form of aggressive exfoliation is produced by sponges composed of nonwoven polyester fibers (Buf Puf) (13). These sponges are too aggressive for most of the rosacea patients. Rosacea patients have sensitive skin that must be handled gently, like a fine silk scarf. Pulling, tugging, rubbing vigorously, and strong cleansers will ruin a silk scarf immediately and are not recommended for the rosacea patient with sensitive skin. Some rosacea sufferers scrub their faces mercilessly hoping to cleanse away the inflammatory lesions and redness, when in actuality they are only worsening the barrier damage. However, barrier damage repair can be facilitated with moisturizers, the next topic for discussion.

Facial moisturizers

Moisturizers are important to provide an environment suitable for barrier repair in the rosacea patient. Facial moisturizers are the most important cosmetic in the prevention of a facial rosacea flare (Figure 2.2). These moisturizers attempt to mimic the effect of sebum and the intercellular lipids composed of sphingolipids, free sterols, and free fatty acids. They intend to provide an environment allowing the stratum corneum barrier to heal by replacing the corneocytes and the intercellular lipids. Yet, the moisturizing substances must not occlude the sweat ducts, or miliaria will result; must not produce irritation at the follicular ostia, or an acneiform eruption will break out; and must not



FIGURE 2.2 An example of the anti-inflammatory facial moisturizers available for rosacea patients, which are typically labeled as redness-reducing moisturizers.

initiate comedone formation. Furthermore, the facial moisturizer must not produce noxious sensory stimuli, which may also provoke a rosacea flare.

Moisturizers are used to heal the barrier-damaged skin by minimizing transepidermal water loss (TEWL) and creating an environment optimal for rosacea control. Three categories of substances that can be combined to enhance the water content of the skin are occlusives, humectants, and hydrocolloids. Occlusives are oily substances that retard TEWL by placing an oil slick over the skin surface, whereas humectants are substances that attract water to the skin, not from the environment, unless the ambient humidity is 70%, but rather from the inner layers of the skin. Humectants draw water from the viable dermis into the viable epidermis, and then from the nonviable epidermis into the stratum corneum. Finally, hydrocolloids are physically large substances that cover the skin, thus retarding TEWL.

Moisturizers to prevent facial rosacea flares combine with occlusive agents and humectant agents to prevent water loss, attract water, and facilitate barrier repair, respectively.

The best moisturizers to prevent facial rosacea flares combine occlusive and humectant ingredients. For example, a well-formulated moisturizer might contain petrolatum, mineral oil, and dimethicone as occlusive agents. Petrolatum is the synthetic substance that is most like intercellular lipids, but too high a concentration will yield a sticky greasy ointment. The aesthetics of petrolatum can be improved by adding dimethicone, which can also prevent water loss but reduces the petrolatum concentration and yields a thinner, more acceptable formulation. Mineral oil is not quite as greasy as petrolatum, but still an excellent barrier repair agent; it further improves the ability of the moisturizer to spread, yielding enhanced aesthetics. The addition of glycerin to the formulation attracts water from the dermis, speeding up hydration. It is through the careful combination of these ingredients that facial moisturizers can be constructed to prevent a rosacea flare.

Facial cosmeceuticals

Cosmeceuticals are OTC moisturizers with various active ingredients designed to enhance the appearance of the skin. Most of the cosmeceuticals designed for rosacea patients contain anti-inflammatory agents that are intended to reduce redness. The anti-inflammatory agents are botanical extracts that may complement prescription therapy in the maintenance phase of rosacea treatment. Commonly used botanical anti-inflammatory agents in the current marketplace include *Ginkgo biloba*, green tea, aloe vera, allantoin, and licochalcone. Their rationale for use in redness-reducing cosmeceuticals is discussed.

Cosmeceuticals for rosacea patients generally contain anti-inflammatory agents to reduce facial redness.

Ginkgo biloba

G. biloba leaves contain unique polyphenols such as terpenoids (ginkgolides, bilobalides), flavonoids, and flavonoid glycosides

with anti-inflammatory effects. These anti-inflammatory effects have been linked to antiradical and antilipoperoxidant effects in experimental fibroblast models. *Ginkgo* leaves are also purported to alter skin microcirculation by reducing blood flow at the capillary level and inducing a vasomotor change in the arterioles of the subpapillary skin plexus. Taken together, these changes may lead to decreased skin redness.

Green tea

Green tea, also known as *Camellia sinensis*, is another anti-inflammatory botanical agent containing polyphenols, such as epicatechin, epicatechin-3-gallate, epigallocatechin, and epigallocatechin-3-gallate. The term “green tea” refers to the manufacture of the botanical extract from fresh leaves of the tea plant by steaming and drying at elevated temperatures, avoiding oxidation and polymerization of the polyphenolic components. A study by Katiyar et al. demonstrated the anti-inflammatory effects of topical green tea application on C3H mice (14). A second study by the same authors found that topically applied green tea extract containing epigallocatechin-3-gallate reduced the UVB-induced inflammation as measured by double skin-fold swelling (15). Green tea extracts are the most commonly used botanical anti-inflammatory cosmeceutical at the time of this writing.

Aloe vera

The second-most commonly used anti-inflammatory botanical herb is aloe vera. The mucilage is released from the plant leaves as a colorless gel and contains 99.5% water and a complex mixture of mucopolysaccharides, amino acids, hydroxy quinone glycosides, and minerals. Compounds isolated from aloe vera juice include aloin, aloe emodin, aletinic acid, choline, and choline salicylate. The reported cutaneous effects of aloe vera relevant to rosacea include reduced inflammation, decreased skin bacterial colonization, and enhanced wound healing. The anti-inflammatory effects of aloe vera may result from its ability to inhibit cyclooxygenase as part of the arachidonic acid pathway through the choline salicylate component of the juice. However, the final concentration of aloe vera in any moisturizer must be at least 10% to achieve a cosmeceutical effect relevant for rosacea patients.

Allantoin

Allantoin is the oldest anti-inflammatory ingredient added to many moisturizers labeled as appropriate for sensitive skin. It is found naturally in the comfrey root but usually synthesized by the alkaline oxidation of uric acid in a cold environment. Allantoin is a white crystalline powder readily soluble in hot water, making it easy to formulate in cream and lotion moisturizers designed for sensitive skin. It is called a skin protectant and may be helpful in redness reduction.

Licochalcone A

Licochalcone A is isolated by heating the root of the *Glycyrrhiza inflata* licorice plant. It possesses anti-inflammatory properties, as evidenced by its in vitro ability to inhibit the keratinocyte release of PGE₂ in response to UVB-induced erythema and the lipopolysaccharide-induced release of PGE₂ by adult dermal fibroblasts (16). Licochalcone A is the active agent in one of the largest product lines currently sold internationally for redness reduction.

Bisabolol

Alpha-bisabolol is the antioxidant anti-inflammatory in chamomile, which comes from a yellow flower that is used to make

calming chamomile tea. It is a colorless viscous oil that is usually found in its synthetic form in cosmetics. Mice studies demonstrate that bisabolol inhibits pro-inflammatory cytokines, which is its basis for inclusion in redness-reducing formulations.

Feverfew

Feverfew is a herbaceous perennial that grows as a small bush with daisy-like flowers. Feverfew is found in facial redness-reducing formulations and is scientifically known as *Tanacetum parthenium*. It, too, has anti-inflammatory, antioxidant properties like most ingredients in cosmetic redness products; however, here the active ingredient is parthenolide. It is thought that parthenolide can bind and inhibit IKK-beta, which is important in cytokine-mediated signaling. In skin equivalents, it was shown to decrease UV-induced reactive oxygen species, thus functioning as an antioxidant.

Centella asiatica extract

Centella asiatica, also known as tiger grass, is native to Africa and Asia and contains a variety of pentacyclic triterpenoids and trisaccharides. The main active ingredients for redness reduction include asiaticoside, asiatic acid, medecassic acid, and madecassoside. These also function as antioxidant anti-inflammatory ingredients.

Azelaic acid

Azelaic acid is used in both prescription and OTC rosacea treatments. Azelaic acid is derived from the commensal skin fungus *Malassezia furfur*; however, it is industrially produced by the ozonolysis of oleic acid. It is a potent antioxidant and anti-inflammatory, accounting for its use in rosacea treatment. Because it is a natural product, it can be used in OTC rosacea formulations.

Lapachol

One of the newest ingredients for redness reduction in the cosmetic market is lapachol (2-hydroxy-3-(3-methyl-2-butenyl)-1,4-naphthoquinone), also known as pau d'arco. It was identified in 1882 and is derived from the inner bark of the *Tabebuia* tree, native to Central and South America. It is used in folk medicine both topically and orally as an anti-inflammatory, but has also been shown to exhibit antibacterial, antifungal, and anticancer activities. The bark extract is thought to produce anti-inflammatory and antinociceptive effects by inhibiting the release of histamine. For this reason, lapachol is used to decrease the facial itching and redness associated with rosacea.

Facial camouflage cosmetics

Many times, a complete redness reduction with pharmaceuticals and skin care products is impossible due to the presence of telangiectasias, which cannot be addressed with either treatment modality. This leaves colored cosmetics as a viable alternative for all female rosacea patients, and possibly some males. The cosmetics can camouflage the underlying redness by either blending colors or concealing the underlying skin to achieve a more desirable appearance.

Green moisturizers are useful for rosacea patients, in minimizing facial redness under a facial foundation.

The art of blending colors to minimize facial redness utilizes a color complementary to red, which is green. Moisturizers with a slight green tint are applied after the prescription medication and well blended. Because the mixture of red and green produces brown, the sheer green tint will tone down bright red cheeks. Sometimes, a tan facial foundation is applied over the green tint to match the desired skin color. The green tint allows a sheer facial foundation to better camouflage the red tones. If the red remains apparent, a more translucent or even opaque facial foundation can be used.

Troubleshooting facial cosmetics and skin care in rosacea patients

Occasionally, a rosacea patient will present who cannot use any topical medications and skin care or cosmetic products without an adverse effect. The dermatologist may at first think that the patient is histrionic because these patients present with a basket full of problematic products and will have usually seen multiple dermatologists. In this case, it may be worthwhile to embark on a logical elimination scheme to determine which products can and cannot be tolerated. This discussion introduces an algorithm for dealing with these difficult patients, based more on the art of medicine than the science, that first discontinues all unnecessary products and then reintroduces them systematically. The algorithm is outlined as follows:

1. Discontinue all topical cosmetics, OTC treatment products, cleansers, moisturizers, and fragrances. Use only a lipid-free cleanser and a bland moisturizing cream for two weeks.
2. Discontinue all topical prescription medications for two weeks. Especially, avoid medications containing retinoids, benzoyl peroxide, glycolic acid, and propylene glycol. Oral medications for rosacea may be continued.
3. Eliminate all sources of skin friction by selecting loose, soft clothing.
4. Discontinue any physical activities that involve skin friction, such as weight lifting, running, or horseback riding.
5. Evaluate the patient at two weeks to determine whether any improvement has occurred or whether any concomitant dermatoses are present. If an underlying dermatosis, such as seborrheic dermatitis, psoriasis, eczema, atopic dermatitis, or perioral dermatitis appears, treat as appropriate until two weeks after all visible signs of the newly diagnosed skin disease have disappeared.
6. Patch test the patient to elicit any allergens with the standard dermatologic patch test substances. Determine which of these allergens are clinically relevant and make avoidance recommendations.
7. Evaluate the patient's mental status especially, noting signs of depression, menopause, or psychiatric disease.
8. Allow the female patient to add one facial cosmetic in the following order: lipstick, face powder, blush.
9. Test all remaining cosmetics used by the patient by applying nightly to a 2-cm area lateral to the eye for at least five consecutive nights. Cosmetics should be tested in the following order: mascara, eyeliner, eyebrow pencil, eye shadow, facial foundation, blush, facial powder, and any other colored facial cosmetics.
10. Finally, test all topical rosacea medications by applying nightly to a 2-cm area lateral to the eye for five consecutive nights.

11. Analyze all data and present the patient with a list of medications, skin care products, and cosmetics that are appropriate for use.

This is indeed a time-consuming undertaking, but it is a thorough approach to determining the topical products that are appropriate for the challenging patient.

Summary

Rosacea patients are a challenge to the dermatologist, who aims to give practical advice on the selection of skin care and cosmetic products. This chapter has discussed the variety of cleansers, moisturizers, and cosmeceuticals in the current marketplace that may or may not be appropriate for rosacea patients. The key to success lies in customizing a skin treatment regimen for each patient. Identifying the skin needs and prescribing products that match those needs will not only treat rosacea but satisfy the patient. An approach for identifying products suitable for the problematic patient has also been presented. The concepts discussed in this chapter should provide ideas for supplementing traditional rosacea therapy with skin care and cosmetic products.

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3

FACIAL MOISTURIZERS AND ECZEMA

Facial moisturizers are some of the most important over-the-counter skin care products. Dramatic changes are induced in the skin through the addition or removal of water. A well-hydrated facial skin is soft, smooth, and beautiful, whereas poorly hydrated facial skin is rough, harsh, and unattractive (Figure 3.1). The main effect produced by most cosmeceuticals that are designed to minimize the appearance of wrinkles is excellent skin hydration. Conditions ranging from facial wrinkles of dehydration to facial eczema are treated by moisturization.

Various terms are used by the cosmetics industry to describe the effects of creams and lotions: lubricants, moisturizers, repair or replenishing products, emollients, etc. These terms do not have a scientific meaning because the mechanisms for rehydrating dry skin or rejuvenating damaged skin remain to be elucidated. In basic terms, lubricants refer to those products that increase skin slip in dry skin that is rough and flaky; moisturizers impart moisture to the skin by increasing the skin flexibility; and repair or replenishing products are intended to reverse the appearance of aging skin. All three classes of products are based on emollients. An understanding of the function of facial moisturizers and their formulation is essential to the dermatologist, who must maintain the health of facial skin once the dermatitis has resolved (1).

Physiology of xerosis

Xerosis is a result of decreased water content of the stratum corneum which leads to abnormal desquamation of corneocytes (Figure 3.2). For the skin to appear and feel normal, the water content of this layer must be above 10% (2). Water is lost through evaporation to the environment under low humidity conditions and must be replenished by water from the lower epidermal and dermal layers (3). The stratum corneum must have the ability to maintain this moisture, or the skin will feel rough, scaly, and dry. However, this is indeed a simplistic view because there are minimal differences between the amount of water present in the stratum corneum of dry and normal skin (4). Xerotic skin is due to more than simply low water content (5). Electron micrographic studies of dry skin demonstrate a stratum corneum that is thicker, fissured, and disorganized (Figure 3.3).

Water is lost through evaporation to the environment under low humidity conditions and must be replenished by water from the lower epidermal and dermal layers.

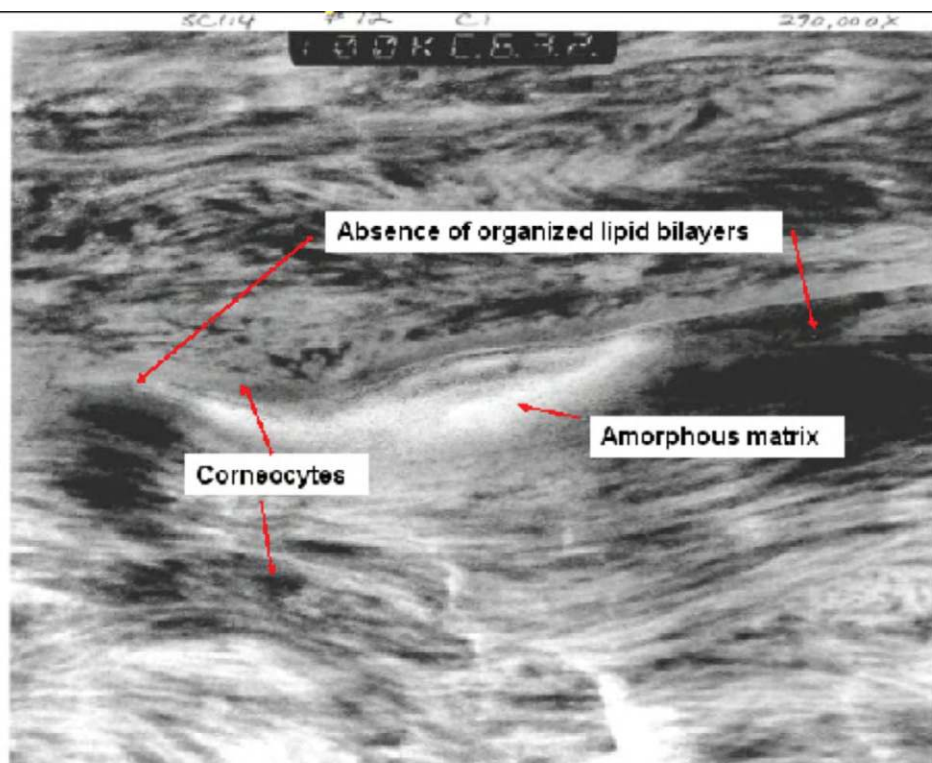


FIGURE 3.1 A scanning electron microscope image of xerotic skin with barrier damage demonstrated by the presence of a disorganized lipid bilayer.

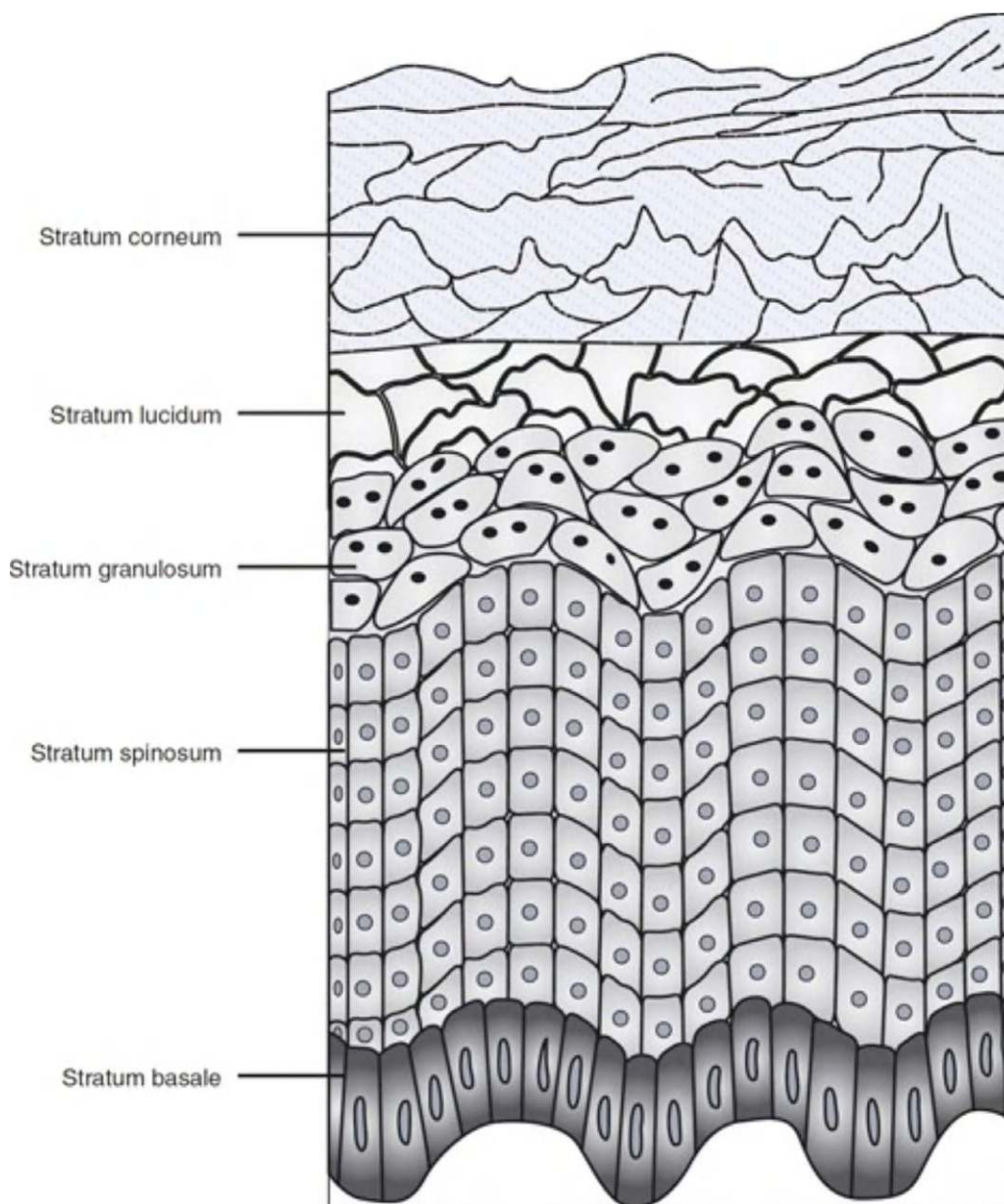


FIGURE 3.2 The process of corneocyte maturation requires a progressive dehydration of the cells as they move from the basal layer to the stratum corneum.

There are three intercellular lipids implicated in epidermal barrier function: sphingolipids, free sterols, and free fatty acids (6). In addition, it is thought that the lamellar bodies (Odland bodies, membrane-coating granules, and cementsomes), which contain sphingolipids, free sterols, and phospholipids, play a key role in barrier function and are essential to trap water and prevent excessive water loss (7, 8). The lipids are necessary for barrier function because solvent extraction of these chemicals leads to xerosis, directly proportional to the amount of lipid removed (9). The major lipid by weight found in the stratum corneum is ceramide, which becomes a sphingolipid if glycosylated via the primary alcohol of sphingosine (10). Ceramides have most of the long-chain fatty acids and linoleic acid in the skin. Perturbations within the barrier result in rapid lamellar body secretion and a cascade of cytokine changes associated with adhesion molecule expression and growth factor production (11). If skin with barrier

perturbations is occluded with a vapor-impermeable wrap, the expected burst in lipid synthesis is blocked. However, occlusion with a vapor-permeable wrap does not prevent barrier recovery (12). Therefore, transepidermal water loss (TEWL) is necessary to initiate synthesis of lipids to allow barrier repair (13, 14).

The three intercellular lipids implicated in epidermal barrier function are sphingolipids, free sterols, and free fatty acids.

Remoisturization of the skin must then occur in four steps: initiation of barrier repair, alteration of surface cutaneous moisture partition coefficient, onset of dermal-epidermal moisture diffusion, and synthesis of intercellular lipids (15). It is generally

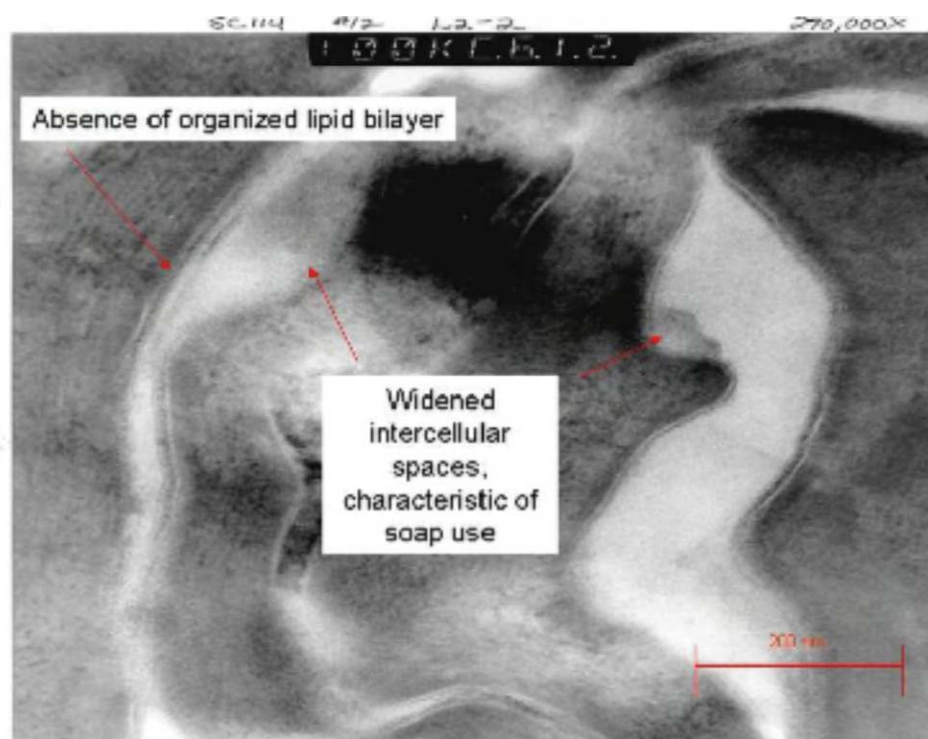


FIGURE 3.3 A scanning electron microscope image of surfactant-induced dry skin with barrier damage.

thought in the cosmetics industry that a stratum corneum containing 20–35% water will exhibit the softness and pliability of normal stratum corneum (16).

Other disease states, such as facial atopic dermatitis, also demonstrate abnormal barrier function due to ceramide distribution (17, 18). Interestingly enough, xerosis tends to increase with age due to a lower inherent water content of the stratum corneum (19). However, this does not totally account for the scaliness and roughness of aged skin; probably an abnormal desquamatory process is also present (20).

There are other lipids present in the stratum corneum, in addition to those previously discussed, that are worth mentioning: cholesterol sulfate, free sterols, free fatty acids, triglycerides, sterol wax/esters, squalene, and n-alkanes (21). Cholesterol sulfate only comprises 2–3% of the total epidermal lipids but is important in corneocyte desquamation (22). It appears that corneocyte desquamation is mediated through the desulfation of cholesterol sulfate (23). Fatty acids are also important because it has been demonstrated that barrier function can be restored by topical or systemic administration of linoleic acid-rich oils in essential fatty acid-deficient rats (24).

Goals of a facial moisturizer

In order of consumer perceived importance, there are four basic goals for a facial moisturizer: make the skin smooth and soft, increase skin hydration, improve appearance, and possibly deliver a cosmeceutical ingredient to the skin surface. A moisturizer that does not deliver on these four attributes cannot be a success in the marketplace. These concepts are explored next in more detail.

1. Improved skin smoothness and softness

The most basic consumer need achieved by moisturizer application is smooth and soft skin. All moisturizers in the current

marketplace make the skin smooth and soft; however, better formulations are longer lasting. Skin that is smooth and soft is an assessment of the organization of the corneocytes on the skin surface. As the intercellular lipids are removed, the edges of the corneocytes fold, creating friction as the hand is rubbed across the skin surface. Creating smooth and soft skin utilizes emollients, which are thin, oily substances capable of depositing between the desquamating corneocytes temporarily until the next cleansing, at which time they must be reapplied.

2. Increased skin hydration

Moisturizers that are medically relevant must increase skin hydration by retarding water loss from the skin surface, also known as TEWL. This is accomplished by placing a water-impermeable film over the skin to retard evaporation and by applying substances to the skin surface to attract water. Moisturizers do not moisturize the skin, which is a misnomer. Only through skin barrier repair can TEWL be permanently returned to normal levels.

Increased skin hydration is the mechanism by which most cosmeceuticals decrease fine lines of dehydration, especially those around the eye, where the skin is thinnest. Retarding TEWL will hydrate this skin temporarily until the moisturizer is removed with cleansing. Although wrinkle reduction may appear to be a functional benefit, it is a result of increased skin hydration that will be temporary unless skin barrier repair occurs.

3. Improved optical appearance

A lesser moisturizer goal is to improve skin appearance, a characteristic known as radiance or luminosity. These attributes are the appreciation of the amount of light reflected by the skin surface back into the eye of the observer, which is directly related to the smoothness of the skin surface. With advancing age, skin melanin, hemoglobin, and collagen distribution become more irregular.

Cosmeceutical moisturizers capable of delivering a lightly pigmented film to the skin surface or enhancing light reflection from the skin surface may improve the optical appearance of the skin. Pigments, such as iron oxide, and optically reflective materials, such as mica or fish scale, can be added to moisturizers to create anti-aging appearance benefits.

The primary two methods for remoisturization of the skin are occlusives and humectants.

Mechanisms of moisturization

There are four mechanisms by which the stratum corneum can be rehydrated: occlusives, humectants, hydrophilic matrices, and sunscreens (25).

Occlusives

There are 20 different generic classes of chemicals that can function as occlusives to retard TEWL. Each chemical imparts a different feel and thickness to the moisturizer. The following list presents some of the more widely used substances (26):

1. *Hydrocarbon oils and waxes*: petrolatum, mineral oil, paraffin, and squalene
2. *Oils*: Silicone oils
3. *Fats*: Vegetable and animal fats
4. *Fatty acids*: lanolin acid and stearic acid
5. *Fatty alcohol*: lanolin alcohol and cetyl alcohol
6. *Polyhydric alcohols*: propylene glycol
7. *Wax esters*: lanolin, beeswax, and stearyl stearate
8. *Vegetable waxes*: carnauba and candelilla
9. *Phospholipids*: lecithin
10. *Sterols*: cholesterol

The most occlusive of the above chemicals is petrolatum (27). It appears, however, that total occlusion of the stratum corneum is undesirable. Although the TEWL can be completely halted, once the occlusive is removed, water loss resumes at its preapplication level. Thus, the occlusive moisturizer has not allowed the stratum corneum to repair its barrier function (28). However, petrolatum does not appear to function as an impermeable barrier; rather, it permeates throughout the interstices of the stratum corneum allowing the barrier function to be reestablished (29).

Petrolatum remains the most effective occlusive moisturizing agent.

Although petrolatum is a very effective facial moisturizer, it is not commonly used, except in formulations for very dry skin. It is very greasy and does not allow makeup to perform well. It also does not allow sweat to evaporate from the skin surface, creating the feeling of warmth. Finally, it stains clothing. Petrolatum is used in small amounts in facial moisturizers but is usually mixed with dimethicone and cetyl alcohol to make a more cosmetically acceptable formulation. This need for cosmetic elegance has led to all the countless facial moisturizers on the market today.

Humectants

Another concept in rehydrating the facial stratum corneum is the use of humectants. Humectants have been used in cosmetics for many years to increase the shelf life by preventing product evaporation and subsequent thickening due to variations in temperature and humidity. For example, humectants are a necessary part of all oil-in-water creams to maintain their required water content. Substances that function as humectants are glycerin, honey, sodium lactate, urea, propylene glycol, sorbitol, pyrrolidone carboxylic acid, gelatin, hyaluronic acid, vitamins, and some proteins (26, 30).

Cosmetic chemists have theorized that humectants could be used to draw water from the environment under conditions where the ambient humidity exceeds 70%, and more commonly from the deeper epidermal and dermal tissues to rehydrate the stratum corneum. Water that is applied to the skin in the absence of a humectant is rapidly lost to the atmosphere (31). Humectants may also allow the skin to feel smoother by filling holes in the stratum corneum through swelling (32). However, under low-humidity conditions, humectants such as glycerin will actually draw moisture from the skin and increase TEWL (33). Therefore, a good moisturizer should combine both occlusive and humectant properties.

Glycerin is mixed with occlusive petrolatum and dimethicone in many facial moisturizers to aid in drawing water to the skin surface that is held in place by the artificial barrier. Too much glycerin can make the facial moisturizer sticky by holding sweat to the skin surface. Other humectants, such as vitamins and proteins, are added to complement the effect of glycerin. Although the patient may believe that the proteins or peptides are affecting skin collagen, they are in actuality preventing facial skin water loss by humectancy. This is the art of facial moisturizer formulation.

Hydrophilic matrices

Hydrophilic matrices are high-molecular-weight substances that physically retard water loss from the face. Some of the more recent advances in facial moisturization have been in this category. Topical hyaluronic acid is a high-molecular-weight substance that is one of the newer hydrophilic matrices found in facial moisturizers. It sits on the skin surface, physically blocks water loss, and functions as a humectant to hold water. Many proteins also function as humectants and hydrophilic matrices simultaneously. One manufacturer produces a facial moisturizer based on colloidal oatmeal, familiar to dermatologists from the oatmeal bath, which also physically prevents water loss. Hydrophilic matrices are the least commonly used moisturizing mechanism in facial moisturizers.

Hydrophilic moisturizers are large molecular weight substances that impede water loss.

Sunscreens

The most potent antiaging ingredient in any facial moisturizer is sunscreen. As a matter of fact, most of the claims that deal with aging are supported by the sunscreen primarily and the moisturizer secondarily. It is widely felt that protection against UVB and UVA radiation is beneficial in the prevention of skin aging, but this theory has never been tested, only observed. Sunscreens are

listed as moisturizers because they prevent cellular damage and thus prevent dehydration. Sunscreens are considered moisturizing ingredients but do not alter facial skin water loss in the profound manner of occlusive and humectant ingredients.

Mechanisms of emollience

Emollience is another important characteristic of moisturizers, independent of their ability to increase skin hydration. Emollients function by filling the spaces between the desquamating corneocytes with oil droplets (34), but their effect is only temporary. They make the skin feel smooth and soft, which is the primary facial moisturizer attribute addressed by most patients (Figure 3.4). Some moisturizing ingredients are emollients, but not all emollients are moisturizing ingredients.

Emollients function by filling the spaces between the desquamating corneocytes, making the skin feel smooth and soft.

Emollients can be divided into several categories: protective emollients, fattening emollients, dry emollients, and astringent emollients (35). Protective emollients are substances such as diisopropyl dilinoleate and isopropyl isostearate that remain on the skin longer than average time and allow the skin to feel smooth immediately upon application. Fattening emollients, such as castor oil, propylene glycol, jojoba oil, isostearyl isostearate, and octyl stearate, also leave a long-lasting film on the skin but may feel greasy. Dry emollients such as isopropyl palmitate, decyl oleate, and isostearyl alcohol do not offer much skin protection but produce a dry feel. Finally, astringent emollients, such as dimethicones and cyclomethicones, isopropyl myristate and octyl octanoate, have minimal greasy residue and can reduce the oily feel of other emollients.

Dimethicone can function as an emollient and as an occlusive moisturizer.



FIGURE 3.4 Most patients evaluate the efficacy of a moisturizer for its emollient properties, not for its barrier repair properties.

Basic facial moisturizer types

1. Creams and lotions

Creams and lotions are emulsions containing hydrophilic and hydrophobic ingredients. Creams generally have a higher viscosity, whereas lotions are thinner with a lower viscosity; however, there is no viscosity that defines a cream or a lotion. Acrylic-based polymers, such as carbomers, which are cross-linked polyacrylate polymers, are used to thicken the product and control viscosity. In either viscosity, the emulsion can be oil-in-water (O/W), where the oil is emulsified into the water, or water-in-oil (W/O), where the water is emulsified into the oil. O/W emulsions are the most popular for cosmeceutical use; however, emulsifiers are responsible for many of the problems associated with moisturizers because they can also solubilize intercellular lipids. Liquid crystal forming emulsifiers that do not damage the intercellular lipids include lecithin or hydrogenated lecithin. Other skin-friendly emulsifiers include behentrimonium methosulfate and dicetyldimonium chloride.

2. Ointments

Ointments are anhydrous semisolid preparations composed of fats, waxes, animal and plant oils, and hydrocarbons. Because they do not include the water necessary for microbial growth, they can be formulated without preservatives or with a low preservative load. By definition, they are also waterproof, but they possess poor aesthetics because they are sticky and stain clothing. This cosmeceutical formulation may be preferred in patients with extremely dry skin or preservative allergies, but very few cosmeceutical moisturizers and many therapeutic moisturizers fall into this category.

3. Serums

A new formulation in cosmeceuticals is the serum, a thin water- or oil-based product applied to freshly washed skin. The serum provides minimal moisturization benefits but is used to apply an active agent to the skin beneath a moisturizer. Because the serum formulation is not necessarily an emulsion, it does not require emulsifiers, which could damage the active ingredient. Usually, the serum has few ingredients designed to optimize the availability of the active agent, which may be a vitamin, growth factor, botanical extract, and so on.

Facial moisturizer formulation

Most moisturizers consist of water, lipids, emulsifiers, preservatives, fragrance, color, and specialty additives. Interestingly, water accounts for 60–80% of any moisturizer; however, externally applied water does not moisturize the face. In fact, the rate of water passage through the skin increases with increased hydration (36). The water functions as a diluent and evaporates, leaving the active agents behind. Emulsifiers are generally soaps in concentrations of 0.5% or less and function to keep the water and lipids in one continuous phase. Parabens are the most commonly used preservatives in moisturizers, usually combined with one of the formaldehyde donor preservatives (15). The variety of specialty additives incorporated into moisturizers is endless, limited only by the imagination of the cosmetic chemist (Figure 3.5).

Facial moisturizers consist of water, lipids, emulsifiers, preservatives, fragrance, color, and specialty additives.



FIGURE 3.5 The ability of a moisturizer to create an environment for facial barrier repair cannot be assessed by visually inspecting the viscosity properties of the product.

A marketable moisturizer facial formulation must fulfill three criteria: it must increase the water content of the skin (moisturization), make the skin feel smooth and soft (emollience), and protect injured or exposed skin from harmful or annoying stimuli (skin protection).

Facial moisturizers and related products are the fastest growing cosmetic market (Figure 3.6). There are two basic formulations: O/W emulsions, in which water is the dominant phase, and W/O emulsions, in which oil is the dominant phase. O/W formulations are used for the thinner daytime facial moisturizers, and W/O formulations are used for night creams or facial replenishing creams. O/W emulsions can be identified by their cool feel and nonglossy appearance, whereas W/O emulsions can be identified by their warm feel and glossy appearance (37). Daytime moisturizers are generally composed of mineral oil, propylene glycol, and water in sufficient quantity to form a lotion (Figure 3.7). Night creams are composed of mineral oil, lanolin alcohol, petrolatum, and water to form a cream (Figure 3.8). Specialized eye creams are night creams with some of the more irritating ingredients removed to prevent eye stinging. The differences between products thus lie in



FIGURE 3.6 Facial moisturizers improve appearance by hydrating fine lines of dehydration, especially around the eyes.



FIGURE 3.7 A demonstration of the viscosity of a day cream formulation.

the addition of fragrances, exotic oils, vitamins, protein or amino acid products, and other minor moisturizing aids.

The plethora of facial moisturizers has made categorization of the various products difficult; however, a brief look at the claims and composition of some key products is valuable. The cosmetic companies market facial moisturizers based on skin types. Naturally, products designed for oily complexions are oil-free or contain small amounts of light oils. Products for normal skin contain moderate amounts of light oils, and products for dry skin contain increased amounts of heavier oils. The lighter oil used is generally mineral oil, and the heavier oil is petrolatum. Thus, moisturizing products can be developed for all skin types based on varying water-to-oil ratios.

Oily complexion moisturizers are oil-free and composed of water and silicone derivatives, such as cyclomethicone or dimethicone.

Oily complexion products that are oil-free are composed of water and silicone derivatives, such as cyclomethicone or dimethicone.



FIGURE 3.8 A demonstration of the viscosity of a night cream formulation.

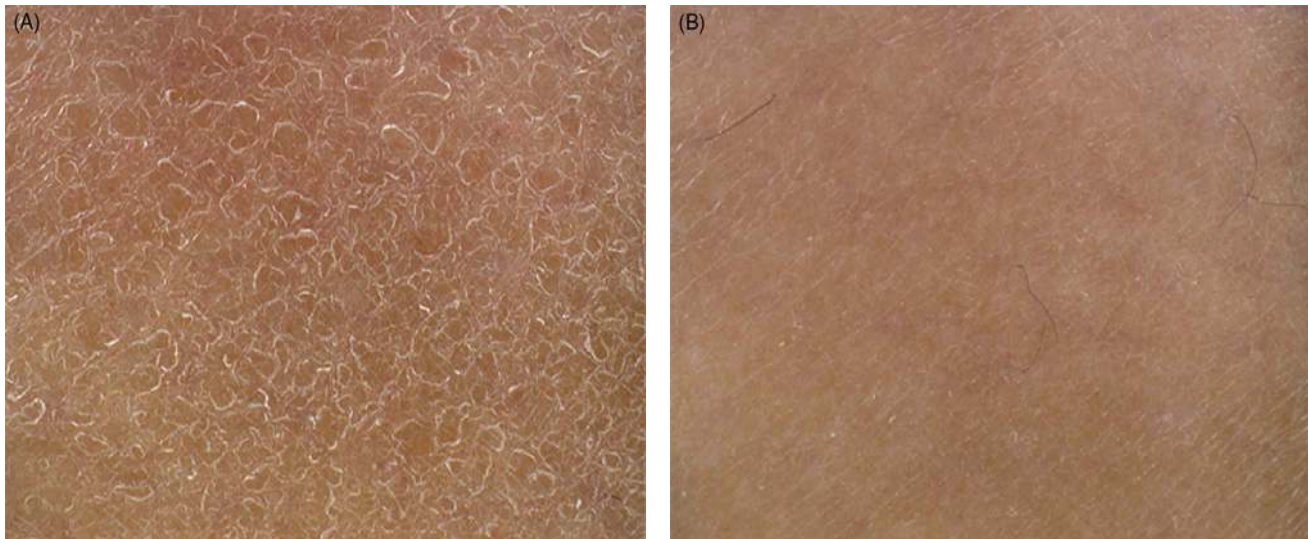


FIGURE 3.9 (A) The appearance of dry skin prior to application of a moisturizer. (B) The same dry skin in (A) immediately following moisturizer application which has smoothed the skin scale temporarily and improved the appearance.

This combination has been shown to be noncomedogenic in the rabbit ear assay. These products are nongreasy because the bulk of the product evaporates from the face. Many oily complexion moisturizers also claim to provide oil control, which is accomplished through the use of oil-absorbing substances such as talc, clay, starch, or synthetic polymers.

Products designed for normal or combination skin contain predominantly water, mineral oil, and propylene glycol with very small amounts of petrolatum. These products leave a greater oily residue on the face than oil-free formulations. Moisturizers in this line are also called anti-wrinkle lotions, protective creams, or sport creams if they contain sunscreening agents.

Normal skin facial moisturizers are composed predominantly of water, mineral oil, and propylene glycol with very small amounts of petrolatum.

Dry skin moisturizers contain water, mineral oil, propylene glycol, and larger amounts of petrolatum or lanolin in addition to low concentrations of numerous additives claiming to rebuild, renew, or replenish. The patients should realize that there is no perfect skin moisturizer. Creams and lotions that claim to restore or rebuild tissue in the dermis do not penetrate deeply enough to have any effect. The extremely high cost of some moisturizers is not justified by the value of the ingredients. Patients are buying a certain feel, fragrance, or image. If the patient achieves more self-confidence or an increased sense of well-being after using a certain facial cream, the money has been well spent. The role of the physician should be to identify cosmetic claims that are unfounded, so the patient has a medical perspective on the product he or she chooses to purchase.

Dry skin facial moisturizers contain water, mineral oil, propylene glycol, and larger amounts of petrolatum.

It is important that the patient select the appropriate facial moisturizer for his or her skin type. Most cosmetic companies clearly label which moisturizers are for oily, normal, and dry skin. Even though patients with oily skin may be hesitant to use a moisturizer, a product that contains oil-absorbing talc or kaolin can decrease facial shine. Patients with oily skin often use a soap containing benzoyl peroxide to remove unwanted oil and aid in acne treatment. These soaps can leave the face scaly with the subsequent washing, immediately interfering with the foundation application. An oil-free moisturizer can help flatten the scale, enabling smooth foundation application rather than preferentially adhering to skin scale. Patients selecting an oil-free foundation must use an oil-free moisturizer to ensure maximum foundation wear and minimal color drift.

Patients with dry skin will benefit from the selection of an appropriate moisturizer. Fine wrinkling due to cutaneous dehydration and roughness due to skin scale can be improved (Figure 3.9).

Facial moisturizer efficacy evaluation

The efficacy of facial moisturizers can be difficult to assess; however, several excellent noninvasive methods have been developed: regression analysis, profilometry, squamometry, in vivo image analysis, corneometry, and evaporimetry (38). These methods are used to evaluate the benefits of a given moisturizer formulation without injury to the skin.

Regression analysis is a method of evaluating moisturizer efficacy under clinical conditions. Patients are selected and treated by an objective observer with moisturizers at a predetermined test site for two weeks. The test site is evaluated on days 7 and 14. If an improvement is noted, the moisturizer application is discontinued and the test site is evaluated daily for two weeks, or until the baseline skin dryness has reappeared (39). This method is particularly valuable because the efficacy of all facial moisturizers is excellent immediately following application, but the true effectiveness can only be assessed with the passage of time (40).

Regression analysis evaluates the longevity of the effect of a moisturizer on the skin.

Profilometry involves the analysis of silicone rubber (Silflo) replicas of the skin surface. These silicone replicas are cast into plastic positives, which are then measured with a computerized stylus instrument that provides a contour tracing of the surface. Thus, a two- or three-dimensional topogram is created. Unfortunately, this method can be inaccurate because the silicone application to the skin surface tends to flatten and disturb the desquamating skin scale (41). The use of actual silicone replicas is now sometimes replaced with video imaging of the skin surface, but the replicas remain the more accurate standard.

Video imaging and silicone replicas examine the skin surface topography.

Squametry involves the analysis of skin squames harvested by pressing a sticky tape against the skin. The outermost, loosely adherent skin scale is then removed. The tape provides a specimen that retains the topographical relationships of the skin surface and the pattern of desquamation. Image processing is then used to evaluate the scaliness of the skin (42). This technique is very useful when evaluating the effect of facial moisturizers on patients with desquamatory defects. Squametry can also be used to painlessly harvest corneocytes for the extraction of ceramides and lipids to determine the effect of facial moisturizers on intercellular lipid composition. Further, the squames can be dissolved with a solvent to examine the penetration of externally applied moisturizers into the skin. Multiple squames removed successively provide a penetration map for the moisturizer.

Squametry can be used to track the penetration of a moisturizing ingredient into the stratum corneum.

In vivo image analysis uses a video microscope to magnify the skin surface and examine the condition of the facial corneocytes in real time (43). Care is necessary to standardize lighting and camera angles to insure accurate data for analysis. In vivo imaging can also measure pigmentation and erythema to examine the effect of skin lightening preparations or the erythema of rosacea.

Finally, two techniques are available to measure the amount of water present in the skin or that coming out of the skin. The amount of water in the skin can be assessed by evaluating the conductance of the skin with a technique known as corneometry. Corneometry puts a low-voltage current into the skin with an electrode consisting of pins. One set of pins delivers the current, while the second set of pins senses the current. The more water there is in the skin, the more significant the hydration. Thus, increased corneometry readings indicate an increased skin hydration (44, 45). Evaporimetry measures the amount of water coming out of the skin, known as TEWL (46). This is accomplished by using two humidity meters spaced at a known distance from the skin and evaluating the passage of water vapor per time past the probe. More occlusive substances would be expected to reduce water loss, whereas humectants, such as glycerin, actually increase water loss (47, 48). Lower evaporimetry measurements mean that the skin barrier is better, whereas higher evaporimetry measurements mean that the skin barrier is damaged. A quality moisturizer would be expected to lower TEWL and decrease the evaporimetry reading.

Corneometry evaluates the amount of water in the skin, whereas evaporimetry evaluates the amount of water leaving the skin.

Even though these sophisticated noninvasive methods of cutaneous evaluation sound appealing, there is no substitute for the opinion of a trained, unbiased observer when evaluating moisturizer effectiveness. Mechanistic evaluation can be easily biased to produce data that serves the best interests of the manufacturer. Computers cannot yet accurately synthesize all the tactile and visual information that can be obtained with human evaluation. The noninvasive techniques simply present another tool for assessing facial moisturizer function (49).

Facial moisturizer: Adverse reactions

Many patients with dry skin will claim that they are “allergic” to most moisturizers as a result of skin stinging experienced following application. This may represent an irritant contact dermatitis rather than a true allergic contact dermatitis (50). These patients should avoid moisturizers containing propylene glycol, which may cause burning upon application to damaged skin. Other substances found in facial moisturizers that cause stinging include benzoic acid, cinnamic acid compounds, lactic acid, urea, emulsifiers, formaldehyde, and sorbic acid.

Moisturizing ointments, creams, lotions, and gels should be patch tested “as is.” If an irritant reaction is experienced with closed patch testing, the product should be retested with open patch testing and provocative use testing (51).

Summary

Facial moisturizers are one of the most important categories of skin care products. They can reduce wrinkles and minimize dry skin. Their composition is simple, but their effects are profound. Using occlusive and humectant ingredients, they can improve the look and feel of the skin within minutes. Moisturizers also form the basis for all prescription topical formulations and can supplement or hinder the functioning of drugs.

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4

SENSITIVE SKIN AND CONTACT DERMATITIS

Treating sensitive skin can indeed present a challenge to the dermatologist, because formulations that are typically not problematic for the general population cause intense stinging, burning, and redness in individuals with sensitive skin. Patients with sensitive skin can present with either skin that appears normal to the eye or overt skin disease. Those with overt skin disease are sometimes easier to evaluate because visual inspection can provide an idea of how to approach the problem. Invisible sensitive skin is a tremendous challenge as there is nothing to evaluate, except the patient's history. This is most disconcerting to the dermatologist, who relies solely on history when all else has failed and the diagnosis is still not forthcoming. This is the perplexing part of treating sensitive skin, and this chapter discusses methods of treating both invisible and visible sensitive facial skin (1). It will then segue into contact dermatitis and its relationship with cosmetics and skin care products.

Visible sensitive skin is characterized by eczema, atopic dermatitis, and rosacea.

Visible sensitive facial skin

Visible sensitive facial skin is the easiest condition to diagnose, since the outward manifestations of erythema, desquamation, lichenification, and inflammation identify the presence of a severe barrier defect (Figure 4.1). Any patient with a barrier defect will possess the signs and symptoms of sensitive skin until complete healing occurs. The three most common causes of barrier defect-induced sensitive facial skin are eczema, atopic dermatitis, and rosacea. These three diseases nicely illustrate the three

components of sensitive skin, which include barrier disruption, immune hyper-reactivity, and heightened neurosensory response.

The three components of visible sensitive skin are barrier disruption, immune hyper-reactivity, and heightened neurosensory response.

Eczema

Eczema is characterized by barrier disruption, which is the most common cause of sensitive facial skin. The barrier can be disrupted chemically through the use of cleansers and cosmetics that remove intercellular lipids, or physically through the use of abrasive substances that induce stratum corneum exfoliation. In some cases, the barrier may be defective due to conditions such as insufficient sebum production, inadequate intercellular lipids, or abnormal keratinocyte organization. The end result is the induction of the inflammatory cascade accompanied by erythema, desquamation, itching, stinging, burning, and possibly pain. The immediate goal of treatment is to stop the inflammation through the use of topical, oral, or injectable corticosteroids, depending on the severity of the eczema. Newer topical options for the treatment of eczema-induced sensitive facial skin include the calcineurin inhibitors pimecrolimus and tacrolimus.

However, resolution of the inflammation is not sufficient for the treatment of eczema. Proper skin care must also be instituted to minimize the return of the conditions that led to the onset of eczema. This includes the selection of skin care maintenance products, such as cleansers and moisturizers. Care of sensitive skin involves not only the treatment of the acute skin disease, but also the prevention of recurrence through proper skin care maintenance.

Atopic dermatitis

Sensitive facial skin due to eczema is predicated only on physical barrier disruption, whereas sensitive facial skin associated with atopic dermatitis is predicated on both a barrier defect and immune hyper-reactivity, as manifested by the association of asthma and hay fever. Patients with atopic dermatitis not only have sensitive skin on the exterior of the body, but also sensitive mucosa lining the eyes, nose, and lungs. Thus, the treatment of sensitive facial skin in the atopic population involves topical and systemic considerations. There is also a prominent link between the worsening of hay fever and the onset of skin symptoms, which requires broader treatment considerations.

All the treatments previously described for eczema also apply to atopic dermatitis, but additional therapy is required to minimize the immune hyper-reactivity. Although this may take the form of oral or injectable corticosteroids, antihistamines (hydroxyzine, cetirizine hydrochloride, diphenhydramine, and fexofenadine hydrochloride) are typically added to decrease cutaneous and ocular itching. Antihistamines also improve the symptoms of hay fever and may prevent a flare should the patient be exposed to pollens or other inhaled allergens. The avoidance of sensitive



FIGURE 4.1 Visible sensitive skin is easy for the dermatologist to diagnose.

skin in the atopic patient is largely predicated on the avoidance of inciting substances. This requires the creation of an allergy-free environment by removing old carpet, nonwashable drapes, items likely to collect dust, feather pillows and bedding, stuffed animal toys, heavy pollinating trees and plants, live pets, and so forth. The prevention of the release of histamine is the key to controlling the sensitive facial skin caused by atopic dermatitis.

Rosacea

Rosacea is an example of the third component of sensitive facial skin, which is a heightened neurosensory response. This means that patients with rosacea experience stinging and burning more frequently than the general population as a reaction to minor irritants. Whether this sensitive facial skin is due to nerve alterations from chronic photodamage, vasomotor instability, altered systemic effects of ingested histamine, or central facial lymphedema is unclear.

The treatments for rosacea-induced sensitive facial skin are significantly different from those for eczema or atopic dermatitis (2). Anti-inflammatories in the form of oral and topical antibiotics form the therapeutic armamentarium. Antibiotics of the tetracycline family are used most commonly orally, while azelaic acid, metronidazole, sulfur, and sodium sulfacetamide are the most popular topical agents. However, the effect of the anti-inflammatory antibiotic can be enhanced through the use of complementary skin care products that enhance barrier function.

Invisible sensitive skin is characterized by itching, stinging, burning, and possibly pain.

Invisible sensitive skin

Eczema, atopic dermatitis, and rosacea are in some ways the easiest forms of sensitive skin to treat. The skin disease is easily seen, and the treatment success can be monitored visibly. If the skin looks more normal, generally the symptoms of itching, stinging, burning, and pain will also be improved. Unfortunately, there are some patients who present with sensitive facial skin and no clinical findings. These patients typically present with a bag full of skin care products they claim cannot be used because they cause facial acne, rashes, or discomfort. This situation presents a challenge for the physician because it is unclear how to proceed.

Several treatment ideas are worth considering. The patient may have subclinical barrier disruption. For this reason, treatment with a topical corticosteroid of appropriate strength for two weeks may be advisable. If symptoms improve, then the answer is clear. The patient may have subclinical eczematous disease. If the symptoms do not improve, it is then worthwhile to examine the next most common cause of invisible sensitive skin—contact dermatitis—which is discussed later in this chapter.

Sensitive facial skin product guidelines

In many cases, it is impossible to determine the exact cause of the sensitive skin. No obvious skin disease is clinically present, yet the patient experiences intense stinging and burning sensation whenever skin care products or cosmetics are applied to the skin. Frequently, patch testing reveals no obvious source of irritant or allergic contact dermatitis. This then leaves the physician to use empiric methods to make product recommendations to the patient.

TABLE 4.1: Considerations for the Minimization of Contact Dermatitis from Skin Care Products and Cosmetics

- 1. Eliminate common allergens and irritants, or reduce their concentration.
- 2. Select products from a reputable manufacturer that uses high-quality, pure ingredients free of contaminants.
- 3. Products should be well preserved to prevent the formation of auto-oxidation byproducts.
- 4. Paraben preservatives have proven to be the least problematic.
- 5. Avoid solvents, volatile vehicles, vasodilatory substances, and sensory stimulators in all products.
- 6. Minimize the use of surfactants and select minimally irritating emulsifier systems.

Products must be carefully selected based on the use of ingredients that are least likely to damage the skin barrier, elicit a noxious sensory response, or alter the skin structure (Table 4.1). Products with botanical anti-inflammatories may be helpful, but most patients want specific suggestions on how to select skin care products and cosmetics. This section discusses the approach I use in my practice for product selection for the sensitive skin patient who has not responded to any of the previously outlined treatment modalities.

Products for sensitive skin must be carefully selected based on the use of ingredients that are least likely to damage the skin barrier, elicit a noxious sensory response, or alter the skin structure.

Even patients with sensitive skin require basic hygiene. The face and body must be cleansed. There is no doubt that synthetic detergent cleansers, also known as syndets, provide the best skin cleansing while minimizing barrier damage. Bars based on sodium cocoyl isethionate appear to have the best performance (Figure 4.2). Some patients, however, only require the use of a facial syndet cleanser occasionally because their sebum production and physical activity are minimal. For these patients, a lipid-free cleanser is preferable because it can be used without water and wiped away. These products may contain water, glycerine, cetyl alcohol, stearyl alcohol, sodium laurel sulfate, and



FIGURE 4.2 Synthetic detergents or syndet cleansers produce gentle cleansing for patients with sensitive skin. From left to right, they are available as bars, opaque liquids, or foaming clear washes.

occasionally propylene glycol. They leave behind a thin moisturizing film and can be used effectively in persons with excessively dry, sensitive, or dermatitic skin. They do not have strong antibacterial properties, however, and may not remove odor from the armpit or groin. Lipid-free cleansers are best used where minimal cleansing is desired.

After completing cleansing, the sensitive skin patient requires moisturization. The moisturizer should create an optimal environment for barrier repair while not inducing any type of skin reaction. For example, the product should not contain any mild irritants that may present as an acneiform eruption in a sensitive skin patient due to the presence of follicular irritant contact dermatitis. The best moisturizers are simple oil-in-water emulsions. The most common oil used is white petrolatum, but dimethicone and cyclomethicone are also acceptable oils in the sensitive skin population for decreasing the greasiness of a simple petrolatum and water formulation. As mentioned previously, the fewer ingredients, the better.

Sensitive skin products should contain as few ingredients as possible.

Sensitive skin women also require recommendations on proper cosmetic selection. This can be a challenge for the physician, since cosmetic formulations change rapidly as dictated by the needs of fashion. The best method for evaluating problematic facial cosmetics is the provocative use test, performed by applying a 2-cm area of product lateral to the eye for five consecutive nights (Figure 4.3). This allows the isolation of the cosmetic products



FIGURE 4.3 Facial foundations can be tested for sensitive skin suitability by applying a small amount to the lateral eye for five consecutive nights.



FIGURE 4.4 Powder cosmetics are preferred in sensitive skin.

one at a time on the most sensitive part of the face, which provides the highest probability of uncovering the problem. Powder cosmetics overall appear to have the fewest ingredients and present the least problems (Figure 4.4).

Contact dermatitis

The use of cosmetics and skin care products can occasionally result in contact dermatitis. This is certainly a minor issue, but no discussion of cosmetic dermatology could be complete without addressing this important aspect of patient care. With the tremendous variety of products available for purchase, it is easy for the consumer to simply discard or return any product that has produced an untoward reaction. Occasionally, however, a patient finds that he or she experiences numerous reactions or severe reactions, which require the expertise of a dermatologist skilled in the diagnosis and treatment of contact dermatitis. Contact dermatitis can be classified as irritant contact dermatitis, allergic contact dermatitis, contact urticaria, phototoxic contact dermatitis, or photoallergic contact dermatitis. Each of these subjects is discussed in the framework of skin care products and cosmetics.

Irritant contact dermatitis

Irritant contact dermatitis, the most commonly encountered adverse reaction to cosmetics and skin care products, is manifested as erythematous, burning, pruritic skin that may develop microvesiculation and later desquamation. The dermatitis is characterized by stratum corneum damage without immunologic phenomena. The irritancy may be due to the presence of chemical factors with excessively high or low pH or by volatile vehicles that dissolve protective sebum (3). Physical factors including the rubbing necessary to apply cosmetics or abrasive particles within cosmetics may cause irritancy. Most importantly, a damaged stratum corneum may be incapable of providing a protective barrier so that any cosmetic applied to the damaged skin will cause irritation. This is the case in patients with atopic dermatitis, xerotic eczema, or neurodermatitis. These patients will frequently describe numerous products that produce “allergic” symptoms. In actuality, there is no immunologic basis for the dermatitis except an irritancy heightened by a damaged stratum corneum. Any cosmetic applied to dermatitic skin may produce irritation; therefore, patients should not

wear cosmetics or use personal care items until the dermatitis has resolved.

Any cosmetic applied to dermatitic skin may produce irritation.

Allergic contact dermatitis

It is difficult to differentiate allergic contact dermatitis from irritant contact dermatitis clinically, but the distinction is essential for good patient care. Both conditions may present as erythematous plaques; however, acute allergic contact dermatitis may exhibit more vesiculation. In some cases, late-stage allergic and irritant contact dermatitis cannot be differentiated clinically or histologically. Allergic contact dermatitis is an immunologic phenomenon requiring antigen-presenting and antigen-processing cells irrespective of the condition of the protective stratum corneum. Therefore, an intact stratum corneum cannot prevent the development of allergic contact dermatitis in sensitized individuals. The only course is avoidance of the allergen (4). The most common cosmetic-induced causes of allergic contact dermatitis as determined by the North American Contact Dermatitis Group are listed by product category (Table 4.2) and ingredient (Table 4.3) (5). Other studies have also been published by the European dermatologic community (6, 7).

An intact stratum corneum cannot prevent the development of allergic contact dermatitis in sensitized individuals.

Contact urticaria

Contact urticaria may be an immunologic or nonimmunologic reaction to cosmetics and skin care products. It is characterized by the development of a wheal-and-flare response to a topically applied chemical. The spectrum of clinical presentation ranges from itching and burning to generalized urticaria

TABLE 4.2: Causes of Allergic Contact Dermatitis per the North American Contact Dermatitis Group

Skin care products	28%
Hair care products	24%
Facial cosmetics	11%
Nail cosmetics	8%
Fragrance products	7%

Source: Data from Ref. 5.

TABLE 4.3: Ingredients Causing Allergic Contact Dermatitis in Order of Decreasing Incidence

Fragrances
Preservatives
p-Phenylenediamine (hair dye component)
Lanolin
Glyceryl thioglycolate (permanent wave solution component)
Propylene glycol
Toluenesulfonamide/formaldehyde resin (nail polish component)
Sunscreens

Source: Data from Ref. 5.

TABLE 4.4: Substances Used in Cosmetics that Cause Contact Urticaria

Nonimmunologic
Acetic acid
Alcohols
Balsam of Peru
Benzoic acid
Cinnamic acid
Cinnamic aldehyde
Formaldehyde
Sodium benzoate
Sorbic acid
Immunologic
Acrylic monomer
Alcohols
Ammonia
Benzoic acid
Benzophenone
Diethyltoluamide
Formaldehyde
Henna
Menthol
Parabens
Polyethylene glycol
Polysorbate 60
Salicylic acid
Sodium sulfide
Uncertain
Ammonium persulfate
Para-phenylenediamine

and anaphylaxis. Nonimmunologic contact urticaria is induced when histamine is released by a direct contactant and thus passive transfer is not possible. It is more commonly encountered than immunologic contact urticaria, where immunologic mechanisms are involved in histamine release; thus the phenomenon can only be elicited in sensitized individuals, and passive transfer is possible. However, there are some chemicals that produce contact urticaria due to uncertain mechanisms. Table 4.4 lists the nonimmunologic and immunologic causes of contact urticaria to substances encountered in cosmetics (8). Testing for contact urticaria should be carried out under carefully controlled conditions with nearby resuscitation facilities to manage potential anaphylaxis.

Contact urticaria is characterized by the development of a wheal-and-flare response to a topically applied chemical.

Phototoxic and photoallergic dermatitis

Phototoxic and photoallergic dermatitis are limited to areas exposed to light. Phototoxic reactions are based on nonimmunologic mechanisms and usually appear as sunburns that may be followed by hyperpigmentation and desquamation. The molecules that produce phototoxicity are generally of low molecular weight and possess highly resonant structures that readily absorb mainly UVA radiation (9). Photoallergic dermatitis, on the other hand, is less common and immunologically mediated; it generally requires repeat exposure and can be passively transferred.

It is characterized by erythema, edema, and vesiculation. Photoallergens are generally low-molecular-weight, lipid-soluble substances that possess highly resonant structures that absorb energy over a wide range of wavelengths, but again, predominantly UVA. The light photochemically converts the photosensitizer into its active form (10). Less ultraviolet radiation energy is required to elicit a photoallergic reaction compared with a phototoxic reaction (11). Differentiating between the two may be difficult, however, especially if a severe phototoxic reaction results in vesiculation. Substances found in cosmetics that may cause photoallergic reactions include fragrances such as methylcoumarin and musk ambrette, antibacterial agents, and para-aminobenzoic acid esters such as sunscreen agents (12).

Photoallergens are low-molecular-weight, lipid-soluble substances that possess highly resonant structures, which absorb energy over a wide range of wavelengths.

Patch testing

Patch testing is performed to determine the source of allergic contact dermatitis (13). Generally, the appropriate substances for patch testing are selected from the dermatologic patch test tray (Table 4.5) and applied to filter paper discs affixed to a strip of polyethylene-coated aluminum foil (Al-test) or placed in 8-mm aluminum chambers affixed to a nonwoven textile tape (14). The prepackaged TRUE test can also be used. The healthy skin of the upper back is selected and marked for placement of the tape strips, which are worn for 48 hours. During this time, the patient should not get the patches wet or engage in activities that induce heavy sweating. The tests are initially evaluated at 20 minutes after removal and again at two to seven days (15). Table 4.6 shows the method of evaluation used by the North American Contact Dermatitis Group.

There are two other methods of patch testing that are useful in patients with suspected cosmetics or skin care product

TABLE 4.5: Substances on a Standard Patch Test Tray

1. Benzocaine 5% petrolatum
2. Imidazolidinyl urea 2% aqueous
3. Thiram mix 1% petrolatum
4. Lanolin alcohol 30% petrolatum
5. Neomycin sulfate 20% petrolatum
6. p-Phenylenediamine 1% petrolatum
7. Mercaptobenzothiazole 1% petrolatum
8. P-tert-butylphenol formaldehyde resin 1% in petrolatum
9. Formaldehyde 1% aqueous
10. Carba mix 3% petrolatum
11. Rosin (colophony) 20% petrolatum
12. Black rubber mix 0.6% petrolatum
13. Ethylenediamine dihydrochloride 1% petrolatum
14. Quaternium-15 2% petrolatum
15. Mercapto mix 1% petrolatum
16. Epoxy resin 1% petrolatum
17. Balsam of Peru 25% petrolatum
18. Potassium dichromate 0.25% petrolatum
19. Nickel sulfate 2.5% petrolatum
20. Cinnamic aldehyde 1% petrolatum

TABLE 4.6: Evaluation of Patch Test Reactions

+/-	=	Doubtful reaction; possibly caused by a weak irritant effect: the reaction shows only a weak erythema without infiltration
+	=	Weak reaction; erythema with infiltration and possibly papules
++	=	Strong reaction; erythema, infiltration, papules, vesicles
+++	=	Extreme reaction; erythema, infiltration, papules, confluent vesicles or bullae
-	=	Negative reaction
IR	=	Irritant reaction
NT	=	Not patch tested

sensitivities: open patch tests and provocative use tests. Open patch testing is useful when the test chemical is suspected of being a cutaneous irritant. The chemical is applied to the skin on the outer aspect of the arms above the elbow, unoccluded, twice daily for two or more days without washing the test site. The site is evaluated in the same manner as illustrated in Table 4.6. False-negative results may occur with this method. Provocative use testing is valuable in confirming positive reactions to cosmetic products containing ingredients that were previously found to be sources of allergic contact dermatitis with standard patch testing. The product is applied twice daily to the skin 3 cm in diameter above or below the antecubital fossae for one week. A modification of this test for eye cosmetics is application to the skin lateral to the eye twice daily for one week. Reactions are also evaluated as illustrated in Table 4.6.

Two additional methods of patch testing useful in patients with suspected cosmetics or skin care product sensitivities are the open patch test and provocative use test.

Additional sensitivity testing

Testing beyond patch testing may be required to ensure the complete safety of cosmetic and skin care products. Ingredients used in cosmetics are evaluated by the Cosmetic Ingredient Review Committee, which makes recommendations for the use and concentration of the chemical in question.

Draize test

The Draize test is an evaluation of dermal irritation using an animal model (16). Semiocclusive patch tests of the evaluation substance are placed at 100% concentration on both intact and abraded albino rabbit skin. Readings are performed at 24 and 72 hours after leaving the skin uncovered for 30 to 60 minutes to allow local effects to subside. The sites are evaluated for erythema and edema to determine the degree of irritancy (17). This test is required by law for cosmetics and skin care products under the Federal Hazardous Substances Act (18) to predict the toxicity of chemicals to humans in a manner that overestimates the risk (19, 20).

Repeat insult patch test

Repeat insult patch testing evaluates skin sensitization by repeating chemical exposure at the same site on the body. Ten patches

are applied to the same site at 48-hour intervals for a three- to four-week period. The skin is allowed to rest for two weeks, and then a repeat challenge of the same chemical is applied to the skin for 48 hours and read. This method is commonly used by reputable cosmetic companies in evaluating ingredients and final products for minor sources of sensitization before manufacturing them on a large scale.

Cumulative irritancy test

The cumulative irritancy test is designed to assess the irritancy of an ingredient, such as those found in a cosmetic or skin care item, or a final product. The test involves daily application of the same substance to the test site under occlusion for 21 days (21). The repeat application is designed to maximize the irritant reactions.

Eye irritancy test

The eye irritancy test is important for cosmetic products because they may accidentally enter the eyes. This test assesses the irritant effects of substances on the conjunctivum, cornea, and iris of albino rabbits. This is similar to patch testing; however, 0.10 mL of the test substance is instilled into the eye. In one group of rabbits, the treated eyes are left unwashed; in the second group, the treated eyes are washed with 20 mL of lukewarm water after 2 seconds, and in the third group, the eyes are washed with 20 mL of lukewarm water after 4 seconds. The eyes are evaluated at 24, 48, and 72 hours and 4 and 7 days after treatment, or for as long as the injury persists (22). Human subjects are also used to assess the irritant capacity of products introduced into or around the eye. Cosmetics and skin care products should be tested in this manner to ensure human safety.

Photopatch testing

Photopatch testing is performed when photosensitivity evaluation is required. Two patch test pads are placed with the suspected chemical: one on a site to be irradiated and the other on a protected site. The pads are placed on the skin for 48 hours (23). One site is subjected to ultraviolet radiation of the wavelength desired and read in 24 to 48 hours. This process may be repeated if desired. A phototoxic reaction consists of erythema and usually arises within six hours. A photoallergic reaction is characterized by erythema, papules, and vesicles. If only the irradiated site is positive, a diagnosis of photoallergy can be made. If both the irradiated and the protected sites are positive, a diagnosis of allergic contact dermatitis can be made. If the irradiated site is more positive than the protected site, then a diagnosis of allergic contact dermatitis and photoallergy can be made. Substances that cause photoallergic dermatitis found in cosmetics are tested as follows: methylcoumarin 5% in petrolatum, musk ambrette 5% in petrolatum, and para-aminobenzoic acid esters 10% in petrolatum.

Cutaneous stinging

There is a group of patients who note stinging or burning within several minutes after applying a cosmetic that intensifies over 5 to 10 minutes and then resolves after 15 minutes. These patients are known as “stingers” and will not tolerate certain cosmetic products even though patch testing for allergic contact dermatitis is negative and no evidence of irritant contact dermatitis is present. Patients who are “stingers” can be identified by inducing sweating (110°F and 80% relative humidity or exposure to a desktop facial sauna machine) and applying a 5–10% aqueous solution of lactic acid to the nasolabial fold. Susceptible individuals develop stinging for at least 5 to 10 minutes. These individuals can then

TABLE 4.7: Substances that Induce Stinging

Slight stingers
Benzene
Phenol
Salicylic acid
Resorcinol
Phosphoric acid
Moderate stingers
Sodium carbonate
Trisodium phosphate
Propylene glycol
Propylene carbonate
Propylene glycol diacetate
Dimethylacetamide
Dimethylformamide
Dimethyl sulfoxide
Diethyltoluamide
Dimethyl phthalate
2-ethyl-1,3-hexanediol
Benzoyl peroxide
Severe stingers
Crude coal tar
Phosphoric acid
Hydrochloric acid
Sodium hydroxide
2-ethoxyethyl p-methoxy-cinnamate

Source: Table adapted from Ref. 24.

be used as test panel subjects to evaluate the stinging capacity of cosmetic ingredients or finished products by applying the test substance on one nasolabial fold and a bland control on the other nasolabial fold. Substances that can induce stinging are listed in Table 4.7 (24).

Summary

The diagnosis and treatment of sensitive skin is a medical challenge. Any treatment must address the barrier disruption, immune hyper-reactivity, and heightened sensory responsiveness that characterize sensitive skin. If the sensitive skin is due to a visible dermatosis, the treatment can be streamlined, but if it is an invisible sensitive skin, a long treatment algorithm must be followed to further elucidate valuable diagnostic information. Patch testing may be necessary if irritant or allergic contact dermatitis is suspected. Finally, basic skin care and cosmetic recommendations can be made to the sensitive skin patient to minimize the chances of encountering a problem.

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AGING SKIN AND COSMECEUTICALS

The cosmeceutical category is an undefined, unclassified, and unregulated area of dermatology that is yet in its infancy (1). Traditional cosmeceuticals involve the topical application of biologically active ingredients, which affect the skin barrier and overall skin health. The ability of these ingredients to enhance skin functioning depends on how they are formulated into creams and lotions to maintain the integrity of the active agent, deliver it in a biologically active form to the skin, reach the target site in sufficient quantity to exert an effect, and properly release from the carrier vehicle. In the United States, cosmeceuticals are sold as cosmetics, making marketing, packaging, and aesthetic appeal important considerations. Ideally, the cosmeceutical should be clinically tested for efficacy to ensure a proven skin benefit, but also to substantiate marketing claims. The recognition that there are governmental limitations on efficacy claims restricts cosmeceutical development because products can only be assessed in terms of their ability to improve skin appearance but not function. Improving function would remove the cosmeceutical from the cosmetic category and place it in the drug category. Herein rests the challenge of defining the cosmeceutical category, the topic of this chapter.

When the cosmeceutical category was first introduced to the dermatologist, cosmeceuticals were prescription items that addressed appearance issues (2). The first cosmeceutical that met these criteria was topical tretinoin. Tretinoin has been a significant force in dermatology, but is not as popular as some cosmetic formulations containing less biologically effective retinol. Why? Unfortunately, tretinoin produces no short-term benefits. As a matter of fact, tretinoin produces short-term setbacks in skin appearance due to the peeling and redness that occur during the first two weeks of use, requiring the encouragement of a dermatologist for compliance. The long-term benefits of tretinoin take at least six months to realize. Although the functional benefits of tretinoin are great, there are no aesthetic benefits. This has led to the proliferation of over-the-counter (OTC) retinol, retinyl propionate, and retinaldehyde moisturizers that cannot deliver the ultimate collagen regeneration benefits of prescription tretinoin, but do not cause irritation and peeling. Thus, a modern cosmeceutical must combine the aesthetics of a cosmetic with the efficacy of a drug.

The next cosmeceutical introduced to the dermatologist was topical minoxidil. This product demonstrated a functional benefit in terms of hair growth, but at least six months of use was necessary to perceive any increase in hair fullness. To achieve topical minoxidil penetration, a high concentration of propylene glycol was required, which produced scalp itching and dryness. The established safety profile of this prescription drug allowed reclassification into the over-the-counter (OTC) drug market, but the lack of immediate aesthetic benefits prevented this formulation from reaching its full potential for use among patients with male or female pattern alopecia. Thus, a modern cosmeceutical must produce an immediate benefit like a cosmetic but also a long-term benefit like a drug.

The world of the prescription cosmeceutical has come to a virtual standstill following the approval of tretinoin and minoxidil. Yet, the concept of cosmeceuticals is alive and well. Patients are well-educated via the mass media, periodicals, and the Internet,

demanding sophistication in products they purchase. These demands have led to the new concept of cosmeceuticals, which can be most accurately described as multifunctional cosmetics, products that are purchased without a prescription that do more than scent or color the skin. These modern cosmeceuticals are expected to have superior feel and smell while providing a visibly perceivable improvement in skin appearance. Our review of cosmeceuticals and skin care products begins with a discussion of aging skin.

Aging skin

Aging of the skin can be classified into two components: intrinsic and extrinsic aging. As the names imply, intrinsic aging is due to genetically controlled senescence, and extrinsic aging is due to environmental factors superimposed on intrinsic aging. Environmental factors known to accelerate extrinsic aging are sun exposure and cigarette smoking. Cutaneous aging due to sun exposure is known as photoaging (3).

Youthful skin is characterized by its unblemished, evenly pigmented, smooth, and pink appearance. This contrasts with intrinsically aged skin, which is thin, inelastic, and finely wrinkled with deepening of facial expression lines (4). These changes are evident histologically as a thinned epidermis and dermis with the flattening of the rete pegs at the dermoepidermal junction (5). Extrinsically aged, sun-exposed skin appears clinically as blemished, thickened, yellowed, lax, rough, and leathery (6). These changes may begin as early as the second decade (7) and can be used to divide photoaged skin into four groups known as the Glogau Classification (Table 5.1). It may also contain precancerous and cancerous growths, as well as telangiectasias and lentigenes (8). Some propensity toward cancerous growths may be due to a decrease in Langerhans cells and their function (9). Photoaged skin is characterized histologically by epidermal dysplasia with varying degrees of cytologic atypia, loss of keratinocyte polarity, an inflammatory infiltrate, decreased collagen, increased ground substance, and elastosis. Elastosis is the degradation of elastic material, which, in early photoaging, is increased in amount and seen microscopically as thickened, twisted, degraded elastic fibers (10). These fibers degenerate into an amorphous mass as photoaging progresses (11). Thus, intrinsic aging of the skin results in atrophy, whereas extrinsic photoaging results in hypertrophy. This distinction is not always clinically apparent, but in ideal cases, intrinsically aged skin has fine wrinkling, whereas photoaged skin demonstrates coarse wrinkling and furrowing (12) (Figure 5.1). Many substances have been put forth to treat aging skin, perhaps the first being hormone creams, which is discussed next.

Aging and hormones

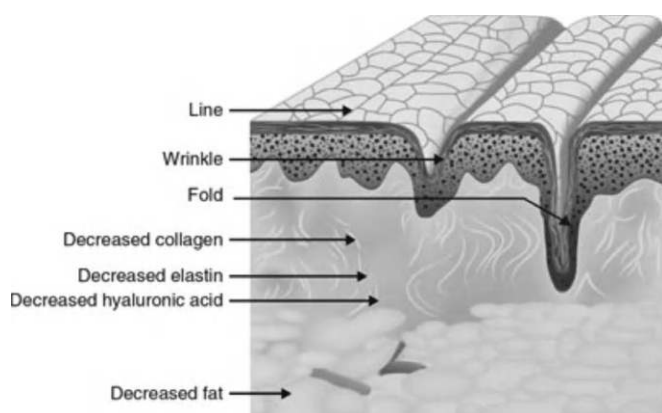
Since the beginning of time, humans have searched for topicals and ingestibles that promise to deliver the magic of youth. Prior to the 1930s, many products were sold door to door, promising a youth elixir, but some contained toxic ingredients such as arsenic and mercury. One of the most popular antiaging preparations

TABLE 5.1: Glogau Classification of Photoaging Groups

Group 1 Mild	
	No keratosis
	Little wrinkling
	No scarring
	Little or no makeup
	Usually age 28–35 years
Group 2 Moderate	
	Early actinic keratoses
	Slight yellow skin discoloration
	Early wrinkling (parallel smile lines)
	Mild scarring
	Little makeup
	Usually age 35–50 years
Group 3 Advanced	
	Actinic keratoses
	Obvious yellow skin discoloration with telangiectasia
	Wrinkling present at rest
	Moderate acne scarring
	Always wears makeup
	Usually age 50–65 years
Group 4 Severe	
	Actinic keratoses and skin cancers have occurred
	Wrinkling of actinic gravitational and dynamic origin
	Severe acne scarring
	Wears makeup, but does not cover well
	Usually age 60–75 years

at the time the Cosmetics and Toiletries Act was penned in the 1930s was facial moisturizers containing estrogen (Figure 5.2). The introduction of legislation defining cosmetics as products that do not alter the structure or function of the skin reclassified hormone creams as drugs, and they were removed from the consumer market. However, the past 70 years have brought an increased understanding of skin physiology and the recognition that even water can alter the structure and function of the skin. This has created a renewed interest in cosmeceuticals, especially in the realm of hormone therapy.

There is no doubt that hormone therapy is effective for improving the appearance of aging skin. Not only do estrogens improve skin rigidity and decrease wrinkling, but they also increase skin thickness as measured by ultrasound (13), increase skin sebum

**FIGURE 5.1** Many defects contribute to the appearance of aged skin.

production as measured by a Sebumeter (14), increase skin elasticity as measured by skin deformability using a suction device (15), increase skin hydration as measured by corneometry (16), and increase skin collagen content as measured by skin biopsy (17). Many methods that assess skin function point to oral and transdermal estrogen as a valuable replacement hormone.

Various studies have also examined estrogen delivery topically. Estrogen is readily soluble in a creamy vehicle and easily penetrates the stratum corneum due to its small chemical properties. It is the ideal cosmeceutical for topical application. Topical estrogen has been shown to increase the production of type III collagen and the overall collagen fiber count after six months of application (18). It also increased the acid mucopolysaccharide and hyaluronic acid levels in the skin, which are important for maintaining skin hydration and barrier function (19). The combination of increased dermal volume, due to more collagen fibers, and increased dermal hydration, due to more hyaluronic acid, may explain the decreased wrinkling apparent in women using estrogens. It is important to note that there is currently no other substance available to the cosmetic formulator that delivers such documentable, reproducible results in women.

Phytoestrogens, such as genistein, daidzein, and glycitein, are found in fermented soy and can be consumed in the form of roasted soy nuts or tofu.

The legal restriction on OTC estrogen has led to an interest in phytoestrogens, especially those derived from soy. Phytoestrogens, such as genistein, daidzein, and glycitein, are found in fermented soy and can be consumed in the form of roasted soy nuts or tofu. Soy protein supplements have been investigated for their benefit in a variety of postmenopausal symptoms, but the data is somewhat inconsistent. One controlled study by Kotsopoulos et al. found that a soy protein supplement had no statistically significant effect compared with the placebo on dry skin (20). Yet, genistein is one of the most popular botanical additives to skin care products, promising to decrease the appearance of fine lines on the face. It can be difficult, however, to determine whether the decreased wrinkling advertised by the manufacturer is due to the vehicle moisturizer decreasing the lines of dehydration and altering light reflection from the skin surface or true changes in skin collagen production and decreased wrinkling due to increased dermal thickness. In the current regulatory climate, no cosmetic manufacturer wants to determine the answer to this question. Moisturizing the skin and changing the optical characteristics is the realm of cosmetics, but enhancing collagen production is the realm of a drug. Any soy product that documented an increased collagen production would certainly be removed from the market by the Food and Drug Administration (FDA). It is for this reason that research is lacking in the topical application of phytoestrogens.

The question then remains as to why topical estrogen creams and estrogen replacement therapy are so controversial when the skin benefits have been well documented. There have been some concerns that estrogens predispose women to malignant melanoma in the literature, although the reports are contradictory. A study by Smith et al. demonstrated no link between melanoma and oral contraceptives or replacement estrogens (21). Topical estrogens are even more controversial because they are theoretically linked to breast cancer and cancer of other female reproductive

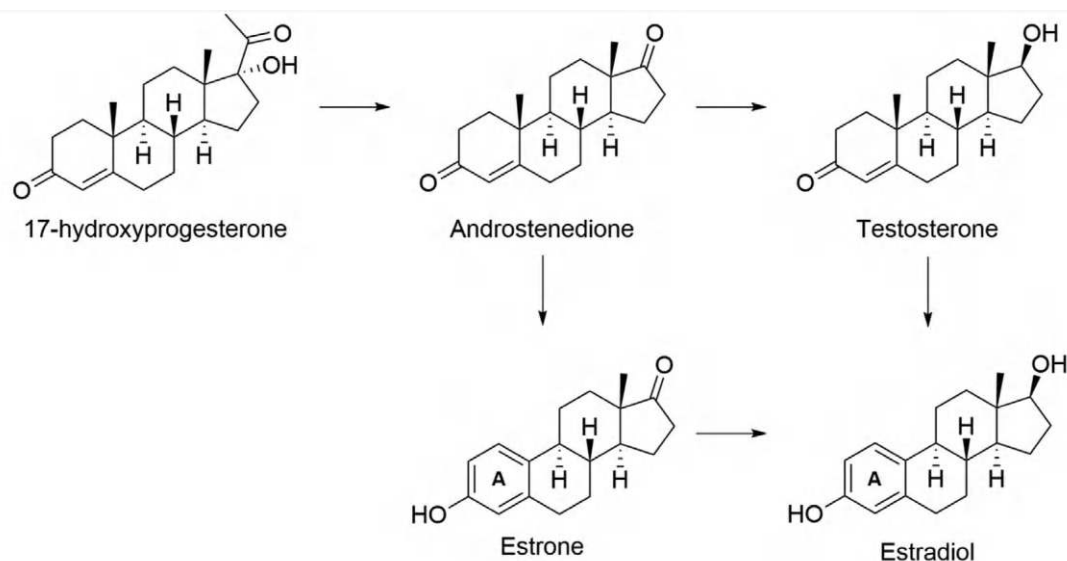


FIGURE 5.2 Estrogen creams were the first cosmeceutical facial moisturizer for aging skin.

organs. No company wants to market a topical product with such tremendous opportunity for lawsuits because cause and effect are difficult to demonstrate or negate. Topical estrogens are also associated with facial telangiectasias, which is undesirable.

One area of estrogen benefit for skin appearance is rarely discussed in the literature. This is the decrease in facial bone mass. Many articles allude to the benefit of oral estrogens in bone mineral density, but few have studied the mineralization of the facial bones (22). Much of the wrinkling experienced with advancing age is not due to skin effects, but due to loss of the underlying subcutaneous tissue and bony architecture. Loss of facial bone structure also contributes to wrinkling, which may be improved through oral estrogen supplementation.

Development of cosmeceuticals

Since the removal of the first cosmeceutical, topical estrogen, from the market, many other cosmeceutical formulations have been introduced. There is nothing special about cosmeceuticals, which are classified by industry as functional cosmetics. This means that the ingredients that are included in formulations must come from a list of raw materials that are generally recognized as safe, or the cosmeceutical would be classified as a drug. The easiest source of new cosmeceutical ingredients is the plant kingdom. Plants are rich in endogenous antioxidants because they must survive in an environment rich in UV radiation insults. Plant extracts are also felt to be safe and meet the FDA criteria for substances that can be put in OTC formulations. It is generally felt that substances that are safe for oral consumption can be assumed safe when applied topically. This has led to a renewed interest in herbal preparations, which form the basis for functionality in many cosmeceuticals (Figure 5.3).

Cosmeceuticals are moisturizers that contain active agents commonly derived from plant materials, such as flowers, seeds, roots, leaves, twigs, and berries.

The search for novel herbals has led to the gathering of flowers, seeds, roots, leaves, twigs, and berries from plants all over the world. This can be a complex process because the constituents of a plant extract are influenced by the season in which the plant material is picked, the growing conditions, and the processing



FIGURE 5.3 Botanicals form the basis for many cosmeceutical formulations.

TABLE 5.2: Botanical Sources of Cosmeceutical Functional Ingredients

1. *Plant source*: leaves, roots, fruits, berries, stems, twigs, barks, flowers
2. *Growing conditions*: soil composition, amount of available water, climate variations, plant stress
3. *Harvesting conditions*: time from harvest to transport, care of plant materials during shipping, storage conditions prior to manufacture
4. *Preparation methods*: crushing, grinding, boiling, distilling, pressing, drying
5. *Final extract status*: liquid, powder, paste, syrup, crystal
6. *Concentration*: sufficient amount of active agent to produce the biologic effect

of the botanical ingredient. The popular sources for botanical cosmeceutical ingredients are summarized in Table 5.2. Once a possible functional cosmeceutical active agent has been identified and synthesized, it is typically applied to a fibroblast gene chip to determine whether it affects any key cellular event. After the demonstration of a presumed physiological effect, the active agent is tested in vitro to determine its effect on cultured fibroblasts. If positive data are obtained, the active agent is studied in a mouse model for confirmation. It is then placed in a vehicle suitable for human application, and clinical studies are undertaken. Successful human clinical studies pave the way for successful introduction into the marketplace via ingredient licensing arrangements. These steps for cosmeceutical development are summarized in Table 5.3.

An important consideration in cosmeceutical development is safety. Cosmeceuticals are considered cosmetics by the US government and as such are unregulated. However, the cosmetic industry does an excellent job of self-policing the safety of products introduced into the marketplace. No reputable cosmetic manufacturer wants to introduce problematic formulations that would tarnish the hard-earned reputation of the company. Most of the quality cosmeceuticals are formulated from ingredients that already have a proven safety record in the marketplace. This may be due to their extraction from foods, such as topical lycopene from tomatoes or topical avocadin from avocados. Alternatively, extensive animal testing may be undertaken by the raw material supplier to determine that the new ingredient is appropriate

TABLE 5.3: Steps in Cosmeceutical Development

1. New botanical material received in the laboratory.
2. Various fractions of the botanical extracted.
3. Fractions analyzed for relationship to known chemical compounds.
4. Purified fraction exposed to gene array chip.
5. Analysis completed for upregulation or downregulation of key events in cellular oxidation, inflammation, or irritation.
6. New isolate studied in an in vitro model of cell culture for confirmation of gene array results.
7. Positive in vitro findings lead to isolate analysis in mouse model focusing on markers of possible cutaneous benefit.
8. Positive mouse findings lead to formulation in a vehicle suitable for human use.
9. Human model testing conducted to determine whether the active agent has any cutaneous value.
10. Formulation fine-tuned and patented.
11. New ingredient licensed to cosmetic manufacturer.
12. New technology enters the marketplace.

for human use. In the case of botanicals, most are assumed safe based on their ubiquitous nature.

Cosmeceuticals are unregulated and presently considered cosmetics in the United States.

Cosmeceutical overview

A tremendous variety of ingredients can be incorporated into cosmeceuticals, far beyond the reach of this text. For an in-depth discussion, the reader is referred to a book ZDD edited on cosmeceuticals published by Elsevier in its fourth edition in 2025. In this chapter, we would like to highlight a few cosmeceutical ingredients that are of particular interest. They belong to three families of substances, including carotenoids, flavonoids, and polyphenols. These are the major categories of antioxidants, which have excellent evidence to support their oral ingestion but less impressive evidence to support their topical application.

The three major families of antioxidants found in cosmeceuticals are carotenoids, flavonoids, and polyphenols.

Carotenoids

Carotenoids are derivatives of vitamin A and have found widespread use in cosmeceuticals due to the established topical anti-aging benefits associated with the prescription retinoid tretinoin. The carotenoids are a large family of orange-, red-, and yellow-appearing substances that perform vital antioxidant roles when ingested and are less well established as topical antioxidants.

Astaxanthin

Astaxanthin is a pink carotenoid found in high concentration in salmon, accounting for the characteristic pink color of the fish. This is the rationale for antiaging diets recommending the ingestion of a serving of salmon five times weekly (23). For topical application purposes, astaxanthin is obtained from the marine microalgae *Haematococcus pluvialis*. The efficacy of astaxanthin is attributed to its cell membrane, which is composed of two external lipid layers. It has been touted as possessing stronger antioxidant abilities than vitamin E (24). It is both water- and oil-soluble and is only produced by algae when exposed to intense UV radiation.

Few topical studies exist to confirm the topical effect of astaxanthin (25), but it has been studied extensively as an oral supplement (26). It is used as a homeopathic treatment for macular degeneration because, unlike canthaxanthin, another carotenoid, it does not crystallize in the eye. It crosses the blood–brain barrier and has been studied in brain dysfunction, including spinal cord injuries and Parkinson's disease (27). Even though other carotenoids, such as beta-carotene, have been proven ineffective in reducing the oxidative stress associated with cardiovascular disease, astaxanthin is currently undergoing further investigation (28).

Astaxanthin in concentrations of 0.03–0.07% produces a pink color cream. This limits the concentration that can be used, but no topical adverse reactions have been associated with this carotenoid. The topical antioxidant benefits of astaxanthin have not been established.

added to skin care products. It functions as a skin antioxidant and prevents the lipids in the moisturizer from becoming rancid. The antioxidant effect of tetrahydrocurcumin is said to be greater than that of vitamin E by cosmetic chemists, and it is further said to provide antioxidant skin benefits by quenching oxygen radicals and inhibiting nuclear factor-KB (32, 33). The effects of curcumin as a topical antioxidant in the skin have not been studied well.

Silymarin

Silymarin is an extract of the milk thistle plant (*Silybum marianum*), which belongs to the Aster family of plants, including daisies, thistles, and artichokes. The plant is named milk thistle because the oldest recorded use of the extract was to enhance human lactation, and the plant produces a white milky sap. The extract consists of three flavonoids derived from the fruit, seeds, and leaves of the plant. These flavonoids are silybin, silydianin, and silychristin. Homeopathically, silymarin is used to treat liver disease, but it is a strong antioxidant preventing lipid peroxidation by scavenging free radical species. Its antioxidant effects were demonstrated topically in hairline mice by the 92% reduction of skin tumors following UVB exposure (34, 35). The mechanism for this decrease in tumor production is unknown, but topical silymarin has been shown to decrease the formation of pyrimidine dimers in a mouse model (36). It has also been found to improve the healing of burns in albino rats (37).

Silymarin is found in a number of high-end moisturizers for benign photoaging to prevent cutaneous oxidative damage and to reduce facial redness. A double-blind placebo-controlled study in 46 subjects with stage I to III rosacea found improvement in skin redness, papules, itching, hydration, and skin color (38). This was believed to be due to its direct activity on modulating cytokines and angiokines. Other well-controlled human trials are lacking.

Pycnogenol

Pycnogenol is an extract of French marine pine bark (*Pinus pinaster*), which grows only on the southwest coast of France in Les Landes de Gascogne. The extract is a water-soluble liquid containing several phenolic constituents, including taxifolin, catechin, and procyanidins. It also contains several phenolic acids, including p-hydroxybenzoic, protocatechuic, gallic, vanillic, p-couric, caffeic, and ferulic. It is a trademarked ingredient that is sold for oral consumption as a preventative for cardiovascular disease (39), a treatment for diabetic microangiopathy (40), and a pain reliever for muscle cramps (41). It is a potent free-radical scavenger that can reduce the vitamin C radical, returning vitamin C to its active form (42). Active vitamin C, in turn, regenerates vitamin E to its active form, maintaining the natural oxygen-scavenging mechanisms of the skin intact.

Pycnogenol is the ideal antiaging additive because it demonstrates no chronic toxicity, mutagenicity, teratogenicity, or allergenicity (43). It is consumed orally to enhance the production of nitric oxide, which inhibits platelet aggregation in coronary artery disease, and thus it is also deemed safe for topical use. Its use for skin indications is less well documented, however. In B16 melanoma cells, it was shown to inhibit tyrosinase activity and melanin biosynthesis (44). Many discussions of antioxidant flavonoids include a mention of pycnogenol, but few quality data are presented (45).

Polyphenols

Polyphenols are a subset of flavonoids used in many cosmeceuticals. Two main sources of polyphenols are tea and fruits. Pomegranate is an example of a commonly used polyphenol cosmeceutical.

Pomegranate

Similar to lycopene, another oral supplement appearing in health drinks and vitamins is pomegranate extract. Pomegranate, botanically known as *Punica granatum*, is a deciduous tree bearing a red fruit native to Afghanistan, Pakistan, Iran, and northern India (46). It was brought to California by the Spanish settlers in 1769 and is commercially cultivated for its juice. The pomegranate became famous in Greek mythology when Persephone was kidnapped by Hades and taken to the Underworld to be his wife. Persephone consumed four pomegranate seeds while in the Underworld and thus had to spend four months every year in Hades, during which time, nothing would grow. This gave rise to the season of winter.

Pomegranate juice, commonly consumed in the Middle East, provides about 16% of the adult requirement of vitamin C per 100-mg serving. It also contains pantothenic acid, also known as vitamin B5, potassium, and antioxidant polyphenols. These substances have been demonstrated to protect against UVA- and UVB-induced cell damage in SKU-1064 human skin fibroblasts (47). Pomegranate juice is also purported to reduce oxidative stress and affect LDL and platelet aggregation in humans and apolipoprotein E-deficient mice (48, 49). It has also been studied for improving the levels of hyperlipidemia in diabetic patients (50).

Unfortunately, there is little evidence to support the use of most cosmeceutical active ingredients. The vehicle moisturizer remains the active agent in most cases.

Retinoids

Retinoids represent one of the most important categories of cosmeceuticals in both the prescription and OTC realms (Figure 5.6). Prescription retinoids, such as tretinoin, can reverse photo-induced skin changes (51–53). Tretinoin has been shown to transform an atrophic epidermis into a hyperplastic, thicker epidermis resulting in the improvement of skin wrinkling (54). Tretinoin also induces papillary dermal collagen synthesis, new blood vessel formation, increased glycosaminoglycan deposition, and exfoliation of retained stratum corneum (55, 56). These histologic changes translate clinically into skin with less yellow and more pink hues, accompanied by increased tactile

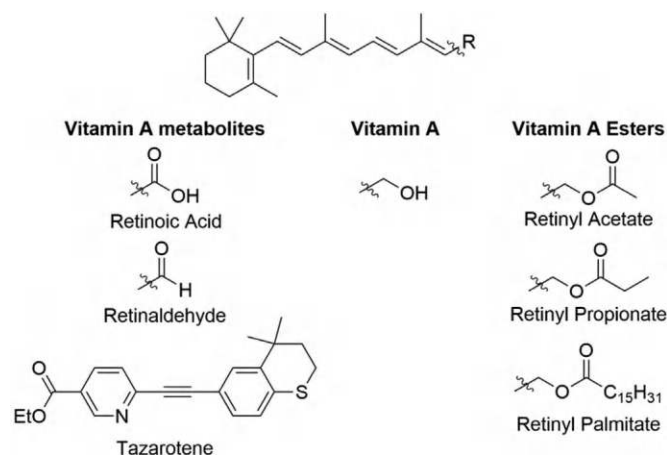


FIGURE 5.6 The family of OTC and prescription retinoids.

smoothness (57). Changes may be perceived in four months in some patients who use topical tretinoin daily, but more improvement is seen with longer therapy. Naturally, more improvement is visible in patients with severe photoaging, but results are also seen in non-sun-exposed elderly skin (58). It is interesting to note improved psychosocial status in patients who undergo topical tretinoin therapy (59).

Retinoids represent one of the most important categories of cosmeceuticals in both the prescription and OTC realms.

Tretinoin must be applied daily to the face to achieve reversal of photoaging. Patients who initiate treatment may experience varying degrees of erythema and dermatitis for the first two to six weeks of therapy. It is thought that the skin eventually “hardens” to the irritating effect of the tretinoin, with the disappearance of burning, pruritus, and desquamation (60). This hardening effect is lost when application is discontinued.

Topical tretinoin is the most commonly used cutaneous prescription cosmeceutical. However, successful use may require alterations in skin care products and cosmetics. During the phase of retinoid dermatitis, a mild cleansing bar may need to be substituted for a deodorant soap to prevent further xerosis and irritation. The use of all drying agents, such as astringents and toners, exfoliants, abrasive scrubbers, and cleansing masks, should be discontinued. Oil-free or water-based facial foundations will tend to adhere preferentially to facial scale, necessitating the use of an appropriate moisturizer to smooth the desquamating stratum corneum prior to application of foundation. Where possible, foundations with a higher oil content designed for dry skin can be selected. These alterations in skin care may facilitate the use of tretinoin.

In addition to prescription retinoids, OTC retinoids are found in some cosmeceuticals in the form of retinol, retinyl palmitate, retinyl propionate, and retinaldehyde. It is theoretically possible to interconvert the retinoids from one form to another. For example, retinyl palmitate and retinyl propionate, chemically known as retinyl esters, can become biologically active following a cutaneous enzymatic cleavage of the ester bond and subsequent conversion to retinol. Retinol is the naturally occurring vitamin A form found in red, yellow, and orange fruits and vegetables. Although retinol is necessary for vision, it is highly unstable (Figure 5.7). Retinol can be oxidized to retinaldehyde and then oxidized to retinoic acid, also known as prescription tretinoin. It is this cutaneous conversion of retinol to retinoic acid that is responsible for the biologic activity of some of the new stabilized OTC vitamin A preparations designed to improve the appearance of benign photodamaged skin (61). Unfortunately, only small amounts of retinyl palmitate and retinol can be converted by the skin, accounting for the increased efficacy seen with prescription preparations containing retinoic acid.

OTC retinoids include retinol, retinyl palmitate, retinyl propionate, and retinaldehyde.

The main problem with prescription retinoids is their irritancy. Unfortunately, as the biological efficacy of the retinoid increases, so does the irritancy. This is also the case with the OTC retinoids.



FIGURE 5.7 Retinol is the most popular OTC retinoid used in cosmeceutical formulations.

Retinol is a greater irritant than the retinyl esters and is also more unstable. It is for this reason that cosmeceutical formulations not manufactured under strict oxygen-free conditions prefer to add retinyl palmitate to moisturizing creams. However, the retinyl palmitate may act as an antioxidant for the lipids present in the moisturizer.

The topical benefit of retinol has been documented by well-controlled studies (62). It is commonly felt among dermatologists that retinol is of benefit (63), but it is difficult in moisturizer studies that do not include vehicle control to separate the retinol benefit from the moisturizer benefit. Nevertheless, of all the carotenoids available for formulation, retinol has the greatest evidence to support topical application efficacy.

Hydroxy acids

No discussion of cosmeceuticals would be complete without the mention of the hydroxy acids. The hydroxy acids were some of the first substances to initiate interest in cosmeceuticals. Interestingly, hydroxy acids represent the oldest facial cosmeceuticals. It is said that Cleopatra used the debris at the bottom of the wine barrels to massage her face. Chemically, this was the tartaric acid; thus Cleopatra was the first woman recorded to routinely apply facial alpha-hydroxy acids. Alpha-hydroxy acids represent a group of chemicals consisting of organic carboxylic acids in which a hydroxy group is at the alpha position. Members of this group include glycolic, lactic, citric, malic, mandelic, and tartaric acid. Glycolic acid is derived from sugar cane, lactic acid is derived from fermented milk, citric acid is found in citrus fruits, malic acid is found in unripe apples, mandelic acid is an extract of bitter

TABLE 5.4: Glycolic Acid: Different Concentrations with Different pH Levels

Concentration (%)	pH
5	1.7
10	1.6
20	1.5
30	1.4
40	1.3
50	1.2
60	1.0
70	0.6

almonds, and tartaric acid is found in fermented grapes (64). The acids are now produced synthetically for cosmetic use.

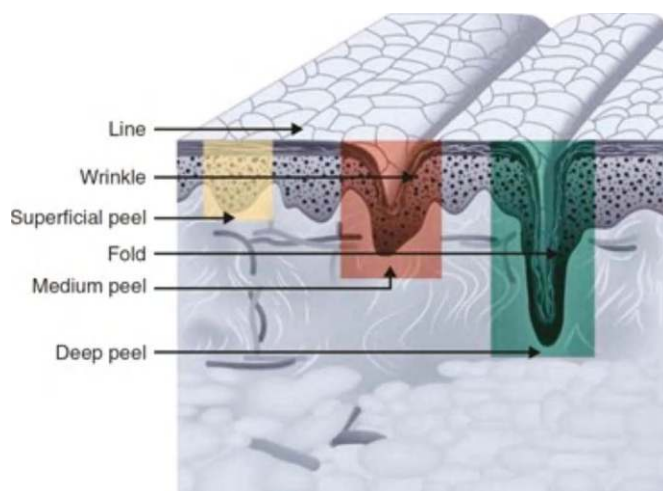
The alpha-hydroxy acids include glycolic, lactic, citric, malic, mandelic, and tartaric acids.

Glycolic acid is the most popular of the alpha-hydroxy acids for antiaging purposes available in OTC and physician-dispensed products. Its pH varies with concentration, as demonstrated in Table 5.4. This acidic pH is sometimes buffered for facial application with phosphoric acid and monosodium phosphate or neutralized with sodium hydroxide (65). A desirable pH for facial application lies between 2.8 and 4.8. Glycolic acid is finding its way into formulations for facial moisturizers, cleansers, and toners. Additionally, it is used alone or in combination with other chemicals at various concentrations for facial peels (66–68). The epidermal effects of glycolic acid are manifested by decreased keratinocyte cohesion, which may be due to alterations in ionic bonding (69), while the dermal effects lead to increased mucopolysaccharide and collagen synthesis (70). Visibly, this translates into less cutaneous wrinkling and dyspigmentation (71). Furthermore, glycolic acid may act as an antioxidant, as demonstrated by its ability to alleviate the erythema observed after ultraviolet radiation exposure to the skin (72).

Alpha-hydroxy acids and tretinoin may be combined as therapy for photoaged skin because the combination is well tolerated, and the effects may be additive (73). They act very different chemically because the hydrophilic alpha-hydroxy acids diffuse freely throughout the watery intercellular phase, whereas the hydrophobic retinoids require proteins in the plasma and skin to act as carriers (54). Current trends use an 8% glycolic acid moisturizer in the morning, accompanied by a bedtime use of the highest strength of tretinoin tolerated. This treatment can be supplemented with biweekly to monthly glycolic acid face peels in concentrations of 20%, 35%, 50%, and 70%. Better-controlled clinical studies with histologic evaluation are required before the optimum therapy for photoaged skin emerges (Figure 5.8).

Snail mucin

What is the most frequently searched ingredient on the Internet? Snail mucin! This slime produced by snails is expected to reach a market value of \$770 million by 2025. It is an ingredient of antiquity, originally used by the ancient Greeks for its ability to reduce aging and ameliorate inflammation. Hippocrates mentioned the use of snail mucin as a skin medicament. Although the mucin is secreted by snails for adhesion, hydration, and lubrication, it

**FIGURE 5.8** Alpha-hydroxy acid peels produce superficial skin peeling to temporarily improve skin texture and induce exfoliation.

has many other novel functions, making it a popular cosmetic ingredient.

Mucin produced by the snail's foot is a highly glycosylated protein that allows the snail to stick to any surface, including the ability to climb while inverted. This contrasts with the mucin that is secreted from the back of the snail, which is used for hydration and antimicrobial purposes. Snail mucin has been found in mouse model wounds to inhibit the activity of *Staphylococcus aureus*, *S. epidermidis*, and *Pseudomonas aeruginosa*. Other uses of snail mucin include drug delivery, wound healing, and anti-tumor properties against cancers including melanoma. Snail mucin from *Helix aspersa* was shown to decrease the viability and metastatic potential of melanoma cells.

The mucin for cosmetic purposes can be obtained from garden snails, including *Cryptomphalus aspersa* and *H. aspersa*. The snails are grown on farms and put in a cage or placed on a glass slide to collect the secretions, which are then purified. The secretions are stimulated by exposing the snails to low-voltage electric current less than 1,000 V for short periods, water jet sprays, or cracking the shell of the snail. The snails can also be placed in a NaCl solution that osmotically dehydrates the snail to produce mucin or stimulated via vibration, ozone, or ultrasound (74). The mucin contains growth factors, hyaluronic acid, antioxidants, and anti-inflammatory substances, such as allantoin. It also contains glycolic acid, lactic acid, collagen, and elastin. It is a clear liquid with a pH of 4.8.

Cosmetic uses for snail mucin include moisturization, anti-aging, scarring, and hyperpigmentation. Moisturization is delivered by the high hyaluronic acid concentration in snail mucin. Hyaluronic acid is a glycosaminoglycan that acts as a humectant to attract and hold 1,000-fold its weight in water. Anti-aging properties are attributed to its ability to increase matrix metalloproteinase (MMP) expression, mesenchymal stem cell differentiation, prevent oxidative damage, and stimulate the extracellular matrix (75). Indeed, a 12-week study conducted on 40 female and male subjects aged 40–70 years of Fitzpatrick skin types I–IV using a product that contained snail mucin and egg extract in addition to a retinoid demonstrated a statistically significant ($p < 0.001$) 39% increase in skin elasticity, 53% reduction in skin roughness, and 26% improvement in skin brightness after 12 weeks of use (76). The scarring benefits of snail mucin have been

attributed to its ability to increase the proliferation and migration of keratinocytes and fibroblasts. Finally, the pigmentation benefits have been attributed to the presence of lactic and glycolic acids in snail mucin.

Getting slimed with snail mucin is a practice captivating Internet searchers. It is a natural biologic ingredient that possesses a complex structure with many attributed benefits, and it is estimated that the snail mucin market will continue to grow by 8.3% annually. The country with the largest consumption of snail mucin is South Korea. The biggest growth outlet for snail mucin products is e-commerce, as expected, based on the popularity of snail mucin online searches. No doubt, dermatologists will get many questions regarding this interesting ingredient!

Bakuchiol

Bakuchiol is a new cosmeceutical anti-aging ingredient with purported retinoid effects without the retinoid irritation. It is a meroterpenoid phenol that is abundant in the seeds and leaves of the *Psoralea corylifolia* plant. Bakuchiol originates in India, where it is used as a spice called babchi. It is purported to possess anti-inflammatory, antioxidant, antiandrogen, and antibacterial properties. It has no structural resemblance to retinoids but appears to function like retinol. In a DNA microarray study, it upregulated collagen types I and IV. Bakuchiol is the new retinoid-like ingredient in many anti-aging moisturizer formulations.

Ergothioneine

Ergothioneine is a naturally occurring amino acid and one of the newest cosmeceutical antioxidant ingredients. L-ergothioneine is a highly effective low-molecular-weight antioxidant that is consumed in the diet from mushrooms. It accumulates in human cells that are subjected to high levels of oxidative damage from reactive oxygen species such as the proteins, lipids, and DNA in keratinocytes. Further, L-ergothioneine may promote DNA repair. Its protective function is only possible in cells that express the L-ergothioneine-specific receptor/transporter OCTN1. Thus, L-ergothioneine and its receptor/transporter are an important part of the skin antioxidant defenses. It might also be important in the protection of mtDNA from reactive oxygen species generated by the electron transport chain, making it a systemic antioxidant as well. Ergothioneine is finding its way to a variety of topical formulations with purported anti-aging benefits.

Growth factors

Growth factors are expanding their reach in the cosmeceutical market. This may be because it is possible for growth factors to modulate cellular behavior and reprogram aging cells to act in a more youthful fashion. Growth factors are usually obtained from either cultured human cells or genetically engineered microorganisms. Most of the currently marketed growth factor-containing moisturizers use cultured human fibroblasts on a three-dimensional matrix induced to produce collagen. However, growth factors may also be obtained from stem cells derived from adipose tissue or the newborn umbilical cord. Finally, growth factors can be made via recombinant technology using bacteria or yeast cultures that have been modified to include a DNA sequence for a specific growth factor. For example, epidermal growth factor has been given the cosmetic ingredient name (INCI) human oligopeptide-1, platelet-derived growth factor has been given the cosmetic ingredient name human oligopeptide-10, and fibroblast growth factor 9 has been given the name human oligopeptide-12. These are the names that are used to indicate the presence of the

growth factor on the required ingredient disclosure, and dermatologists should look for these names when trying to determine whether a cosmeceutical contains growth factors.

The first commercialized growth factors in the marketplace were obtained from cell fibroblast cultures of newborn foreskins. The fibroblasts from fresh circumcision tissue were cultured in a petri dish with media until confluent. The spent media with nutrients depleted and cellular excretion materials was removed and fresh media was placed in the petri dish. The spent media, known as conditioned media, contained growth factors, cytokines, and soluble proteins. It is also now recognized that in addition to growth factors, the spent media also contained exosomes, a topic that will be discussed shortly.

It is also possible to obtain autologous growth factors, which may be more effective because the tissue is taken from one donor location and injected into another body location. One technique involves removing a 3- to 4-mm skin punch biopsy from the patient and flash freezing for shipment to a biobank for processing. The fibroblasts are cultured and the spent media is removed containing autologous growth factors that are then put into a suitable vehicle. The extra tissue is frozen at -80°C for later use and provides an additional supply of fibroblasts for renewal of the cell culture. Another technique for obtaining autologous growth factors involves obtaining blood-derived growth factors. Here, the growth factors are obtained by drawing 40–60 cc of the patient's blood followed by double spinning the blood to obtain platelet-rich plasma (PRP). The autologous growth factors in the PRP include platelet-derived growth factor (PDGF), epidermal growth factor (EGF), and vascular endothelial growth factor (VEGF). It is theorized that autologous growth factors might be more biologically active because they are specific to the receptors of the donor.

Topical growth factors are hydrophilic molecules larger than 15,000 Daltons. Molecules that are larger than 500 Daltons do not penetrate the skin barrier; this is a protective mechanism because proteins are highly allergenic substances. This means growth factors may have limited topical penetration, which can be enhanced through physical and chemical means. For example, growth factors may be applied following laser resurfacing or radiofrequency microneedling to promote healing. Growth factor liposomal serums have also been developed to enhance penetration after topical application. For example, one company places transforming growth factor beta (TGF-beta) in the center of the hydrophilic liposome, surrounded by a protective lipid bilayer. The liposome theoretically facilitates passage of the growth factor between the corneocytes, through the intercellular lipids, and in contact with the viable epidermis and dermis where it may be physiologically active.

Concern has been expressed regarding the ability of growth factors to promote the growth of premalignant and malignant cells. Most growth factor products are used by patients with actinically damaged skin, so it is possible that the growth of early actinic keratoses and squamous cell carcinomas could be promoted. If this were the case, however, one might expect to see an increase in these lesions as millions of units of growth factor-containing cosmeceuticals have been sold. Nevertheless, this safety issue cannot be ignored.

It can be challenging to determine the functional benefit of topical growth factors because the effect of the moisturizing vehicle must be separated from the effect of the growth factor. You might argue that you cannot separate the effect of the moisturizing vehicle from the growth factor because the cosmeceutical is advertised and sold based on the entire final formulation. A lot of formulation effort goes into creating the vehicle, which can

provide many skin benefits. For example, the vehicle may contain occlusive moisturizers to decrease transepidermal water loss and humectants to attract and hold water in the skin. These ingredients improve the fine lines of facial dehydration. The vehicle may also contain emollient substances to physically smooth the skin surface, creating softer skin. Finally, the vehicle may contain light-reflective materials that improve facial shine, radiance, and luminosity through purely optical effects. This is why vehicle-controlled studies are so important in the cosmeceutical realm to examine the additive effect of an active ingredient over the effect of the vehicle.

The final concern is whether the growth factor is active, stable, and working. It is certainly a challenge to keep the growth factors in the moisturizer formulation active for the life of the product. In the laboratory, most growth factors are stored at temperatures below -20°C to maintain stability. Obviously, this is not possible in the consumer marketplace. Enzyme-linked immunosorbent assay (ELISA) tests can be used to examine the stability of growth factors in finished formulations, but this testing is also limited because the protein may be detected by ELISA, but may be inactive. It is thought in the cosmeceutical industry that about 5–10% of the growth factor that is put in the bottle remains active at room temperature, but this varies widely from product to product. Because growth factors are regulatory proteins, this may be enough to elicit an effect, but this must be confirmed through more in-depth testing. Remember, the ingredient disclosure lists what went in the bottle, not what comes out of the bottle. Dermatologists should inquire as to how stability testing was performed for growth factor-containing products they choose to dispense.

Peptides

Another area of tremendous interest and popularity is peptides. Peptides are showing up in both mass and prestige products with the intent for the peptide to also modulate cellular functioning. Peptides are composed of amino acids, and the number of amino acids determines the peptide category. For example, two amino acids form a dipeptide, three amino acids form a tripeptide, four amino acids form a tetrapeptide, and so on. The term oligopeptide can be used to describe peptides that comprise between two and 20 amino acids. The number of amino acids, type of amino acid, and order of amino acids determine the properties of the peptide. Peptides can interact with selective skin target sites in extremely low concentration and are short-lived. Peptides are very expensive and are therefore placed in formulations at the parts-per-million level.

Glutathione and carnosine are the two antioxidant peptides commonly used in cosmeceutical formulations. Glutathione (gamma-glutamyl-cysteinyl-glycine; GSH) is a tripeptide antioxidant that decreases in concentration in the body with aging; thus cutaneous application is thought to replenish glutathione stores. However, ingestion is probably more effective. Carnosine (beta-alanyl-1-histidine) is a biomimetic antioxidant peptide that is a scavenger of reactive oxygen species in the cell membrane, preventing the oxidation of free fatty acids. It can also inhibit glycation, the nonenzymatic binding of sugars to proteins, known as advanced glycation end products (AGE). Over time, carnosine is degraded to beta-alanine and histamine. Beta-alanine is thought to stimulate the biosynthesis of nucleic acids and collagen. Thus, both the peptide and its breakdown products are thought to be biologically active.

There are several classes of peptides used in cosmeceutical formulations, including neuropeptides and signal peptides. Neuropeptides are intended to act like a local neurotoxin in

blocking neurotransmitters at the neuromuscular junction and reducing lines of facial expression, minimizing wrinkle depth, and improving skin roughness without systemic effects. The peptide acetyl octapeptide-3 is an example of a neuropeptide composed of the amino acids aspartic acid, glutamic acid, glutamine, and methionine. Other widely used neuropeptides include acetyl hexapeptide-3 (Argireline), pentapeptide-18 (Leuphasyl), pentapeptide-3 (Vialox), and tripeptide-3 (Syn-Ake).

Signal peptides are different from neuropeptides because they are intended to initiate some biologic signal to include the production of growth factors, collagen, elastin, proteoglycans, and fibronectin. The most widely used signal peptide is KTTKS (lysine-threonine-threonine-lysine-serine). This peptide is part of the sequence of amino acids derived from the pro-collagen I C-terminus end. It can be conjugated to palmitic acid to create Palmitoyl-KTTKS, enhancing skin penetration that may be limited unless the peptides are very small. In fibroblast culture, this signal peptide can stimulate the production of type I and III collagen and fibronectin. Other similar signal tripeptides include Palmitoyl sh-Tripeptide-3 Amide, Palmitoyl sh-Tripeptide-1 Amide, Acetyl Tripeptide-54 Amide, and Acetyl Tripeptide-74 Amide.

Signal peptides are commonly found in topical formulations to promote hair growth. The tripeptide glycine-histidine-lysine (GHK) is a collagen fragment used to stimulate collagen synthesis and stimulate hair growth when coupled with biotin (biotinyl-GHK). Biotin apparently strengthens the ability of the tripeptide to bind to the hair keratin. These hair-promoting peptides are used in concentrations of 2–5 ppm in commercial formulations. The idea here is that a signal can be presented to the hair that cascades to elicit a far-reaching, broader effect.

Peptides have also been developed to modulate pigmentation because melanogenesis is triggered by the alpha-MSH peptide. Many alpha-MSH peptide fragments have been synthesized, including a tetrapeptide composed of proline-lysine-glutamate-lysine (PKEK). In vitro, this peptide was shown to decrease inflammatory cytokines, such as interleukin (IL)-6, IL-8, and tumor necrosis factor alpha (TNF-alpha), known to worsen post-inflammatory hyperpigmentation.

Exosomes

Exosomes are a relatively new technology in dermatology designed to enhance skin aesthetics. The term “exosomes” is based on “exo,” meaning outside the cell, and “somes,” referring to their spherical structure. Thus, exosomes are extracellular vesicles produced in the endosomal compartment by all types of eukaryotic cells, ranging in diameter from 30 to 150 nanometers. Much like liposomes, exosomes have an outer lipid bilayer, but their interior contains proteins, lipids, DNA, microRNA (miRNA), and messenger RNA (mRNA). Exosomes are found in urine, saliva, blood, and cerebrospinal fluid.

Exosomes in general are not new. They were discovered more than 30 years ago as extracellular vesicles that were released from cells upon fusion of an intermediate endocytic compartment, known as the multivesicular body, with the plasma membrane. Exosomes are expelled by exocytosis and were thought to function solely as a method of cellular waste disposal, but it is now known that they function in intracellular communication and allow the transmission of molecules between cells. This means they can influence the immune system through adaptive responses to pathogens and tumors and also serve as a drug delivery system. In dermatology, exosomes containing mRNA may affect protein production in the receiving cell.

Exosomes can be derived from various sources and thus possess many different cellular effects, including differentiation, proliferation, migration, angiogenesis, and cell death. For example, exosomes can be obtained from the culture medium of mesenchymal stem cells. The medium, which is cell-free and contains the exosomes, is collected and put directly into a cosmeceutical formulation. Several culture medium–based established skin care lines now recognize their products contain not only growth factors but also exosomes. Exosomes can also be isolated from umbilical cord mesenchymal stem cells, adipose-derived stem cells, bone marrow–derived stem cells, dermal fibroblasts, platelets, placenta, and keratinocytes. The exosomes are collected by differential centrifugation of the culture medium at very high speeds.

The cutaneous benefit of the exosome depends on its source and may include aging, wound healing, scar reduction, hair growth, and pigment regulation. For example, keratinocyte-derived exosomes have been found to modulate melanin synthesis (77). Umbilical cord–derived exosomes increased fibroblast collagen 1, fibronectin, and elastin gene expression (78). Adipose-derived stem cells promoted cell proliferation and migration (79). Dermal papilla–derived exosomes regulated hair follicle growth and stimulated proliferation of the outer root sheath (80). However, much of this work has been done in vitro on cell cultures or in animal models. Excellent double-blind placebo-controlled human studies are lacking in most dermatology exosome indications.

Formulating exosome-containing cosmeceutical products can indeed be challenging. There are no standard techniques for the identification, isolation, and storage of exosomes. For most animal studies, the exosomes are subcutaneously injected or introduced into an open wound bed. Both of these routes of administration bypass the stratum corneum and eliminate the need for a moisturizer vehicle carrier. Exosomes are biologic substances, which creates some FDA implications, and require special handling to retain viability. The exosomes may go into the bottle, but for them to deliver their contents intact, the exosomes must also come out of the bottle. Most currently marketed exosome products are put in emulsifiers and preservative-containing moisturizers for daily application. Ingredients designed to destroy bacterial and fungal product contamination, also known as preservatives, must be carefully examined to observe their effect on the physical structure of an exosome. Moreover, the pH and osmotic concentration of the moisturizer vehicle could also damage exosomes.

Exosomes are a promising area in dermatology, not only for aesthetic uses but also for disease treatment. Adipose-derived exosomes have been studied in atopic dermatitis for their ability to exert a paracrine effect and modulate inflammation (81). Exosomes in patients with systemic lupus erythematosus (SLE) mediated higher production of tumor necrosis factor- α and IL-6, which may play a role in the pathogenesis of SLE, providing a target for treatment and a method of following disease activity (82). Exosomes for aesthetic uses may provide aging cells with genetic material, inducing more youthful cellular behavior. Exosomes hold great promise, but several pitfalls must be overcome before exosomes realize their full dermatologic potential.

Circadian rhythm

Another emerging concept in cosmeceuticals is developing skin care regimens that complement circadian rhythms. The concept of body rhythms has been popularized as important in overall health. These rhythms are fluctuations in mental, physical, and emotional well-being based on the clock related to the day/night cycle, hormones, meals, sleep/wake cycle, adrenal gland

production, thyroid gland, and clock genes. The study of the body's circadian rhythm is known as chronobiology and dates back to the 18th century. There are three types of chronobiology rhythms: infradian rhythms, ultradian rhythms, and circadian rhythms. Infradian rhythms last more than 24 hours and are repeated only every few days, weeks, or months, representing such activities as female menses. Ultradian rhythms are shorter than 24 hours and often last several hours, such as ingestion of food. Finally, circadian rhythms last 24 hours with distinctive day/night cycles.

Circadian rhythms are endogenous and adjusted to the local environment by cues called zeitgebers, meaning “time giver” in German. The 2017 Nobel Prize in physiology or medicine was awarded for research in molecular mechanisms controlling circadian rhythms in fruit flies. In humans, the circadian clock is in the suprachiasmatic nucleus, located in the hypothalamus. PER1 and PER2 genes are expressed in the suprachiasmatic nucleus, representing the primary circadian pacemaker in the human brain. These circadian rhythms are also important in the skin, with robust autonomic clocks in keratinocytes, fibroblasts, melanocytes, mast cells, and hair follicles. Important skin functions affected by circadian rhythms include free radical production and neutralization, DNA damage and repair, keratinocyte/fibroblast differentiation and proliferation, and barrier and immune functioning.

There are key differences between skin activities that occur during the day and night. During the day, the skin has the highest pH, sebum production, and thickness with the lowest cell proliferation. Conversely, during the night, the skin has the highest DNA repair, cell proliferation, barrier permeability, skin penetration, blood flow, moisturizer loss, and the lowest barrier recovery rate. This has led to the development of moisturizers to address the diurnal variation in skin needs and a new concept in cosmeceuticals.

A very obvious example of a circadian rhythm-based moisturizer would be the inclusion of sunscreen. Sunscreen-containing moisturizers should be worn during the day and not at night, based on daytime sun exposure. Because the skin barrier permeability is higher at night, more occlusive moisturizer formulations should be used to include products with less water and more oils. Occlusive ingredients include petrolatum, mineral oil, and shea butter. Because sebum product is higher during the day, oil-control ingredients such as talc or kaolin should be placed in daytime products. Also, because the skin pH is higher during the day, it may be worthwhile to make daytime formulations slightly more acidic to lower pH. These are examples of how cosmeceuticals can be modified to address the circadian rhythm concept.

Skin care in mature patients

This chapter closes with an examination of skin care products in mature patients. These products include cleansers, color cosmetics, face masks, and exfoliants. Cleansers are important for good hygiene while maintaining the skin barrier. Color cosmetics are necessary to camouflage photoaging and face masks can be used to improve skin texture. Exfoliants can smooth the skin surface by minimizing the effect of the desquamatory failure found in mature skin.

Facial cleansers

The skin barrier in aging skin is not as robust as during youth. This means that cleansing, which is important for facial hygiene, must be thorough yet mild. Sebum production decreases with

advancing age, so the aggressiveness of the cleanser must be balanced between removing environmental soils and sebum, and preservation of the intercellular lipids. A variety of mild cleansers have been developed to meet the needs of mature skin. These are discussed next.

1. Cold cream cleansers

The original cleanser for cosmetic removal and mild facial cleansing invented by Theron T. Pond in 1846 was known as “cold cream” and is still popular today. Cold cream, composed of water, beeswax, and mineral oil, uses fats to solubilize lipophilic skin soils. Beeswax and mineral oil function as lipid solvents that combine with the detergent action of borax, also known as decahydrate of sodium tetraborate, to cleanse the face. The formulation also contains ceresin and carbomer to thicken the cream and fragrance. The cold cream is wiped on with the fingers, wiped off with a tissue, and may be rinsed or left on the face. Cold cream is an excellent facial cleanser and cosmetic remover for mature patients with dry skin.

2. Cleansing milks

A thinner variant of cleansing cream is cleansing milk, without the more viscous waxes designed for normal to dry mature skin. Cleansing milk contains water and lightweight oils, such as olive oil, sunflower oil, jojoba oil, or sesame seed oil, and emollients, such as glycerine, making it less likely to leave a facial residue. The oils are emulsified into the water, making cleansing milks an oil-in-water emulsion providing cleansing by dissolving, as opposed to emulsifying, skin soils. The liquid is dispensed from a bottle and wiped over the face with a cotton pad. The cleanser can be wiped off, or wiped first, followed by water rinsing. Cleansing milks are commonly used for the removal of eye cosmetics because they are non-irritating and do not readily blur vision with an oily residue.

3. Cleansing oils

Cleansing oils are a water-in-oil emulsion primarily used for the removal of facial or waterproof eyelid cosmetics and waterproof sunscreens that cannot be easily removed with soap and water. The oil is spread over the face with a cotton pad, rubbed, and rinsed away with water. The clear oil will turn milky when rinsed with water. Mineral oil, castor oil, jojoba oil, and olive oil are commonly used. Olive oil can be comedogenic; thus the cleansing oil should be thoroughly water rinsed and might require the addition of a detergent for complete removal.

4. Oil cleansing balms

Oil cleansing balms are similar to cold cream cleansers, except they have a petroleum jelly consistency at room temperature and liquefy when they come in contact with the warm facial skin. These products are used to remove waterproof stage and surgical cosmetics, as well as waterproof sunscreens, but are also suitable for dry skin. The thick balm is oil-based and contains mineral oil, sunflower oil, olive oil, coconut oil, mango seed butter, apricot kernel oil, sweet almond oil, grape seed oil, orange peel oil, avocado oil, and so on. These oils are combined with beeswax or shea butter (*Butyrospermum parkii*) to create a thick balm that is massaged over the face with the fingers in a circular motion to also remove waterproof products from the pores. Many products come with a muslin cloth to moisten with warm water to aid in rubbing the product thoroughly over the face. With continued rubbing, the product will become a liquid that can be wiped away with the rinsed muslin cloth, leaving an oily residue. It may

be necessary to follow the cleansing balm with soap and water cleansing in patients with oily skin.

5. Micellar water cleansers

Micellar water cleansers, also known as cleansing waters, contain water and a very mild surfactant representing a dilute cleansing solution. A micelle is a molecular cluster with a hydrophilic and a hydrophobic end, in this case, dissolved in a water solution. The hydrophobic end attaches to the skin soil, dissolving the soil in water through the hydrophilic end and allowing water rinsing to cleanse the face. Several different surfactants can be used, such as cetrimonium bromide, a cationic quaternary surfactant also known as a “quat.” Quats are mild surfactants commonly found in hair conditioners that allow the excess conditioner to water rinse down the drain, preventing the hair from appearing greasy. Polysorbate 20 is also used because it is a non-foaming surfactant. Amphoteric surfactants of the type found in baby shampoo can also be used, such as disodium cocoamphodiacetate. The product is stroked on the face with a cotton pad, rubbed to remove skin soil, and rinsed with water. Micellar water is excellent at removing water-soluble cosmetics or facial cleansing in patients with dry, sensitive skin.

6. Polymeric cleansers

The newest cleansing category is polymeric cleansers. Hydrophobically modified polymers (HMPs) are added to surfactants to create a polymer/surfactant complex that is functional, aesthetic, and mild. The HMPs interact with the hydrophobic tails of the surfactant, forming larger surfactant structures that cannot readily penetrate the stratum corneum. The binding of the HMPs also lowers the surfactant concentration in the micelles formed during cleansing, decreasing protein damage. Finally, HMPs provide for increased foam formation, a cleanser trait consumers find desirable but is not necessarily present in mild cleansers for dry, mature skin. This cleanser technology method basically increases mildness by reducing skin permeability.

Color cosmetics, face masks, and exfoliants can be used to improve the appearance of mature skin.

Color cosmetics

Cutaneous sun exposure accelerates and exaggerates the clinical changes associated with advanced age (83). Thus, individuals turn to cosmetics, which can aid in the camouflage of telangiectasias and lentigines, but cannot conceal the deep wrinkling found in photoaging. Facial foundations become difficult to apply evenly and tend to migrate into cutaneous furrows. The yellow skin hue imparted by elastosis can be improved by using a purple undercover cosmetic, but again uniform application is difficult. The patient may attempt to solve these problems by using a high-coverage cream foundation. Unfortunately, thicker facial foundations, which can cover skin color abnormalities, only accentuate the deep wrinkling and furrows. One possible cosmetic solution is to use a white eyeliner pencil to line the depths of each furrow and a subsequent application of a moderate-coverage facial foundation appropriate for the patient's skin type. The white pigment placed at the depth of each furrow will make the recessed skin less shadowed, depending on the concept of facial contouring. Lining each furrow is time-consuming but can improve, although not eliminate, the photoaged skin appearance.

Face masks

Face masks consist of substances applied to the face for an extended period for therapeutic and/or esthetic purposes. Masks are available for domestic and professional uses. They may be packaged in a jar or bottle for immediate application to the face or as dry ingredients in a pouch for mixing with water. Typically, a mask is applied on a weekly basis to provide a time for relaxation, an esthetically pleasing sensation, and skin benefits. There are four basic mask formulations: wax-based, vinyl- or rubber-based, hydrocolloid, and earth-based.

Wax masks

Wax masks are popular among women who visit professional spas for their warm, esthetically pleasing feel. They are composed of beeswax or, more commonly, paraffin wax, to which petroleum jelly and cetyl or stearyl alcohols have been added to provide a soft, pliable material for facial application with a soft brush. The wax is heated in a pot placed in a water bath to control the temperature and prevent burning. Sometimes the wax is dipped from the pot and painted over the face, and other times it may be brushed over thin cotton gauze draped over the face. Gauze is commonly used to enable the facial technician to remove the wax in one piece (84). Gauze also prevents the wax from sticking to the vellus hairs on the face, which may be painfully epilated as the wax is peeled off the face.

Wax-based face masks temporarily impede cutaneous transepidermal water loss. This effect is limited only to the time the mask is in direct contact with the face, unless a suitable occlusive moisturizer is applied immediately following mask removal. For this reason, they are popular in persons with dry skin.

Vinyl- and rubber-based masks

Vinyl and rubber-based masks are popular masks for home use because they are easily squeezed from a pouch onto the face and removed in one piece. Rubber-based masks are usually based on latex, whereas vinyl-based masks are based on film-forming substances, such as polyvinyl alcohol or vinyl acetate. Because of the concern over latex allergy, there are no true rubber-based masks for home use.

Vinyl masks are squeezed premixed from a tube or pouch and applied with fingertips or a wooden applicator to the face. Upon evaporation of the vehicle, a thin, flexible vinyl film remains behind on the face. The mask is generally left in contact with the skin for 10 to 30 minutes and then peeled off in one sheet by loosening the edges from the face.

Vinyl and rubber masks are appropriate for all skin types. The evaporation of the vehicle from the wet mask creates a cooling sensation, and the shrinking of the mask with drying may give the impression that the skin is actually tightening. These masks can temporarily impede transepidermal water loss while they are in contact with the skin.

Hydrocolloid masks

Hydrocolloid masks are used both in professional salons and at home. Hydrocolloids are substances, such as oatmeal, that are of large molecular weight and thus interfere with transepidermal water loss. These masks are formulated from gums and humectants and enjoy tremendous popularity because many specialty ingredients are easily incorporated into their formulation. They are marketed in the form of dry ingredients in a sealed pouch that must be mixed with warm water prior to application. The resulting paste is then smeared over the face with the hands or a wooden blade and allowed to dry (85).

Hydrocolloid masks leave the skin feeling smooth and create the sensation of skin tightening as the water evaporates and the mask dries. Temporary moisturization can occur while the mask is on the skin. Specialty additives such as honey, egg whites, chamomile flowers, aloe vera, almond oil, zinc oxide, sulfur, avocado, and witch hazel may be used to customize the mask. Many spas have their own special concoction. By varying the ingredients, masks can be created for all skin types. In addition, herbal medicine can be practiced by combining various healing plants into a poultice for facial application.

Earth-based masks

Earth-based masks, also known as paste masks or mud packs, are formulated of absorbent clays such as bentonite, kaolin, or china clay. The clays produce an astringent effect on the skin, making this mask most appropriate for oily-complected patients. The astringent effect of the mask can be enhanced through the addition of other substances such as magnesium, zinc oxide, or salicylic acid.

Exfoliants

Exfoliants containing hydroxy acids produce both epidermal and dermal changes. The epidermal changes are immediate and occur at the junction of the stratum corneum and stratum granulosum. They constitute a reduction in the thickness of the hyperkeratotic stratum corneum due to decreased corneocyte adhesion (86). The dermal effects, which are delayed, consist of increased glycosaminoglycan synthesis (69). These effects are most pronounced with the alpha-hydroxy acids (glycolic acid, lactic acid, and malic acid), which rapidly penetrate the epidermis to enter the dermis. Individuals with sensitive skin may not be able to tolerate the low pH of 3 required to cause this epidermal renewal (87). This has led to development of polyhydroxy acids (gluconolactone, lactobionic acid, and ferulic acid), which are larger-molecular-weight hydroxy acids that do not penetrate as rapidly to the dermis. This produces less irritation; therefore, polyhydroxy acid is suitable for persons with sensitive skin, eczema, and atopic dermatitis.

Another mechanism for reducing the irritation of chemical exfoliants is through neutralization or buffering. Irritation can also be minimized by raising the exfoliant pH through sodium hydroxide neutralization; however, this also reduces the exfoliation produced. The use of buffering agents, such as phosphoric acid or monosodium phosphate, is preferable because the buffer maintains the product at a desired pH (88). Ideally, the pH of an exfoliant solution should not be lower than 3. Exfoliation is induced more with a lower pH because the hydroxy acid concentration is increased, but a greater irritation in the form of stinging and burning is also expected.

Beta-hydroxy acids, such as salicylic acid, may also be used but do not produce dermal penetration. Salicylic acid is technically not a beta-hydroxy acid; it is rather a phenolic compound, but the marketing nomenclature has popularized this terminology. Salicylic acid is an oil-soluble acid, as compared with the alpha-hydroxy acids, which are mainly water-soluble, and remains on the skin surface. Because exfoliation occurs on the skin surface, this is a desirable characteristic that minimizes irritation.

Exfoliants provide the quickest way to improve the appearance of aging skin. They can improve skin smoothness, skin color, and skin light reflection. This can result in the aggressive use of these products, but the benefits decline if used continuously.

Summary

Cosmeceuticals form an important part of the OTC skin treatment market in aging skin. It is felt that cosmeceutical development has been stymied, largely due to the failure of the FDA to develop a new classification system. It is thought that a new "quasi-drug" category, similar to the Japanese designation, would allow the introduction of more robust active ingredients into cosmeceuticals. These more robust ingredients would provide enhanced consumer-perceived skin benefits, supporting stronger claims.

In summary, it is likely that cosmeceuticals will become an ever-increasing part of the fund of knowledge of dermatology. We are now only at the beginning of the cosmeceutical story. Cosmeceuticals were derived from the cosmetic industry's desire to go beyond simply adorning the skin and to improve the appearance of the skin by tackling important functional issues that meet the demands of consumers. Now, the cosmeceutical category needs to learn from the drug category. The principles of the scientific method must be applied to the clinical study of cosmeceuticals. No longer can *in vitro* data be used to extrapolate visible clinical results, nor can 15-subject clinical studies be used to determine the value of a specific ingredient. Trends without statistical significance are of no use anymore to confirm the skin effect of a given formulation. Dermatology will move the cosmeceutical category forward, and the cosmeceutical category will move dermatology forward.

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6

FACIAL SCARRING AND CAMOUFLAGING

Special color cosmetics are available for individuals with acquired or congenital contour and color defects of the face. These cosmetics are known as camouflage cosmetics because they attempt to re-create a more attractive appearance. They do not, however, duplicate the appearance of a freshly washed, unadorned face. It is obvious to all that the individual is wearing a cosmetic. Therefore, camouflage cosmetics are designed to minimize facial defects while accentuating the attractive features of the face (1).

Paramedical camouflage artists, estheticians, dermatologists, plastic surgeons, and cosmetic consultants use camouflaging cosmetics. Their successful use requires a well-formulated, quality product applied with the skill of a stage makeup technician and the artistic abilities of a painter.

Camouflaging of facial defects

Key to understanding the importance and use of camouflage cosmetics is a basic discussion of the types of facial defects that can occur. There are defects of contour, pigmentation, or a combination of both.

Camouflaging is required for facial defects of contour, pigmentation, or a combination of both.

Defects of contour are defined as areas where the scar tissue is hypertrophied or atrophied. In addition, the scar tissue may demonstrate a texture difference due to the absence of follicular ostia and hair. Pigmentation defects are abnormalities solely in the color of the skin and not in the texture. Some pigmentation abnormalities arise from tumors of the skin, whereas others are due to systemic abnormalities or extrinsic effects, such as sun exposure (Table 6.1) (2, 3).

These defects can be camouflaged using principles that are adapted from stage makeup texts. Camouflaging is the art of illusion and demands that the cosmetics be applied both with skill and artistic ability. Fortunately, the cosmetics can be easily applied and removed, providing an opportunity for experimentation and easy alteration of a bad result.

TABLE 6.1: Facial Pigmentation Defects

Facial Color	Disease Process	Foundation Color
Red	Psoriasis, lupus, rosacea	Green undercover foundation
Yellow	Solar elastosis, chemotherapy, dialysis	Purple undercover foundation
Brown hyperpigmentation	Chloasma, lentigines, nevi	White undercover foundation
Hypopigmentation and depigmentation	Post-inflammatory, congenital, vitiligo	Brown undercover foundation

Facial scar recontouring

The basic concept of facial scar recontouring is predicated on the fact that dark colors make surfaces recede, whereas light colors make surfaces appear to project (4). Thus, lighter colors will minimize depressed areas of scarring, whereas darker colors will minimize protuberant areas of the scar.

Facial scar contouring is predicated on the fact that dark colors make surfaces recede, whereas light colors make surfaces appear to project.

Figure 6.1 demonstrates how this technique works on a patient who has sustained a depressed scar following surgery for the removal of skin cancer on the nose. The scar itself is lightened to compensate for decreased light reflection, while the sides and tip of the nose are darkened to draw attention away from the surgical defect.

Camouflaging of pigmentation defects

Pigmentation defects can be camouflaged by applying an opaque cosmetic that allows none of the abnormal underlying skin tones to be appreciated or by applying foundations of complementary colors (Figure 6.2). For example, red pigmentation defects can be camouflaged by applying a green foundation, which is the complementary color to red. The blending of the red skin with the green foundation yields a brown tone, which can be readily covered by a more conventional facial foundation. Furthermore, yellow skin tones can be blended with a complementary colored purple foundation to also yield brown tones. Skin areas that are lighter or darker than the desired complexion can be camouflaged by applying facial foundations with the appropriate amount of brown pigment to hide the defect (5) (Figure 6.3).

Pigmentation defects can be camouflaged by applying an opaque cosmetic that allows none of the abnormal underlying skin tones to be appreciated or by applying foundations of complementary colors.



FIGURE 6.1 Cosmetic camouflaging of a depressed scar on the nose. The depressed scar is minimized with a lighter cosmetic that is placed in the scar, down the sides of the nose, and on the nasal tip for appearance contouring and normalization.



FIGURE 6.2 An opaque facial foundation that camouflages underlying pigmentation abnormalities can be easily applied from a roll-up tube.

Camouflage cosmetics

There are many companies in the United States and Europe that manufacture cosmetics specifically designed for camouflaging purposes. A good camouflage artist will generally purchase a color palette from at least two different companies to provide the necessary mixture of cosmetic shades required to match a given patient's skin tone (6).



FIGURE 6.3 The brown facial foundation can be stroked directly over the facial pigmentation defect.

Different formulations of camouflaging cosmetics are designed to meet the needs of each defect to be concealed. The basic products required for camouflaging are makeup bases, lining colors, and rouges. Makeup bases or facial foundations are designed to create the desired skin color. They are available as hard grease paints, soft grease paints, pancakes, and liquids. Hard grease paints come in stick form and consist of pigments in an anhydrous, waxy base. Application requires great skill and is more time-consuming than other makeup bases. This product is extremely long-wearing and mainly reserved for theatrical uses.

Soft grease paints come in a jar or are squeezed from a tube and have a creamy texture due to the incorporation of low-viscosity oils in addition to waxes in the anhydrous preparation (Figure 6.4). They usually contain a high proportion of titanium dioxide to provide superior coverage (7). These products tend to have a high shine and do not survive body heat; thus, some type of setting preparation is required to prolong wear.

Pancake products are packaged in a flat, round container. The product is removed from the compact by stroking with a wet sponge (Figure 6.5). It is composed of talc, kaolin, zinc oxide, precipitated chalk, titanium dioxide, and iron oxide (8). This product dries quickly and possesses a matte or dull finish. Unfortunately, it is easily removed with body warmth and perspiration but is easy to retouch if necessary (Figure 6.6).

Liquid foundations for camouflaging are similar to those marketed for general use; however, increased amounts of titanium dioxide provide superior coverage. Also, these products usually contain a higher concentration of oils to allow complete color



FIGURE 6.4 Camouflage cosmetics can be squeezed from a tube for application to the face.



FIGURE 6.5 An example of a camouflage cosmetic that is stroked from the compact with a wet sponge.

development and improved wearability. Special liquid cosmetics are available for application under a traditional facial foundation. These products, as discussed previously, are formulated with green and purple pigments to camouflage red and yellow color defects, respectively.

Liquid foundations for camouflaging are similar to those marketed for general use; however, increased amounts of titanium dioxide provide superior coverage.

Special colors are required in localized facial areas to provide shading and highlighting for contour defects. Products used for this purpose are known as lining colors, also called moist rouges, and dry rouges, otherwise called powdered rouges. Lining colors are available in all shades of gray, maroon, red, brown, green, blue, white, and black. They are packaged both in hard sticks and soft tins. These products can be mixed to obtain the desired final specialty color for use. Dry rouges are compressed powder compacts and are available in shades of red. They do not wear as long as their oil-containing counterparts, but are easily used for quick touch-ups and final shading purposes.



FIGURE 6.6 The cream foundation is stroked from a sponge onto the entire face or just the areas where camouflage is required.

Application of camouflage cosmetics

The most popular camouflage facial foundations are the creamy products, which are scooped from a jar or tin with a spatula and applied to the hand for warming. These products are the easiest to use because they exhibit a long playtime, good blending characteristics, minimal application skill, excellent coverage, and adequate wearability for most individuals (9).

Initially, a makeup base must be selected that is closest to the patient's natural skin color. Blending is usually necessary, but no more than three colors should be combined because this produces a final muddy color quality. If the patient has an underlying pigmentation problem, this counts as one color. In this case, the pink color of the wound, due to the increased vascular supply to promote healing, counts as one color. Other color abnormalities may be due to increased melanin, which produces a brown color, or increased hemosiderin, which produces a rust color, or degenerated facial elastin, which produces a yellow color.

Depending on the situation, it may be desirable to camouflage the red hues by initially applying a green undercover cosmetic and then a traditional facial foundation, thus avoiding the surgical products. If, however, the color contrast is too prominent, a high-coverage surgical foundation that covers all underlying skin tones may be a better camouflaging makeup selection.

Once the closest foundation color has been selected, it may be necessary to blend in yellow if the individual has a sallow complexion or red if the patient has a ruddy complexion. All facial tones should be represented in the final foundation blend if a good color match is to be obtained. Blending is usually done by applying a small amount of the makeup to the back of the hand. This provides a good surface for blending, which can be easily held up to the face to evaluate the color match, and also warms the product, which allows easier mixing and application.

The final foundation color mix is then dabbed, not rubbed, over the scarred area and then applied from the central face outward into the hairline for approximately 0.25 inch and blended over the ears and beneath the chin. It is necessary to feather the cosmetic where the application ends to achieve a more natural appearance. The importance of dabbing cannot be overemphasized because scars do not contain appendageal structures, such as follicular ostia, which are necessary for good cosmetic adherence. Rubbing will remove the makeup as it is applied. The cosmetic should actually be pressed into the skin and allowed to dry for five minutes.

Following this brief drying period, the cosmetic must be set with an unpigmented, finely ground, talc-based powder to prevent smudging, improve wearability, provide waterproof characteristics, and impart a matte finish. Camouflaging makeups are designed to be worn with this powder and do not function properly without it. The powder should be pressed, not dusted, on top of the foundation (Figure 6.7).

Shading and highlighting principles are employed to minimize the scar contour abnormalities. Unfortunately, the camouflage foundation may actually accentuate the surface irregularities of the scar and normal skin structures, such as pores and wrinkles. Depressed scars usually appear darker than the surrounding skin even though the same color foundation has been applied, due to the presence of shadows. Thus, a lighter powdered rouge is applied over the scar. If the scar is elevated, a darker powdered rouge needs to be applied. Finally,

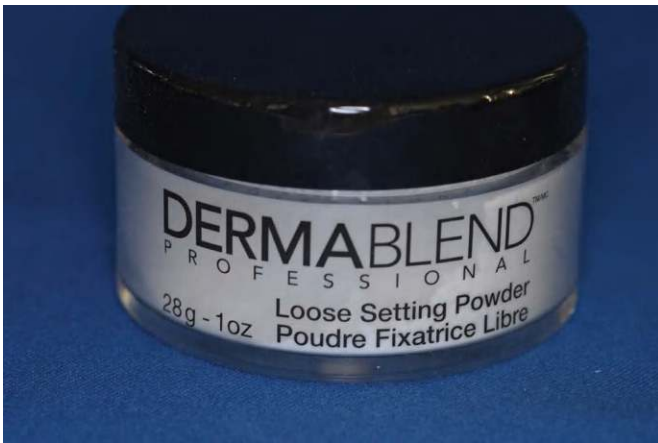


FIGURE 6.7 Unpigmented finishing powder designed to set and increase the wear time of camouflage facial foundations.

a reddish powdered rouge is dusted over the central face (central forehead, nose, and chin) and upper cheeks to mimic natural color variations of the face. Unfortunately, high-coverage surgical makeup also covers these facial landmarks, resulting in a flat, mask-like face. Other colored facial cosmetics (eye shadow, eyeliner, mascara, etc.) are usually necessary to give an attractive final appearance (10).

In general, the removal of camouflaging cosmetics requires more than washing with soap and water because of the waterproof nature of the product. Most companies provide an oily cleanser for cosmetic removal and then recommend soap and water cleansing of the skin. The cosmetic should only be worn when needed and definitely thoroughly removed at bedtime (11).

Camouflage cosmetics are generally used by patients without difficulty. Usually, a specially trained paramedical camouflage artist or esthetician will train the patient in proper blending and application of the makeup. Two to three hour-long sessions are enough to solve most of the problems encountered with the cosmetic, but sometimes special difficulties may arise. Most camouflage foundations contain a high concentration of oils that may rarely cause comedone formation in predisposed individuals. Evaluating ingredient lists for the absence or presence of comedogenic oils is not of much practical value; rather, the foundation should be tested by the patient. This is accomplished by applying a small amount of the cosmetic to the upper lateral cheek for two to four weeks, followed by a dermatologic evaluation.

Acne may also arise in certain susceptible individuals who use camouflaging foundations. Camouflaging cosmetics are much more likely to be acneogenic than comedogenic because they are worn for a prolonged period of time and must be occlusive to provide adequate coverage and waterproof properties. The occlusion may also lead to miliaria formation. However, allergic contact dermatitis to camouflage makeups is rare because the formulation is generally fragrance-free with a low preservative concentration. It is possible, however, for both allergic and irritant contact dermatitis to occur from the use of camouflage cosmetics. These products can be open or closed patch tested "as is."

Body camouflaging

Camouflaging cosmetics appropriate for covering macular pigmentation defects on the legs, arms, and body are also available. The easiest products to apply are thinner creams squeezed from a tube that spread better over larger areas but provide less coverage than the thicker facial products. Unfortunately, application is difficult and unsatisfactory in body areas densely covered with hair. Application with a sponge is recommended, followed by loose powder to improve wearability and impart a better waterproof finish. A special removal product is required.

Camouflaging cosmetics appropriate for covering macular pigmentation defects on the legs, arms, and body are also available.

These products use either zinc oxide or titanium dioxide for coverage, iron pigments for color, methyl cellulose or other waxes for viscosity, and glycerin or other nonevaporating substances for increased adherence of the product to the skin. They are a rare cause of irritant or allergic contact dermatitis and can be open or closed patch tested "as is."

Summary

Camouflaging techniques are important to the dermatologist, who may need to counsel patients on temporary or permanent use. For temporary redness or discoloration of the skin that may occur after surgery or laser resurfacing, a camouflage cosmetic will be used for a limited period until the skin heals. Other patients may experience permanent contour or pigmentation problems that require continued use of camouflaging techniques. This chapter has highlighted the theory, application, and removal of cosmetics for camouflaging purposes.

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SKIN OF COLOR AND PIGMENTATION

Under the stratum corneum and epidermis, skin is the same, although skin complexions and tones vary. The dermis appears a creamy white in persons of all cultural backgrounds; thus, ethnic skin concerns focus primarily on the interaction between melanin production, melanin transfer, and factors affecting melanogenesis (Figure 7.1). Light reflection from the skin surface and within the skin accounts for the blending of brown melanin, red hemoglobin, and yellow collagen. Subtle differences in melanin allow skin to appear almost black when the concentration is high and a reddish-white when the concentration is low. Melanin is produced in two forms: pheomelanin, a polymer of benzothiazine, which is red, and eumelanin, a polymer of dihydroxyindole and dihydroxyindole carboxylic acid, and their reduced forms, which is a dark brown (Figure 7.2). Eumelanin is the ancestral brown-black melanin formed as an oblong or spherical granule about 0.9 μm long and 0.3 μm wide. Pheomelanin is the red-yellow pigment formed as a spherical granule about 0.7 μm in diameter. It is a less common form of melanin found in higher concentrations in the female lips, areola, and genitalia. It is the various combinations of these two pigments that produce the diversity of skin colors observed in modern society. This chapter examines the ethnic skin and pigmentation issues.

Subtle differences in melanin concentration allow the skin to appear almost black when the melanin concentration is high and a reddish-white when the melanin concentration is low.

Melanin and skin color

Melanin production is the primary differentiating factor in multi-cultural skin. Skin color is determined by several genes, including the recently discovered SLC24A5, which accounts for the average

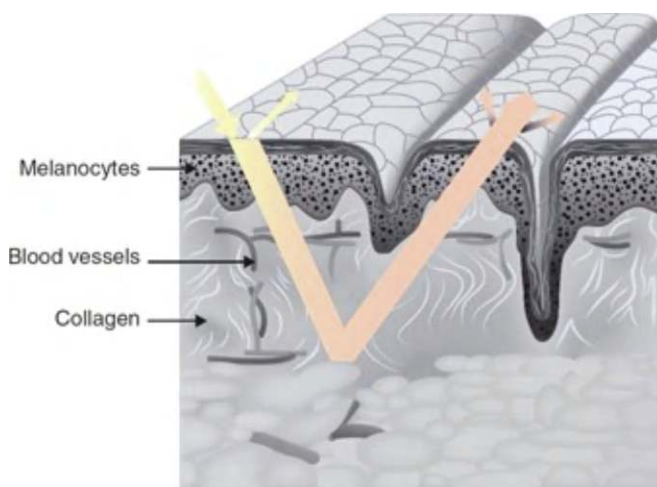


FIGURE 7.1 Light reflection from the skin surface and within the skin account for the blending of brown melanin, red hemoglobin, and yellow collagen.

difference of 30 melanin units between European and African skin. Another important gene is the melanocortin-1-receptor (MC1R), which is a hormone produced by the pituitary gland that stimulates melanin production. The MC1R gene consists of 954 nucleotides. Among Africans, there are no differences in the amino acid sequences of the receptor proteins, but 18 differences have been noted among light-skinned populations in Ireland, England, and Sweden. Although it has been thought that light skin was a genetic mutation to allow adequate vitamin D production by the body, this theory remains controversial.

Skin color is determined by several genes, including the recently discovered SLC24A5, which accounts for the average difference of 30 melanin units between European and African skin.

Melanin is produced in response to sun exposure, transforming harmful UV radiation into heat. This explains the uncomfortable skin warmth when dark skin is exposed to the sun, which is not the case with poorly melanized skin, accounting for the preponderance of light-complected persons engaging in tanning practices. Tanning is a boon for skin injury and not a health benefit.

The number of melanocytes, typically 1,000–2,000/ mm^2 of skin, does not differ between skin colors, but their ability to produce and transfer melanin is different. Melanocytes are located at the lower level of the epidermis and transfer melanin to skin cells in packages known as melanosomes. Melanosomes in recipient cells accumulate atop the cellular nucleus, where they protect nuclear DNA from ionizing radiation damage and the resultant cellular mutations. These cellular mutations contribute to photoaging when mild, precancerous changes when moderate, and photocarcinogenesis when severe. Irregular melanin transfer results in a mottled pigmentation characteristic of photoaged skin.

The number of melanocytes, typically 1,000–2,000/ mm^2 of skin, does not differ between skin colors, but the ability to produce and transfer melanin is different.

Melanogenesis can be affected by many factors that differ cross-culturally. Irregular melanin production is of prime cosmetic importance. Increased melanin production can occur in response to a variety of different stimuli, including UV radiation, injury, and hormone production. Melanogenesis can be epidermal or dermal. Epidermal melanogenesis is due to the release and subsequent oxidation of arachidonic acid to prostaglandins, leukotrienes, and other inflammatory mediators, which initiates pigment production. If the inflammation disrupts the basal cell layer, the melanin is released and trapped by macrophages in the dermis. Dermal pigment, also known as pigmentary incontinence, is not amenable to cosmetic intervention, whereas epidermal pigment can be effectively modulated. The difference can be detected

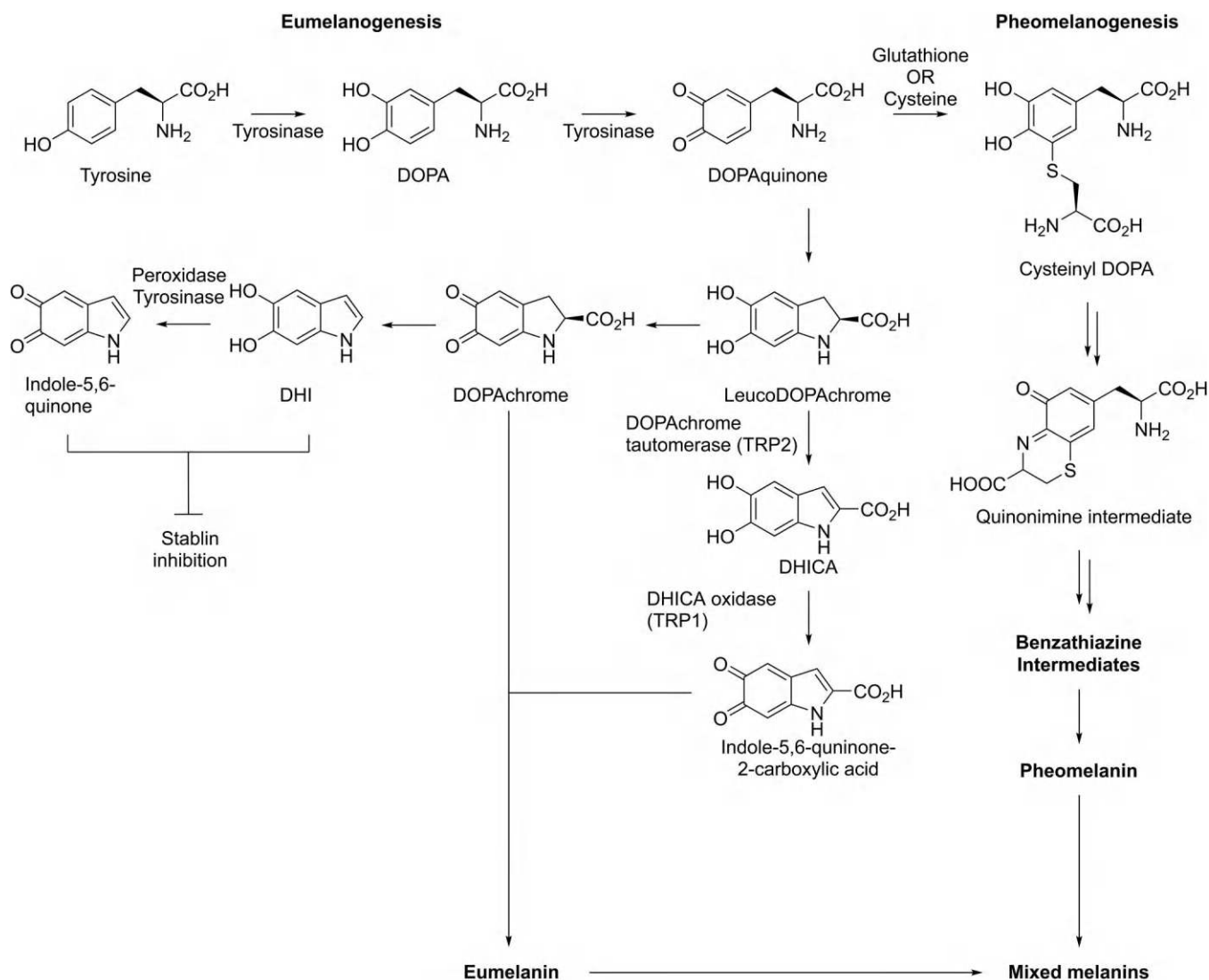


FIGURE 7.2 The biosynthetic pathway for melanin demonstrating the differences between eumelanin and pheomelanin. DOPA, L-3,4-dihydroxyphenylalanine.

visually because epidermal pigment can vary from light brown to dark black, whereas dermal pigment has a grayish appearance.

In addition to skin color appearance, there are other differences of cosmetic importance between Caucasian skin and African American skin. These include the presence of more mixed apocrine and eccrine sweat glands (1), increased blood and lymphatic vessels (2), a predisposition to hyperpigmentation (3), a denser and more compact stratum corneum (4), increased transepidermal water loss following irritation (5), and possibly an increased skin sensitivity to irritants in African American skin (6, 7).

Physiologic skin differences

In general, all skin is more similar than it is different, yet there are a number of reported differences between the skins of various ethnicities, including Caucasians, African Americans, and Hispanics. There are inconsistencies in the literature and few large-scale studies examining the unique attributes of the skin of different ethnicities. An area of frequent investigation is

differences in skin barrier function between ethnicities, which is somewhat controversial because there is a great deal of interindividual variation regardless of ethnicity. Most people possess a more robust skin barrier in more temperate climates and a less robust skin barrier in cold and low-humidity environments. Ambient humidity is the most important variable to control when examining ethnic skin differences. Usually, transepidermal water loss measurements are used as the best indicator of skin barrier condition; however, acclimating to the environment in which the measurements are taken is key to accuracy. Most reports hold that African American skin possesses higher transepidermal water loss than Caucasian skin, although the opposite has also been reported, but less frequently. Higher transepidermal water is an indicator of poorer barrier function in African Americans than Caucasians and may explain the perceived higher incidence of sensitivity in African American individuals.

Skin hydration is also felt to be different between ethnicities, which is usually measured through a technique known as corneometry. Corneometry is an indirect measurement of the water content

TABLE 7.1: Skin Characteristic Comparison

	African American	Caucasian
Corneocyte surface area	Same, 900 micrometers	Same, 900 micrometers
Stratum corneum cell layers	20 cell layers	16 cell layers
Spontaneous desquamation rate	2.5 times Caucasian	
Transepidermal water loss	Same	Same
Stratum corneum lipid content	Higher than Caucasian	
Ceramides	Lower than Caucasian	
Mast cell granules	Larger than Caucasian	
Melanophages size	Larger than Caucasian	

of the skin through skin conductance. Skin conductance has been reported to be higher in African American and Hispanic ethnicities than Caucasians. This means that African American and Hispanic skin is naturally better moisturized than Caucasian skin.

Some differences noted in skin barrier function and hydration among various ethnicities may be due to skin lipids, which are found in the intercellular space between the corneocytes. The skin lipid content is higher in African American skin than Caucasian skin. In addition, the ratio between ceramides, cholesterol, and free fatty acids is also different. Ceramides, which are rapidly produced when skin barrier damage occurs, are 50% lower in African American skin as compared to Caucasian skin.

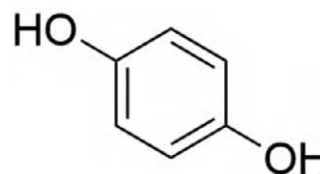
Stratum corneum desquamation does vary between ethnicities. Desquamation in African American skin is 2.5 times greater than desquamation in Caucasian skin. It is often said that African American skin appears ashier than Caucasian skin. This observation could be due to increased desquamation, but also due to the pigment in the desquamating skin scale. Desquamated African American skin appears brown, but when an air interface is introduced between the skin and the skin scale, the skin scale appears gray and thus resembles ash. This makes the desquamating scale more visible as compared to Caucasian skin scale, where the white scale is cast against a white background. This makes emolliency more important in African American skin because emollients are oily substances able to intercalate between the desquamating corneocytes and smooth down the skin scale temporarily until sloughing occurs.

There are other structural differences between African American and Caucasian skin. The stratum corneum is more compact in African American skin than Caucasian skin, and the dermis has more closely stacked smaller collagen fiber bundles with surrounding ground substance in African American skin. The differences are summarized in Table 7.1. These unique features may account for some of the observed dermatologic differences.

Skin lightening

Skin lightening is an important cosmetic need that has been poorly addressed to date. Many prescription and nonprescription skin-lightening agents have been developed, but none work efficiently to completely lighten the skin. A brief review of these substances used in over-the-counter (OTC) skin-lightening preparations is discussed.

The gold standard for prescription pigment lightening is hydroquinone.

**FIGURE 7.3** The chemical structure of hydroquinone.

Hydroquinone

The gold standard for prescription hyperpigmentation therapy remains hydroquinone. This substance is actually quite controversial, having been removed from the OTC markets in Europe, Asia, and the United States. Concern arose because oral hydroquinone has been reported to cause cancer in mice that are fed large amounts of the substance. Although oral consumption is probably not related to topical application, hydroquinone remains controversial because it actually is toxic to melanocytes. Hydroquinone, a phenolic compound chemically known as 1,4 dihydroxybenzene, functions by inhibiting the enzymatic oxidation of tyrosine and phenol oxidases (Figure 7.3). It covalently binds to histidine or interacts with copper at the active site of tyrosinase. It also inhibits RNA and DNA synthesis and may alter melanosome formation, thus selectively damaging melanocytes. These activities suppress the melanocyte metabolic processes, inducing a gradual decrease in melanin pigment production (8).

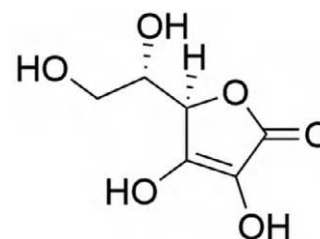
Hydroquinone is unstable and turns brown upon contact with air. Once the hydroquinone has oxidized, it is no longer active and should be discarded.

Ascorbic acid

Ascorbic acid, also known as vitamin C, is used in the treatment of hyperpigmentation (Figure 7.4). It interrupts the production of melanogenesis by interacting with copper ions to reduce dopa-quinone and blocking dihydroquinindol-2-carboxyl acid oxidation (9). Ascorbic acid, an antioxidant, is rapidly oxidized when exposed to air and is of limited stability. High concentrations of ascorbic acid must be used with caution because the low pH can be irritating to the skin.

Licorice extract

Licorice extracts are being used as topical anti-inflammatory preparations to decrease skin redness and hyperpigmentation (Figure 7.5). The active agents are known as liquiritin and isoliquiritin, which are glycosides containing flavonoids (10). Liquiritin induces skin-lightening by dispersing melanin. It is typically applied to the skin at a dose of 1 g/day for four weeks to see the clinical result. Irritation is not a side effect. Other licorice

**FIGURE 7.4** The chemical structure of highly photosensitive vitamin C.

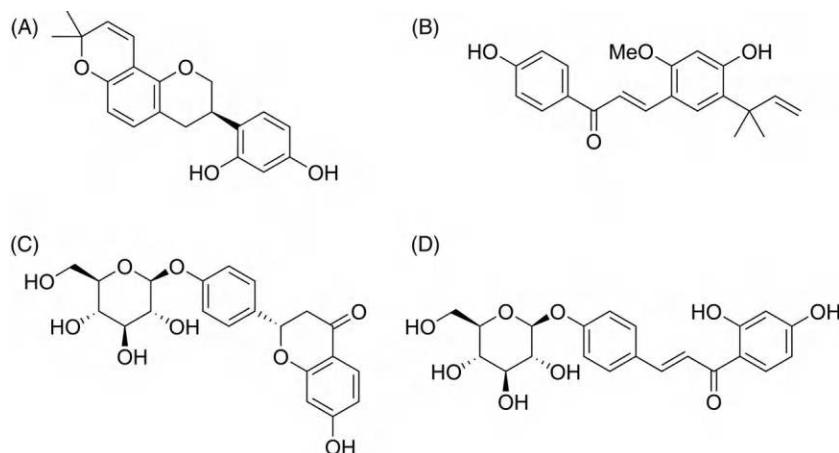


FIGURE 7.5 Compounds in licorice extract used in skin care products: (A) glabridin, (B) licochalcone A, (C) liquiritin, and (D) isoliquiritin.

extracts that are also used in skin-lightening preparations include glabridin and licochalcone A.

Alpha-lipoic acid

Alpha-lipoic acid is found in a variety of antiaging cosmeceuticals, functions as an antioxidant, but may also have very limited pigment-lightening properties. It is a disulfide derivative of octanoic acid that is able to inhibit tyrosinase. However, it is a large molecule, and therefore, cutaneous penetration to the level of the melanocyte is challenging for the acid.

Kojic acid

Kojic acid, chemically known as 5-hydroxymethyl-4H-pyran-4-one, was one of the most popular cosmeceutical skin-lightening agents found in cosmetic-counter skin-lightening creams distributed worldwide; however, it was also found to be toxic to melanocytes and has been removed from most OTC preparations (Figure 7.6). It is a hydrophilic fungal derivative obtained from *Aspergillus* and *Penicillium* species (11). Some studies indicate that kojic acid is equivalent to hydroquinone in pigment-lightening ability (12). The activity of kojic acid is attributed to its ability to prevent tyrosinase activity by binding to copper.

Ascorbic acid is a popular cosmetic skin-lightening ingredient.

Aloesin

Aloesin is a low-molecular-weight glycoprotein obtained from the aloe vera plant. It is a natural hydroxymethylchromone that

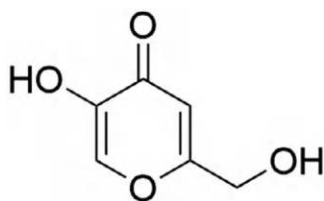


FIGURE 7.6 Kojic acid is a highly effective skin-lightening agent widely used in the cosmetic industry.

functions to inhibit tyrosinase by competitive inhibition at the DOPA (L-3,4-dihydroxyphenylalanine) oxidation site (13, 14). In contrast to hydroquinone, it shows no cell cytotoxicity; however, it has a limited ability to penetrate the skin due to its hydrophilic nature. It is sometimes mixed with arbutin, our next topic of discussion, to enhance its skin-lightening abilities.

Arbutin

Arbutin is obtained from the leaves of the Indian bearberry plant (*Vaccinium vitis-idaea*) that was used extensively by the American Indians in skin preparations (Figure 7.7). It is a naturally occurring gluconopyranoside that causes decreased tyrosinase activity without affecting the messenger RNA expression (15). It also inhibits melanosome maturation. Arbutin is not toxic to melanocytes and is used in a variety of pigment-lightening preparations at a concentration of 3%. Higher concentrations are more efficacious than lower concentrations, but a paradoxical pigment darkening may occur. Naturally occurring arbutin has been largely replaced by synthetic deoxyarbutin, which can be combined with silymarin and azelaic acid, discussed next, for a more efficacious skin-brightening product.

Silymarin

Silymarin is a naturally derived ingredient from the milk thistle plant that is rich in polyphenolic flavonoids, which are potent antioxidants and anti-inflammatories. However, silymarin also prevents melanin production by inhibiting levodopa (L-DOPA) oxidation activity of tyrosinase and reducing the expression of tyrosinase protein. Silymarin is typically used in combination

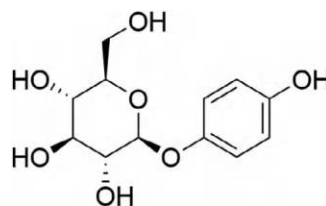


FIGURE 7.7 Arbutin is a botanical skin-lightening agent that is not toxic to melanocytes.

with other botanically derived melanin production inhibitors, such as azelaic acid.

Azelaic acid

Azelaic acid is well known to the dermatologist as a prescription medication for the treatment of rosacea. Azelaic acid is a natural fungal derivative produced by *Malassezia furfur*, the causative organism of tinea versicolor, and possesses anti-inflammatory and antibacterial properties. Because azelaic acid is naturally present on the skin surface, it is now found in many cosmetic products. Azelaic acid functions as a pigment brightener by inhibiting tyrosinase, mitochondrial oxidoreductase activation, and DNA synthesis.

Tranexamic acid

One of the newest topical pigment-lightening ingredients in the OTC realm is tranexamic acid. Tranexamic acid is a prescription anti-fibrinolytic drug when administered by injection for postpartum bleeding and orally for the treatment of menorrhagia because it improves blood clotting. It has been administered by injection, orally, and topically for pigment brightening. Tranexamic acid's International Union of Pure and Applied Chemistry (IUPAC) chemical name is trans-4-aminomethylcyclohexane carboxylic acid. It is a synthetic lysine derivative that inhibits plasminogen activation, thereby stopping the conversion of plasminogen to plasmin. This results in the reduction of arachidonic acid and prostaglandin levels, which reduces melanocyte tyrosinase activity and leads to skin brightening. Tranexamic acid also reduces tyrosinase-related proteins (TRP1 and TRP2). Orally, the drug is administered at doses of 250 mg twice daily for 3 months to lighten skin. It has also been administered intradermally with microneedling to improve pigmentation. These are both off-label indications according to the US Food and Drug Administration (FDA). Tranexamic acid is finding its way into many topical skin-brightening products in combination with some of the aforementioned ingredients.

Cysteamine

The newest addition to the OTC pigment-brightening armamentarium is cysteamine, chemically known as cysteamine hydrochloride, derived from the degradation of Coenzyme A. It is a naturally occurring metabolite of L-cysteine, a sulfur-containing amino acid. Therefore, cysteamine has an unpleasant sulfur odor that must be stabilized in formulation. It brightens pigment by inhibiting tyrosinase, chelating iron and copper, scavenging dopaquinone, and increasing intracellular glutathione. It is administered orally in a lysosomal storage disorder known as nephropathic cystinosis. Cysteamine is a potent antioxidant and a cutaneous irritant that causes dryness, tingling, and burning. It should not be applied immediately after washing the face. Some physicians recommend putting it on the face for an hour followed by washing to minimize irritation, whereas others recommend using a moisturizer on top of the cysteamine formulation.

Cosmetics for skin of color

The formulations and types of facial cosmetics available to patients with darker skin tones are the same as those formulated for lighter skin tones. Cosmetic companies are rapidly enlarging their color selection to include darker skin tones, and many new cosmetic companies are producing product lines specifically created for women of color (16).

The unique aspect of color cosmetic formulation for darker skin tones is the blending of pigments with the underlying skin color. Fair-skinned individuals, with little underlying skin pigment, can select a color cosmetic and expect it to look similar in the packaging and on the skin. However, women of color can expect cosmetics to look entirely different in the package than on the skin. For example, a light pink blush that provides cheek highlights in a Caucasian patient is imperceptible on a Fitzpatrick type V skin. Therefore, cosmetics for skin of color generally contain vivid pigments to provide the desired result.

It is estimated that 35 shades of facial foundation are necessary to match skin of color, whereas only 7 shades of facial foundation are necessary to match Caucasian skin.

Facial foundations for women of color are found both at the cosmetic counter and in mass merchandisers. It is estimated that there are more than 35 different colors of dark skin, requiring tremendous color selection for complexion matching (17). This is compared to the seven basic colors of Caucasian skin. African American women traditionally wear facial foundations to blend uneven facial tones, whereas fair-skinned individuals wear facial foundations to add color to the skin. A greater emphasis is placed on skin-of-color foundations for dry skin because pigmented skin is more subject to the ashy appearance of dry skin scale due to its higher rate of transepidermal water loss (5, 18). Many women of color consider their skin to be extremely "sensitive," even though studies do not demonstrate a genetic predisposition to contact dermatitis. This may be due to the long-lasting post-inflammatory hyperpigmentation seen with skin care product irritation in women of color (19, 20).

The description of skin of color requires consideration of value, intensity, and undertone.

The description of deeply pigmented skin requires a more complex discussion of color in terms of value, intensity, and undertone (21). The value of a color is a measure of its light reflectivity. Dark skin with blue/black or mahogany hues may appear deeper in color due to the low value of these colors. Intensity refers to the brightness or dullness of a color. True colors, without the addition of white, brown, or black pigments, tend to have higher intensity than mixed colors. For example, primary red has a greater intensity than brick red produced by the mixing of primary red with brown. This is an important concept in selecting facial foundations for dark skin because too many pigments can leave the skin with a muddy appearance due to reduced color intensity. Finally, undertones are extremely important. The undertones account for the tremendous variation seen in skin of color. Red, yellow, and orange undertones are said to give the skin a warm appearance, whereas blue, purple, and green undertones are said to give the skin a cool appearance. Based on an analysis of undertones, skin of color can be further classified as jet black, blue/black, purple/black, brown/red, bronze, honey, etc.

Color cosmetics applied to the faces of women of color must contain deeper pigments. Popular eye shadow colors include deep blue, lilac, wine, gold, or emerald. Facial highlighter and

blush colors for facial contouring in skin of color are deep plum, bronze, deep orange, coral, wine, or burgundy. The color selected depends upon the skin color shade, for example: wine or plum blush for jet-black skin; coral or deep orange for brown skin; and pink or peach for light brown skin. The eye and face contouring methods, however, are the same for light- and dark-skinned patients.

Summary

This chapter examined the unique needs of skin of color, including OTC pigment-lightening preparations. It assessed the use of color cosmetics for facial adornment. Even though the genetic differences among various skin colors are minimal, cosmetic formulations must be tailored to suit all skin colors.

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8

MALE SKIN CARE

The male skin care market is rapidly expanding in the United States because of new product development and aggressive marketing tactics. Manufacturers see male skin care as a large area for economic growth because the female skin care market has shown stagnate sales for several years. Much of the interest in male skin care has focused on the concept of the “metrosexual” man. The metrosexual man is concerned with fashion, hair care, nail appearance, skin treatments, and cosmetic products. This image contrasts with the “urban” man who is a low-maintenance person and uses toothpaste, bar soap, mass-market shampoo, and shaving cream as the sum total of his products. The advertising push to popularize the image of a metrosexual man is seen as a way to boost the sale of hair, skin, and nail care products and services by creating an image to which men of all ages can aspire.

Men use many of the same skin care products as women. Do these formulations need to be different, or can the same moisturizer with a more masculine fragrance be used on the male face? Is male skin that different from the female skin? This chapter examines the unique issues differentiating male and female skin care.

Male facial skin is thicker than female facial skin due to the presence of terminal hair follicles.

Male vs. female skin

The differences between male skin and female skin are obvious to the human eye. Male skin is thicker than female skin, in part due to the presence of terminal hair follicles over much of the body. This difference is most pronounced on the face, where women have only vellus hairs, which are fine and colorless, whereas men have fully developed terminal hairs, which are coarse, pigmented, and take up space within the skin. The presence of male facial hair is partially responsible for the more favorable appearance of mature men over mature women. As UV radiation activates collagenase to destroy dermal collagen, the male beard allows the skin to resist wrinkling. Thus, photoaged males do not exhibit the pronounced redundant facial skin seen in photoaged females.

What does the thicker male skin mean for the skin care market? It means that photoaging does not appear as early in men as it does in women. Although women are eager at a young age to engage in the purchase of wrinkle creams, men are more resistant. The rugged, coarse look is valued as a sign of masculinity and maturity. The thicker male skin is also less able to respond to the beneficial effects of moisturization, especially on the hair-bearing upper cheeks. Wrinkle creams simply do not appeal to men immediately, due to their perceived lack of need and poor immediate efficacy.

The male beard also gives the skin a coarse texture that hides surface cosmetic irregularities, such as scarring, pigmentation changes, and broken capillaries. If the beard-containing skin of the male face is stretched, many of these problems become apparent. Thus, women are much more anxious to “fix” problems than men, who do not see skin changes as easily or as early in life.

Some of the resistance of male skin to aging is due to its inherent ability to diffuse UV radiation, especially in the UVA range. UVA radiation is the wavelength responsible for photoaging and penetrates more deeply in women, causing greater damage to female skin. This allows women to age more rapidly than men, a phenomenon magnified by the media preference for younger leading women paired with older leading men.

Male skin is more resistant to adverse reactions.

Male skin and adverse reactions

The difference in skin thickness also affects the decreased frequency of adverse product reactions experienced by men. Women experience adverse reactions more commonly than men. The thinner skin may allow irritants and allergens to penetrate deeper in female skin, but the increased incidence may also be due to greater product usage. Overall, women use more skin care products and cosmetics than men. This increased usage magnifies the chances of contacting an irritant or an allergen. Women are also more likely to undergo procedures that destroy the skin barrier, such as facial peels, microdermabrasion, and spa treatments. This may account for the sensitive skin appeal of products marketed to women, which does not necessarily resonate with the male skin care market. In general, male skin is less subject to irritation and adverse reactions than female skin.

Hormonal considerations in male skin care

The discussion to this point has focused on the most obvious visual difference, which is skin thickness and the presence of the male beard, but other equally important considerations also merit mention that affect product formulation. Perhaps one of the most important unique features of male skin is the dominance of testosterone. Testosterone secretion increases at puberty in males, with constant levels throughout life. Testosterone causes the production of facial and body sebum, which sets the stage for the growth of *Propionibacterium acnes* and the onset of acne. Acne is generally more severe in men than women.

Because testosterone secretion is present throughout life in men, it means that sebum production also remains high. This provides skin moisturization making the needs for facial and body creams for men somewhat different. Although men do indeed develop dry skin at about age 60 years and beyond, dry skin is a much greater concern for females. The male need for emollience is perhaps greater in middle age than for moisturization, unless skin disease is present.

Men prefer deodorant cleansers with antibacterials because bacteria rapidly degrade the abundant apocrine sweat produced.

Testosterone not only triggers the onset of abundant sebum production but also increases the secretion of apocrine sweat in the eyelids, breasts, scalp, buttocks, and armpits. Both sebum and apocrine sweat create different skin cleansing needs. Odor must be controlled, but the formulator must also consider the interaction of the sebum and sweat with skin care products. It is for this reason that fragrance must be carefully considered in male skin care. Men typically prefer deodorant soaps and antibacterial products because bacteria degrade the apocrine sweat rapidly, creating a characteristic musty smell. This apocrine sweat, mixed with sebum rich in testosterone, creates a locker room smell that can ruin the most carefully balanced fragrance. This means that male products need more careful fragrance development for body odor than female products.

Male skin and hair removal

Although male body hair provides excellent sunscreen, better than anything packaged in a bottle, it also requires grooming. Shaving is the most common method used for body hair management, but some men have embraced laser hair removal. One of the problems with laser hair removal is that it changes the apparent skin color and texture. Loss of the hair in the follicular ostia eliminates brown tones, the most common color of male facial hair, leaving the skin appearing lighter. Loss of the hair also eliminates the coarse texture of the male facial skin and predisposes to wrinkling, as discussed earlier. It is unlikely that shaving will be abandoned by the entire male community for these reasons. A more detailed discussion of shaving is found in the chapter on hair removal techniques.

Shaving is the most effective physical method of exfoliation.

Shaving also produces some unexpected skin benefits. It is probably the most effective physical method of exfoliation, better than topical hydroxy acids, hand-held microdermabrasion devices, or mechanical brushes. It efficiently removes desquamating corneocytes along with beard debris. Shaving is also an effective method of removing open comedones from the skin, providing acne treatment. However, improper shaving techniques result in razor burn and pseudofolliculitis barbae. Razor burns result from the removal of the skin around where the hair exits, an opening known as the follicular ostia. Newer razors with spring-mounted blades and shaving gels that reduce friction can minimize the occurrence of razor burn. Pseudofolliculitis barbae is seen in individuals with kinky facial hair, where the sharp edge of the cut hair re-enters the skin, causing inflammation in the form of a papule or pustule. This can result in darkening of the skin, which is discussed next.

Pigmentation issues

Darkening of the skin, known as postinflammatory hyperpigmentation, is a reaction to injury in persons with darker skin tones, such as males of Mediterranean, Oriental, Indian, or

African descent. The injury can be from acne, sunburn, skin disease, irritant contact dermatitis, allergic contact dermatitis, or a traumatic scratch. Because melanocytes are felt to be an important part of the immune system, it is postulated that this hyperpigmentation is an immune response to skin injury, but the exact reason for this reaction is largely unknown. Thus, products designed for male skin of color must be carefully formulated to minimize any skin irritation because postinflammatory hyperpigmentation is the inevitable result. It may take six months to one year to return the skin to normal color after the injury, which accounts for the tremendous skin-lightening product focus in cultures with darker complected individuals. In order for the skin to return to proper color, the extra melanin produced must be phagocytized or consumed by white blood cells and then removed from the skin.

Men typically need emollients to smooth facial skin scale after shaving rather than true moisturizers.

Moisturizers

Shaving is usually the final male grooming activity, which is different from those of women, who usually apply a facial moisturizer after cleansing. Why do most men not apply a moisturizer? This is because male facial sebum production is typically high, obviating the need to moisturize. Most men do not need to retard transepidermal water loss because they do not expose their skin to the number of products used by women, they do not engage in multiple barrier-damaging procedures, and their rapid sebum replacement is adequate. Unless skin disease is present, men typically need emollients rather than moisturizers, which smooth down the desquamating corneocytes by filling in the intercellular spaces where lipids may have been removed from overaggressive cleansing. The most popular emollient is dimethicone, which may be delivered to the skin surface in the form of a toner, aftershave lotion, or skin bracer. This is a key difference in products developed for men and women.

Moisturizers for women are typically more occlusive to increase skin hydration and minimize periorbital wrinkling due to dehydration. These fine periorbital wrinkles are considered signs of aging in women but appear to contribute to character in men. Thus, antiaging moisturizers have been slow to catch on in the male skin care market. Although young women are eager to purchase wrinkle creams, men are not. They value their rugged, tough look as a sign of masculinity and maturity. The thicker male skin is also not as responsive to beneficial effects of moisturization as female skin, especially on the hair-bearing upper cheeks. Wrinkle creams simply do not appeal to men as they do to women, due to their perceived lack of need and poor immediate efficacy.

Some of the resistance of male skin to aging is due to the photoprotection afforded by facial hair.



FIGURE 8.1 More aesthetic, high-SPF (sun protection factor) sunscreens have been developed with new formulation technology to appeal more to men.

Photoprotection

Some of the resistance of male skin to aging is due to the photoprotection afforded by facial hair. The hair follicles also increase the skin thickness, decreasing the penetration of UVA radiation into male skin. This allows women to age more rapidly than men, a phenomenon magnified by the media preference for younger leading women paired with older leading men. Thus, men do not see the need for the application of sun protection to the same degree as their female counterparts, although the incidence of skin cancer is higher in men than women (Figure 8.1). A thorough discussion of sunscreens is found in the photoprotection and sunscreen chapter.

Summary

Male skin care is similar but different from female skin care. The presence of the facial beard provides photoprotection and resistance to facial wrinkling, but hair removal can be challenging. Shaving can improve skin texture and minimize acne, but poor shaving techniques can cause razor burn and aggravate pseudofolliculitis barbae. The unique male biofilm, composed of apocrine sweat and sebum, requires different hygiene needs. It is not enough to package male skin care products in blue bottles and female skin care products in pink bottles. The material inside the bottle must cater to the unique skin needs of the different sexes.

9

FACIAL PHOTOPROTECTION

No one knows what encouraged the desire for tanned skin. Some believe that during prohibition, alcoholic beverages were readily available on the offshore islands of the United States of America, and the affluent visited these islands to drink and tan. It is thought that from this point forward, tanning became synonymous with wealth, and tanned facial skin continues to be desirable to this day. The facial skin is constantly bombarded with photons of light during the day and shows the effects of excess UV radiation more readily than any other body area. The skin both absorbs and scatters these energetic photons. Photons that are scattered are reflected back to the eye and create the perception of beautiful skin that can be enhanced or adorned by cosmetics. The photons that are

absorbed are converted into energy, which damages the collagen and promotes photoaging.

Solar radiation, also known as the electromagnetic spectrum, comprises approximately 5% ultraviolet rays, 35% visible light, and 60% infrared rays.

The radiation that is emitted by the sun lies on the electromagnetic spectrum and is approximately 5% ultraviolet (UV), 35% visible, and 60% infrared rays of light (Figure 9.1). UV radiation in the form of UVB in the range of 280–320 nm, and UVA in the range of

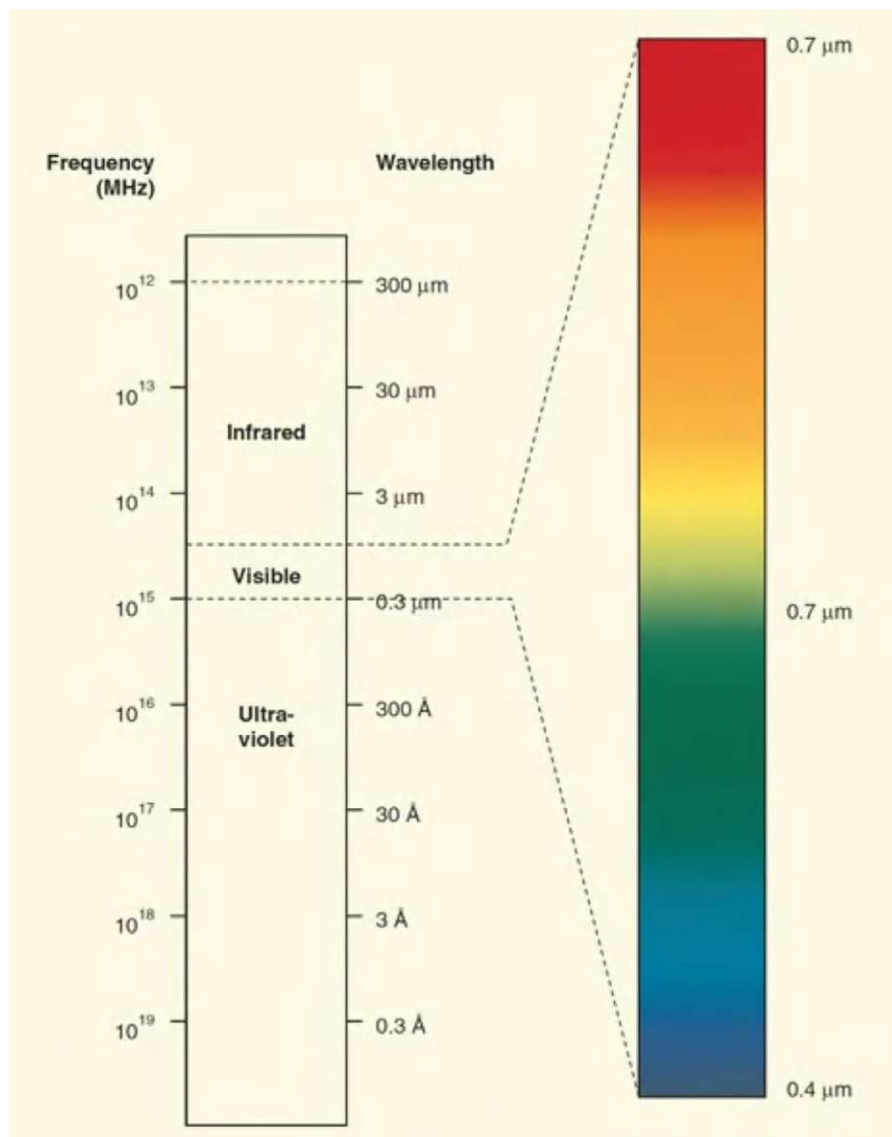


FIGURE 9.1 The electromagnetic spectrum.

320–380 nm, is invisible to the eye. UVA radiation can be further categorized as UVA1 (340–400 nm) and UVA2 (320–340 nm). Proteins and DNA absorb much of the UV rays, and the amount absorbed is known as the dose, calculated as intensity multiplied by time. High-intensity UV for a short period can be very damaging, which is the concern with artificial tanning booth radiation. These bulbs emit a predetermined number of watts per square centimeter, with UVB possessing 1,000 times the energy of UVA.

The stratum corneum is the first line of defense that functions to reflect and scatter damaging radiation and minimize penetration.

The stratum corneum is the first line of UV defense mechanism to reflect and scatter the damaging radiation and minimize penetration. It is for this reason that facial exfoliants containing glycolic acid, lactic acid, and salicylic acid should be followed by sunscreen application because they decrease endogenous skin photoprotection. The sun rays are further absorbed by melanin, which is a physiochemical defense absorbing both UV and visible light. It is the oxidation of melanin that results in a tanned facial appearance, not synonymous with health but rather oxidative damage. Wavelengths less than 320 nm are absorbed by the stratum corneum and epidermis, while wavelengths greater than 320 nm enter the dermis. Penetration into the dermis can be enhanced by wetting the stratum corneum and altering the refractive index. This is why applying baby oil to the face, which contains primarily mineral oil, increases the tanning response by decreasing endogenous facial photoprotection.

The target of UVA and UVB damage is DNA, cell membrane lipids, structural proteins, and enzymes. Cellular damage incites an inflammatory response designed to initiate skin repair but may result in further skin damage. Cells that have been damaged by UV activate the p53 gene that determines whether the damage is fatal and the cell should be destroyed, a process known as apoptosis, or whether DNA repair should be initiated. Apoptosis is the systematic destruction of the nucleus and cytoskeleton that results in a protein shell formation. Due to its pink amorphous structure on H&E staining, it is also called a sunburn cell. They contain clumped filaments, melanin granules, and intact lysosomes amid a pink nucleus and cytoplasm. Although UV damage can activate apoptosis and prevent abnormal cells from reproducing, it can also deactivate the p53 gene, allowing genetically damaged cells to divide, which leads to neoplasia and skin cancer formation over time.

The initial symptom of sun damage is skin erythema produced by vasodilation in response to cellular damage. Erythema appears two to six hours after sun damage, also known as sunburn, and may peak up to 12 to 20 hours later depending on the amount of radiation received. It is this sunburn response that accounts for the minimal erythema dose (MED) that is used to determine the sun protection factor (SPF) for sunscreens. SPF, discussed again in detail in the body photoprotection chapter, indicates the increase in time afforded by a sunscreen to receive a dose of UV that induces erythema. Following the appearance of erythema, tanning occurs due to photo-oxidation of melanin, which is the immediate pigment darkening effect. Further pigment production occurs two to three days after sunburn, when melanogenesis is initiated based on the skin type (Table 9.1).

Over time, this cumulative skin damage manifests as photoaging. Histologically, the epidermis possesses a flattened dermal–epidermal junction and thinning of the spinous layer. The papillary dermis is thinned with dilated blood vessels, and an amorphous,

TABLE 9.1: Skin Type Classifications

Fitzpatrick Skin Type	Description
I	Extremely fair skin, always burns, never tans
II	Fair skin, always burns, sometimes tans
III	Medium skin, sometimes burns, always tans
IV	Olive skin, rarely burns, always tans
V	Moderately pigmented brown skin, never burns, always tans
VI	Markedly pigmented black skin, never burns, always tans

fragmented, fibrotic material representing solar elastosis accumulates in the reticular dermis. Facial photoprotection attempts to prevent such effects. This chapter examines the facial photoprotection topic in detail, but should be read along with the body photoprotection chapter for a complete overview.

Sunscreen filter classification

The first sunscreen was marketed in the United States in 1928 and consisted of an emulsion of benzyl salicylate and benzyl cinnamate. Para-aminobenzoic acid (PABA) was introduced in 1943, which paved the way for many new sunscreen formulations. Physical agents, such as red petrolatum, were used by the military during World War II (1). In 1978, the US Food and Drug Administration (FDA) reclassified sunscreens from cosmetics to over-the-counter (OTC) drugs designed to protect “the structure and function of the human integument against actinic damage” (2). From that point forward, many sunscreen formulations have been introduced, providing better and better photoprotection.

Sunscreen filters are the active ingredients providing photoprotection (Table 9.2). Active ingredients can be classified into

TABLE 9.2: Approved US Sunscreen Filters

	UV Protection	Peak Absorbance (nm)
ORGANIC FILTERS		
Benzophenones:		
Oxybenzone	UVB, UVA2	288,325
Dioxybenzone	UVB, UVA2	352
Sulisobenzone	UVB, UVA2	36
Cinnamates		
Cinoxate	UVB	289
Octinoxate	UVB, UVA2	311
PABA Derivative		
Padimate O	UVB	311
Salicylates		
Homosalate	UVA, UVA2	306
Octisalate	UVB, UVA2	307
Other Filters		
Avobenzone	UVA1	360
Ecamsule	UVA1, UVA2	NA
Ensulizole	UVB, UVA2	310
Meradimate	UVA1, UVA2	340
Octocrylene	UVB, UVA2	303
INORGANIC FILTERS		
Titanium dioxide	VL, UVA, UVB	Varies with particle size
Zinc oxide	VL, UVA, UVB	Varies with particle size

UVB=280–230nm, UVA2=320–340nm, UVA1=340–400nm

two major categories: organic and inorganic. Organic filters use resonance delocalization from conjugated double bonds to absorb UV radiation and dissipate it as heat (3). They are generally aromatic compounds, based on the benzene ring's ability to transform high-energy ultraviolet radiation into harmless long-wave radiation above the 380 nm range. They are degraded in the process of photoprotection and must be frequently reapplied to maintain proper protection from the sun. Inorganic filters, in contrast, are usually ground particulates that reflect or scatter UV radiation, absorbing relatively little of the energy. They are not degraded, and therefore, they stay and act longer on the skin surface, a property known as photostability.

Sunscreen filters can be classified as organic and inorganic.

The FDA has rated the chemicals listed in Table 9.2 as safe, effective sunscreen filters as described in the Sunscreen Monograph (4,5). There are many more filters available worldwide, but new filters have not been approved in the United States.

UVA organic sunscreen filters

There are three main families of UVA organic sunscreen filters. These are the benzophenones, avobenzone, and anthranilates. Each of these filters undergoes a chemical reaction when a photon of UV is absorbed, with the energy released from the skin surface as heat. Their different aesthetic and photoprotective properties are employed by the sunscreen formulator to develop a product that protects the skin yet is pleasant to use.

Benzophenones

There are three sunscreens in the benzophenone family: oxybenzone (benzophenone-3), sulisobenzene (benzophenone-4), and dioxybenzone (benzophenone-8). Oxybenzone is approved for use in the United States and provides weak UVA photoprotection below 320 nm. Dioxybenzone and sulisobenzene are unapproved. With the increasing push for UVA photoprotection, the use of oxybenzone has increased dramatically, resulting in increased reports of allergic contact dermatitis. Oxybenzone is also used in conjunction with avobenzone, discussed next, to enhance the photostability of sunscreen formulations. Oxybenzone is commonly used as a secondary sunscreen because it is an oily liquid, making the sunscreen sticky if used in too high a concentration.

Oxybenzone and avobenzone are two commonly used organic UVA sunscreen filters.

Avobenzone

Avobenzone, also known as Parsol 1789, was an important step forward in UVA photoprotection. It is the most recently monographed sunscreen ingredient. Unfortunately, it is not photostable, with 36% of the avobenzone destroyed shortly after sun exposure. It is estimated that all of the avobenzone is degraded after five hours or 50 joules of exposure, necessitating frequent reapplication. Avobenzone is also chemically incompatible with other commonly used physical sunscreens, such as zinc oxide and titanium dioxide. However, avobenzone can now be stabilized by adding oxybenzone and other ingredients, such as



FIGURE 9.2 An avobenzone formulation stabilized with octocrylene to achieve a high sun protection factor rating.

2-6-diethylhexylnaphthalate or octocrylene (Figure 9.2). These ingredients absorb energy from excited-state avobenzone, allowing avobenzone to return to a ground state and prevent photodegradation. Because 2-6-diethylhexylnaphthalate is photostable, it radiates off the energy as heat or phosphorescence. Octocrylene, also an organic sunscreen, is photostable and can absorb the photon of energy without undergoing degradation (Figure 9.3). This relatively new concept of photostabilization is important to ensure the longevity of sunscreens on the skin. Combining photostable avobenzone with other photostable substances was a novel advance in photoprotection.

Anthranilates

There are several anthranilates available for sunscreen formulation, but only menthyl anthranilate is used in the United States. Menthyl anthranilate, also known as meradimate, has its peak absorption at 336 nm and is used as a secondary sunscreen because it too is a clear, thick, sticky oil that can only be used in low concentration in formulations meant for aesthetic reasons. It has an excellent safety profile and low allergenicity. It is very stable in formulation, without the photodegradation issues discussed in the case of avobenzone.

Menthyl anthranilate, a clear sticky oil, is a secondary UVA organic filter because in high concentration, it makes the sunscreen sticky.



FIGURE 9.3 Octocrylene is a sticky thick liquid in the raw material form.

UVB organic sunscreen ingredients

UVB organic sunscreen ingredients also undergo a chemical reaction, radiating off the UV rays as heat. The chemical families that function in UVB photoprotection are the PABA derivatives, salicylates, and cinnamates. Each is briefly discussed in relation to current sunscreen formulations.

PABA derivatives, salicylates, and cinnamates are the major UVB organic sunscreen filters.

PABA derivatives

For all practical purposes, PABA derivatives are rarely used in modern sunscreen formulations. A recent review of the marketplace showed that as few as 2% of sunscreens use PABA derivatives because of allergenicity concerns. PABA derivatives can also stain clothing. Octyl dimethyl PABA, also known as Padimate O, is the most commonly used PABA and has a maximal absorption at 296 nm. It has average photostability, with about 15.5% lost with UV exposure. There have been some popular press articles questioning the cancer-causing potential of pure PABA. This is not a relevant concern because pure PABA is not used in any of the modern sunscreens.

Salicylates

The salicylates are an important class of UVB photoprotectants. This class includes octyl salicylate (octisalate), homomenthyl salicylate (homosalate), and trolamine salicylate. Trolamine salicylate is no longer used because it was banned by the FDA in 2019 due to an increased risk of bleeding and salicylate toxicity. The internal hydrogen bonding of the salicylates provides for UVB absorption at 300 to 310 nm. Approximately 56% of the sunscreens in the current marketplace use the salicylates as a secondary active sunscreen agent because they have an excellent safety record with minimal reports of allergic reactions.

TABLE 9.3: Inorganic Sunscreen Filters

Kaolin
Magnesium silicate
Magnesium oxide
Titanium dioxide
Iron oxide
Zinc oxide

Cinnamates

The cinnamates are the most popular sunscreen category currently used in sunscreens, sunscreen-containing moisturizers, and facial foundations; 86% of products with an SPF rating contain octyl methoxycinnamate, also known as octinoxate, which has maximal absorption at 305 nm. Octyl methoxycinnamate has excellent photostability, with only 4.5% degradation after UVB exposure. For this reason, octyl methoxycinnamate is a popular primary sunscreen. A primary sunscreen means that it is used in the highest concentration and is listed first under the active ingredient disclosure on the back of the sunscreen box. All sunscreens must have an active ingredient disclosure required by law as they are classified as OTC drugs. The secondary sunscreen is listed second and is next highest in concentration, followed by the tertiary and quaternary sunscreens. Most sunscreen formulations contain several sunscreen filters to provide broad-spectrum photoprotection by mixing filters with different absorptive wavelengths while balancing aesthetic qualities.

UVA/UVB inorganic sunscreen filters

The inorganic UVA/UVB sunscreen filters are titanium dioxide and zinc oxide. These are the main inorganic filters, but a complete list of the monographed ingredients is found in Table 9.3. Titanium dioxide is usually micronized to contain particles of various sizes to provide optimal UV scattering abilities (Figure 9.4). Unfortunately, it leaves a white film on the skin and is used mainly for beach wear products. Zinc oxide is usually available in a microfine form, meaning



FIGURE 9.4 Micronized titanium dioxide in the raw material form.



FIGURE 9.5 Microfine zinc oxide in the raw material form.

it contains small particles of one size, making it appropriate for day wear (Figure 9.5). Titanium dioxide and zinc oxide are known as inorganic filters because they do not undergo a chemical reaction when struck by a photon of UV energy. They are inherently photostable. These particulates reflect most of the energy, but a small amount may be absorbed. The absorbed energy may result in the formation of secondary oxygen radicals; therefore, most titanium dioxide and zinc oxide sunscreen powders are now coated with dimethicone to quench the secondary oxygen radicals (Figure 9.6).

Zinc oxide and titanium dioxide are the two broad-spectrum inorganic sunscreen filters.



FIGURE 9.6 Dimethicone-coated zinc oxide is used to decrease secondary oxygen radical formation in sunscreens.

A newly introduced colorless zinc oxide with extremely small particles is finding its way into many cosmetics and moisturizers. Some of the particles are so small that they are known as nanoparticles, which are less than 100 nm in size. These particles are controversial because their small size may allow them to penetrate the skin, but they escape body removal by macrophage phagocytosis. Nanoparticle sunscreens are the next topic of discussion.

Nanoparticle sunscreens

There is a growing concern over the presence of nanoparticles in the environment. These particles are less than 100 nm in size, are invisible to the human eye, can penetrate the skin and lung tissue, and gain access to the lymphatics and blood circulation. From there, these particles can be widely distributed throughout the body. Once these particles enter the body, they cannot be removed because their small size escapes detection. Concern has been voiced in the medical community that nanoparticles of metals might be responsible for neurologic diseases. Others have wondered whether the chronic inflammation induced by nanoparticles might not cause other degenerative diseases.

The biggest present concern in the skin care industry is the use of nanoparticle zinc oxide and titanium dioxide. These white particles become invisible when manufactured in a nanoparticle size, making them suitable for all skin types, including persons of Fitzpatrick skin types III to VI. These highly effective nanoparticle sunscreens are poised to dominate the market, but environmental concerns arise when the disposition of nanoparticles in the environment is considered. After a day at the beach, the sunscreen is rinsed into the ocean water and finally completely removed in the shower. These zinc oxide nanoparticles find their way into the water columns of the world. Nanoparticle zinc is antibacterial, another possible use for this technology, and is also toxic to plankton, the first line of the aquatic food chain. Imagine the consequences of large-scale aquatic organism death due to invisible nanoparticles. It is for this reason that many countries are taking a regulatory stance on nanoparticle use.

The cosmetic industry in the United States has called for a voluntary halt on widespread nanoparticle use until more information can be obtained. No reputable manufacturer wants to put nanoparticle products in the marketplace with long-term adverse health implications, even though there is no governmental organization forbidding its use in the United States. This is not the case in Europe. Sweden has banned the use of nanoparticle formulations, and the European Union has asked that all presently marketed nanoparticle-containing products have the term “nano” on the packaging. Further, all products marketed with nanoparticles after 2013 must be registered with the government. The FDA convened a taskforce to examine nanoparticles, but no documents have been produced.

The penetration of nanoparticles into the skin is perhaps the biggest immediate health concern. However, it is impossible to generalize. The skin barrier, composed of protein-rich corneocytes and intervening covalently bound lipid layers, is extremely effective at keeping out substances deleterious to the body. Larger nanoparticles of size 14 to 100 nm do not penetrate the skin, but nanoparticles less than 13 nm in size can penetrate the skin. These extremely small nanoparticles in the range of 10 nm are labeled as quantum dots. Quantum dots are a specialized form of nanoparticle with unique electrical and magnetic properties. Quantum dots are currently being investigated for their use in computing for the next generation of microcomputers.

Nanoparticles less than 13 nm in size can penetrate the skin.

Nanoparticle penetration is theoretically less likely if the particles are larger than 13 nm. However, in reality, nanoparticles do not remain as nanoparticles in skin care and sunscreen formulations. Nanoparticles can be sprinkled into an emulsion and put into a zinc oxide sunscreen, but they do not remain nanoparticles. Nanoparticles like to aggregate, meaning that they stick together. A clump of fifteen 10-nm nanoparticles is no longer a nanoparticle because their cumulative size of 150 nm is larger than 100 nm, the upper limit for nanoparticles. Further, nanoparticles placed in emulsions, which are the basis for the lotion that suspends the nanoparticles in sunscreens, tend to agglomerate. This means that the clumps of nanoparticles stick together even further when placed in an oil-in-water mixture. Ten clumps of 150-nm aggregated nanoparticles become 1500 nm, well above the nanoparticle limit. In theory, nanoparticles could exist singly and penetrate the skin, but in actuality, the aggregation and agglomeration of particles found in nature protects both the body and the environment from deleterious effects. This is not to say, however, that further research is not needed to evaluate the behavior and safety of nanoparticles (6).

The tendency of nanoparticles to aggregate and agglomerate prevents them from penetrating the skin when used in sunscreen formulations.

Tinted sunscreens

Visible light is becoming an increasing concern, especially in skin of color, where melasma, tanning, and post-inflammatory hyperpigmentation can be induced by this wavelength of the visible spectrum. Visible light is in the range of 400–700 nm, comprises 44% of solar radiation, and can penetrate to a depth of 90–750 micrometers as compared to 1.5–90 micrometers for UV radiation. To minimize the penetration of visible light, tinted sunscreens have been developed to match or blend with all Fitzpatrick skin types. The tint is obtained by combining pigments: titanium dioxide, which is white, with iron oxides obtained from ferrous sulfate that are yellow, red, and black. The pigments provide coverage and opacity, while the iron oxides combine to mimic the various skin colors. Sometimes synthetic mica is added to create an optical blurring effect and improve color matching. No safety issues have been identified with tinted sunscreens (7).

Sunscreen formulation

Sunscreens are typically made from combinations of the ingredients previously discussed. Usually, sun filters with different areas of UV protection are combined to yield a sunscreen with the broadest protection possible. Oily ingredients are usually used in low concentration to prevent a sticky feel but may be required to achieve the desired SPF. Sunscreen formulation is definitely an art, yet the question remains as to why sunscreens do not provide optimal protection. Careful formulation is only a part of the

success of a sunscreen. The ability of the sunscreen to be applied in an even thin film that will not separate or move is important. Sunscreens combine with sebum, sweat, topical medications, and cosmetics, which can interrupt or destroy the film. Furthermore, most sunscreens are tested in a laboratory under ideal wearing conditions. For practical purposes, it is probable that most sunscreens perform at half of their rated SPF, based on actual application and wear conditions.

The SPF is calculated as follows:

UV energy required to produce an MED on protected skin/
UV energy required to produce an MED on unprotected skin.

Thus, a patient who experiences reddening of the skin in 10 minutes of sun exposure without protection would be able to stay in the sun 60 minutes before the same degree of erythema developed while wearing a sunscreen with an SPF of 6. Many dermatologists feel that patients should wear a sunscreen with an SPF of 15 or higher to obtain adequate sun protection. Unfortunately, SPF is an evaluation of the UVB protective skin effects and does not account for UVA photoprotection. Methods have been proposed to define a protection factor for UVA protection factor, but no final rating system has been developed (8). Given the current SPF rating system, patients probably need to use a sunscreen with an SPF of 30 or higher to receive some degree of UVA photoprotection, especially important on the face for photoaging and skin prevention (Figure 9.7).



FIGURE 9.7 A sun protection factor rating of 30 or higher is indicative of some degree of UVA photoprotection.

The performance of a sunscreen depends on the concentration of the sunscreen filter and its ability to remain on the skin.

The performance of a sunscreen depends on the concentration of the filters and the ability to remain on the skin. Increasing the concentration of a sunscreen filter can increase the SPF; for example, 3% octyl dimethyl PABA has an SPF of 4, whereas 4% octyl dimethyl PABA has an SPF of 5. Better performance can be obtained with the octyl dimethyl ester of PABA because it is less water-soluble than PABA, accounting for its use in waterproof sunscreens and superior performance under humid conditions. Environmental factors such as heat, wind, humidity, perspiration, and thickness of sunscreen film application are also important in sunscreen performance, but these cannot be controlled (9). Higher SPF sunscreens are not necessarily more irritating than lower SPF varieties.

A superior sunscreen can also be produced by combining sunscreens agents. A sunscreen containing only 8% octyl dimethyl PABA has an SPF of 8, whereas a sunscreen combining 8% octyl dimethyl PABA with 3% oxybenzone has an SPF of 20. Most sunscreens will combine organic and inorganic filters for optimal photoprotection.

Sunscreens are a more common source of irritant than allergic contact dermatitis.

Sunscreens are a more common source of irritant than allergic contact dermatitis, but distinguishing dermatitis from solar-induced phenomena can occasionally be difficult (10, 11). Reports of contact urticaria have also been published, but again, the reaction may be solar induced rather than sunscreen induced (12). PABA is a known sensitizer at a 5% concentration (13), but marketed sunscreens in the US have not used PABA because it was banned in 2019. PABA esters, such as padimate A and padimate O, are used instead and possess a lower sensitization potential (14). Cinnamates are also sensitizers, even though they are commonly incorporated into hypoallergenic sunscreen formulations. Cinnamates interact with balsam of Peru, coca leaves, cinnamic acid, cinnamic aldehyde, and cinnamon oils (15). Both the salicylates (16) and anthranilates are rare sensitizers (17, 18). Finally, photoallergic reactions have been reported with the benzophenones (19, 20).

Inorganic filters are not sensitizers, but are occlusive, and can produce miliaria. It has been reported that the inclusion of titanium dioxide in sunscreen formulations reduces the incidence of photoallergic contact dermatitis, possibly due to its ability to reflect ultraviolet radiation (12).

Sunscreen safety

Sunscreen safety has become an area of concern not only for the human user but also for the environment. Sunscreen actives have been recovered from the urine of humans, and this is of concern because sunscreen must stay on the skin surface to provide photoprotection. It is unclear how much sunscreen enters the body accidentally by sweating into the mouth or by touching foods with sunscreen-contaminated hands. The 500 Da rule is being

followed by sunscreen manufacturers to minimize percutaneous absorption because particles larger than 500 Da do not readily penetrate the skin.

Many of the sunscreen safety concerns involve oxybenzone. It is a photoallergen and has the highest incidence of photoallergy among sunscreen filters. Oxybenzone may also have estrogenic effects, as was demonstrated by oral administration in an animal model. Although it would be challenging for a human to consume the amount of oxybenzone fed to the animals, hand-washing before eating when wearing sunscreen is advised (21). Oxybenzone, octinoxate, and octocrylene are also showing up in wastewater treatment facilities, with a higher concentration seen during the summer months. The significance of this is not known, but oxybenzone may not be thoroughly removed by water treatment. Further, oxybenzone has been identified as a threat to coral reefs as it washes from the skin of divers around the reefs, resulting in coral reef bleaching due to oxidative stress. Oxybenzone has also been found in fish, which may be a concern for humans who consume the fish (22).

Summary

Photoprotection of the face is an important dermatologic consideration. Most of the antiaging facial products base their claims on the inclusion of sunscreen filters. Although no one has proven that sunscreens inhibit skin aging in humans, it is assumed that photoprotection is the key to beautiful skin for life. This chapter discussed the types of ingredients that can be incorporated into sunscreens to provide photoprotection and sunless tanning products as a method for simulating tanned skin. The best solution to the problems associated with tanning is to change current fashion norms to rediscover the beauty of untanned, naturally pigmented skin.

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10

LIP COSMETIC CONSIDERATIONS

The lips are a site of great interest because they are involved in phonation and eating. Also, they are an important part of personal appearance. Lips are formed from transitional epithelium wedged between traditional keratinized dry skin and moist mucosal skin, which is a portal of entry for bacteria, viruses, food, and medication (Figure 10.1). They are an instrument of affection as delivered by a kiss and the focal point of the face. Much poetry has been written about beautiful ruby red lips through the ages. However, as the lips age, they begin to thin and lose their characteristic shape. This is due to loss of the fat that gives the lip substance. A profile view of a child will reveal lips that protrude from the face, whereas the profile of a 70-year-old woman will reveal lips that are flat and even depressed from the facial surface. Many of the new cosmetic fillers, such as hyaluronic acid, are designed to replace this lost fat. The loss of lip shape is also accentuated by loss of teeth and bony gum structures that give the lips their characteristic Cupid's bow shape. The lip muscles remain intact throughout life, but cannot make up for the loss of the underlying fat suspended over a bony frame.

Luscious lips are considered a sign of female beauty. Although lip fashion may change over time, the definition of beautiful lips is constant. Well-proportioned lips should begin at one pupil and extend to the opposite the pupil. Lipsticks can be used to elongate the lips and correct suboptimal proportions. They can also be used to add shine, attract attention, and coordinate colors. Lip cosmetics have been used since 7000 BC, when the Sumerians adorned the lips of their male and female royalty. The art of lip adornment was passed on through generations from the Egyptians to the Syrians to the Babylonians to the Persians to the Greeks to the Romans and finally to present-day civilization. Plant materials, such as hybrid saffron or brazilwood were usually used to obtain a reddish color. The earliest true lipsticks consisted of beeswax, tallow, and pigment. Modern lipstick was introduced in the 1920s, when the "push-up" holder, still used today, was invented. Lipsticks can create or assist in the treatment of lip conditions (Table 10.1). This chapter focuses on the various

types of lip cosmetics and their use in a variety of dermatologic situations.

Lipstick formulation

Lipstick is an extruded rod of color dispersed in a blend of oils, waxes, and fats packaged in a roll-up tube (Figure 10.2). The ratio of the oils and waxes is varied by the cosmetic chemist to arrive at the final attributes of the product. For example, a lipstick designed to camouflage lip imperfections must be long wearing. Elevating the wax concentration, reducing the oil concentration, and increasing the pigment concentration can increase the length of time the color remains on the lips. Lipsticks can also be used to treat non-actinic cheilitis by providing higher lip emollience. This formulation would be composed of a low-wax and high-oil concentration to produce a smooth creamy lip feel.

Lipsticks can be used to treat non-actinic cheilitis by providing higher lip emollience.

Waxes are used to help the lip color adhere to the lip. The waxes commonly incorporated into lipstick formulations are white beeswax, candelilla wax, carnauba wax, ozokerite wax, lanolin wax, ceresin wax, and other synthetic waxes. Lipsticks usually contain a combination of these waxes, carefully selected and blended to achieve the desired melting point. Oils are then added to soften the wax and add shine to the lips. The oils that can be used include castor oil, white mineral oil, lanolin oil, hydrogenated vegetable oils, or oleyl alcohol. The oils are also necessary for the dispersion of the pigments.

Various types of coloring agents are used in lipsticks, in addition to the waxes and oils previously discussed. Recently, the safety of these coloring agents has been questioned because a

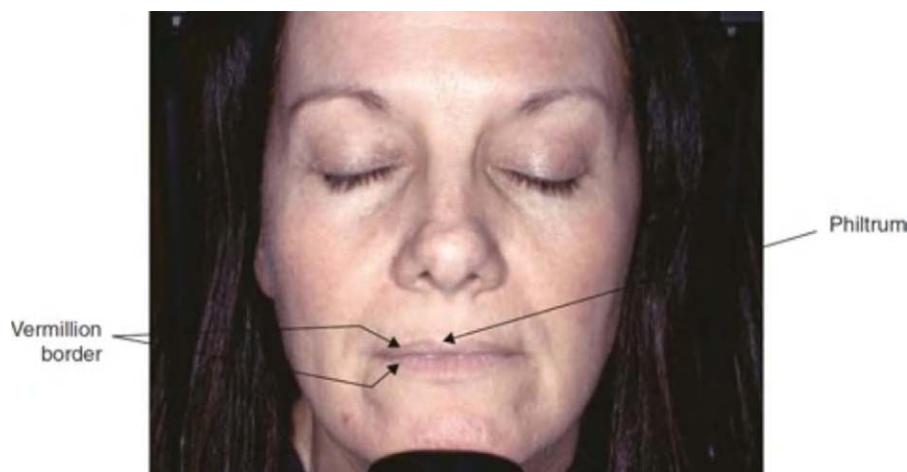


FIGURE 10.1 Anatomy of normal lips.

TABLE 10.1: Lip Cosmetics

Lipsticks	Appearance	Coverage	Wearability	Main Ingredients
Lipsticks				
Pigmented	Matte	Full	Moderate	Wax, oil, pigment
Frosted	Pearlescent	Full	Moderate	Wax, oil, pigment
Transparent	Shiny	Very sheer	Short	High percentage of oil, soluble dyes
Indelible	Matte	Moderate	Very long	Wax, oil, bromo acid dyes
Lip crayons	Pearlescent or matte	Full	Moderate	Wax, less oil lipstick, pigment
Lip liners	Matte	Not applicable	Long	Wax, pigment
Lip creams and gloss pots	Shiny	Sheer	Very short	Petrolatum, oil, pigment
Lip sealants	Matte	Not applicable	Long	Water, glycerin, wax, oil, dimethicone
Lip balm	Matte	None	Long	Wax, mineral oil, chemical sunscreen

Coverage: very sheer = transparent, sheer = semitransparent, moderate = translucent, heavy = semiopaque, full = opaque.

Wearability: very short = 2 hours, short = 3 hours, moderate = 4 hours, long = 8 hours.

consumer watchdog group announced that several red lipsticks possessed detectable lead levels. The colors used in all cosmetics, including lipsticks, must be approved by the US Food and Drug Administration (FDA) (Table 10.2). The FDA divides certified colors into three groups: food, drug, and cosmetic (FD&C) colors, drug and cosmetic (D&C) colors, and external drug and cosmetic colors. Only the first two groups can be used in lipsticks. The external drug and cosmetic colors can only be used in locations where they are not likely to enter the mouth.

Companies that manufacture lip cosmetics purchase their individual ingredients from suppliers. The cosmetic company

TABLE 10.2: Lipstick Colorants Permitted in the United States

FD&C or D&C Blue No. 1, Al Lake	D&C Red No. 11, Ca
FD&C or D&C Blue No. 2, Al Lake	D&C Red No. 12, Ba
FD&C or D&C Red No. 2, Al Lake	D&C Red No. 13, Sr
FD&C or D&C Red No. 3, Al Lake	D&C Red No. 19, Al Lake
FD&C Yellow No. 5, Al Lake	D&C Red No. 21
D&C Yellow No. 5, Zr-Al Lake	R&C Red No. 27
D&C Yellow No. 6, Al Lake	D&C Red No. 27, Al Lake
FD&C or D&C Yellow, No. 6, Al Lake	D&C Red No. 30D&C Red No. 36
D&C Orange No. 5	D&C Blue No. 1, Al Lake
D&C Orange No. 5, Al Lake	Iron oxide—all shades
D&C Orange No. 10	Carmine
D&C Orange No. 10, Al Lake	Bronze powder
D&C Orange No. 17, Ba Lake	Carbon black
D&C Red No. 3, Al Lake	Guanine
D&C Red No. 6, Na or Ba	Manganese violet
D&C Red No. 7, Ca	Mica
D&C Red No. 8, Na	Aluminum powder
D&C Red No. 9, Ba	Bismuth oxychloride
D&C Red No. 10, Na	Carotene

Source: Adapted from deNavarre MG. Lipstick. In: The Chemistry and Manufacture of Cosmetics. 2nd edn. Allured Publishing Corporation, Wheaton, IL: 1975: 778.



FIGURE 10.2 Lipstick is a creamy pigmented cosmetic dispensed from a roll-up tube to temporarily color the lips.

typically receives a certificate indicating that the purchased ingredient meets certain standards. On top of this safeguard, most companies also perform internal testing to ensure ingredient purity. There are many checks and balances to prevent the inadvertent contamination of cosmetics.

There are a variety of lipsticks designed for unique consumer needs. Because lipsticks can be used for camouflaging, moisturizing, and photoprotection, there are formulations designed specifically for each purpose (Figure 10.3). An evaluation of these special needs products is important because the dermatologist is likely to encounter patients who can supplement their lip therapy with proper lipstick selection.

Long-wearing lipsticks

Individuals who have a lip deformity or problems with lip bleeding due to upper and lower lip rhagades may find a long-wearing lipstick helpful. Basically, the lipstick stays in place once applied

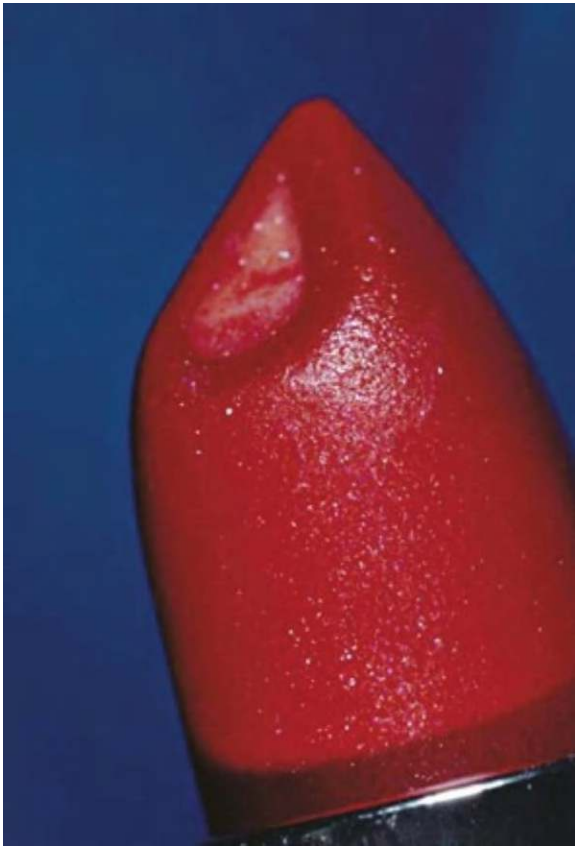


FIGURE 10.3 A moisturizing lipstick with a central core of lip moisturizer surrounded by an outer layer of pigmented lipstick.

and does not migrate because it stains the lip. These lipsticks should be used in persons who are undergoing lip filler enhancement, where not all the lines can be filled or when the lines cross from the perioral skin onto the vermillion.

Long-wearing lipsticks employ indelible coloring agents to stain the lip. Indelible coloring agents include bromo acids, such as fluoresceins, halogenated fluoresceins, and related water-insoluble dyes. The most commonly used indelible coloring agent is acid eosin, a tetrabromo derivative of fluorescein. Acid eosin, also known as bromo acid or D&C Red No. 21, is naturally colored orange, but changes to a red salt at a pH of 4. Conditions present on the lip change the orange lipstick to a vivid red indelible stain that is long lasting. This accounts for the red color of all long-wearing lipsticks (Figure 10.4).

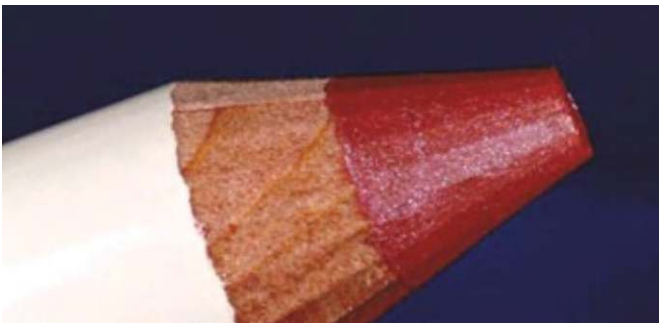


FIGURE 10.4 A long-wearing lipstick in the form of a lip crayon.

Long-wearing lipsticks employ indelible coloring agents, most commonly eosin, to stain the lip.

The biggest problem with long-wearing lipsticks is that they dry the lips and precipitate cheilitis. For this reason, long-wearing lipsticks should not be used in persons with dry lips, as the lip xerosis will worsen with continued use of a lip stain. It is also possible to develop an irritant contact dermatitis to bromo acid in lipsticks. In patients who have unexplained lip dryness and irritation, it may be worthwhile to recommend the discontinuation of long-wearing lip products.

Lip balms

An important variant of the lipstick is the lip balm. Lip balms do not contain pigment and are not used for decoration of the lips, but rather to provide moisturization of the lips and protection from the sun and cold. These products form a moisture-resistant film over the lips and act as an occlusive moisturizer to prevent water loss from the transitional mucosa. They usually contain a mixture of mineral oil, wax, and dimethicone. Lip balms may also contain organic sunscreens. Most lip balms have a sun protection factor (SPF) in the 15–30 range. Higher SPF lip balms are difficult to develop because the organic filter concentration would need to be increased, and these filters have a horrible bitter taste. Yet, lip balms remain an excellent source of photoprotection in persons with actinic cheilitis, leukoplakia, or a history of photo-induced lip cancer.

Lip balms can provide both moisturization and photoprotection to the lips.

There is a great deal of information on the Internet about the “addictive” potential of lip balms. Some consumers claim that they are addicted to lip balm, carry a tube in their pocket at all times, and must reapply the lip balm several times an hour. ZDD independently researched this phenomenon several years ago and determined that patients were not addicted to the lip balm, but rather the waxy feel of the lip balm on the lips. It was a sensory rather than a functional addiction. The lip balm did not precipitate further lip dryness, but created a warm moist feel immediately after application that disappeared as the product remained on the lips. This necessitated the frequent reapplication as the film dissolved.

Lip sealants

Lip sealants are similar in function to eye shadow-setting creams in that both products prepare the skin for increased cosmetic wearability. Lip sealants prevent movement of the product into the fine lines around the lips, encouraging the lip cosmetic to remain in place. They contain water, talc, glycerin, wax, mineral oil, and dimethicone. The cream is applied to the lips like lipstick or with a finger and allowed to dry before a pigmented lip cosmetic is applied. Facial foundation can also be applied to the lips as a sealant.



FIGURE 10.5 Lip gloss may be dispensed from a plastic tube and stroked over the lips with its angled application tip.

Lip sealants contain dimethicone, can fill in lip wrinkles, and provide a base for the subsequent application of lipstick.

Lip gloss

Another popular product to moisturize the lips is lip gloss. Lip gloss is different from lip balm as it does not contain waxes, only oils and dimethicone. Lip gloss is most popular among adolescents, who may select lip gloss as their first cosmetic. It adds shine, smell, and taste to the lips, but not necessarily moisturization (Figure 10.5). Lip gloss migrates rapidly off the lip and is not a good choice for mature individuals. Additionally, some oils may be comedogenic. The dermatologist should caution about the use of lip gloss in acne patients with refractory vermilion border comedones.

Lip gloss has seen a resurgence in the popularity of film-forming polymer lipsticks. The polymer dries to a hard pigmented film on the lips, but is extremely drying. To prevent cheilitis and add shine, many polymer lip products are co-packaged with a lip gloss for frequent application, and this is the next topic of discussion.

Polymer film lipsticks

Another method for enhancing the ability of a lip color to remain on the lips is through the creation of polymer films. Polymer film lipsticks are the newest introduction into the lipstick market. These lip products are packaged as two-tube products where one end contains the lip color and the opposite end contains a lip gloss or balm. The pigmented polymer is applied first and allowed to dry, followed by the moisturizing gloss or balm. These products stay on until peeled or rubbed off (Figure 10.6).

For persons who need a long-wearing lip product for camouflage purposes, the polymer film lipsticks are wonderful. They form an opaque film, which can cover pigmentation or vascular abnormalities of the lip. Another layer of camouflage can be added by putting a creamy opaque lipstick on top for moisturization and shine.

The polymer lip products can be used to artistically draw on the lips, if they are asymmetric or too small (Figure 10.7). The polymer film sticks well to any skin surface, but the best results are obtained when combined with a lip liner. The lip liner forms



FIGURE 10.6 Tubes of various polymer lipstick colors that also contain a lip stain.



FIGURE 10.7 Angled brushes are used to stroke the colored polymer lip product over the lips.

an even edge that can be painted over with the polymer film applicator. In contrast with lipsticks that are rubbed from a waxy stick, polymer film lip products are stroked across the lips with an angled sponge brush. This requires a steady hand for successful application (Figure 10.8).



FIGURE 10.8 The artistic application of the lip polymer to the lips.

To prevent cheilitis and add shine, many polymer lip products are co-packaged with a lip gloss for frequent application.

Lip liners

As mentioned previously, the new polymer lip products are best combined with a lip liner. Lip liners are thin extruded pigmented rods encased in wood or placed in an automatic pencil-type holder (Figure 10.9). Their formulation is similar to lipsticks, except that stiffer waxes with higher melting points are used with minimal oil. This creates an extremely hard rod that applies a thick layer of pigment to the lips. Lip liners are used to define the outer edge of the lips and are valuable in reconstructing a normal lip contour. The thick wax layer applied around the lips also prevents creamier lip products from bleeding. Lip liner is usually selected one to two shades darker than the lipstick.

Lip liners are used to define the outer edge of the lips and are valuable in reconstructing a normal lip contour.

Lip liners are indispensable for persons who require lip definition or lip enhancement. They can nicely aid in lip definition for women who have undergone lip augmentation with fillers. Lip liner can also be used to temporarily draw lip proportions prior to filler injections to make sure that the patient is comfortable with the proposed lip size.

Opaque lipsticks

Opaque lip cosmetics can be used over polymer lip products to prevent inevitable lip dryness (Figure 10.10). An opaque lip cosmetic is also preferred in patients who require lip camouflaging. The opaqueness is due to incorporation of high titanium dioxide levels in the lipstick. Titanium dioxide provides the best coverage of all the white pigments, including zinc oxide. It must be ground to a fine powder to enable smooth application of the lipstick. It also adds color brightness to lip cosmetics and is used to create pastel shades. Opaque lipsticks are the best lip protection for women with actinic cheilitis. They can nicely protect the



FIGURE 10.9 Pigmented lip liners in an automatic pencil-type holder.



FIGURE 10.10 Opaque lipsticks provide excellent sun protection in women.

lip transitional mucosa after cryosurgery or lip advancement for reconstruction following lip cancer surgery.

Opaque lipsticks are the best lip protection for women with actinic cheilitis.

Tooth-whitening lipsticks

Another new category of lipsticks is tooth-whitening lipsticks. These are sold primarily in drug stores. The name may be misleading, however, because the lipstick does not actually whiten the teeth like the popular tooth-whitening kits containing peroxide. These lipsticks have a bluish-red color that makes the teeth appear white due to the color contrast.

Tooth-whitening lipsticks have a bluish-red color that makes the teeth appear white due to the color contrast.

Lip cosmetics and allergic contact dermatitis

Lipstick can be a cause of allergic contact dermatitis. The lipstick ingredients reported to cause allergic contact dermatitis include ricinoleic acid (1), benzoic acid (2), lithol rubine BCA (Pigment Red 57-1) (3), microcrystalline wax (4), oxybenzone (5), propyl gallate (6), and C18 aliphatic compounds (7).

The most common cause of allergic contact dermatitis in lipstick is castor oil.

Castor oil is a ubiquitous lipstick ingredient used to dissolve bromo acid dyes, although it may cause allergic contact dermatitis (8–10). However, the bromo acid dye eosin (D&C Red No. 21) is also a cause (11). If a patient has recurrent allergic contact dermatitis to different types and brands of lipstick, castor oil allergy is almost always the problem. Still, most women want

to wear lipstick. An excellent alternative is one of the polymer lipsticks previously discussed, as these products do not contain castor oil.

Lip tattooing

Definition of the vermilion border can be achieved temporarily with lip cosmetics, as previously discussed, or permanently enhanced through lip tattooing. Less conventional than the use of lip liners, this method is practiced by dermatologists and plastic surgeons. Lip tattooing is performed by inserting a red pigment such as cinnabar, a red dye containing mercuric sulfide, into the upper dermis along the vermilion border through punctures created by a specially designed needle. The normal lip contour can be followed, resulting in the appearance of permanent lipstick, or the pigment can be placed to reshape malformed lips. Lip tattooing can also be used to reconstruct the vermilion border in patients with treated actinic cheilitis or leukoplakia. It is possible to develop a tattoo granuloma because cinnabar is the most allergenic of the tattoo pigments.

Lip tattoo granulomas may occur from cinnabar, the red pigment used for permanently tattooed lipstick.

This technique is not recommended for women, except in cases of extreme surgical deformity because fashion dictates the desirable lip appearance and the patient will not be able to wear lighter lipstick shades in pink or peach. However, the permanence of lip color may be more desirable in male patients, who do not require fashion flexibility. Patients should recognize that there is some fading of the pigment color with time, and the movement of the pigment within the dermis occurs due to macrophage phagocytosis.

Lip cosmetics are used by many individuals, some of whom may have special dermatologic needs. The discussion now turns to the special lip needs of acne patients, mature patients, and individuals who require the assistance of corrective lip cosmetics.

Lip cosmetics for acne patients

Lip cosmetics are used by acne patients, but must be carefully selected to avoid worsening of the acne. Acne patients should select lip cosmetics with low oil content to minimize the formation of comedones around the vermilion border and perioral acne. Lip creams and gloss pots contain mostly oil and should be avoided in favor of lip crayons and lipsticks. Lip cosmetics with a higher oil content have a creamy feel and a glossy shine on application. Acne patients with oily complexions will also notice the movement of the lip cosmetic away from the lips as sebum combines with the cosmetic. Lip crayons and lip liners will provide the longest wear in these patients. The use of a lip stain may also be considered.

Acne patients should select lip cosmetics with low oil content to minimize the formation of comedones around the vermilion border and perioral acne.

Lip cosmetics for mature patients

Lip cosmetics are important to mature patients not only to pigment and enlarge the important facial landmark that is the lips, but also to assist in the prevention and treatment of lip disease. With maturity, the lip architecture changes secondary to subcutaneous fat loss, the wearing of dentures, and change to the bony structures of the face give rise to perleche (also known as angular cheilitis). Perleche arises as the collection of saliva in the folds of the corners of the mouth creates maceration, providing the perfect environment for yeast growth. Yeast causes further tissue breakdown and painful cracked skin that is best treated by a combination of topical low-potency topical corticosteroids and topical antifungal/anti-yeast creams. Perleche can be prevented by using an occlusive lip balm that does not support the yeast growth and protects the lip corners from moisture contact.

Perleche can be prevented by using an occlusive lip balm that does not support yeast growth and protects the lip corners from moisture contact.

In addition to biofilm disease, the lips can also be subject to dryness in mature patients. Abundant oil glands can be visualized lining the vermilion of the lips, but the production of these glands decreases with advancing age. Dryness of the lips, known as cheilitis, leads to cracking and peeling of the lips. Cheilitis can be accentuated by heat exposure from smoking or actinic damage. Lip balms, lip moisturizers, or lipsticks can be used to aid in the treatment of cheilitis. Good occlusion is typically required to allow these conditions to resolve, which is best achieved with oily substances such as petrolatum, waxes, and silicones. Some elderly individuals may appear to have chronic cheilitis due to the continual presence of peeling skin over the lips. This may be due to dryness, but also may be due to insufficient exfoliation of the lip surface. The use of a stiff lip balm with high drag over the lips when applied may be helpful in this condition.

Lip balms can be further adapted to provide both lip moisturization and sun protection. A quality lip balm used on a daily basis with an SPF of at least 15 can prevent actinic cheilitis. A sunscreen-containing lip balm is also the best way to prevent the recurrence of herpes simplex labialis because the virus can be photo reactivated. Finally, sunscreen-containing lip balms can prevent skin cancer of the lip, a serious medical condition in mature individuals.

Finally, color can be added to a pale mature face quickly with lip cosmetics. In addition, only a minimal application skill is required and the steady hand necessary for eye cosmetic application is not needed. These characteristics make lip cosmetics popular among mature patients. The most common complaint in this age group is the movement, or "bleeding," of lip cosmetics into the fine wrinkles that develop on the upper and lower lips from elastic tissue degeneration or gingival bone resorption. Often mature persons with dry lips select a moisturizing lipstick and subsequently experience lipstick bleeding. Lip cosmetic bleeding can be minimized by preparing the lips first with a lip sealant or facial foundation, using a stiff lip liner, and avoiding creamy lipsticks or lip

creams in favor of lip crayons. All lipsticks are moisturizers to some extent, but stiff lip balms or sticks cannot be applied as moisturizers under lipsticks because this will encourage lipstick bleeding.

Mature patients may wish to use a lip cosmetic to cover lentigines, venous lakes, or actinic cheilitis. Darker lipstick colors provide better coverage than lighter colors. Lipsticks that contain titanium dioxide are superior to lip crayons or lip creams. Application to the lips of a facial foundation containing titanium dioxide adds additional coverage. A bluish-red lipstick will have the added advantage of seeming to whiten the discolored teeth.

Corrective lip cosmetics

Congenital or post-surgical lip defects can be masked by an effective application of lip cosmetics. A well-proportioned mouth in a closed, relaxed state should be positioned between the medial aspects of the irides (Figure 10.11) (12). Lips that do not span this distance are perceived as small. Small lips can be enlarged by using a lip liner to draw the lip boundary on the outer edge of the vermillion and then filling in with a deeply pigmented, matte finish lipstick (Figure 10.12A). Uniformly thin lips (Figure 10.12B), a thin lower lip possibly due to lip advancement surgery, (Figure 10.12C), or a thin upper lip (Figure 10.12D) can be

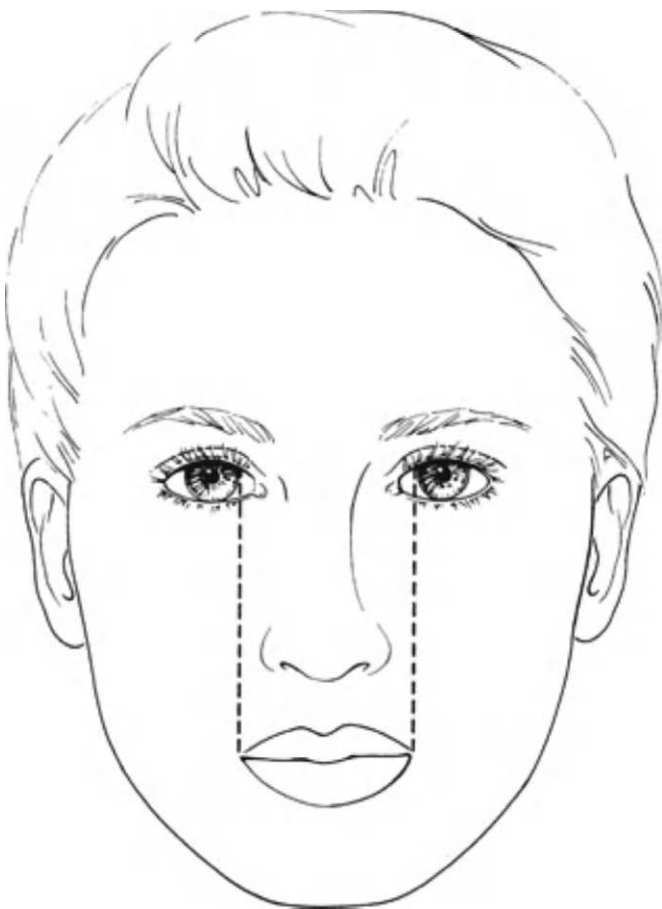


FIGURE 10.11 The length of the closed, relaxed mouth should equal the distance between the medial aspect of the irises in a well-proportioned face.

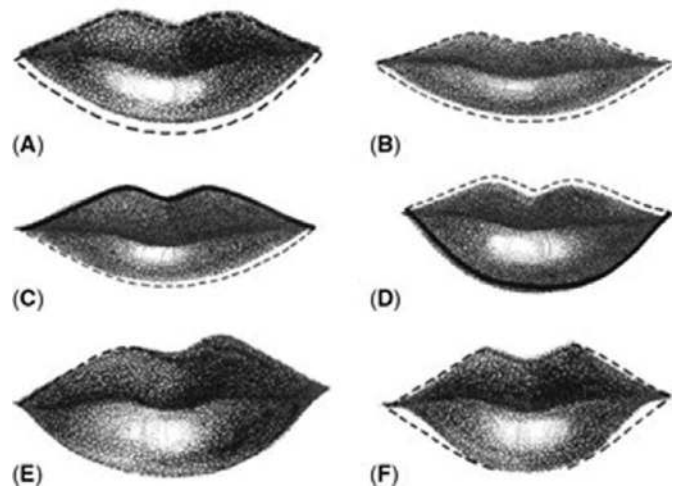


FIGURE 10.12 Contouring of the lips: (A) enlarge small lips, (B) thicken thin lips, (C) thicken a thin lower lip, (D) thicken a thin upper lip, (E) decrease the size of thick lips, and (F) correct crooked lips.

thickened by also lining outside the vermillion where required and selecting a lighter, frosted finish lipstick. Conversely, thick lips possibly due to a congenital hemangioma or granulomatous cheilitis, for example, are lined inside the vermillion (Figure 10.12E). Figure 10.12 also demonstrates the lip lining technique with a dashed line for crooked (Figure 10.12F). The lip liner should be one shade darker than the lipstick for optimal effect.

Abnormal lip shape due to congenital causes or surgery can be masked by effective application of lip cosmetics.

Summary

Lipsticks are useful for cosmetic adornment, but can also be employed by the dermatologist to facilitate the healing of various lip conditions (13). For example, actinic cheilitis can be minimized by using a sunscreen-containing lip balm or an opaque lipstick. Remember that an opaque lipstick has an unlimited SPF because the transitional lip mucosa is completely protected. Lip abnormalities can be minimized by selecting a polymer lip product combined with a lip liner. Finally, patients who experience problems such as lip swelling with the use of lipsticks may be allergic to castor oil or other ingredients. Lipsticks and lip balms are to the lips what hand cream is to the hands. Both are important therapeutic adjuvants in the treatment of dermatologic disease.

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Eyes, more than any other body part, express a person's inner thoughts and emotions. For this reason, the eyes are elaborately adorned, but the anatomy of the eyelid area also makes the eyes a common site of irritation, dermatitis, and infection. Eyelid cosmetic use dates back to antiquity, recorded as early as 4000 BC. Green powder made from malachite was heavily applied to both the upper and lower eyelids, accompanied by dark kohl eyeliner paste composed of powdered antimony, burnt almonds, black copper oxide, and brown clay ocher. The eyeliner paste was stored in a pot and moistened with saliva prior to application. Eyelid glitter from ground beetle shells was used for additional effect (1).

This chapter examines eyelid cosmetics, eyelash cosmetics, and eyelid skin issues. It assesses the unique needs of the eyelid skin and the impact of colored adornments in the form of eye shadow, eyeliner, mascara, and eyebrow pencil as it relates to dermatology. Our discussion opens with a discussion of the eye area skin, and then segues to the world of colored eye cosmetics.

Eyelid considerations

The eyelid skin is one of the most interesting areas on the body (Figure 11.1). It moves constantly as the eyes open and close; thus, it must possess unique mechanical properties. It must be thin enough for rapid movement, yet strong enough to protect the tender eye tissues. Eyelid tissue shows the state of health and age of an individual more rapidly than any other skin of the body. When others comment on a tired appearance, they are usually assessing the appearance of the eyes and the eyelid tissue. When others comment on a sickly appearance, they are also assessing the appearance of the eyes and the eyelid tissue. The eyelid skin appears to age quickly, resulting in the presence of redundant upper eyelid tissue and lower eyelid bags. The redundant upper eyelid tissue is due to loss of facial fat, cumulative collagen loss in

the eyelid skin from UV exposure, and the effect of gravity pulling down the upper eyelid skin. Lower eyelid bags are also formed due to the effect of UV damage and gravity, but edema or swelling may also contribute. This edema may be due to retained body fluids or the release of histamine from inhaled allergens. All these factors contribute to the complexity of the eyelid skin.

The eyelids are the most common site for irritant and allergic contact dermatitis from cosmetics and skin care products.

The eyelids are the thinnest skin on the body; hence, the eyelids are the most common site for irritant contact dermatitis and allergic contact dermatitis, either from products that are directly applied to the eyelids or from products transferred to the eyelids by the hands. The eyelid skin also has a paucity of sebaceous glands, making it a common area of skin dryness. Although there are no hairs on the eyelids themselves, the eyelashes form an interesting transition between the keratinized eyelid skin and the cartilage of the tarsal plate, giving structure to the edge of the eyelid. Tearing from the eye impacts the skin of the eyelid because wetting and drying of the eyelid tissues can predispose to dermatitis.

The eyelids are also a common source of symptoms induced by allergies. These symptoms can be itching, stinging, or burning. Most persons with these symptoms respond by vigorously rubbing the eyelids. This can cause mechanical damage to the eyelid skin from a minor trauma resulting in sloughing of portions of the protective stratum corneum to a major trauma resulting in small tears in the skin. Most of the skin on the body responds by thickening or callousing when rubbed. Eyelid skin will also thicken, but this predisposes to decreased functioning and worsening of the symptoms.

The eyelid bridges the transitional area between the well-keratinized cutaneous skin of the face and the moist mucosa of the conjunctiva that lines the inner eyelid and the globe. Moisture from tearing wets the eyelid skin and enhances irritant and allergen penetration. It can also help dissolve any allergen or irritant, possibly enhancing the adverse reaction. The eyes are also uniquely designed to sense substances that might cause vision damage, and thus the eyelids have a heightened immune response. Swelling induced by topical, inhaled, or ingested allergens is frequently seen initially in the eyelids. The thin nature of the skin also allows the swelling, due to tissue edema, to appear more dramatic than on other body areas where the skin is thicker and less mobile.

In addition to irritant and allergic contact dermatitis involving the cutaneous eyelid, the eyelids can also be the site of biofilm diseases. Ocular rosacea and sties are basically acne of the glands in the eyelid resulting from alterations in the tear biofilm. Overgrowth of bacteria can precipitate the problem. Yeast overgrowth in the eye area results in seborrheic blepharitis.

The eyelid skin is also uniquely affected by the immune status of the individual. Most persons with inhaled allergies to pollen, fragrance, dust, etc. will complain not only of a runny nose but also



FIGURE 11.1 The eyelids are of considerable medical and cosmetic concern: (A) puffiness may develop in the upper eyelid, (B) extra skin in the upper eyelid may obscure the natural fold and impair vision, (C) extra skin in the lower eyelid may cause fine wrinkles, (D) bags or dark circles can develop under the lower eyelid.

of itchy eyes. Because the mucosa is devoid of a physical barrier to allergens and infection, the immune system is particularly fortified in these locations. For this reason, hyperimmune states that affect the overall body skin are keenly present in the eyelid area. For example, persons with atopic dermatitis will demonstrate an additional skin fold on the lower eyelid, a minor criteria for the diagnosis. They represent a unique population of sensitive eyelid persons who have problems with many eye area cosmetics and skin care products.

By far the most common dermatologic disease to afflict the eyelid is eczema. Because the eyelid is relatively poor in oil glands, dry eyelid skin is frequently seen due to overaggressive removal of lipids. This may be due to the use of a strong cleanser or products designed to solubilize oil-based waterproof cosmetics, such as mascara and eyeliner. Anything that damages the intercellular lipids or the corneocytes will result in eyelid eczema. Thus, eyelid hygiene must strike a careful balance between the removal of excess sebum and old cosmetics to prevent from eyelash infections and seborrheic blepharitis, while preventing any damage to the intercellular lipids and ensuing eyelid eczema. Moisturizers for the eye area should contain occlusive substances that have minimal chance for allergenicity or irritancy, reduced ability to enter the eye, and excellent moisturization properties.

The thinness of the eyelid skin also makes the use of sunscreens important. UVA radiation can easily penetrate to the dermis of the thin eyelid skin, causing premature wrinkling. The eyelids are also a common site for UVB-induced sunburn. Eyelid sunscreens must be carefully formulated to avoid allergic and irritant contact dermatitis, prevent stinging and burning should the product enter the eye, and provide superior photoprotection.

There are more color cosmetics for the eyelid area than any other body area, such as mascara, eyeliner, eye shadow, and eyebrow pencil.

Finally, eyelids are also a common site for cosmetic adornment. The eyelid area has more separate color cosmetics than any other body area, such as mascara, eyeliner, eye shadow, and eyebrow pencil. These cosmetics and the products used to remove them can be a source of both allergic and irritant contact dermatitis. Modern color cosmetics for eyelids became popular between 1959 and 1962 (2). This chapter now focuses on eye cosmetics and discusses the subject for the dermatologist.

Eye shadows

Eye shadows are applied to the upper eyelid to add color to the face and accentuate the emotionally expressive eyes. Eye shadows are available in several forms: pressed powders, anhydrous creams, emulsions, sticks, and pencils. Color variety is extensive, but coal tar derivatives cannot be used on periocular skin. Only purified, natural colors or inorganic pigments can be used in the United States as a result of the Food, Drug, and Cosmetic Act of 1938 (Table 11.1) (3).

No coal tar derivatives for pigments can be used in the eye area; only approved purified natural colors or inorganic pigments can be used.

TABLE 11.1: Eyelid-Approved Pigments

Iron oxides
Titanium dioxide (alone or combined with mica)
Copper, aluminum, and silver powder
Ultramarine blue, violet, and pink
Manganese violet
Carmine
Chrome oxide and hydrate
Iron blue
Bismuth oxychloride (alone, or on mica or talc)
Mica

Variations in eye shadow surface texture can range from dull to a pearly shine to an iridescent finish. Titanium dioxide (TiO_2) is used in pastel matte (dull) finish eye shadows to improve coverage. However, it is not found in frosted (pearled shine) finish eye shadows because it tends to mask the desired pearled effect. Bismuth oxychloride (BiOCl), mica, and fish scale essence are the standard materials used to produce a pearly shine. A metallic (iridescent) finish is provided by copper, brass, aluminum, gold, or silver powders (Figure 11.2).

Eye shadows are used to adorn the eyelid with a rainbow of colors for personal expression.

Pressed powder eye shadows are the most popular formulation and are applied to the eyelid by lightly stroking a soft sponge-tipped applicator across the skin (Figure 11.3). They are predominantly talc with pigments and zinc or magnesium stearate used as a binder. Kaolin or chalk may be added to improve oil absorption and increase wearability. A water or oily binder system may also be used, with oily binder systems such as mineral oil, beeswax, or lanolin predominating. Powder eye shadows that are labeled “creamy” or “enriched” contain increased amounts of the oily binder (Figure 11.4).

Anhydrous, or water-free, cream eye shadows contain pigments in petrolatum, cocoa butter, or lanolin (Figure 11.5). These formulations are waterproof, but have a short wearing time due to their tendency to migrate into the eyelid folds, especially in



FIGURE 11.2 An iridescent eye shadow with a glittery shine draws attention to the eyelid, but can cause irritation in persons with sensitive eyes.



FIGURE 11.3 Pressed powder eye shadows are the most popular formulation and are packaged in compacts with various color combinations to create dramatic upper eyelid fashion statements.

patients with oily complexions or redundant eyelid skin. The product is applied with the finger and gently rubbed across the eyelid skin. Anhydrous cream eye shadows have also been formulated as an emulsion applied with a sponge-tipped applicator or wand withdrawn from a cylindrical tube and stroked across the eyelid. These products, known as automatic eye shadows, are also waterproof, with increased wear duration over the creams. They contain beeswax, cyclomethicone, and pigments in a volatile petroleum distillate vehicle.

The most popular anhydrous eye shadows are eye shadow sticks and pencils. They are composed of pigments in petrolatum, but have added waxes, such as paraffin, carnauba, or ozokerite wax, to allow extrusion of the product into a rod. Eye shadow sticks come in roll-up tubes and must be creamy to prevent drag as they are rubbed across the eyelid skin. For this reason, eye shadow sticks tend to migrate into eyelid creases in oily-complected patients or those with redundant eyelid skin. A more modern packaging is to encase the rod in wood, thus forming an eye shadow pencil that is rubbed across the eyelid. The pencil form is not as creamy as the eye shadow stick.

Eye shadows are stroked or rubbed across the eyelid, depending on the type of formulation. Selection of eye shadow color



FIGURE 11.5 Cream eye shadows tend to migrate into the eyelid folds in mature patients, but are more water-resistant than powder varieties.

is a matter of personal preference and fashion, although colors complementary to the natural color of the iris are most attractive (Figures 11.6 and 11.7).

Eye shadow setting creams

Eye shadow setting creams are unpigmented and designed to provide an adherent base over which the pigmented eye shadow can be applied. They increase the wearability of eye shadows and are most useful in oily-complected patients or those with redundant eyelid skin who experience migration of eye shadow into eyelid creases. The setting cream is composed of beeswax, talc, and cyclomethicone. Beeswax seals the eyelid skin, whereas the talc provides an increased adherence for the eye shadow pigment. Some newer cream eye shadows incorporate a setting cream for a longer wear.

Eye shadow setting creams are useful in patients with redundant upper eyelid skin to prevent migration of makeup materials into the folds.



FIGURE 11.4 A brush is used to apply the powder eye shadow to the eyelid.



FIGURE 11.6 An eye shadow palette created for hazel eyes with tones of brown and green.



FIGURE 11.7 Eye shadows are applied with a variety of brushes, similar to paint brushes, to create living temporary art on the female eyelid.

Eyelid cosmetic removers

Waterproof eye shadows must be removed with special removal products containing surfactants, such as cocamidopropyl betaine. These products may be oil-based or oil-free and can be designed to remove all eye cosmetics, including eyeliner and mascara. Allergic contact dermatitis has been reported with the use of these eye cosmetic removers (4).

Eyelid contact dermatitis

The eyelid skin is the thinnest on the body and frequently affected by both irritant and allergic contact dermatitis (5, 6). The North American Contact Dermatitis Group has determined that 12% of cosmetic reactions occur on the eyelid, but only 4% could be linked to eye makeup use (7). Unfortunately, it may be difficult to determine the etiology of the eyelid dermatitis with routine patch testing (8). Many substances can be transferred to the eye area by the hands, such as nail polish, complicating dermatologic evaluation (9).

The North American Contact Dermatitis Group has determined that 12% of cosmetic reactions occur on the eyelid, but only 4% could be linked to eye makeup use.

A thorough evaluation of eyelid dermatitis requires consideration of various entities. Maibach and Engasser have developed the concept of upper eyelid dermatitis syndrome. The causes of upper eyelid dermatitis syndrome, as listed in Table 11.2 (10, 11).

Once it has been determined that eye cosmetics are the source of the dermatitis, the distinction between irritant and allergic contact dermatitis must be made. Irritant contact dermatitis is more common than allergic contact dermatitis. Eye cosmetic ingredients associated with allergic contact dermatitis are listed in Table 11.3 (21, 22).

Open or closed patch testing can be performed “as is” with eye cosmetics, but automatic emulsions, such as mascara, should be allowed to thoroughly dry prior to occlusion (23). Use testing is recommended for eye cosmetics: the product is placed at

TABLE 11.2: Causes of Upper Eyelid Dermatitis Syndrome

Mechanical rubbing
Irritant contact dermatitis
Allergic contact dermatitis
Infection
Photoirritation
Contact urticaria
Atopic dermatitis
Psoriasis
Collagen vascular disease
Conjunctivitis
Seborrheic blepharitis
Idiopathic causes

the corner of the eye for five consecutive nights and evaluated for allergic or irritant contact dermatitis.

Eyelid cosmetics for special populations

Eyelid cosmetics for sensitive skin patients and contact lens wearers

Patients with sensitive skin and multiple allergies frequently have difficulty finding an eye shadow product that does not burn or itch upon application. Certainly, any eye shadow applied over a broken or inflamed skin will cause discomfort. Patients with these problems should avoid all eye cosmetics until they heal. The patients should also be evaluated for upper eyelid dermatitis syndrome, as previously discussed.

To minimize the recurrence of dermatitis, allergic patients should avoid shiny, frosted, or iridescent eye shadows; the bismuth oxychloride, mica, metal powders, or fish scale essence may contribute to an irritant contact dermatitis. These substances may also have sharp-edged particles that can produce pruritus. Matte finish eye shadows are therefore recommended for sensitive skin patients (Figure 11.8).

TABLE 11.3: Cosmetic Ingredients that Cause Allergic Contact Dermatitis in Eyelids

Preservatives (12)
Parabens
Phenyl mercuric acetate
Imidazolidinyl urea
Quaternium-15
Potassium sorbate
Antioxidants
Butylated hydroxyanisole (13)
Butylated hydroxytoluene (13)
Di-tert-butyl-hydroquinone (14)
Resins
Colophony (15)
Pearlescent additives
Bismuth oxychloride (16)
Emollients
Lanolin (17)
Propylene glycol (18)
Fragrances (19)
Pigment contaminants
Nickel (20)



FIGURE 11.8 The matte finish eye shadow on the left will cause less irritant contact dermatitis than the frosted shiny finish eye shadow on the right.

Some patients also experience more irritation with darker eye shadow colors, such as deep purple, forest green, or navy blue. Selection of a lighter shade product in peach, pink, or tan may resolve the irritancy.

Patients with sensitive upper eyelid skin should select matte finish eye shadows without shine or iridescence.

Creams, sticks, and pencils may cause irritation as the product is rubbed on the eyelid. The friction from this rubbing may cause tears to develop in the eyelid skin, increasing the probability of irritation. Automatic eye shadows containing volatile vehicles, emulsifiers, and surfactants that may also be irritating. Thus, matte finish, pressed powder eye shadows applied gently with a sponge applicator have the least potential for irritation (24).

Matte finish eye shadows are also recommended for contact lens wearers because the mica, metal powders, or fish scale essence in frosted finish eye shadows may lodge under the contact lens, causing irritation or possibly corneal abrasion. It is advisable to insert the contact lens before application of an appropriate eye shadow and to take the lens out prior to cosmetic removal.

Eyelid cosmetics for acne patients

Cream, stick, and pencil eye shadows do not perform well on acne patients with oily complexions. Because these products are oil-based, the patient's sebum mixes with the eye shadow, encouraging migration into folds. Placing an unpigmented eye shadow setting cream beneath the colored eye shadow may improve wearability slightly, but the oil-based eye shadow product may exacerbate acne or increase follicular irritation. Pressed powder eye shadows are recommended for acne patients because the talc base has oil-control qualities and does not place additional oils on the face. For extended wear, powder eye shadow can be applied with a moistened sponge applicator.

Cream, stick, and pencil eye shadows do not perform well on acne patients with oily complexions.

Eyelid cosmetics for mature patients

Mature patients should select eyelid cosmetics that minimize the appearance of redundant skin on the upper eyelid. Redundant skin encourages migration of cream, stick, and pencil eye shadows into the folds, drawing attention to the creases. Pressed powder eye shadows are recommended, even though patients may think that rich creamy eye shadows aid in moisturizing dry eyelids. Frosted finish and iridescent eye shadows also draw attention to the crepe texture of the redundant skin. Therefore, matte finish or light shine eye shadows are recommended. All eye shadows should be placed over an eye shadow setting cream in mature patients. Mature patients can also extend the wearing time of powder eye shadow by applying it with a moistened sponge applicator.

Mature skin on the upper eyelid may also demonstrate dyspigmentation from lentigines or telangiectasias. Mature patients may be tempted to select vivid, dark eye shadow colors to cover the undesirable eyelid skin color. However, vivid colors draw attention to the upper eyelid and should be avoided in favor of pastels and muted colors (pink, bluish gray, mauve, tan, and peach). Dyspigmentation can be covered by applying a facial foundation to the upper eyelid followed by a pressed powder eye shadow. Applying facial foundation to the upper eyelid also improves the eye shadow wearability.

Dyspigmentation of the upper eyelid in mature patients can be camouflaged by applying a facial foundation to the upper eyelid followed by a pressed powder eye shadow.

Eye cosmetic camouflage techniques

Eye cosmetics can be used to correct the appearance of eye defects arising from surgery, congenital anomalies, or dermatoheliosis. The correction is created by carefully selecting eye shadow colors and placing them appropriately on the eyelids.

The eyes on a well-proportioned face are placed in such a way that the inner canthal distance is equal to the width of one eye (Figure 11.9). If the eyes are closer together, the patient appears hypoteloric; if the eyes are further apart, the patient appears hypertelorlic. Abnormal intercanthal distance is congenital and may or may not be associated with other anomalies. A more pleasing appearance can be imparted to hypoteloric eyes by sweeping deeply colored eye shadow up and out from the center to outer corners of the lid (Figure 11.10A). Hypertelorlic eyes are de-emphasized by placing deeply colored eye shadow from the inner canthus to the central eyelid (Figure 11.10B). The color draws any attention away from the abnormality (25).

The eyes should be placed on the face in a way that the inner canthal distance is equal to the width of one eye.

Deeply colored eye shadows can also be effectively used to correct the size of the eyes. Female patients who have had skin cancer on the eyelid margin may appear to have smaller eyes due to wedge resection. The eyes can be made to appear larger if deeply colored eye shadow is placed along the lateral orbital ridge and eyebrow, with a small amount placed beneath the lateral lower lash line (Figure 11.10C). A light colored eye shadow should be

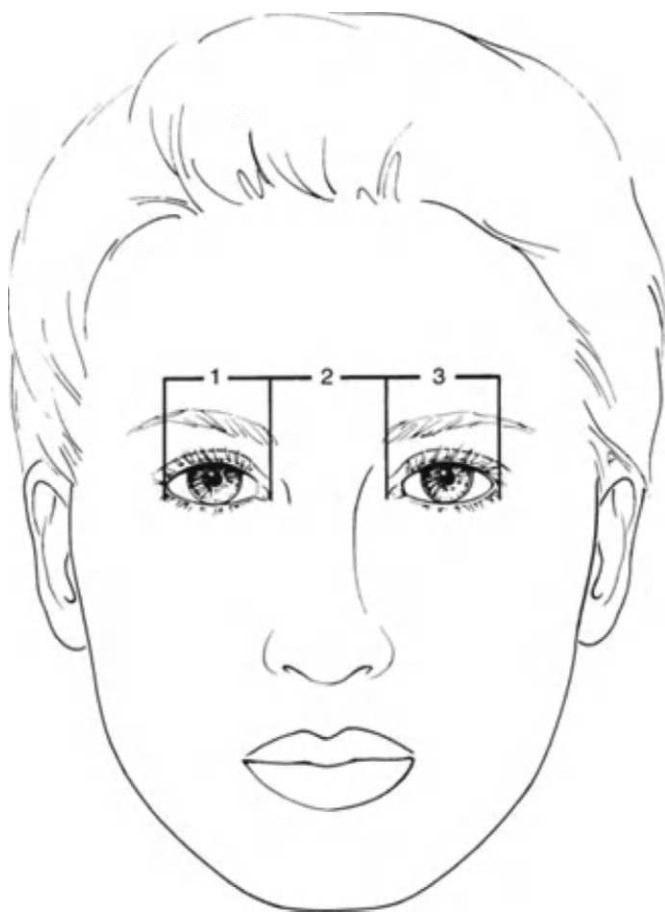


FIGURE 11.9 The intercanthal distance should equal the width of one eye in a well-proportioned face.

placed medially beneath the eyebrow. Large eyes in a female patient with exophthalmos due to hyperthyroidism can be made to appear smaller by applying a dark eye shadow only in the crease and on the lateral eyelid (Figure 11.10D). A light eye shadow is then placed on the medial eyelid (26).

Probably the most common cosmetic eye problem seen in female patients is blepharochalasis, commonly known as drooping or hooded eyelids. A drooping eyelid can be cosmetically corrected by covering the entire eyelid from the lash line to the crease with a light matte finish eye shadow (Figure 11.10E). A complementary matte finish eye shadow two to three shades darker should be applied on the medial and lateral eyelids, leaving the area above the iris in a lighter color. Sometimes unilateral ptosis develops following Bell's palsy or surgery. Normally, the upper eyelid should touch the superior border of the iris and the lower eyelid should touch the inferior border of the iris. More dramatic eye makeup should be applied to the drooping eyelid. Both eyes should be initially colored as illustrated in Figure 11.10E; however, a brown eye shadow crayon should be used on the drooping eyelid to apply a line in the crease and above the lash line (Figure 11.10F).

Unfortunately, none of these suggestions for eye recontouring can restore the eye to its normal appearance. The intention is to provide the physician with some suggestions to share with female patients who are distraught about their appearance following surgery or as a result of the process of aging.

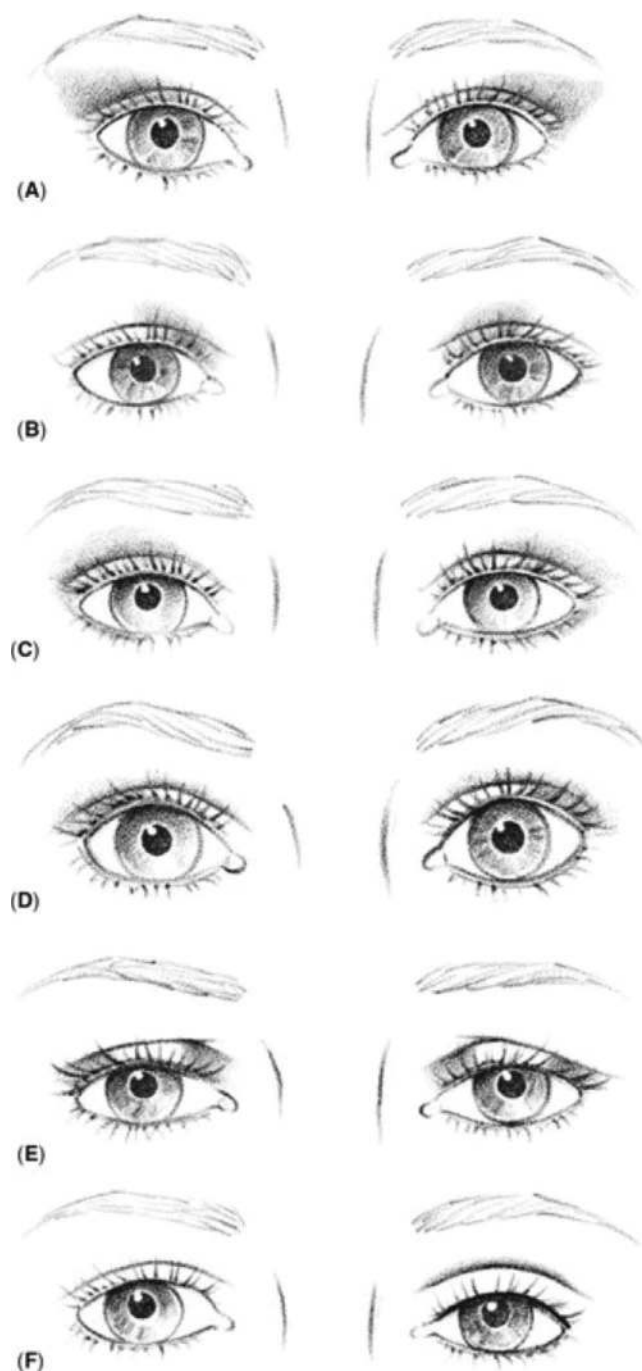


FIGURE 11.10 Contouring of eyes (A) to make hypoteloric eyes appear more widely set, (B) to make hyperteloritic eyes appear more closely set, (C) to enlarge small eyes, (D) to decrease large eyes, (E) to de-emphasize bilateral blepharochalasis, and (F) to de-emphasize unilateral ptosis.

Eyelash cosmetics

Eyelash cosmetics include mascaras, eyeliners, eyelash dyes, and artificial eyelashes (Table 11.4). Our discussion begins with mascara, the most commonly used eyelash cosmetic, whose application dates to biblical times. Its purpose is to darken, thicken, and lengthen the eyelashes. Because the eyelashes form a frame for the eye, luxuriant eyelashes can attract attention to this expressive

TABLE 11.4: Eyelash Cosmetics

Eyelash Cosmetics	Main Ingredients	Function	Adverse Reactions
Cake mascara	Soap and pigments	Darken and thicken eyelashes	Irritation due to soaps
Cream mascara	Vanishing base and pigments	Darken and thicken eyelashes	Irritant contact dermatitis
Water-based liquid mascara	Waxes, pigments, and resins	Darken and thicken eyelashes	Irritant and allergic contact dermatitis
Solvent-based liquid mascara	Petroleum distillates, pigments, and waxes	Darken and thicken eyelashes	Irritant and allergic contact dermatitis
Water/solvent mascara	Water-in-oil or oil-in-water emulsions	Darken and thicken eyelashes	Irritant and allergic contact dermatitis
Cake eyeliner	Talc, pigment, and binders	Define eyelash line	Minimal
Liquid eyeliner	Latex or other polymers and pigments	Define eyelash line	Irritant contact dermatitis
Pencil eyeliner	Waxes and pigment	Define eyelash line	Minimal
Eyeliner tattooing	Tattoo pigments	Permanently define lash line	Minimal
Eyelash dyes	See chart under hair dyes (page)	Darken eyelashes	Irritant and allergic contact dermatitis
Artificial eyelashes	Human or synthetic hair fibers	Thicken eyelashes	Irritant contact dermatitis to lashes, allergic contact dermatitis to glue

facial feature. Most women consider long eyelashes a prerequisite for being attractive.

The original mascara worn by women of many ancient civilizations was kohl, which was based on antimony trisulfide. Mascara was subsequently refined into a cake comprising sodium stearate soap and lampblack. The product was mixed with water and stroked from the cake with a brush and applied to the eyelashes. This formulation produced eye irritation on contact due to sodium stearate. Reformulation with triethanolamine stearate resolved this tendency, and beeswax was subsequently added to allow the product to be somewhat water-resistant (27).

Mascaras must be carefully formulated to allow easy and even application without smudging, irritancy, or toxicity. Coal tar colors are prohibited by the U.S. Food, Drug, and Cosmetic Act for use on the eyelashes. Therefore, mascara colorants must be selected from vegetable colors or inorganic pigments and lakes. Colors employed include iron oxide to produce black, ultramarine blue to create navy, and umber (brown ochre) or burnt sienna (a mixture of hydrated ferric oxide with manganic oxide) or synthetic brown oxide to create brown (28).

Modern liquid mascaras, available in tubes with a multitufted applicator brush, have virtually replaced cake- and cream-type mascaras (Figure 11.11). The applicator is inserted into the tube between uses, providing numerous opportunities to inoculate bacteria into the mascara. The most dangerous of these bacteria is *Pseudomonas aeruginosa*. Even though mascaras contain antibacterials, it is still wise to discard all mascara tubes after three months and not allow multiple persons to use the same mascara tube (29). Persons susceptible to infection, known bacterial carriers, should select solvent-based or disposable mascaras.

It is still wise to discard all mascara tubes after three months and not allow multiple persons to use the same mascara tube to prevent serious eye infections.

Mascaras are available in various formulas to coordinate with current color and fashion styles. The selection of colors is wide, with various shades of blacks and browns most commonly seen, but pinks, greens, yellows, purples, and blues are also available. Even unpigmented mascara is available for those who wish to lengthen but not darken lashes.

Mascara styles, dictated by fashion, are based on the type of applicator brush employed. If thick eyelashes are fashionable, lash-thickening mascaras are used with a larger, longer bristle brush applicator to apply mascara generously. If long eyelashes are fashionable, lash-lengthening mascaras with a short bristle brush are used to apply successive thin mascara coats and increase lash separation (Figure 11.12).

Mascaras are available in several modern formulations: cake, cream, and liquid. Liquid mascaras can be further divided into water-based, solvent-based, and a water/solvent hybrid.



FIGURE 11.11 Mascara is removed from a tube on a tufted applicator to darken the eyelashes.



FIGURE 11.12 Mascara can be stroked over the eyelashes in successive coats to thicken and lengthen the eyelashes.

Cake mascara

Cake mascara consists of soap and pigments compressed into a cake. The cake is stroked with a water-moistened brush and applied to the eyelashes (Figure 11.13). Unfortunately, this form is not water-resistant and smudges with tears, perspiration, or rain. Furthermore, the soaps are somewhat irritating to the eye.

Cake mascaras remained popular until the 1960s, when cream and liquid preparations were introduced, which provided a greater ease of application. Cake mascaras are still available and may be appropriate for patients who have developed eyelid or conjunctival irritation to the newer formulations.

Cream mascara

Cream mascaras, developed after cake mascaras, were quickly becoming popular due to their lesser propensity to run with moisture contact. Additionally, they did not clump or cake as easily on the eyelashes. The product consisted of a pigment suspended in a vanishing cream base that was brushed from a tube onto the eyelashes.

Liquid mascara

Liquid mascara has largely replaced cake and thicker cream mascaras because of the development of the automatic mascara



FIGURE 11.13 Cake mascaras are moistened and then stroked over the eyelashes.

tube. This invention consists of a tube into which a round brush is inserted through a small aperture to remove a metered amount of the product. There are water-based, solvent-based, and hybrid mascaras, which are discussed next.

Water-based mascaras

Water-based mascaras are so named because they are formulated of waxes (beeswax, carnauba wax, and synthetic waxes), in addition to pigments (iron oxides, chrome oxides, ultramarine blue, carmine, and titanium dioxide) and resins dissolved in water. They are classified as oil-in-water emulsions. The water evaporates readily, creating a fast-drying product that thickens and darkens the lashes. The product is water-soluble, allowing for easy removal, but unfortunately smudges with perspiration and tearing. Some water-based mascaras are labeled “water-resistant” if they contain an increased amount of wax or a polymer to improve adherence of pigment to the lashes.

Water-based mascaras are easily contaminated with bacteria, which readily grow in water, and must include preservatives, usually parabens. Thus, these products may potentially cause an allergic reaction in paraben-sensitive individuals; however, water-based mascaras are generally the least sensitizing of the mascara types. Some patients may experience a contact irritation from the emulsifiers required to maintain the pigment in solution.

Water-based mascaras are easily contaminated with bacteria, which readily grow in water, and must include preservatives, usually parabens.

Specialty additives can be incorporated into the formulation to enhance the cosmetic appearance of the lashes. These substances include hydrolyzed animal protein to condition lashes, nylon, or rayon fibers to elongate lashes and polyvinylpyrrolidone resins to decrease smudging.

Solvent-based mascara

Solvent-based mascaras are formulated with petroleum distillates to which pigments (iron oxides, chrome oxides, ultramarine blue, carmine, and titanium dioxide) and waxes (candelilla wax, carnauba wax, ozokerite, and hydrogenated castor oil) are added, thus making them waterproof. As a result, the product performs well with perspiration and tearing, but the removal of which is difficult and requires an oil-based lotion or cream. Deposits may form on the lashes if the product is not removed completely. Care must be taken to avoid smudging the product immediately after application because solvent-based mascaras have a prolonged drying time.

Preservatives are still added, but microbial contamination is not a significant problem because the petroleum-based solvents are antibacterial. Some products also contain talc or kaolin to improve lash thickening and nylon or rayon fibers to lengthen lashes. Solvent-based mascaras can be an eye irritant.

Water/solvent hybrid mascaras

Some mascaras combine both solvent-based and water-based systems to form either a water-in-oil or oil-in-water emulsion. The idea is to create an optimal product that thickens with a short drying time like the water-based mascaras, but provides waterproof lash separation like a solvent-based mascara. The water in the formulation requires incorporation of a good preservative system.

Eyelash cosmetic safety issues

The most feared adverse reaction to mascaras is that of infection, particularly *P. aeruginosa* corneal infections, which can permanently destroy visual acuity (30, 31). *Staphylococcus epidermidis* and *S. aureus* organisms may also proliferate in contaminated mascaras (32). Infections are more common if the globe is traumatized with the infected mascara. As mentioned previously, individuals with recurrent bacterial infections due to colonization should probably select solvent-based mascaras (33).

Fungal organisms can also contaminate mascaras and result in eye infection (34). This is rarer and usually only found in patients who are immunocompromised or wear contact lenses.

The pigment contained within mascaras can result in conjunctival pigmentation if the mascara is washed into the conjunctival sac by lacrimal fluid (35). This colored particulate matter can be observed on the upper margin of the tarsal conjunctiva. Histologically, the pigment is seen within macrophages and extracellularly, with varying degrees of lymphocytic infiltrates. Electron microscopy suggests that ferritin, carbon, and iron oxides are present within the tissues in such cases (36). Unfortunately, there is no treatment for the condition, which fortunately is usually asymptomatic.

The pigment contained within mascaras can result in conjunctival pigmentation if the mascara is washed into the conjunctival sac by lacrimal fluid.

Allergic contact dermatitis has been reported to rosin (colophony) (37) and dihydroabietyl alcohol (Abitol, Eastman Chemical Company) (38, 39), which are contained in some mascaras. However, waterproof eye cosmetic removal products for removal of solvent-based mascaras can also be a source of eyelid dermatitis (4). Mascaras can be open or closed patch tested “as is,” but should be allowed to thoroughly dry prior to closed patch testing to avoid an irritant reaction from the volatile vehicle.

Eyeliner

Eyeliner defines the margins of the eye. It is placed immediately outside and sometimes inside the lash line. The color and placement of eyeliner are dictated by fashion. In the 1960s, a well-defined, thin black line drawn outside the upper and lower lash line was considered appropriate; however, the 1980s look was to use a subdued gray or deep blue smudged thick line outside the lower lash line only. The look of the 1990s was a thick, sharp black line surrounding the entire eye with extension beyond the lateral canthus, a look sometimes termed “cat eye.”

Eyeliner defines the margins of the eye and can be placed outside or inside the lash line.

Eyeliner is available in cake, liquid, and pencil forms. Cake eyeliner has the same composition as eye shadow, except for the addition of surfactants promoting formation of a paste when the powder is mixed with water. Cake eyeliner has largely been replaced by liquid eyeliner, which contains the same pigments



FIGURE 11.14 Pencil eyeliners are rubbed on the eyelash line and leave behind a wax pigmented film.

premixed in a water-soluble latex base. Latex-based liquid eyeliners contain water, cellulose gum, thickeners (magnesium aluminum silicate), and styrene-butadiene latex. These products are packaged as marking pens or in the same form as mascaras, with a cylindrical tube and unitufted applicator brush. Automatic eyeliners are based on polymers, such as an ammonium acrylate copolymer, which leave a pigmented film after drying (40).

Pencil-type eyeliners are popular due to their application ease (Figure 11.14). Automatic liquid eyeliners create a defined line that requires a steady artistic hand for application, but pencil eyeliners give a smudged look and require less application skill. Pencil eyeliners contain natural and synthetic waxes combined with pigments, mineral or vegetable oils, and lanolin derivatives that are extruded into rods and encased in wood. The pencil is then sharpened to the desired tip, which can be thin or broad depending on the patient's preference. Frequent sharpening also removes the exposed part of the eyeliner, thus decreasing contamination.

The application method used for eyeliners depends largely on fashion. The cake, liquid, or pencil is stroked across the upper or lower eyelid in the amount and position desired (Figure 11.15).

Eyeliners are subject to the same bacterial and fungal contamination seen with mascaras, especially if the liquid form



FIGURE 11.15 Liquid eyeliners are frequently stroked outside the eyelash line and leave behind a pigmented polymer film.

is chosen. But the main adverse reaction is the possibility of conjunctival pigmentation, also seen with mascaras (41). This problem is more commonly associated with eyeliner when it is applied within the lower lid margin. Usually, blue eyeliner is used in this location to create the appearance of a whiter sclera. This practice is unsafe.

Open and closed patch testing can be performed “as is,” but liquid eyeliner should be allowed to dry prior to occlusion.

Eyeliner tattooing

Eyeliner tattooing, practiced by ophthalmologists, dermatologists, plastic surgeons, and some beauty operators, involves the intradermal insertion of black pigment, or other colored pigments such as brown or navy blue, on or outside the upper and lower eyelash line. The pigment is inserted into the upper dermis at a constant depth by punctures created with a specially designed needle. The black, brown, green, or navy-blue pigments are of low allergenic potential, accounting for the rare incidence of side effects.

Permanent eyeliner is a black tattoo artistically placed to highlight the eyelash margin.

Eyeliner tattooing has gained popularity among entertainment personalities, both male and female; however, a permanent eyeliner does not allow the fashion versatility that the average patient desires. Patients with permanent eyelash loss may wish to consider eyeliner tattooing, which can be applied as outlined under corrective eyelash cosmetics. Tattooing should be done in a thin line so that the patient can apply a colored eyeliner pencil, if desired, to conform to fashion trends.

Patients who elect for eyeliner tattooing should recognize that the color will fade with time and some migration of the pigment is possible. The decision should be considered carefully before tattooing because the pigment is exceedingly difficult to remove once inserted into the dermis.

Eyelash dyes

Eyelash dyes are used by those persons who have light-colored eyelashes due to canities, natural hair color, or dermatoses such as vitiligo. No over-the-counter eyelash dyes are available, due to the risk of eye damage. The US Food and Drug Administration (FDA) is currently attempting to outlaw the use of eyelash dyes. Some dyeing products are imported illegally from Europe, and other salons use products intended for scalp hair on the eyelashes. Products used by professional cosmetologists may contain either para-phenylenediamine dyes or metallic dyes. A further discussion of these products is included in the chapter on hair coloring.

Eyelash dyes are not available for home use.

Eyelash dyes should not be used more than every three weeks because they are extremely irritating to the eye and can cause an irritant or allergic contact dermatitis. They are patch tested in the same manner as hair dyes.

Light-colored eyelashes can be darkened nicely by a repeated application of black or brown waterproof mascara containing talc or kaolin for lash thickening.

Artificial eyelashes

Artificial eyelashes are popular among those in the entertainment industry and consumers. They can be effectively used by patients who have thin or absent eyelashes. Human hair and synthetic nylon lashes are available in varying colors and lengths, with costs ranging from \$1 to \$20 (Figure 11.16). The lashes are attached to existing lashes on the upper or lower eyelids with a clear or pigmented methacrylate-based glue.

Artificial eyelashes are available as singlets, demilashes, and complete eyelash—es to camouflage eyelash loss.

Artificial eyelashes are available in several forms outlined below:

1. Individuals

Individual eyelashes, also known as singlets, are groups of 4–6 hairs that are glued to the base of the natural eyelashes. They are especially useful for areas of thin or lacking lashes, where a few additional hairs can be glued to the base of bordering hairs. These individual eyelashes can also be glued to the natural eyelashes at the lateral eye to make a hypoteloric face more attractive, or used effectively at the lateral upper lash line to minimize the appearance of overhanging eyelids. They are challenging to apply and many choose to have this procedure done professionally.

2. Clusters

Cluster false eyelashes, also known as flares or accents, are tiny strips of hairs that are glued to the upper eyelid. They are commonly used in the corner of the eye for emphasis. These lashes can be dramatically long or pigmented in various natural and unnatural colors.

3. Strips

Strip false eyelashes are synthetic hairs attached to a band that is then glued to the upper eyelid. The band can be black to mimic eyeliner or clear. Strips create an entire upper eyelid number



FIGURE 11.16 Complete eyelashes to be glued just above natural eyelashes to add lash fullness and length.

of eyelashes and can be varied in length to create different eye appearances. For example, mature hooded eyes can be improved by wearing strip eyelashes that are longer in the center than at the sides. This keeps the eyelash length appearance consistent over the entire upper eyelid. Artificial eyelashes can be easily trimmed and customized with scissors to fit the length of any eye.

4. Magnetic

Magnetic false eyelashes are a relatively new technology that eliminates the use of glue to affix the hairs. Eyelash glue damages the natural eyelashes over time, perpetuating the need to wear more dramatic false eyelashes using increasing amounts of adhesive. Magnetic false eyelashes come in a set of two. One eyelash band with micromagnets goes on top of the natural eyelashes, and the second band with micromagnets goes under the natural eyelashes. This sandwiches the natural eyelashes between two magnets. The magnets can be rubbed side to side to release the hold. Pulling straight will depilate natural eyelash hairs before the magnets release.

5. Fantasy

Fantasy eyelashes are theatrical displays of brightly colored synthetic hairs or feathers that are glued to the upper eyelid margin. They are used for adornment purposes.

Artificial eyelashes may be difficult to wear because the eyelashes themselves can irritate the eye, tarsal plate, and eyelid. Both irritant and allergic contact dermatitis can develop in response to the attachment glue and removal solvent. The most adherent eyelash glues are methacrylate-based, which is a known sensitizer.

Eyelash permanent waving

Lash permanent waving, also known as lash perming, utilizes the same techniques as hair permanent waving to reshape the eyelashes so they stick out from the eye in an acute angle, rather than gently curling. The technique increases the apparent length of the natural eyelash by changing the shape of the hair. This procedure is performed in a salon with the client lying down with a silicone pad affixed to the upper eyelid. The pad serves as a form to reshape the eyelash hairs after the perming lotion is applied. The perming lotion applied for 10 minutes breaks the eyelash disulfide bonds and allows the eyelash hair to assume the shape of the silicone pad. The setting lotion applied for 10 minutes reforms the disulfide bonds in their new configuration. A conditioner is then applied to the eyelash hairs much like a standard hair conditioner to smooth the disrupted cuticle. The lashes must be kept dry and mascara-free for 24 hours and the clients are advised to sleep on their back not to crush the freshly permed eyelashes. The perm costs about \$150 and lasts around 8 weeks.

Eyelash cosmetics for special needs

Certain patients within a physician's practice may require careful selection of eyelash cosmetics. These are patients with allergies, contact lenses, and patients undergoing treatment for acne. Mature patients may require special eyelash cosmetic consultation to achieve an optimal appearance.

Eyelash cosmetics for sensitive patients and contact lens wearers

Eyelash cosmetics are commonly a source of irritant or allergic contact dermatitis. Most cases represent irritant dermatitis because the FDA closely regulates the chemicals, preservatives,

and pigments used in eyelash cosmetics. Many sensitive skin patients find mascaras extremely irritating to their eyes and should be advised to wear a product specifically designed for allergic patients or a water-based mascara. Unpigmented mascaras seem to cause less irritation in some patients.

Application techniques can also minimize problems. Mascara can be applied in several coats only to the eyelash tips. This emphasizes the lashes while limiting mascara contact with the eye and skin. All waterproof mascaras should be avoided because the removal solvent and the rubbing required to remove the mascara may produce irritation. Artificial eyelashes and eyelash dyeing should also be avoided.

Pencil-type eyeliners are better tolerated by some sensitive skin patients, but the eyeliner should never be placed inside the lower lid margin where it will be removed by tearing and washed into the eye. This is not advisable because the pigment may tattoo the conjunctiva and possibly the lower palpebral sac.

Some contact lens wearers are bothered by mascaras that cake on the lashes and flake into the eye. Water-based mascaras are more likely to cake than solvent-based mascaras. Patients wearing soft contact lenses, with a high water content, may prefer waterproof solvent-based mascaras because these are less likely to bind to the lens. The pigment in mascaras and eyeliners can actually stain water- and gas-permeable contact lenses.

Eyelash cosmetics for acne and oily-complected patients

Many dermatologists recommend water-based cosmetics for their acne patients as a general rule, including water-based mascaras. Acne patients who have oily complexions may find that water-based mascaras become easily wet by sebum, causing running and smudging. Solvent-based mascaras should be recommended for oily-complected patients. The solvent-based mascaras can smudge if not adequately allowed to dry between coats but, once dry, they are resistant to smudging.

Patients with oily complexions may also notice that pencil-type eyeliners wear poorly and smudge. This is due to poor adhesion between the cosmetic and skin caused by sebum. The pencil-type eyeliner will wear longer if a foundation covered by a loose powder is placed on the eyelid prior to eyeliner application. A polymer eyeliner could also be selected as an alternative.

Eyelash cosmetics for mature patients

Eyelash cosmetics are important in the mature patient. Mascara can darken lashes lightened by canities and should be applied from the base of the lash to the tips in long strokes to cover the lashes completely with pigment. However, black mascara should be avoided in patients with recessed eyes because it will only darken the already shadowed eyes. Brown or navy-blue mascara is more appropriate.

Eyelash length and thickness decrease in mature patients and can be camouflaged with mascara.

Eyelash length and thickness also tend to decrease in the mature patient. Eyelash length can be maximized by using a lengthening mascara that contains nylon or rayon fibers. Each successive coat should dry completely to maximize lash length. Thickening mascaras containing talc or kaolin can increase lash size with repeated applications to the tips only.

The appearance of blepharochalasis can be minimized by lengthening the eyelashes because some eyelash length is covered by redundant skin. An appearance of lengthened eyelashes can be created by curling the eyelashes with an eyelash curler immediately after mascara application. The eyelashes are placed in a rubber padded holder that bends them upward at a more acute angle. This decreases the natural curl of the eyelashes, making them appear longer, but can also promote eyelash breakage. Demilashes, slightly longer than the patient's natural lashes, can also be used to create the appearance of longer eyelashes.

Corrective eyelash cosmetics

Eyelashes function cosmetically as a frame for the eye. Unfortunately, they may thin due to age, alopecia areata or eyelid scarring secondary to surgery or infections such as herpes zoster. Thinned or absent eyelashes result in nondescript eyes and loss of the main focal point for the face.

Eyeliner, mascara, and loose transparent face powder can be used to cosmetically compensate for thinned eyelashes. The first step is to use a liquid eyeliner to dot the upper and lower eyelid (Figure 11.17A), creating the illusion of eyelashes. A light application of dark brown or black fibered mascara should then be applied to the remaining lashes. A powder brush is then dipped in loose powder and dusted on the wet mascara with the eye closed to prevent powder from entering the eye. Another layer of mascara is then applied, and the process is repeated until the remaining lashes have been thickened to the desired degree. This technique is useful only in patients who have generalized eyelash thinning or focal areas of complete loss.

It is more difficult to reconstruct the lash line in patients who have large areas of eyelash loss or total eyelash loss. In these

female patients, a brown or black liquid or pencil eyeliner should be used to rim the entire eye, except for one-quarter inch around the inner canthus on the upper and lower eyelids (Figure 11.17). On the normal eye, terminal hairs do not grow around the inner canthus. For female patients with more extensive loss, artificial demilashes can be applied at this point or, in patients with total eyelash loss, complete artificial eyelashes can be applied.

Eyeliner can also be used to contour the eyes while simultaneously reconstructing a lash line. Small eyes can be enlarged by lining the entire upper lash line and the lateral half of the lower lash line (Figure 11.17C). Hypoteloric eyes can be widened by lining the lateral half of both the upper and lower lash lines (Figure 11.17D).

Eyebrow cosmetics

The accepted shape and width of the eyebrows are subject to fashion trends. Eyebrows were almost completely plucked in the 1950s, with a thin pencil line drawn to connect the few remaining hairs. Unfortunately, many women who are now in their 60s and 70s can no longer grow eyebrow hairs as a result of overplucking during their younger years. This is in direct contrast to the eyebrow look of the 1960s, which was totally natural and ungroomed. The 1990s compromised with thick eyebrows considered attractive, but stray hairs beneath the brow line are plucked to give a groomed appearance. The 2000s still found thick eyebrows desirable, however the widespread acceptance of eyebrow tattooing popularized microblading, a technique discussed later in this chapter.

There are several eyebrow cosmetics: pencils, sealers, dyes, and artificial eyebrows (Table 11.5).

Eyebrow pencil

Eyebrow pencils are used to darken light or gray eyebrows, fill in sparse or absent eyebrow hairs, and reconstruct malformed or misshapen eyebrows. Eyebrow pencils are formed by mixing pigments, petrolatum, lanolin, and synthetic or natural waxes (Figure 11.18). This formulation is similar to that of lipstick products, but differs in one aspect that higher melting point waxes are used to yield a firmer product. Formulations may be encased in wood to form a pencil, or extruded into rods placed in a plastic holder.

Pencils are available in various colors, from grays to browns to blacks. Inert, mainly inorganic, pigments are used because the Federal Food, Drug and Cosmetic Act prohibits the use of coal tar colors in the eye area. They are stroked over the skin in the eyebrow region to actually color the skin and eyebrow hairs (42).

Contact dermatitis to eyebrow pencils is rare. The product can be open or closed patch tested "as is."

Eyebrow sealer

Eyebrow sealers are intended as a grooming agent for unruly eyebrows and a glossing agent to add shine to eyebrow hairs. Originally, white petroleum jelly was used for this purpose, but now cosmetic companies market a more elegant product. The sealer is essentially a liquid hair spray containing polymer-holding agents packaged in a mascara-type tube. A brush is used to stroke the product over the eyebrow hairs (see Figure 11.18).

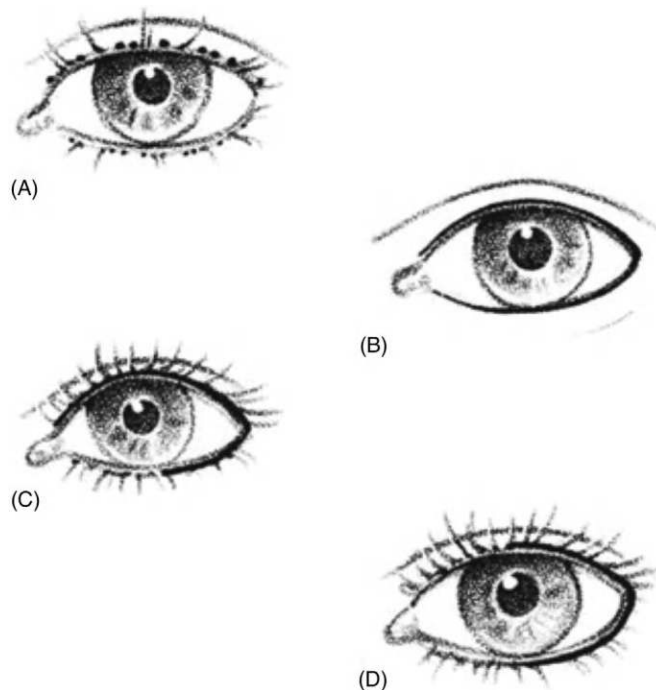


FIGURE 11.17 Eye lining techniques to (A) reconstruct thinned or partially absent eyelashes, (B) reconstruct eyelashes that are completely absent, (C) enlarge small eyes, and (D) widen hypoteloric eyes.

Eyebrow sealers can be used to groom unruly eyebrows in mature individuals.

TABLE 11.5: Eyebrow Cosmetics

Eyebrow Cosmetic	Main Ingredients	Function	Adverse Reactions
Eyebrow pencil	Pigment, wax, petrolatum, lanolin	Darken and thicken eyebrows	Minimal
Eyebrow sealer	Synthetic polymer	Eyebrow hair grooming agent	Minimal
Eyebrow dye	Metallic dyes, stains, or permanent dyes	Darken eyebrow hairs	May be illegal, blindness, contact dermatitis
Artificial eyebrows	Human, synthetic, or wool hair	Replace missing eyebrow hair	Irritant contact dermatitis to hair, allergic contact dermatitis to adhesive
Eyebrow tattooing	Tattoo pigments	Replace missing eyebrows	Allergic contact dermatitis to tattoo pigment

Eyebrow sealers can be used by persons with bushy eyebrows to hold the hairs closer to the orbital ridge, or by those with multidirectional eyebrow hairs who wish to hold the hairs in a more cosmetically acceptable line. The sealer can also be pigmented to darken graying eyebrows. The product is easily removed with soap and water.

Eyebrow sealers could be a source of irritant contact dermatitis due to the incorporation of volatile vehicles. The product can be patch tested “as is,” but should thoroughly dry prior to occlusion.

Eyebrow dye

Eyebrow hair can be dyed in the same manner as scalp hair. This service is offered by many professional salons; however, hair dye packaging specifically states the dyestuff is not to be used in the eye area and contains the following warning: “Caution: This product contains ingredients which may cause skin irritation on certain individuals and a preliminary test according to accompanying directions should first be made. This product must not be used for dyeing the eyelashes or eyebrows; to do so may cause blindness.” The US FDA has engaged unsuccessfully in several lawsuits to remove eye area dyes from the market (43).

Eyebrow dyes in some salons are of the metallic type, stains, or permanent hair dyes. The metallic dyes, containing lead or silver, are applied over a period of weeks and cause gradual darkening of the hairs due to the formation of metallic oxides and sulfides on the hair shaft, imparting a yellow brown to black color. Some salons use professional stains that are specifically

manufactured for eyebrow dyeing. The stain is applied with a toothpick only to the eyebrow hairs because skin contact will result in staining. A special product is used to remove the stain from the skin. Other salons use the same dye that is applied to the scalp for dyeing the eyebrows, taking care to keep material from entering the eye.

The US FDA considers eyebrow dye products illegal.

It should be re-emphasized that the US FDA considers all eyebrow dyeing products that have been previously discussed dangerous and illegal.

Artificial eyebrows

Artificial eyebrows are available for individuals who have permanently lost a substantial amount of their natural eyebrow hair. Synthetic or natural human hair can be knotted onto a thin netting in the appropriate amount and shape for a patient’s face. The netting is then glued on the superior orbital ridge with a waterproof adhesive. Salons specializing in hair replacement can provide patient assistance.

The use of crepe hair is an eyebrow replacement technique, adapted from the theater, which is more appropriate for the patient who has temporarily lost substantial eyebrow hair (44). Crepe hair is made from wool and available as braids in a variety of colors. The braided fibers are separated, straightened, and cut to the desired length. Adhesive is then used to glue the fibers directly to the skin. New fibers must be prepared and glued for each application.

Possible adverse reactions include irritant contact dermatitis to the eyebrow prosthesis and allergic contact dermatitis to the adhesive, which may contain methacrylate.

Eyebrow tattooing and microblading

Eyebrows can be reconstructed or thickened with the use of a tattoo pigment. Brown, black, gray, yellow, or orange pigments can be blended and placed within the superficial dermis to add color to the eyebrow area. Certainly, this must be done by a trained individual under hygienic conditions. Unfortunately, eyebrow tattooing is less than optimal because the overlying skin has a rather unnatural, shiny appearance. Allergic contact dermatitis is possible to some pigments.

A specialized technique for eyebrow tattooing is known as microblading which has become very popular for females with thinning eyebrows. Microblading is basically a superficial eyebrow area tattoo. The tattoo ink color is selected and blended to match the woman’s hair, and then small cuts are made in the eyebrow area to mimic hairs. The pigment is pushed into the cuts to create a semipermanent tattoo.



FIGURE 11.18 The upper tufted brush contains a pigmented eyebrow sealer to groom and darken the eyebrows. The lower stick is an eyebrow pencil dispensed from a plastic tube and stroked across the eyebrow to darken and thicken the brow appearance.

Microblading is designed to last 1–3 years, but most women require an annual touch-up. Some of the microblading ink is removed with scabbing that follows the procedure, which may necessitate a touch-up shortly after the initial procedure. With time, additional tattoo ink will become phagocytized by white blood cells and transported to lymph nodes accounting for pigment fading.

It is critical that no water contact the freshly microbladed area for 1 week. This is because washing and water can remove the pigment that was superficially deposited in the skin until healing occurs. Once the skin has healed, the pigment is trapped in the skin. Avoiding water contact includes not only washing, but also sweating and swimming.

Microblading has largely replaced eyebrow tattooing because the small cuts resemble hairs better than a solid tattooed line. Microblading is also not permanent, allowing for changes in the eyebrow architecture with aging. Loss of subcutaneous fat on the forehead results in lowering of the eyebrows and loss of the natural eyebrow arch. Semipermanent microblading allows for the adjustment of eyebrow contour with aging. Many postmenopausal women notice loss of the lateral third of the eyebrow with estrogen deficiency. This loss removes the very feminine eyebrow curve, creating a more flattened eyebrow appearance characteristic of male facial architecture. Microblading can artistically re-create the lateral eyebrow in the hands of an excellent technician.

The greatest challenge to microblading is finding a skilled technician who has the same vision of the patient's eyebrows as the patient. It is recommended patients take a younger picture of themselves to the salon to show the technician how to recreate the desired eyebrow. It is best to recreate the youthful eyebrow of the patient rather than to try to create eyebrows randomly selected by the patient from a magazine picture. Even though microblading is not permanent, the patient will be saddled with a poor result for at least a year. Asking around about the experiences of friends and getting recommendations from others who have undergone the procedure is the best way to insure an attractive result. Microblading costs between \$500 and \$1200, depending on the location and reputation of the salon.

Corrective eyebrow cosmetics

The structure of the eyebrows can be abnormal due to congenital deformity, surgical procedures, or acquired loss from alopecia universalis, hypothyroidism, leprosy, traumatic scarring, and other conditions. Before cosmetic reconstruction can begin, it is important to identify the proper location of the eyebrow on the face (Figure 11.19). The medial aspect of the eyebrow should begin at a point defined by a straight line drawn from the lateral nose upward. The eyebrow should maximally arch at a point defined by a line drawn from the lateral nose through the pupil. The eyebrow should end at a point defined by a line drawn from the lateral nose through the lateral aspect of the eyeball. Any hair removal to improve eyebrow appearance should be from the inferior aspect of the eyebrow. Hairs should never be removed from the superior border; this will disturb the natural eyebrow contour.

Improper placement of the eyebrows can alter facial expression and the appearance of the eyes.

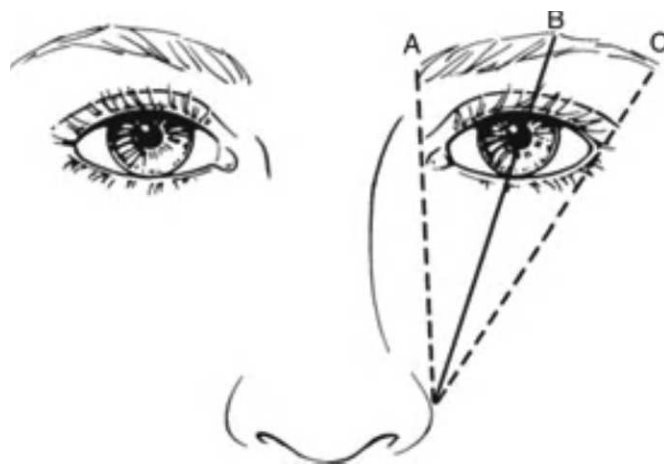


FIGURE 11.19 A well-proportioned eyebrow should begin at point A, maximally arch at point B, and end at point C.

Improper placement of the eyebrows can alter the facial expression and the appearance of the eyes, whereas normal placement gives an aesthetically pleasing appearance (Figure 11.20A). Eyebrows that are placed too far apart give the impression of surprise and can make the patient appear hypertelorism (Figure 11.20B), whereas eyebrows that are too close together give an angry, intense look and impart hypotelorism (Figure 11.20C). If the eyes are improperly placed on the face, these concepts can be used to alter eyebrow position to create the illusion of properly spaced eyes.

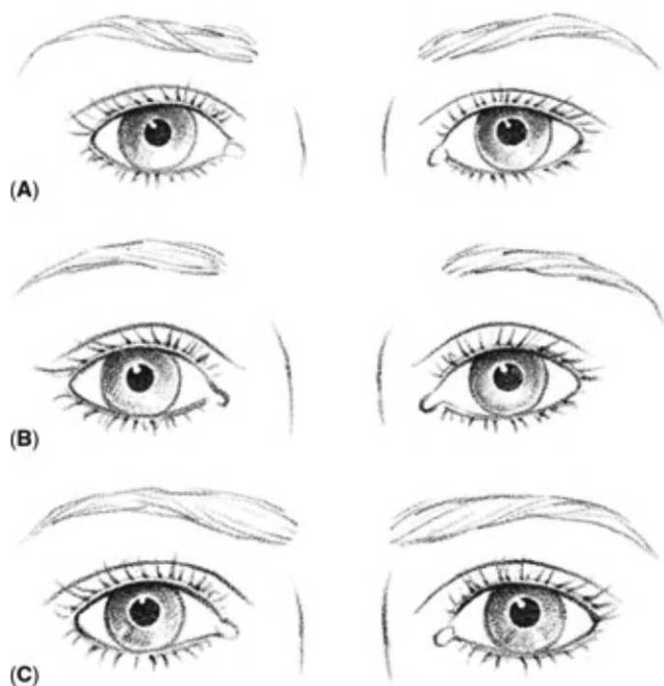


FIGURE 11.20 The intercanthal distance is the same in (A), (B), and (C); however, the distance between the medial eyebrows has been changed. Note the resultant illusion of hypertelorism in (B) and hypotelorism in (C).

Eye eyebrow pencil can be used to camouflage thinning eyebrows. An eyebrow pencil or a crayon can be used to draw absent hairs (Figure 11.21). A more natural appearance is created if the pencil is used in short strokes rather than to draw one straight line (45). The eyebrow pencil will adhere better if the skin is first covered with a facial foundation. A brush can also be used to push the eyebrows into place to cover areas of thinning or loss (Figure 11.22).



FIGURE 11.21 An eyebrow crayon can be used to draw in absent hairs, shown at the bottom of the image, with further darkening provided with pigment on a tufted brush, shown in the upper image.



FIGURE 11.22 An eyebrow brush and comb can be used to groom thinning or absent eyebrows.

Summary

Eye cosmetics can be used to both adorn and camouflage. They can minimize the appearance of eyelash loss seen in several dermatologic conditions while also serving as a source of contact dermatitis and infection. This chapter has presented the formulation of eye cosmetics for the lid and eyelashes to help the dermatologist understand the important considerations for this class of popular cosmetics.

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12

POSTSURGICAL COSMETICS

Postsurgical cosmetics are important in dermatology to aid the patient in proper wound healing while attending to the appearance and emotional needs of the patient. Cosmetics assume medical importance when used in the postsurgical patient to facilitate return to normal daily activities and improve emotional well-being (1, 2). This chapter discusses the proper use and selection of cosmetics and skin care products in the postsurgical period.

Cosmetic selection criteria in the postsurgical patient depend upon the type of wound created. Incisional wounds, closed by sutures, expose only a small amount of unhealed skin to topical cosmetics, whereas large-surface-area wounds, such as those created by shave excisions, dermabrasions, and chemical peels, are allowed to heal by secondary intention, exposing large unhealed skin areas to topical cosmetics.

Wound healing and cosmetics

Wounds created in dermatology heal by both primary and secondary intention. Incisional wounds, closed by sutures that remain in place for 5–14 days, heal by primary intention and require a clean surgical site free of foreign bodies. Therefore, cosmetics should not be applied to the wound until the sutures are removed. Facial foundations should be avoided over sutured areas because they contain finely ground titanium dioxide particles that could act as foreign bodies and impede wound healing through the initiation of an inflammatory response or by inciting milia formation. Facial foundation pigments, such as iron oxide, can also become imbedded in the dermis during healing, resulting in permanent tattooing of the skin. Once the sutures have been removed, the skin barrier has returned, and cosmetics of all types can be safely used.

Large-surface-area wounds healing by secondary intention are devoid of the protective stratum corneum, making post-surgical cosmetic selection important. No cosmetics should be applied to the wound until serous drainage has stopped (Figure 12.1). This is generally not a problem for patients because cosmetics will not adhere to the skin until an epithelial barrier has been reestablished. Premature application of cosmetics can create the same foreign body problem and pigment tattoos discussed under incisional wounds. Individuals who attempt to apply facial foundation too soon following chemical peeling or dermabrasion may also encourage milia formation, a common side effect of both procedures. However, bland moisturizers to impede transepidermal water loss, such as purified petroleum jelly, are recommended until re-epithelialization has occurred.

Cosmetics should not be worn over an incision until the sutures have been removed.

Color cosmetic selection

Following re-epithelialization or suture removal, the patient may wish to use color cosmetics to camouflage the postsurgical erythema. The application of color cosmetics to the face is important

for the patient to re-establish social and emotional well-being following surgery. New cosmetics may need to be selected on a temporary or permanent basis following surgery.

Facial foundations

Facial foundation is the most important cosmetic used in the postsurgical patient. It can camouflage redness and scarring while providing photoprotection (3). The foundation selected should be easily applied and removed while containing few ingredients. Cream or cream/powder formulations are recommended. Cream foundations are dipped from a jar or squeezed from a tube, whereas cream/powder foundations are wiped from a compact with a dry sponge (powder) or a moistened sponge (cream) (4). These foundations are more difficult to bacterially contaminate than liquid foundations due to their low water content. The cream also provides a good barrier to transepidermal water loss and smooths easily around any remaining desquamating stratum corneum (Figure 12.2). They cause less stinging and burning as compared with liquid varieties. A loose powder can be applied over the facial foundation to



FIGURE 12.1 Pigmented facial foundations should be avoided until re-epithelialization has occurred.



FIGURE 12.2 Higher-coverage facial foundations are useful for camouflaging in postsurgical patients while waiting for the erythema to resolve, especially in post–laser resurfacing patients.

improve coverage and impart better rub-resistant characteristics (Figure 12.3).

Cream or cream/powder foundations are the best choice in the postsurgical period.



FIGURE 12.3 A loose powder over a cream or liquid foundation can improve rub-resistant characteristics.

In addition, the patient may need to alter facial foundation color selection in the immediate postoperative period. The color of the foundation may need to contain more reddish hues. Most patients can return to their pre-surgery foundation formulation four to six weeks postoperatively.

Undercover foundations

Some patients with pronounced, long-lasting redness or bruising following surgery may wish to use a product known as an undercover foundation or a color corrector foundation. These products are designed to mask undesirable tones present in the skin using a complementary color combination rather than a heavy-coverage, surgical facial foundation (5). Coverage refers to the ability of the facial foundation to obscure the view of the underlying skin and is related to the opaqueness of the cosmetic. Use of color correctors allows the patient to wear a moderate-coverage foundation, which appears more natural and may be more acceptable to the patient. For example, redness of the face common after dermabrasion, chemical peeling, and laser resurfacing procedures can be minimized with a green color corrector. Green is the complementary color to red, and the combination of both colors yields brown. A green cream or liquid cosmetic applied over a red scar allows camouflaging with a facial foundation that is less opaque and provides less coverage. Less opaque facial foundations appear more natural and are easier to apply and wear.

Green color correctors are the complementary color to red and may assist in camouflaging red scars.

Color correctors are available in other colors besides green for camouflaging other unwanted skin colors. For example, yellow facial tones can be masked by the complementary color purple. When mixed, yellow and purple yield brown. The sallowness of photoaging or the yellow hemosiderin deposits of bruising can be masked by applying a purple cream or liquid color corrector. Conversely, purple bruising commonly seen after facial surgery can be camouflaged with a yellow color corrector (6). Standard brown concealers can also be used (Figure 12.4).



FIGURE 12.4 An example of a liquid brown concealer with an automatic applicator brush that can be dabbed over healing surgical scars.



FIGURE 12.5 A blush can help redefine the cheeks after applying a full-coverage, more opaque facial foundation in postsurgical patients.

Purple is the complementary color to yellow, and purple color correctors can be used to camouflage the final yellow stage of ecchymosis resolution.

Powders and blushes

Facial powders and blushes are applied alone or on top of a facial foundation. Generally, their use should not be resumed until the face has healed to the point where facial foundations can be worn, as discussed previously. Powders without ground particulate matter, such as nutshells or mica, should be selected to avoid damaging the follicular ostia, which can lead to milia and closed comedone formation. Thus, powders with a dull or matte finish are preferred (Figure 12.5).

Matte finish powders and blushes without iridescent particles are the best choice after surgery.

Facial blushes are colored powders designed to add color to the cheeks and face. These products are extremely useful in postsurgical patients to accomplish the following:

1. Restore facial landmarks, such as cheekbones, in patients who are wearing a high-coverage foundation.
2. Camouflage facial redness by applying the blush to the upper cheeks, central forehead, nasal tip, and central chin.
3. Add color to impart the appearance of health.

As with facial powders, blushes should be selected with a matte finish, meaning a dull finish, to avoid the light reflective particulate matter. The particulates can cause itching in an unhealed or early healed surgical wound.

Eye cosmetics

Most patients can resume wearing selected eye cosmetics immediately following surgery, unless the surgery involves the eye area (e.g., eyelid tumor, blepharoplasty, eyelid resurfacing). Mascara applied to darken, lengthen, and thicken the eyelashes may be immediately resumed. However, water-soluble varieties are recommended because the solvents required to remove waterproof varieties may cause stinging. Water-soluble eyeliners may also be resumed to highlight and cosmetically enlarge the eye. Eye shadows, on the other hand, represent a pigmented powder cosmetic and should not be worn until facial foundation use is resumed.

Water-removable mascara and eyeliner should be used in the postsurgical period.

Lip cosmetics

Lip cosmetics may also be resumed immediately following surgery, unless the surgical site involves the lips (e.g., lip tumor removal, lip advancement flap, upper lip dermabrasion). Lip cosmetics are highly recommended as they represent a quick way to add color to the face and restore an acceptable cosmetic appearance.

All cosmetics should be removed from the face before bed.

Removal of cosmetics

Postsurgical patients should wear cosmetics only when necessary and thoroughly remove them as soon as possible. They should remove all cosmetics before going to bed. Ideally, the cosmetic should be removed with mild soap and water, unless waterproof camouflaging foundations requiring a special removal product are used. Waterproof cosmetics should be avoided until healing is complete because the solvents required for their removal can sting and burn. With new rub-resistant polymer-based mascaras and eyeliners, it is no longer necessary to use waterproof cosmetics. Removal of the cosmetics is necessary to prevent infection and other complications in the postsurgical period.

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13

FACIAL ADORNMENT

Facial adornment is the use of colored facial cosmetics to improve appearance. These cosmetics serve little use for functional purpose, but can de-emphasize facial defects and accentuate attractive facial features. The basic facial cosmetics for adornment are powders, blushes, bronzing gels, cover sticks, and undercover creams.

Facial powders

Facial powders provide coverage of complexion imperfections, oil control, a matte finish, and tactile smoothness to the skin. Originally, facial powder was applied over a moisturizer to function as a type of powder foundation. Liquid foundations have largely replaced powder foundations, but for patients who wish for sheer coverage with excellent oil control, a powder foundation performs excellently. An appropriate moisturizer for the patient's skin type is first applied and allowed to set or dry, followed by application of a full-coverage, translucent powder.

Facial powders provide coverage of complexion imperfections, oil control, a matte finish, and tactile smoothness to the skin.

Full coverage powders contain predominantly talc, also known as hydrated magnesium silicate, and increased amounts of covering pigments. The covering pigments used in face powder are listed in order of increasing opaqueness: titanium dioxide, kaolin, magnesium carbonate, magnesium stearate, zinc stearate, prepared chalk, zinc oxide, rice starch, precipitated chalk, and talc. It is generally accepted that the optimum opacity is achieved with a particle size of 0.25 μm . Magnesium carbonate can also be used to improve oil blotting, keep the powder fluffy, and absorb any added perfume. Kaolin (hydrated aluminum silicate) may also function to absorb oil and perspiration. Full-coverage face powders are usually packaged in a compact and applied to the face with a puff ([Figure 13.1](#)) (1).



FIGURE 13.1 Compact facial powder can add color and coverage to the face while assisting with oil control.

Transparent facial powders are more popular today to add coverage and improve oil blotting abilities of a previously applied liquid foundation. Transparent powders have the same formulation as full-coverage powders except they contain less talc, titanium dioxide, or zinc oxide, because coverage is not a priority. Transparent facial powders commonly have a light shine, produced by nacreous pigments, such as bismuth oxychloride, mica, titanium-dioxide-coated mica, or crystalline calcium carbonate.

Facial powder usually uses iron oxides as the main pigment, but other inorganic pigments such as ultramarines, chrome oxide, and chrome hydrate may also be used. These powders are designed to augment the underlying skin and foundation tones, thus transparent powders can be used by patients who have difficulty finding an appropriately tinted facial foundation. Transparent powders may also be selected in complementary colors, such as a pale bluish-green, to decrease facial erythema in rosacea, psoriasis, and systemic lupus patients (see for further details [Chap. 2](#) and [Table 13.1](#)).

Facial powder usually uses iron oxides as the main pigment, but other inorganic pigments such as ultramarines, chrome oxide, and chrome hydrate may also be used.

Specialty additives to some transparent powders include partially hydrolyzed ground raw silk to improve absorbency and impart a velvety matte finish; corn silk, to impart a velvety matte finish; and treated starch and synthetic resins for increased oil absorption. Most transparent powders are packaged loose and come with an applicator brush or puff.

Facial powders are removed from a compact with a puff or dusted loosely from a container with a brush. They impart a matte finish to the face. Patients who desire a shiny or moist semimatte facial appearance should avoid powder because it will absorb the oil in the foundation, thus destroying the “dewy” look. Patients with dry complexions may also wish to avoid facial powder because it can further dry the skin. However, the oil-absorbing abilities of facial powder are extremely valuable in a patient with an oily complexion prone to develop a facial shine.

The incidence of allergic contact dermatitis to facial powder itself is low; however, added fragrances may pose a problem. A more common problem with facial powders is irritant contact dermatitis due to coarse particulate matter, such as nacreous pigments, in the formulation. Inhalation of the powders may cause problems in patients with asthma or vasomotor rhinitis. Facial powder may be open or closed patch tested “as is.”

Facial blushes

Facial blushes, also known as rouges, are designed to enhance rosy cheek color. In many cases, rosy cheeks simply indicate vasomotor instability, or fine telangiectatic mats from actinic damage, although cheek color remains fashionable in the general population.

TABLE 13.1: The Color Chart Showing Cosmetics for Different Skin Colors

Cosmetic	Light Skin	Medium Skin	Dark Skin
(A) Caucasian skin			
Facial foundation	Light beige, pale ivory, light pink	Medium beige, ivory, medium pink, peach	Beige, tan, dark peach
Blush and lipstick	Rose pink, true red	Deep pink, blue red, cherry red, coral	Deep red, cinnamon, burgundy
Eyebrow pencil and mascara	Charcoal gray, dark brown, brown black	Dark brown	Dark brown
Eyeliner	Charcoal gray, brown black	Dark brown	Black
Eye shadow	Light green, purple, pink, light brown, light blue	Deep green, brown, blue	Muted green, brown, muted blue
(B) Black skin			
Facial foundation	Rose, medium beige, medium peach	Medium beige, bronze	Sun bronze, taupe
Blush and lipstick	Medium coral, medium pink, orange red	Deep coral, rose, translucent red	Cinnamon, deep translucent rose, true translucent red
Eyebrow pencil and mascara	Dark brown, charcoal, black	Charcoal, black	Black
Eyeliner	Beige, charcoal, black	Beige, charcoal, black	Beige, charcoal, black
Eye shadow	Beige, lavender, aqua, light blue	Beige, deep lavender, medium blue	Deep violet, deep sea green
(C) Asian skin			
Facial foundation	Light pink, peach, beige	Medium pink, deep peach, medium beige	Dark pink, dark beige
Blush and lipstick	Light pink, orange	Rose, light red	Rose, red
Eyebrow pencil and mascara	Black, charcoal	Black, charcoal	Black
Eyeliner	Black, charcoal	Black, charcoal	Black
Eye shadow	Beige, pink, violet, blue	Turquoise, aqua, lavender, deep blue, green	Deep violet, deep pink, vivid blue, vivid green
(D) Native American skin			
Facial foundation	Light beige	Medium beige	Dark beige
Blush and lipstick	Pink, light red	Peach, pink, light red	Deep rose, cranberry red
Eyebrow pencil and mascara	Charcoal, dark brown, black	Black, charcoal	Black
Eyeliner	Black, charcoal	Black, charcoal	Black
Eye shadow	Beige, cool turquoise, green, aqua	Medium beige, turquoise, aqua, green, deep blue	Beige, deep green, deep blue
(E) South Asian skin			
Facial foundation	Beige, rose beige	Medium beige, rose beige	Beige, light taupe
Blush and lipstick	Peach, pale orange, rose	Red, rose, pink, coral	Deep red, deep rose, orange
Eyebrow pencil and mascara	Dark brown, charcoal	Black, charcoal	Black
Eyeliner	Black, charcoal	Black, charcoal	Black
Eye shadow	Pink, lavender, blue, turquoise, sea green	Deep violet, deep beige, deep pink	Violet, purple, blue

Facial blushes are designed to enhance rosy cheek color.

Blush and rouge are actually synonyms for a cosmetic designed to add color to the cheeks, but to many consumers, blush denotes a powdered product whereas rouge denotes a cream product. Powdered blushes are more popular and are formulated identically to compact face powder, except more vivid pigments are added (Figure 13.2). Because color rather than coverage is desired, powdered blushes do not contain much zinc oxide. Cream rouges are formulated like anhydrous foundations, which contain light esters, waxes, mineral oil, titanium dioxide, and pigments (2). Some patients use lipstick on the cheeks as a form of cream rouge. Lipstick-type formulations used as cream rouge are known as facial gleamers. Powdered blushes can be easily brushed over any foundation formulation, but cream rouges will remove and smudge oil-free and low-oil-content foundations. Cream rouges also do not perform well if the face is powdered.



FIGURE 13.2 A powdered blush appears similar to a face powder except that the product is pigmented more vividly to create the appearance of rosy cheeks, considered a sign of general health.



FIGURE 13.3 Placement of a blush on the cheek.

For a natural appearance, cheek color should be applied beginning at a point directly beneath the pupil on the fleshy part of the cheek, sweeping upward beyond the lateral eye (Figure 13.3) (3). This placement is designed to create or accentuate high cheek bones, which are a desired quality among women (4).

The adverse reaction concerns with blushes and rouges are identical to those for facial powders. The products can be open or closed patch tested “as is.”

Facial bronzing gels

Facial bronzing gels are alternative products available to add facial color. If the product is intended to add color only to the cheeks, it is called a gel rouge, but if the product is designed to provide overall facial color, it is known as a bronzing gel. Gel rouge is available in shades of red and orange, whereas bronzing gels, as the name suggests, are intended to give a tanned appearance (5). Both products stain the skin and provide no coverage. They contain light esters, propylene glycol, alcohol, and water-soluble organic colors in a neutral aqueous gel. They must be applied and spread quickly, because the volatile vehicle yields a short playtime. Staining of the fingertips and clothing during application is a common problem.

Bronzing gels add color to the face usually simulating a tan.

Another product that provides facial color without coverage is a color wash. Color washes are liquid foundations with pigment

but no titanium dioxide, frequently containing some pearl additive, such as bismuth oxychloride or mica. Color washes can be worn alone or under a sheer foundation. They may not be applied over a foundation or on a powdered face. Color washes are more appropriate for patients with dry skin, whereas bronzing gels are more appropriate for patients with oily skin.

Facial buffers and highlighters

Facial buffers and highlighters are formulated exactly like powdered facial blushes except that the color and amount of pearl may vary. Facial blushes are usually of an intense color, ranging from red to orange for accentuating the upper cheeks. Facial buffers, on the other hand, are typically a light pink or peach with a moderate amount of pearl. Their purpose is to blend other facial cosmetics. For example, after the blush is applied to the cheek, a border forms where the color stops. Applying a facial buffer over the blush blends the edges of color into the natural skin tones. Facial buffers can also be used to blend eye shadows into the upper eyelid.

Facial highlighters are more intensely pigmented than facial blushes. They are available in deep burgundy, bronze, or brown and function to color and contour the face (Figure 13.4). For example, a bronze facial highlighter can be applied to the central forehead, nasal tip, and central chin to create the appearance of a tan because these three protuberant areas of the face generally are more deeply pigmented in a patient with recent sun exposure. Facial buffers and highlighters can be artfully used by the patient with facial defects to improve facial contour.

Facial cover sticks

Facial cover sticks are intended for use under a facial foundation to cover imperfections. Facial cover sticks, also known as under eye concealers, are matched to the skin color and applied to cover an abnormal skin color, such as the redness of an acne lesion or the darkness of under eye circles (6) (Figure 13.5). These are maximum coverage products with high amounts of titanium dioxide. Other ingredients include mineral oil, waxes, pigments, and kaolin or talc. Formulations available in a roll-up stick contain more wax than cream formulations, which contain more oil. A popular packaging of the cream formulation is in a cylindrical



FIGURE 13.4 Facial highlighter compressed powder beads that are stroked and blended with a brush to obtain the desired color blend prior to brushing over the face and body.



FIGURE 13.5 A skin-colored cream is dabbed and blended under the eyes to camouflage under eye circles.

tube with an insertable sponge tip applicator. The long-wearing, high coverage characteristics of facial cover sticks require pigment suspended in an oil base. There are some products labeled as “oil-free,” but they contain silicone oils.

Facial cover sticks are intended for use under a facial foundation to cover imperfections.

Facial undercover creams

Facial undercover creams are designed to mask undesirable skin tones. They are formulated like cream foundations with oils, waxes, talc, and pigment. Undercover creams come in a variety of complementary colors and are intended for application under a full-coverage facial foundation. Green undercover creams are used to camouflage a reddish complexion created by such dermatologic conditions as rosacea, psoriasis, lupus, acne, or a facial nevus flammeus. The application of a green cover over underlying red skin produces a net result of brown under a foundation because green mixed with red pigments produces a brown tone. A light purple undercover can be used by patients with a yellow complexion due to renal failure or cirrhosis to yield a pink skin tone. A peach-colored undercover can be used to mask the bluish tones of bruised skin. If the patient chooses to use an undercover cream, she must also commit herself to wearing a full line of facial cosmetics because the cream by itself does not cover the defect.

Facial undercover creams come in a variety of complementary colors for camouflage purposes and are intended for application under a full-coverage facial foundation.

Another undercover product, known as a white pearlized undercover, is an oil-based liquid makeup that contains increased amounts of titanium dioxide without any pigment. This undercover is designed for the patient with actinically damaged skin characterized by fine wrinkling, telangiectasia, and mottled pigmentation. The increased amount of titanium dioxide whitens

the discolored skin, and the pearl created by bismuth oxychloride or mica minimizes the fine wrinkling.

Bronzing powders and tinted moisturizers

Bronzing powders and tinted moisturizers are used to add temporary color to the face and body, generally trying to simulate a tan. Bronzing powders are identical in formulation to face powders except for the addition of different pigments. The powder is stroked from a compact with a powder sponge or puff and applied to the body. The product is usually dusted down the central face, neck, and shoulders to simulate a tan (7). The powder is easily removed by rubbing and provides slight physical sun protection due to the titanium dioxide in most formulations.

Bronzing powders and tinted moisturizers are used to add temporary color to the face and body to simulate a tan.

Tinted moisturizers are liquids, as opposed to the previously discussed bronzing powders, and they contain a brown pigment that provides a sheer tanned appearance in addition to possessing emollient qualities. Technically, it is impossible to separate a tinted moisturizer from a sheer, moisturizing facial foundation. Usually, a facial foundation contains titanium dioxide to provide coverage to underlying cutaneous pigment defects whereas a tinted moisturizer does not, but the distinction is slight.

Facial cosmetics for acne patients

Facial cosmetics selection for acne patients poses a challenge for the dermatologist. Acne patients are generally self-conscious about the blemishes on their complexion and anxious to apply cosmetics that will completely mask the erythema, papules, and nodules that characterize acne vulgaris. They will typically select the facial foundation with the longest wear and highest amount of coverage. These products are inevitably oil-based and extremely occlusive, resulting in additional facial oil and follicular irritation that may aggravate the underlying acne, necessitating further cosmetic application. High-coverage foundations also create a need to use blush, lipstick, and eye shadow because they cover not only the acne lesions but all facial contours. Unfortunately, there is no optimal solution to this problem.

Facial powder can aid in oil control in the acne patient.

Facial powder can be extremely valuable for the acne patient. It can absorb oil, thus increasing the wear of oil-free facial foundations that will rub off or separate when mixed with sebum. Powder can also increase the coverage of an oil-free foundation. To obtain maximum benefits from powder and eliminate a “floured” facial appearance, the powder must be properly selected and applied. A loose transparent powder is best. Transparent powders come in tones of pink, yellow, or brown and the patient should select the tone that best matches her underlying complexion and foundation. The fingertips are then dipped in the loose powder, and it is massaged into the foundation over the entire face. Rubbing the powder into the foundation is superior to dusting the powder onto

the face because it adheres more closely to the foundation and results in an increased foundation wearability and better oil control. Rubbing also eliminates the “floured” facial look and imparts a smooth feel. A fluffy brush is then used to dust away excess powder. The technique may be repeated if oily breakthrough occurs. Oily breakthrough occurs when the foundation has absorbed as much oil as possible, resulting in the development of a facial shine due to oil seeping through the layer of foundation.

Powder can also be used to increase the coverage of oil-free foundations in acne blemish areas. Foundation is dabbed onto the acne lesions with the fingertips and allowed to dry. Loose transparent powder is then massaged into the area. Another layer of foundation is then applied, and the process is repeated until the desired coverage is achieved. Foundation is then applied to the entire face and finished with a facial powder rub as previously described.

Loose powders usually contain less oil than pressed compact powders and are therefore recommended for the acne patient. Most of the loose talc-based powders will work well, except for those that contain ground particulate matter, such as walnut shell powder. These products tend to encourage the formation of closed comedones and milia. Perhaps this is due to sharp-edged particles occluding the follicle, forming closed comedones, or causing epidermal damage resulting in milia.

Acne patients should also select powdered and gel facial cosmetic formulations over oily creams. This means that powdered blush should be selected over cream rouge and bronzing gels should be selected over color washes. Powdered blush can be used effectively by acne patients to absorb oil and provide a reddish color to the upper cheeks, which may aid in blending acne blemishes. For light-skinned acne patients, bronzing gels can effectively add facial color without worsening acne or creating the need to wear a full line of facial cosmetics.

Facial cosmetics for mature patients

Mature patients generally have dry skin with wrinkling and other effects of actinic damage. In the presence of dry skin, oil-absorbing products such as powders should be avoided. If a powder is desired, it should be low in magnesium carbonate and zinc oxide because these two substances have an astringent or drying effect on the face. Powder also tends to migrate into the creases, accentuating wrinkling. However, powdered blushes are still recommended over cream rouges. Cream rouge does not spread well when applied over a foundation of any type. Facial bronzing gels are also difficult to apply over a furrowed skin. If increased facial color is desired, a color wash used alone or under an oil-containing foundation is preferable.

Powders should be avoided in mature patients with dry skin.

Cream undercover cosmetics perform well on mature skin because their oil base can replace a facial moisturizer. Green undercover on the upper cheeks is especially useful in the mature patient with fine facial telangiectasias. The green undercover must be covered with an oil-containing foundation. Powder blush applied to the upper cheeks will also help to blend the telangiectasias. White pearlized undercover can be used beneath a foundation to minimize wrinkling and improve uneven facial pigmentation.

Facial cosmetics for men

Facial color cosmetics for men have been slowly gaining acceptance, but they remain unpopular (8, 9). Men in the entertainment industry use cosmetics designed for women and apply the cosmetics in the same manner as women to accentuate facial color (10). For average daily use, facial cosmetics are impractical for men. The beard precludes even application of facial foundations, because the pigment tends to adhere to the hair shafts and prominent follicular structures. The coarse texture of male skin is also accentuated. If total facial color is required, facial foundations should be avoided in favor of bronzing gels. This product stains the skin, thus providing color, but does not provide coverage. If coverage is required, men should select opaque cover cosmetics discussed in the chapter on facial scarring. Color can be effectively added to the cheeks, forehead, nose, and chin with powdered facial blushes, buffers, or highlighters. A transparent facial powder dusted over the entire face can minimize the appearance of large pore structures and the “five o’clock shadow” created on the cheeks by the regrowth of dark facial hair after early morning shaving. No nationally distributed color cosmetic line developed especially for men is currently available.

Facial cosmetics for children

Color facial cosmetics are available for young girls to adorn the face and cheeks. Most preadolescent and early adolescent girls do not want to “look like they wear makeup,” but still want to go through the motions of applying cosmetics to their face. Popular facial cosmetics in this age group include transparent facial color gels and rouges. Transparent facial color gels and teenage rouges are similar in formulation except that color gels are more lightly colored for all over application to the face, whereas the rouge is brightly colored and only applied to the upper cheeks. They contain light esters, propylene glycol, alcohol, and water-soluble organic colors in a neutral aqueous gel. The product must be applied evenly and quickly to avoid streaking, and it stains everything it contacts, including fingertips.

Neurocosmetics

A new area of skin care, known as neurocosmetics, is gaining popularity. Traditionally, cosmetics have been designed to color and scent the skin. Neurocosmetics, however, are designed to produce a skin sensation that imparts a neurologic response. Topical substances that produce a feeling when applied to the skin are known as sensates. The sensation could be hot, cold, prickly, stinging, cooling, tingling, etc. The sensate produces a mind/body connection that putatively imparts well-being. One well-known current use of sensates is in dandruff shampoos. Many dandruff shampoos contain menthol, designed to produce a cooling sensation when applied to the scalp, to alleviate scalp itch. The cooling sensation is also to alert the user that the shampoo is “working.” This gives the user confidence that the shampoo is doing its job to alleviate the dandruff.

Dermatologists have used sensates for the treatment of itch for many years. The addition of 2% menthol to a moisturizing lotion has been a safe treatment for senile pruritus, xerotic eczema, and prurigo nodularis. Other sensates used in dermatology and in the cosmetic market include capsaicin, the active component in chili peppers, designed to alleviate pain. Dermatologists have practiced neurodermatology for quite some time, but

the concept of neurocosmetics is new in the over-the-counter (OTC) market.

Another method of inducing a sensation with purported skin benefit is facial icing, also known as a cryofacial, which creates a cooling sensation while supposedly decreasing facial puffiness through enhanced lymphatic drainage. This neurocosmetic is touted for its ability to improve undereye bags and brighten the complexion due to vasoconstriction. Some simply use ice cubes in a bag, whereas others use a tubular handheld battery-operated device that has a metal slanted tip with the ability to both cool and heat. Ice globes are popular cryofacial tools that have a round head made of stainless steel or glass attached to a handle. The globe is filled with a freezable liquid and then taken out of the freezer and stroked over the face. Other cryofacial tools include stainless steel rollers or a freezable face mask. Exactly how cold-induced vasoconstriction reduces undereye puffiness is not explained.

Smell is definitely a sense that connects products applied to the skin surface with one of the most primitive parts of the brain. Neurocosmetic lines include a variety of aromatherapy items with scientifically designed scents to “smell like a hug” or “smell like happiness” or “smell like relaxation.” The relaxation neurocosmetic pen combines peppermint, lavender, and tonka bean. Some products are packaged in a bottle with a unique shape designed to also contribute to relaxation as you massage your hands over the bottle, bringing together the senses of smell and touch.

Scented botanicals can be combined with botanicals that contain biologically active chemicals. One example of an ingredient popular in neurocosmetics is an extract of *Griffonia simplicifolia*, a shrub native to West Africa. The seeds of the plant are rich in the amino acid 5-hydroxytryptophan (5-HTP) and are used both topically and orally. 5-HTP increases the production of serotonin, affecting pain, sleep, and mood. This plant extract has been used to assist with anxiety and depression, but is not approved for this use by the US Food and Drug Administration (FDA).

Finally, neurocosmetics can combine a scented botanical oil with the relaxing physical rubbing of a stone over the face that is made of jade or rose quartz with purported geological properties. This technique is known as “gua sha,” also referred to as scraping, spooning, or coining. This neurocosmetic trend is an adaptation of Chinese traditional medicine. The original technique utilizes a tool to scrape the skin to produce light petechiae supposedly stimulating new oxygen flow to the skin. The technique has been extended to the face where the skin is well lubricated and a blunt curved smooth-edged stone is stroked over the skin in the direction of lymphatic drainage. The stone is made of jade or rose quartz, which are thought to be minerals with healing powers. The belief is that enhanced circulation will improve eye puffiness, fine lines, and facial contour. The procedure feels like an aggressive massage that imparts relaxation and well-being. It can be self-administered or performed in a spa type setting. The following steps represent the gua sha procedure:

1. Clean the face and apply a lubricating oil to the entire face.
2. Draw the curved side of the stone along the skin from the chin up to the ear in repeated long up and down motions.
3. Turn the stone to the flat side and glide it in slow long strokes across the cheek.
4. Turn the stone back to the curved side and glide it over the cheekbones.
5. Rub the curved side of the stone in long strokes underneath the eyes and toward the temples.

6. Glide the flat side of the stone from the brow up to the hair-line across the entire forehead.
7. Wash the Gua sha stone.

The goal of the gua sha treatment appears to be encouragement of lymphatic drainage. There is no agreement among dermatologists if lymphatic draining promotes facial skin health. Further, it is unknown if lymphatic draining of the face can be improved via aggressive massage. There is little in the published scientific literature regarding the technique at this time. However, gua sha is a perfect example of the burgeoning neurocosmetic arena.

Corrective facial cosmetics

Corrective cosmetics for facial lesions are based on the principle that dark colors make the lesions appear smaller and to recede, whereas light colors make the lesions look larger and appear to come forward. This concept is illustrated in Figure 13.6 where the black oval appears recessed and smaller compared with the white oval. Powdered blush-type products are best suited for this purpose. Areas of the face that need to be lightened should be brushed with a light pink or peach pearled blush or buffer. Areas of the face that need to be darkened should be brushed with a deep plum or bronze matte finish blush or highlighter.

Corrective facial cosmetics are based on the principle that dark colors make the lesions appear smaller and to recede, whereas light colors make the lesions look larger and appear to come forward.

Cosmetic facial sculpting is most successful for optimizing the shape of the face, the size of the forehead and chin, or the contour of the nose. The perfect facial shape is oval and symmetrical about the midline because this form is most pleasing to the eye. An oval face is one and one-half times as long as it is wide, and should taper gradually from its widest dimension at the forehead to its smallest dimension at the chin. The face should be divided into equal thirds from superior to inferior: forehead to the glabella, glabella to the subnasale, and subnasale to the base of the chin. The face should be divided equally into fifths from ear to ear, with each fifth being the width of one eye (11).

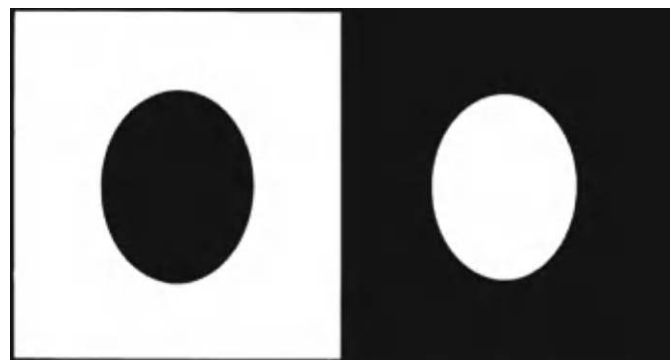


FIGURE 13.6 The two fundamental rules of facial contouring: Dark contours look smaller and appear to recede; light contours look larger and appear to come forward.

The ideal face should be divided into three equal parts from superior to inferior: forehead to the glabella, glabella to the subnasale, and subnasale to the base of the chin.

Other facial shapes are round, where the facial length is short; oblong, where the facial length is long; square, where the jaw is wide; diamond, where the forehead is small; triangular, where the cheeks are wide; and inverted triangular, where the jaw is narrow. By appropriately shading the face, the less optimal shapes described can more closely approximate a perfect oval.

For example, a round face should be shaded with a dark color along the lateral margins to de-emphasize the increased width, whereas an oblong face should be shaded along the forehead and chin to de-emphasize the increased length. A square face should be darkened bilaterally at the jaws. Both diamond and triangular faces should be lightened at the forehead for emphasis, and an inverted triangular face should be lightened at the chin (12).

This same shading technique can also be used to correct a poorly formed forehead and chin. Low-set foreheads should have a light blush applied beneath the hairline, whereas high foreheads should have a dark blush applied here. A receding chin should have a light blush applied at the tip and sides. A double chin should be shaded with a dark blush under the entire jawbone (13).

Facial recontouring is most useful on the nose, where hair, jewelry, or glasses cannot hide the abnormality. Figure 13.7 illustrates the shading techniques. Areas to be darkened are cross-hatched and areas to be lightened are outlined. Figure 13.7A demonstrates a broken nose that has healed crookedly with a deviation to the patient's left. The prominent upper-left side of the nose is darkened, along with the lower-right side and right tip. The opposite sides are lightened. A hook nose or aquiline nose (Figure 13.7B) can also be minimized by darkening the hook along with the lateral nasal tips. A bulbous nose can be improved by shading the entire bulb on the tip and the lateral margins to the nasal root (Figure 13.7C). Shading for long and short noses is shown in Figure 13.7D and E, respectively (14).

Corrective facial cosmetics are no substitute for an anatomically beautiful face, and in some cases patients should be advised to consider surgical revision. These suggestions may be offered to the patient who is awaiting surgery or the patient who has not previously considered cosmetics as a way of creating the illusion of a more perfect face.

Advising the patient on cosmetic selection

The dermatologist is called upon with increasing frequency to give advice on cosmetic selection. Patients are searching for cosmetics that improve skin quality while offering value. Dermatologists, with their understanding of skin physiology and disease, are best suited to render opinions in this area; however, unfamiliarity with available cosmetics and their use may make physicians unable to give valuable, concrete advice. This text is intended to serve as a basic guide for formulating individual patient recommendations. ZDD outlines her approach to advising the patient on cosmetic selection below.

The first step in making cosmetic selection recommendations is to determine where the patient purchases their cosmetics. This is important because the point of purchase is related to the cost of the product. It is wise to keep cost in mind when making patient recommendations. Cosmetic manufacturers intentionally

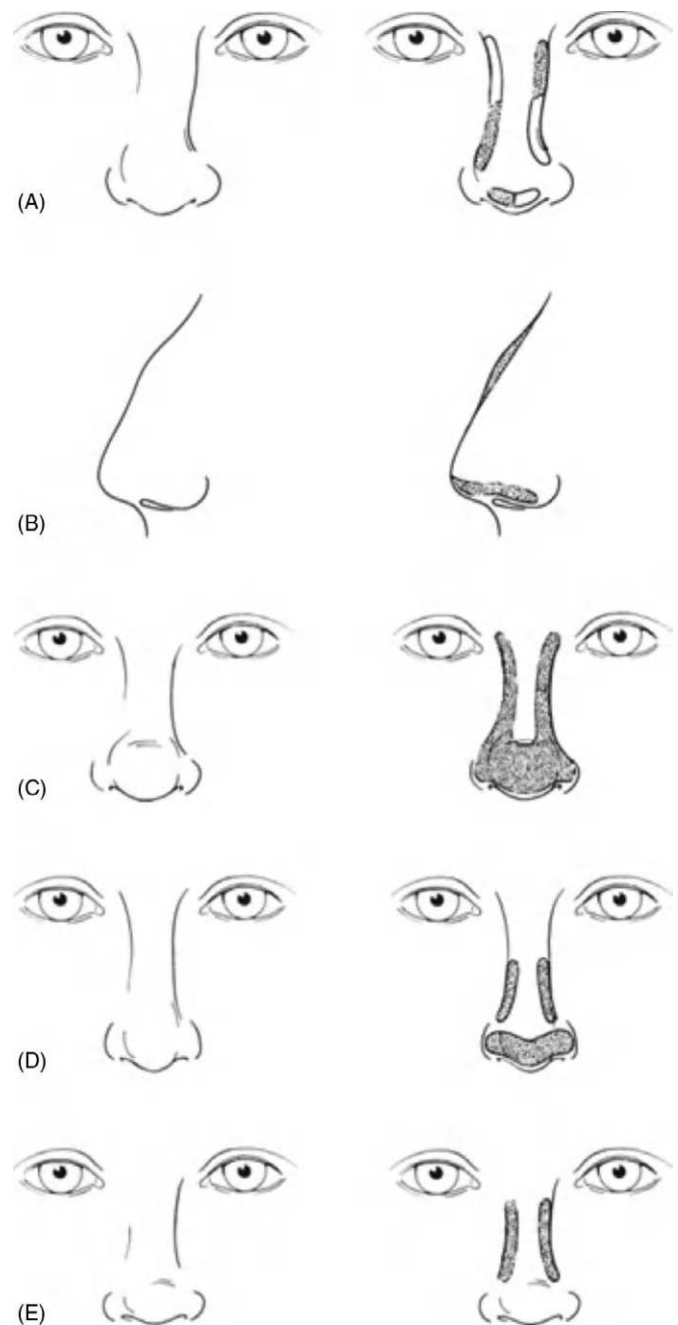


FIGURE 13.7 Contouring of the nose. (A) Crooked nose. (B) Hook or aquiline nose. (C) Bulbous nose. (D) Long nose. (E) Short nose.

produce products to reach consumers through a variety of markets. Some cosmetics are sold in mass merchandisers, such as grocery stores, drug stores, and discount stores. Cosmetics sold through these vendors generally range in price from \$2 to \$15. Other cosmetics are sold exclusively through cosmetic counters in department stores. Even within the department store market, there are products designed for lower price point department stores and higher price point department stores. Lower price-point department stores market cosmetics that sell for \$20 to \$40 as compared to higher price-point department store cosmetics that sell for \$100 to \$200. The most expensive cosmetics are sold

through boutiques and spas. These products range from \$200 to \$500. Interestingly enough, some of these exclusive products are manufactured by the same companies that produce cosmetics under a different label for sale in mass merchandisers. Generally, boutique lines have more attractive, elaborate packaging accompanied by a greater color selection, more expensive fragrances, and innovative specialty additives.

Another route for cosmetics purchase is through household parties and individuals who sell door-to-door in their neighborhood. These products generally are in the \$20 to \$75 range. Lastly, private cosmetics are produced on a contract basis, generally through small manufacturers. Cosmetics can be customized to the needs of the business or simply a standard formulation with a customized label. The price variation in this market is tremendous. It is worthwhile noting that cosmetics sold in these manners, which are produced and marketed for intrastate use, do not fall under the FDA guideline because they are only sold in the state in which they are manufactured. There are very few companies who do business in this manner. Furthermore, smaller cosmetic manufacturers do not have the capital or the facilities to undertake extensive premarketing and postmarketing consumer research. However, there are several large cosmetic companies that market quality products worldwide who reach the consumer through these routes.

The second step is to determine the patient's skin type: very oily, oily, combination, normal, dry, very dry, etc. Moisturizer and facial foundation recommendations must be carefully chosen with the skin type in mind. Interestingly enough, many patients do not know their skin type or have been erroneously assigned a skin type by a salesperson at a cosmetic counter. In my opinion, skin type can be most easily assigned by asking the patient about the amount of sebum production on her/his nose throughout the day following morning washing. Sebum production can be assessed by having the patient run her/his finger down the nose at various times during the day. If the patient has flaking skin on the nose all day and no sebum from morning until 5 PM, they have very dry skin. If the patient has no flaking, but no sebum on their nose at 5 PM, they have dry skin. If the patient has minimal sebum on the nose at 5 PM, they have normal skin. If the patient has sebum on the nose at noon, they have oily skin. Moreover, if the patient has sebum on the nose one hour following morning washing, they have very oily skin. Combination skin, the most common skin type in both women and men, can be assessed by comparing the amount of sebum present on the nose at 5 PM with the amount present on the cheeks. This is a simplistic, but fairly accurate, method of determining the skin type.

Thirdly, once the skin type has been determined, appropriate sections within this text can be consulted for specific cosmetic product recommendations. Some patients, however, also wish

to know what color cosmetics should be selected to enhance the appearance of their skin and facial features. This advice may be beyond the realm of what most dermatologists can provide, and questions of this nature may be more appropriately handled by cosmetologists. Nevertheless, for the physician with an interest in this area, color charts based on skin pigmentation have been provided to coordinate facial foundation, blush, lipstick, eyebrow pencil, mascara, and eye shadow color with skin tones (Table 13.1) (15,16).

Finally, there is no doubt that a personal visit to a mass merchandiser cosmetic display or the department store cosmetic counter can provide valuable first-hand experience. Smelling, touching, and applying cosmetics can provide a wealth of information that cannot be fully described in a text.

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Cosmetic formulation involves the careful selection of ingredients to produce a safe, elegant, efficacious product suitable for patient purchase (1). There are many substances that must be combined to produce such a cosmetic, and consideration must be given to factors, such as moisture barrier effects, pH, lubricating action, soothing effects, osmotic effects, emollience, and percutaneous absorption (2). This chapter discusses the dermatologic concerns of key ingredients found in many cosmetic formulations, which are preservatives, color additives, biologic additives, herbal additives, vitamin additives, and liposomes.

Preservatives

Preservatives have received their share of bad press as of late, being accused of everything from breast cancer to environmental damage. Although preservatives are not terribly appealing ingredients, they are a necessary part of every cosmetic and skin care formulation. Without a preservative, the lipids in most formulations would rapidly oxidize rendering the cream rancid, or the bacterial contamination would render the product unsafe. Preservatives are the second most common allergenic group of substances beyond fragrances (3). However, the number of cases of irritant and allergic contact dermatitis is indeed small compared with the two necessary functions preservatives perform in cosmetics: spoilage prevention prior to purchase and prevention of contamination after purchase (4, 5). In short, preservatives reduce the likelihood of infection from cosmetics use. An independent survey of 250 cosmetics covering a wide range of products revealed a 24.4% contamination rate in unused products, primarily by *Pseudomonas* species and other gram-negative rods, in 1969 (6). The most frequently contaminated products were hand and body lotions and liquid eyeliners. The development of new and better preservatives has improved cosmetic preservation tremendously.

Preservatives are the second-most common allergenic group of substances beyond fragrances.

Unfortunately, the ideal preservative does not exist (7). Desirable qualities in a cosmetic preservative include those listed in Table 14.1 (8). An important function of the cosmetic chemist and the microbiologist is to select the preservative that most closely meets all the aforementioned needs in a given product.

TABLE 14.1: Characteristics of an Ideal Cosmetic Preservative

1. Lack of irritation
2. Lack of sensitization
3. Stable at a wide range of temperatures and pH
4. Stable for extended periods of time
5. Compatible with numerous ingredients and packaging materials
6. Effective against numerous microorganisms
7. No odor or color

Additionally, the preservative must undergo rigorous dermatologic testing to ensure that it is safe for use on human skin (9, 10). Some Internet watchdog groups have singled out preservatives as bad or unnatural ingredients that are unsafe for human use. Much of the data they cite is from the animal ingestion of large quantities of preservatives. The preservatives used in skin care products are not intended for consumption and the concentration of preservatives in skin care products is small, evidenced by the fact that they are listed at the end of the ingredient disclosure. Preservatives are necessary to ensure a long shelf life and prevent infection.

All cosmetics and skin care products contain preservatives.

There is no such thing as a product that is designed without preservation considerations. All products use some type of preservation technique either in packaging, such as an oxygen-free dispenser with a one-way valve, or in formulation, such as incorporating spice extracts as fragrances and natural preservatives. Key to stability of any skin care product on the shelf is consumer safety. The concept that the elimination of preservatives is beneficial for the consumer is not necessarily true.

Numerous preservatives are available for incorporation into cosmetics. Table 14.2 lists some of the preservative substances organized into chemical classes. Each of these chemicals has certain advantages and disadvantages, which are summarized in Table 14.3. There is no perfect preservative substance for cosmetics on the market. Some of the more popular preservatives in use today, due to their relatively low irritancy and allergenicity, include paraben esters, imidazolidinyl urea, phenoxyethanol, Quaternium-15, and Kathon CG (11). The most commonly used preservative in cosmetics in the United States are the paraben esters, followed by imidazolidinyl urea (12).

The most commonly used preservative in US cosmetics and skin care products is paraben ester followed by imidazolidinyl urea.

There has been a move recently to eliminate paraben preservatives from some skin care products. Consumer groups have linked parabens with breast cancer on their websites, encouraging manufacturers to use other preservatives. One of the more popular preservatives substituted for parabens is Kathon-CG, but this preservative is a much greater source of contact dermatitis than parabens and in many respects more problematic. Some of the “natural” skin care products use essential oils and fragrances with antimicrobial capabilities, such as oil of clove, cinnamon, eucalyptus, rose, lavender, lemon, thyme, rosemary, and sandalwood (13). Products that claim to be preservative-free may actually incorporate one of these aromatic preservatives, accompanied by special packaging (Figure 14.1).

TABLE 14.2: Some Preservatives Used in Cosmetics

Organic acids
Benzoic acid
Sorbic acid
Monochloroacetic acid
Formic acid
Salicylic acid
Boric acid
Propionic acid
Sulfurous acid
Citric acid
Dehydroacetic acid
Parabens
Methyl p-hydroxybenzoate
Ethyl p-hydroxybenzoate
Propyl p-hydroxybenzoate
Butyl p-hydroxybenzoate
Benzyl p-hydroxybenzoate
Mercurial compounds
Phenyl mercury acetate
Phenyl mercury borate
Phenyl mercury nitrate
Essential oils
Eucalyptus
Origanum
Thyme
Savory
Lemongrass oil
Aldehydes
Formaldehyde
Alcohols
b-Phenoxy ethyl alcohol
b-p-Chlorophenoxy ethyl alcohol
b-Phenoxy propyl alcohol
Benzyl alcohol
Isopropyl alcohol
Ethyl alcohol
Phenolic compounds
Phenol
o-Phenylphenol
Chlorothymol
Methyl chlorothymol
Dichlorophene
Hexachlorophene
Quaternary ammonium compounds
Benzethonium chloride
Benzalkonium chloride
Cetyl trimethyl ammonium bromide
Cetylpyridinium chloride
Miscellaneous
5-Bromo-5-nitro-1,3-dioxan (Dioxin)
2-Bromo-2-nitropropane-1,3-diol (Bronopol)
Imidazolidinyl urea (Germall 115)
Trichlorosalicylanilide
Trichlorocarbanilide
5-Chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one (Kathon CG)

Source: Adapted from Harry's Cosmetology. In: Wilkinson JB, Moore RJ, eds. 7th edn. New York, NY: Chemical Publishing, 1982: 673–706.

The complexity of cosmetic formulations requires a preservative to function under a variety of conditions. Microorganisms tend to proliferate in the aqueous phase of cosmetics. Under these circumstances, the preservative selected must have a high water solubility and low oil solubility to function. Furthermore, care must be taken to ensure that other ingredients in the formulation do not inactivate the preservative, either by chemically reacting or altering the effective pH range. Some solid substances such as talc, kaolin, titanium dioxide, and zinc oxide actually adsorb the preservative, thus lowering its effective concentration (14).

Organisms that frequently contaminate cosmetics include gram-positive bacteria (*Staphylococcus aureus*, *Streptococcus* species), gram-negative bacteria (*Pseudomonas aeruginosa*, *Escherichia coli*, *Enterobacter aerogenes*), fungi (*Aspergillus niger*, *Penicillium* species, *Alternaria* species), and yeasts (*Candida* species) (15). The necessity of preservatives cannot be denied, but infrequently adverse reactions to cosmetic and skin care preservatives can occur. Paraben esters are the most popular preservatives used in cosmetics because their sensitization potential is low, and they infrequently cause irritancy when applied to healthy skin (16). They are usually found in concentrations of 0.5% or less in the United States, but concentrations up to 5% have been shown to produce minimal irritation. Some individuals who are allergic to parabens may actually tolerate cosmetics containing them, a phenomenon known as the “paraben paradox” (17). Tolerance is related to application site, concentration, duration, and the status of the skin (18). Because they are most effective against gram-positive organisms and fungi, paraben esters are sometimes used in combination with phenoxyethanol to provide better gram-negative coverage (19). Parabens and imidazolidinyl urea (Germall 115) or diazolidinyl urea (Germall II) also act synergistically (20).

Some preservatives, such as imidazolidinyl urea (Germall 115), 2-bromo-2 nitropropane-1,3-diol (Bronopol) (21, 22), Quaternium-15 (Dowicil 200) (23), and dimethylol dimethyl hydantoin (Glydant), form formaldehyde in the presence of water (termed “formaldehyde releasers”). However, the concentration of formaldehyde is usually too low to cause irritancy or allergenicity. Nevertheless, patients who are allergic to formaldehyde may have difficulty with these preservatives (24).

Kathon-CG, the CG standing for cosmetic grade, is a relatively new preservative to the United States (25). It is a source of sensitization and recommended for use in products that are rinsed off the skin, such as hair conditioners and shampoos, in concentrations of less than 5 ppm (26, 27). It is used, however, in some leave-on products, such as hand creams, in low concentration. Kathon-CG and quaternium-15 were found to be the most allergic preservatives in a patch testing study (28).

Parabens are being replaced by Kathon-CG in many cosmetic formulations, but Kathon-CG is a source of allergic contact dermatitis.

Some patients may also develop allergic contact dermatitis or contact urticaria to sorbic acid, but this a less frequently used preservative in cosmetics (29). It is patch tested at a 2% concentration in petrolatum (30).

Preservatives can be difficult to patch test due to their inherent irritancy. Excellent articles discussing patch testing methods and concentrations are available (31). Table 14.4 lists the patch test concentrations of some of the more commonly used preservatives

TABLE 14.3: A Comparison of Preservatives

Preservative	Advantage	Disadvantage
Alcohols	Broad coverage, inexpensive	Volatile, high concentration required
Quaternium-15 (Dowicil 200)	Broad coverage (bacteria, yeasts, molds)	Ineffective against some <i>Pseudomonas</i> species, formaldehyde releaser
Formaldehyde	Broad coverage (fungicide and bactericide)	Irritant, allergen, concentration-regulated unpleasant odor
Quaternary ammonium compounds	Mainly gram-positive bacteria, some gram-negative	Incompatible with anionics and proteins
Parabens	Moderate coverage (fungi, gram-positive bacteria), low allergenicity, low irritancy	Poor against gram-negative bacteria, incompatible with nonionics and cationics, effective only at acidic pH
Organic mercurials	Broad coverage	High toxicity, high irritancy
Phenolics	Broad coverage, effective over wide pH range	High irritancy, volatile
2-Bromo-2-nitropropane-1,3-diol (Bronopol)	Moderate coverage (bacteria)	Formaldehyde releaser, least effective against yeast and fungi
Methylisothiazolinone and methylchlorisothiazolinone (Kathon CG)	Broad coverage (bacteria, yeasts, fungi)	Allergenicity, irritancy, inactivated at high pH
Imidazolidinyl urea (Germall 115)	Moderate coverage (gram-negative bacteria)	Best used combined with parabens and antifungals to obtain a broader coverage
Diazolidinyl urea (Germall II)	Moderate coverage (gram-negative bacteria, <i>Pseudomonas</i> species)	Best used combined with parabens and antifungals to obtain a broader coverage
Organic acids	Broad coverage (bacteria, yeasts)	Irritating, effective only at acidic pH
Dimethyloldimethyl hydantoin (Glydant)	Broad coverage, effective over wide pH range	Less active against yeasts

Source: Adapted from Harry's Cosmeticology. In: Wilkinson JB, Moore RJ, eds. 7th edn. New York, NY: Chemical Publishing, 1982: 673–707.

and their typical concentration in cosmetic formulations. It is interesting to note that there is some variability in recommended patch concentrations depending on the reference used (32, 33).

Color additives

The other problematic groups of ingredients from a media standpoint, besides preservatives, are color additives. Color additives are indispensable in colored cosmetics and account for the perceived benefits of other cosmetic preparations. The use of synthetic organic colors for cosmetic purposes has been regulated since 1938 (34) (Figure 14.2). The coloring agents most frequently

used in cosmetics are listed in Table 14.5 (35). There are 116 permitted certified colors available for the cosmetic chemist to combine into three classes:

1. FD&C colorants are permitted for use in food, drugs, and cosmetics.
2. D&C colorants are permitted for use in drugs and cosmetics.
3. External D&C colorants are permitted for use in externally applied drugs and cosmetics, but the lips and any body surface area covered by mucous membranes are excluded.

TABLE 14.4: Patch Test and Use Concentrations

Preservative	Use Concentration	Patch Test Concentration
Quaternium-15 (Dowicil 200)	0.02–0.3%	2% in petrolatum
Formaldehyde	0.05–0.2%	1% aqueous
Parabens	0.1–0.8%	3% in petrolatum if tested individually, otherwise use 12% in petrolatum of paraben mixture ^a
2-Bromo-2-nitropropane-1,3-diol (Bronopol)	0.01–0.1%	0.5% in petrolatum
Methylisothiazolinone and methylchlorisothiazolinone (Kathon CG)	3–15 PPM	100 PPM aqueous
Imidazolidinyl (Germall 115)	0.05–0.5%	1% in petrolatum or aqueous
Diazolidinyl urea (Germall II)	0.1–0.5%	1% aqueous
Dimethylol dimethyl hydantoin (Glydant)	0.15–0.4%	1–3% aqueous

^a Paraben mixture contains 3% each of methyl-, ethyl-, propyl-, and butyl paraben.



FIGURE 14.1 This facial moisturizer is packaged in an air-free sack inside a plastic container dispensed through a one-way valve. This prevents oxygen from contacting the moisturizer and aids in product preservation.



FIGURE 14.2 Coloring agents used in lip products are regulated by the US government.

The use of synthetic organic colors for cosmetic purposes has been regulated since 1938.

Color additives can be divided into those that are soluble and insoluble (36). Soluble colors may be soluble in a variety of substances including water, alcohol, and oil. These colors are almost all synthetic organic dyestuffs that impart color only when in solution. These soluble synthetic dyestuffs can be further divided into acid dyes, mordant dyes, basic dyes, vat dyes, solvent dyes, and xanthene dyes. Acid dyes are used in the dyeing of many items, such as cosmetics, textiles, food, inks, wood stains, and varnishes. The dyestuffs of this category used in cosmetics are FD&C Blue Nos. 1, 2; FD&C Green Nos. 1, 2, 3; FD&C Red Nos. 2, 3, 4; FD&C Violet No. 1; FD&C Yellow Nos. 5, 6; D&C Blue No. 4; D&C Green No. 5; D&C Orange Nos. 4, 11; D&C Red Nos. 22, 23, 28, 33; D&C Yellow Nos. 7, 10, and Ext. D&C Yellow No. 7. Mordant dyes, basic dyes, and vat dyes are not generally used in cosmetics. Solvent dyes listed for use are D&C Green No. 6; D&C Red Nos. 17, 37; D&C Violet No. 2; and D&C Yellow No. 11. Xanthene dyes, such as fluorescein, are used in the coloring of lipsticks. Dyes of this group approved for use are the acid forms of D&C Orange Nos. 5, 6, 7, 10; D&C Red Nos. 21, 27; and D&C Yellow No. 7. These xanthene dyes are used in their water-soluble form: FD&C Red No. 3; D&C Orange Nos. 11, 12; and D&C Red Nos. 22, 23, 28.

TABLE 14.5: Frequency of Cosmetic Color Additive Use (in Order of Decreasing Frequency)

Titanium dioxide
Iron oxides
Mica
FD&C Yellow No. 5
Ultramarine blue
FD&C Blue No. 1
D&C Red No. 7 calcium lake
Bismuth oxychloride
FD&C Red No. 4
FD&C Yellow No. 6

Insoluble colors consist of inorganic and organic substances. The organic materials are lakes of soluble dyes and pigments, whereas the inorganic materials are largely oxides and metals. The lakes are soluble dyestuffs that are rendered insoluble by precipitation onto a base. Pigments are usually dyes of the azo type. Oxide pigments that are naturally occurring include iron oxides known as ochre, raw and burnt siennas, red oxides, and raw and burnt umbers. Synthetic oxides and ochres are also available to yield shades of red and yellow. Blues are produced as ultramarines, greens formed from chrome oxide, and Guignet's green, whereas blacks are available as carbon black, vegetable black, bone black, and black oxide of iron. Metallic colors include aluminum powders and bronze powders. This is a quick, but useful, overview of the many colorants used in cosmetics and skin care products.

Other popular colorants that do not fit into the above classification include pearl essences, formed from fish scale or bismuth oxychloride, and manganese violet. Color additives are rarely a cause of dermatitis in cosmetics, but reports of dermatitis to coal tar dyes exist (37). Additionally, the D&C Red dyes have been shown to be comedogenic (38).

Biologic additives

Another controversial area of product formulation is the use of biologic additives, or substances that are animal derived. Some cosmetic companies advertise that none of their products contain animal materials, which may be of more value from a marketing, than formulation, standpoint. Biologic additives are derived from the extracts and hydrolysates of glands and tissues of animals of different species. Animal organ extracts can be formulated as aqueous, hydroglyceric, hydroalcoholic, hydroglycolic, and oily. Examples of biologic additives are collagen, elastin, hyaluronic acid, keratin, placenta, amniotic fluid, pancreas, egg extract, blood derivatives, and extracts of the brain and aorta.

Biologic additives are derived from animal products.

Topically applied biologic additives, also known as biofactors, are thought by the cosmetic community to function as active ingredients due to the presence of "intrinsic factors" (39). Intrinsic factors are currently unidentified chemicals that have physiologic effects on the human body. These animal-derived materials are briefly discussed.

Collagen

Collagen is a biologic additive found in moisturizers, hair conditioners, hair shampoos, and nail polishes. It is also available in a form suitable for cutaneous and subcutaneous injection. Collagen is a large molecule composed of three intertwined alpha-helical peptide chains. It is usually obtained from shredded calf skin that is carefully handled to eliminate denaturation. Injectable collagen is processed to separate the chains through hydrolysis. The nonhelical end of the chains, known as the telopeptide, is also removed because it is responsible for the antigenicity of bovine collagen experienced in humans (39).

Injectable bovine and porcine collagen used to be marketed as a filler substance to cosmetically improve facial depressions due to scarring or wrinkling, but it was recently removed. Topical

collagen, on the other hand, can be used in its microfibrillar form for hemostasis or in its hydrolyzed form as a protein humectant in moisturizers. Collagen can absorb up to 30 times its weight in water. Hydrolyzed collagen protein can also be used in hair products, especially instant conditioners, as it can reversibly penetrate chemically treated or damaged hair. Hydrolyzed collagen is still widely used in many modern formulations.

Elastin

Elastin is a structural component of the dermis responsible for the ability of the skin to regain its original configuration following stretching and other deformations. The elastin used topically in cosmetic preparations is obtained from bovine neck ligaments, but most preparations contain some collagen contamination. The elastin is usually added in the form of a hydrolysate consisting of a clear yellow liquid with a pronounced odor. It is added for its ability to function as a humectant; however, collagen has a greater water-binding capacity than elastin.

Hyaluronic acid

Hyaluronic acid is a component of the dermis that has a great cosmetic potential for water retention. In other words, hyaluronic acid can function as a humectant when topically applied. It also can facilitate penetration of other substances through the stratum corneum because a hydrated epidermis is more permeable. For this reason, hyaluronic acid has been termed a “transdermal delivery system” by some cosmetic manufacturers.

Hyaluronic acid is a glycosaminoglycan as are chitin, chondroitin sulfate, and heparin. It falls into the broad category of mucopolysaccharides which are hexosamine-containing polysaccharides of animal origin occurring in their pure state or as protein salts. Hyaluronic acid is obtained from animal sources such as avian combs, calf connective tissue, umbilical cord, and synovia. The hyaluronic acid that is used as a filler for injection is NASHA, which is human hyaluronic acid manufactured by bacteria to eliminate any animal components. This form of hyaluronic acid is increasingly found in skin care products.



FIGURE 14.3 Hyaluronic acid can be applied topically to diminish fine facial lines of dehydration.

Keratin

Keratin, a protein component of the stratum corneum, is used in cosmetics as a humectant moisturizer and to deposit a thin film on the hair and nails. It allows longer curl retention in hair-setting products and can minimally penetrate chemically treated or damaged hair to temporarily replace removed hair proteins. Several salon lines use keratin as their major “hero” ingredient for marketing purposes. One line uses heat-denatured human hair keratin for its hair-strengthening products. Keratin is also found in nail polishes to improve nail hardness. Keratin is a scleroprotein and typically obtained from hydrolyzed bovine horn, horse hair, and boar bristles. It is a brown powder that can be readily added to gels, solutions, and emulsions, thus facilitating its addition to many cosmetic products.

Keratin obtained from heated denatured human hair is a high-priced cosmetic additive in many hair care products.

Placenta

Placenta, as used in cosmetic preparations, is a complex mixture of proteins and enzymes such as alkaline phosphatase, lactate dehydrogenase, malate dehydrogenase, glutamate oxaloacetate transaminase, and glutamate pyruvate transaminase. The number of substances present within the extract depends upon the care with which the placenta was handled. Human and animal placentas are used as sources. In general, the placenta is frozen, ground, and rinsed with sterile deionized water to remove any blood products. The cells are then lysed. The preparation can be treated further depending on the needs of the cosmetic chemist. In the cosmetic literature, placenta extract is thought to accelerate cellular mitosis, enhance blood circulation, and stimulate cellular metabolism (39). It is used in various cosmetics, from facial moisturizing creams to hair conditioners.

Amniotic fluid

Amniotic fluid is used in cosmetics as a moisturizer and a purported “epidermal growth enhancer.” It is found in facial and body moisturizers, bust creams, hair lotions, and scalp treatments. Amniotic fluid is formed by the secretions of the amnion and the vascular transudate. The origin of the fluid used for cosmetic purposes is pregnant cows at three to six months’ gestation. The fluid is withdrawn from the amniotic sac through a hollow needle. It is a sterile yellow liquid of pH 7 that can be supplied as a water-soluble additive or a sterile powder. At present, the use of amniotic fluid in skin care formulations is minimal.

Egg extract

Whole egg extract and the egg yolk extract are used in shampoos, face masks, hair conditioners, and moisturizers. Egg extract is obtained from chicken eggs in the form of a hydrolyzed transparent yellow liquid. An extract can also be prepared from the egg yolk alone. This extract is a viscous, opalescent, gold liquid containing fats, lecithin, and sterols.

Blood derivatives

There are several cosmetic extracts obtained from bovine blood: blood extract, serum albumin, fetuin, and fibronectin. Pure bovine blood extract is obtained by treating the blood to remove unwanted substances, histamines, and pyrogens. The remaining

product is then dried to yield a water-soluble yellow powder. It is thought that this extract stimulates oxygen absorption and is therefore used in shampoos, conditioners, revitalizing creams, and after shave products.

Bovine serum albumin is the fluid that remains after the fibrin and blood cells have been removed. It is available as a liquid and freeze-dried powder. Because bovine serum albumin is used as a growth factor in cultured skin cells, it is thought to increase epidermal cell renewal rate. It is a common additive in creams that “revitalize” the skin.

Salmon sperm polydeoxyribonucleotide (PDRN)

Polydeoxyribonucleotide (PDRN) consists of DNA fragments obtained from the sperm cells of the salmon trout (*Oncorhynchus mykiss*) or the chum salmon (*Oncorhynchus keta*). It is obtained through an extractive process involving high temperatures to achieve 95% pure DNA with molecular weights between 50 and 1500 Kda. The monomer unit of the PDRN chain is the deoxyribonucleotide and is made up of three substances including sugar pentose phosphoric acid, and a purine or pyrimidine base. The PDRN is possibly cleaved by cell membrane enzymes, which then provide a source for purine and pyrimidine that can function synergistically with growth factors and enhance the growth of fibroblasts. The purported benefits of PDRN are numerous, including angiogenesis, collagen synthesis, inflammation decrease, pigmentation reduction, soft tissue regeneration, and wound healing (40–42).

The rather broad benefits of PDRN involve the activation of the adenosine A_{2A} receptor. Adenosine receptors are thought to be targets for the management of reactive oxygen species. The activation of the A_{2A} receptor inhibits the NF-kappaB and mitogen-activated protein kinase (MAPK) signaling pathways that are in turn activated by reactive oxygen species, which decreases the release of pro-inflammatory cytokines. Activation of the A_{2A} receptor also increases cyclic adenosine monophosphate (cAMP). The most direct dermatologically notable effects of PDRN are to block matrix metalloproteinase (MMP)-1, resulting in increased collagen production, and a decrease in intracellular tyrosinase activity, resulting in melanin synthesis inhibition. However, PDRN has also been postulated to improve hair growth and stimulate angiogenesis through increased expression of vascular endothelial growth factor (VEGF) (43).

PDRN can be administered topically or by injection. It has been established that in order to penetrate the stratum corneum, a molecule must be smaller than 500 Da. PDRN may be bigger than this in size, thus penetration enhancing methods have been used to include application post fractional CO_2 laser or post radiofrequency microneedling. The use of PDRN following mechanical microneedling is termed biorevitalization rather than mesotherapy. Many times, PDRN is combined with hyaluronic acid for topical application and injection to increase the water holding capacity of the skin. This combination yields a bioactive filler aimed at improving skin elasticity and firmness while increasing skin volume.

The main questions dermatologists need to ask about PDRN include product safety and available data to support efficacy. It is felt that the high temperatures used to prepare PDRN are sufficient to remove any biologic contaminants. Nevertheless, no large facial injection studies comparing hyaluronic acid alone to hyaluronic acid plus PDRN have been conducted to isolate and document the regenerative effect. A study was conducted involving 40 subjects with plantar fasciitis and no complications were

reported (44). Similarly, a study of 5 patients who had filler and PDRN injected exhibited no complications (45). This is interesting preliminary data, but clearly more definitive work is needed to support safety in dermatologic use.

The data is also rather limited regarding efficacy. Activating a receptor can involve many variables, such as how many receptors need to be activated and for how long to achieve the desired effect. The activation of the A_{2A} receptor inhibits NF-kappaB and MAPK signaling pathways, but how much inhibition is enough to decrease pro-inflammatory cytokines. What if the inflammatory cascade is already activated and the pro-inflammatory cytokines are already released? Is the PDRN still effective? Much of the efficacy data on PDRN comes from in vitro cell culture work or ex vivo work on cultured skin. Although these are valuable study systems, they do not mimic the complexity of in vivo human in-use studies.

Herbal additives

Herbal additives are currently more popular than biologic additives as plants are felt to be more “pure” and less problematic, even though many herbals are contaminated with herbicides and heavy metals. The list of cosmetic plant materials is almost endless and can only be appreciated by reading chemical company advertisements in cosmetics and toiletries trade journals. Most cosmetic manufacturers do not formulate their own additives, but rather buy them in bulk from wholesalers. Table 14.6 contains a few of the many herbal additives and their purported benefits (46).

TABLE 14.6: Herbal Additives

Plant Derivative	Purported Function
Allantoin	Anti-irritating
Almond oil	Emollient
Aloe vera	Skin soother, moisturizer
Avocado oil	Skin soother
Chamomile (bisabolol)	Skin soother
Camphor	Skin refresher
Cypress	Skin refresher
Elder	Skin toner
Geranium	Skin softener
Hawthorne	Astringent
Hazelnut oil	Emollient
Horse tail	Skin toner
<i>Hypericum</i>	Skin refresher
Jojoba	Humectant, moisturizer
Licorice	Skin soother, softener
Linden flower	Skin soother
Lotus	Skin soother, softener
Marigold	Decrease skin edema
Marjoram	Skin toner
Myrrh	Nail strengthener
Sage	Skin toner
Seaweed	Skin soother
Sesame oil	Emollient
Shea butter	Moisturizer
Wheat germ oil	Emollient
Witch hazel	Astringent

The area of plant additives is made more confusing by the centuries of mystique that have surrounded herbal medicine, still actively practiced, and herbal aestheticians, who are making a resurgence with aromatology and herbology. There is no doubt that many of the plant additives impart a pleasing smell and color to cosmetics (47). Plant additives can be obtained as hydroglycolic extracts, essential oils, and whole plant extracts (48). Hydroglycolic extracts are a combination of propylene glycol and water, which yield the water-soluble plant constituents, but not the oil-soluble aromatic fragrances. These extracts are formulated into finished cosmetics in a 3–10% concentration. Essential oils, extensively discussed in the fragrance chapter, yield the volatile nonaqueous constituents but no tannins, flavonoids, carotenoids, or polysaccharides. These extracts are formulated into cosmetics in a 2–5% concentration. Finally, whole plant extracts, also known as aromaphytes, are produced by double extraction and contain all the constituents of the plant. They are used at a 5–20% concentration in cosmetic formulations.

Plant additives impart a pleasing smell and color to cosmetics.

Some of the currently popular herbal additives include aloe, avocado oil, sesame oil, and tea tree oil. Aloe is derived as a gelatinous substance squeezed from the leaf of the *Aloe arborescens* Miller (49). It is thought to be of benefit in healing burns and enhancing skin repair, although no published wound-healing studies have confirmed this belief (50). However, it has been shown to induce capillary vasodilation and act as an antimicrobial in concentrations greater than 70% (51). Avocado, sesame, and tea tree oil are used in moisturizers as emollients. However, tea tree oil, also known as melaleuca oil, is derived from the *Melaleuca alternifolia* Cheel and thought to be effective in the treatment of furuncles, psoriasis, and fungal infections. These claims have not been proven, but cases of allergic contact dermatitis to D-limonene, a constituent of tea tree oil, have been documented (52).

Other plant additives, such as witch hazel, are well-established astringents, whereas allantoin and alpha-bisabolol, a chamomile extract, have been used for years in cosmetics designed for sensitive skin due to anti-inflammatory properties. Some plant additives are found on the skin protectant monograph, such as colloidal oatmeal. Colloidal oatmeal has been used in the bath for dermatitis sufferers, whereby the oats act as a physical barrier to water evaporation from the skin into the bath water, thus minimizing skin dryness. Now, various fractions of oats are available for many different skin uses. The addition of colloidal oatmeal to moisturizers allows manufacturers to make more robust skin treatment claims related to eczema improvement. If you see the word eczema on a skin moisturizer, it likely has colloidal oatmeal to support the claim. However, oatmeal contains many useful phytochemicals. It possesses avenanthramides, which are alkaloids that consist of anthranilic acid and hydroanthranilic acid linked through an amide bond to hydroxycinnamic acid. Avenanthramides are responsible for the antioxidant and anti-inflammatory properties of oats, but also possess itch reducing capabilities. It appears that avenanthramides function primarily through inhibition of NF-kappaB signaling, which decreases the production of pro-inflammatory cytokines, such as interleukin (IL)-8.

An interesting and controversial herbal additive is obtained from the hemp plant, known as cannabidiol. Cannabidiol,

abbreviated CBD, is a compound naturally found in the *Cannabis sativa* family of plants, which includes hemp plants and marijuana. Hemp plants contain abundant CBD and almost no THC, an abbreviation for delta-9-tetrahydrocannabinol, which is the psychoactive drug in marijuana. For this reason, most CBD is derived from industrial hemp plants. In 2018, a Farm Bill was passed that removed hemp from the legal definition of marijuana. This made hemp-based CBD products with less than 0.3% THC federally legal; however, there is some variation regarding CBD under state laws. This is further complicated by the fact that the federal government does not habitually enforce against these products.

There are several parts of the hemp plant that are used commercially. CBD oil is extracted from the leaves and flowers of the hemp plant and hemp oil is extracted from the seeds of the *C. sativa* plant. CBD is a lightweight oil as compared to hemp seed oil that is much greasier.

The human body contains a highly conserved network of endocannabinoid molecular signaling important in bodily homeostasis. Endocannabinoid dysregulation is thought to contribute to atopic dermatitis, itch, pigmentation, hair growth, and acne. Cannabinoid 2 receptors are found in keratinocytes, nerves, melanocytes, eccrine glands, and hair follicles. The main benefits are CBD are purported to include the following:

1. *Sebum regulation*: CBD may decrease sebum production and improve acne due to an anti-inflammatory effect on sebocytes.
2. *Anti-inflammatory*: CBD may reduce redness in eczema and psoriasis due to anti-inflammatory effects.
3. *Skin hydration*: CBD is an oil and may be an occlusive moisturizer improving skin hydration.

However, CBD is difficult to deliver into the skin due to its molecular weight (314.46 Daltons) and much of topically applied CBD may reside on the skin surface unless a carrier system is utilized.

Identifying safe CBD products can be challenging because most are manufactured by small companies. The following recommendations might help patients avoid CBD issues:

1. Look for company testing that verifies the products contain no more than 0.3% THC.
2. Be sure the products have third-party testing performed for potency and safety.
3. Look for certificates of analysis that indicate tests were passed for heavy metals, microbes, and pesticides.
4. Insure that the manufacturing company has not received a warning letter from the FDA.

There are several industry terms used to describe CBD products to the consumer with important meaning. The terms the dermatologist should understand are as follows:

1. *Isolate*: CBD isolate products contain a purified crystal CBD precipitate that does not contain any THC.
2. *Broad-spectrum*: This terminology means THC has been removed to the lowest possible amount. CBD products that are labeled “broad-spectrum” are likely to meet state requirements and can cross state lines without difficulty. These products contain a range of cannabinoids, terpenes, and flavonoids derived from hemp without THC.

3. *Full-spectrum*: This wording means the extracts in the skin care product contain mostly CBD, but can include other cannabinoids including THC, but only at levels of 1% or less. THC in this concentration is not thought to be psychoactive.

The CBD market is growing tremendously and will likely lead to greater use of this herbal extract.

Vitamin additives

Vitamin additives have become popular due to the recognition that beta-carotene, vitamin C, and vitamin E can act as antioxidants. Table 14.7 summarizes some of the currently used vitamins and their purported cosmetic value.

Further study is required before it can be stated that topical vitamin C, vitamin E, and beta-carotene can function as antioxidants, quenching oxygen radicals that can damage structures within the dermis (53). Nevertheless, some interesting preliminary work has been published in this area. Vitamin C is a hydrophilic substance that can function as an antioxidant, or as an oxidant if combined with iron. It has been shown to protect porcine skin from UVB- and UVA-induced phototoxic reactions when topically applied (54). Thus, it may act as a broad-spectrum photoprotectant by enhancing cutaneous levels of vitamin C (55). Studies have demonstrated the value of alpha-tocopherol, also known as vitamin E, as a lipid-soluble chain-breaking antioxidant in erythrocyte membranes (56). Topically applied alpha-tocopherol has also been shown to inhibit UVB-induced edema and erythema, conferring a sun protection factor (SPF) of 3 (57). This is thought to be due to its ability to marginally absorb light and function as a free radical quenching, lipid-soluble antioxidant (58). Carotenoids, of which beta-carotene is an example, have been shown to function as antioxidants in hydrophobic compartments that are inaccessible to tocopherols due to their unique solubility properties (59).

Vitamin additives are commonly used as topical antioxidants, although their oral efficacy is higher.

Liposomes and niosomes

Liposomes and niosomes are not individual ingredients, but rather a formulation technique used to deliver materials to the skin. Nanoparticles are another delivery method, and this discussion is found in the sunscreen chapter. Liposomes and niosomes

were initially discovered in the 1960s and reported by AD Bangham in 1965 in the *Journal of Molecular Biology*. His discovery centered on the observation that phospholipids could be dispersed in an aqueous solution to spontaneously form hollow vesicles, or liposomes, containing the dispersing medium (60). This observation received immediate attention from the pharmaceutical industry, which theorized that liposomes could be used as a delivery system for aqueous solutions of active agents. Later, the cosmetics industry adapted the technology for the delivery of non-prescription ingredients to the skin.

Liposomes are spherical vesicles with diameters between 25 and 5,000 nm formed from membranes that consist of a bilayer of amphiphilic molecules (61).

Amphiphilic refers to the fact that the molecules have both polar and nonpolar ends. Bilayer denotes that the polar heads are directed toward the inside of the vesicle and to its outer surface. (This is in contrast to micelles, which are monolayer structures with the polar head directed to the exterior only.) The nonpolar, or lipophilic tails, are directed toward the middle of the bilayer. This unique structure thus allows the sustained release of water-soluble chemicals from the liposome structure. Liposomes may be one double layered (unilamellar), two to four double layered (oligolamellar), or multilayered (multilamellar) vesicles.

The bilayer that forms the liposome and separates its interior compartment from the external environment is remarkably similar to the cell membrane of mammalian cells. This membrane structure has been highly conserved through evolutionary change. Advocates of liposomes argue that this allows biocompatibility with cells, minimizing adverse reactions (62).

The primary substances used to form liposomes are phospholipids such as phosphatidylcholine. Other minor components may include phosphatidylethanolamine, phosphatidylinositol, and phosphatidic acid. Vegetable phospholipids are also used because of their high concentration of the essential fatty acids, linoleic and linolenic acid. Parameters that influence the function of liposomes in topical preparations include chemical composition, vesicle size, shape, surface charge, lamellarity, and homogeneity. Liposome function is also dependent upon where the active agent is trapped (inside the vesicles, in the membrane, or on the outer surface of the vesicle) and the chemical nature of the active agent (hydrophilic, amphiphilic, or lipophilic). The length of the phospholipid carbon chain largely determines whether a micelle or liposome is formed and the size of the structure.

Niosomes are a specialized form of liposome composed of non-ionic surfactants. Their main components are ethoxylated fatty alcohols and synthetic polyglycerol ethers (polyoxyethylene alkyl ester, polyoxyethylene alkyl ether).

Niosomes are a specialized form of liposome composed of non-ionic surfactants.

Theoretically, liposomes offer the cosmetic chemist new formulations with new physical properties, a new transport system for active agents and possibly increased efficacy of active agents. Liposomes, however, are somewhat unstable as they are readily deformed and possibly lysed by the weight of a glass cover slip

TABLE 14.7: Vitamin Additives

Vitamin	Purported Function
Beta-carotene	Antioxidant
Biotin	Improve fat metabolism
Panthenol	Hair conditioner
Riboflavin	Maintain healthy skin
Vitamin A	Promote skin elasticity, smoothness
Vitamin C	Antioxidant
Vitamin E	Antioxidant
Vitamin F (essential fatty acids)	Skin nourishing

when viewed under the microscope. They are also subject to fusion, aggregation, and precipitation. The vesicular structure can be stabilized by cholesterol and incorporation of an ionic charge, but they remain fragile.

The mechanism of action of liposomes and niosomes on the skin remains controversial. Many articles in cosmetic trade publications have tried to use radiolabeled substances and freeze fracture electron microscopy to observe their interaction with the stratum corneum and papillary dermis. It is unlikely that liposomes and niosomes are able to diffuse intact intercellularly across the stratum corneum. The corneocytes are imbedded in lipids, such as ceramides, glycosylceramides, cholesterol, and fatty acids, which are structurally different from the phospholipids and non-ionic surfactants (63). It is possible that they may enter the skin through appendageal structures, but this accounts for only a small proportion of the skin surface area. Thus, absorption through this route is small.

There is evidence, however, that the components of liposomes and niosomes are able to interact with skin lipids, even if they are not in an intact vesicular form (64). They may be able to reduce transepidermal water loss by supplementing missing substances within the skin lipid barrier. Furthermore, liposomes and niosomes can form chemical associations with keratin proteins.

Liposomes can also be incorporated into cosmetics, bath products, moisturizers, and sunscreens. Empty liposomes have possibilities as bath oils, emollients and wound healing aids due to their rich concentration of phospholipids. Loaded liposomes can be devised to release their contents at specific temperatures or specific pH levels, a concept known as “triggering”. These liposomes can be loaded with sunscreens to enhance distribution within the stratum corneum or moisturizers to reduce transepidermal water loss. The liposome concentration in such formulations is usually 1–10%.

Clean cosmetics

The concept of “clean cosmetics” seems to be gaining traction with consumers in the current marketplace. It is unclear what constitutes “clean cosmetics,” however, cosmetic ingredient watchdogs promulgated the idea that some products contained “bad” substances that could damage skin and overall general health. This then led to the development of lists of ingredients with various safety ratings, allowing consumers to assess the safety of the products they purchase. The problem is that the “good” and “bad” ingredient lists are inconsistent and are made by individuals who do not appear to be cosmetic chemists. Clean cosmetics are supposed to be free of all “bad” ingredients. However, if you look at the lists, you will notice that many of the “bad” ingredients are preservatives. This is expected because preservatives are put in products to kill bacteria and prevent contamination. They are used in very low concentration and are essential to prevent product spoilage. There are no good preservatives by definition.

Other lists of clean cosmetics do not allow any petroleum-derived substances to be used, such as petrolatum or mineral oil. Petrolatum was actually one of the first cosmetics introduced into the marketplace and is the one moisturizer that is closest in construction to the behavior of intercellular lipids. Many of the clean ingredients are botanically derived and are considered “good” because they come from plants; however, dermatologists know that plants can be allergens and are not necessarily good for the skin. Thus, this distinction between “good” and “bad” ingredients is difficult to generalize for all individuals. At present, it appears

that “clean cosmetics” is a marketing campaign to create brand distinction in a crowded marketplace.

Sustainable and green cosmetics

The whole concept of sustainability is sweeping the cosmetics and skin care industry, not only in ingredient selection, but also in packaging. Many cosmetics and skin care products come in elaborate packaging with outer wraps over a cardboard box with a tissue paper interior liner over a cardboard piece to stabilize the bottle during shipping in a plastic bottle. All of these items ultimately end up in a landfill, and there is concern that packaging waste should be recyclable and minimized. The other part of sustainability is not over-harvesting ingredients from natural sources. For example, rare barks that come from Brazil that are used in fragrances could be easily depleted in the rain forest. This has led to fragrance analysis and the production of individual fragrance ingredients that smell like the rare bark, but are completely synthetic. This prevents selective depletion of plants. Other essential oils that are derived from flowers can also be synthetically created, which encourages sustainability of the plant, but also means the ingredients are not natural as they do not come directly from the plant source. Indeed, sustainability is important in cosmetics, yet the exact nature of what sustainability embodies has not been universally defined.

Green skin care is another rather vague marketing term. Some use the term green skin care synonymously with clean skin care, meaning that no harmful ingredients have been used, as discussed previously. However, green skin care products may also contain only plant-derived ingredients with no animal products, such as gelatin or hydrolyzed proteins. They may also eliminate any ingredients obtained as byproducts from fossil fuels. Sometimes green skin care products simply come in a green container! It appears that each consumer can make their own vision of what green skin care products offer.

Summary

This chapter discussed some of the problematic ingredients in cosmetic formulations. Certainly, preservatives and color additives lead the list. Recently, there was some media discussion that lipsticks contained lead and could be a source of lead poisoning. As with all media reports, there is some truth to the concern. Many red lipstick pigments contain very small amounts of lead, but their safety is excellent due to the extremely small amount and the fact that lipstick is not eaten 500 tubes at a time. It must be remembered that no ingredient is 100% safe for all individuals. This realization is important because the dermatologist must listen carefully to patients who note difficulty with certain ingredients to troubleshoot the problem and to arrive at acceptable formulations for patient use.

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Section II

Cosmetics in Dermatology of the Body

Introduction

The body encompasses the largest area of skin, including the neck, back, chest, arms, and legs. Unique cosmetic products are available for the adornment and treatment of all these body areas to meet the needs of odor management, hair growth, and sebum removal. This customization of products has given rise to a multitude of bottles on the store shelf, yet each must have a need because products that do not sell are quickly removed. Let us begin our discussion with the neck and move down the body to examine how skin care products can be used in the treatment and maintenance of this large body surface area.

The neck is an interesting area of highly mobile skin that provides a transition between the thin skin of the face and the thicker skin of the upper chest and back. It contains fully mature hairs in men and thin vellus hairs in women. It is an important area from a cosmetic standpoint because it is an area affected by shaving in men, fragrance application in women, and photodamage in both sexes. Poikiloderma is one of the most common visible cosmetic problems of the neck, resulting from photoaging that causes loss of dermal collagen, visible sebaceous glands, damaged elastin, mottled pigmentation, and telangiectasia. The neck is also the site where women and men apply fragrance, which can be a cause of allergic or irritant contact dermatitis. Finally, the neck in men is a transition area for hair growth between the beard of the face and the body hair of the chest. For this reason, the hair exits the skin in many directions, which predisposes to inflammation of the hair follicular ostia, more commonly known as razor burn. Severe razor burn accompanied by ingrown hairs in African American men is known as pseudofolliculitis barbae and occurs when the curved hair shafts re-enter the skin, causing inflammation and infection. Thus, the neck requires careful cosmetic consideration.

The next area moving down the body is the back and chest. These areas contain the thickest skin of the body required to sustain pulling and twisting movements from arm motion. This thick skin does not heal well and is a common site of unsightly hypertrophic or keloidal scars. In addition, the chest and back have fewer sebaceous glands than the face, yet receive abundant hot water from the shower head, predisposing to eczematous conditions and the need for mild cleansing and superb moisturization.

Tucked away between the chest and the back are the axillae, representing a unique intertriginous body area. Other intertriginous sites on the body that have the same hygiene and skin care needs include those beneath the female breasts, between the upper inner thighs, and in persons who are obese, beneath the abdomen. Intertriginous sites are characterized by moisture retention, skin movement, and warmth. This environment is perfect for the growth of fungus, yeast, and bacteria, thus the intertriginous sites are frequent sites of dermatologic disease. These areas combine

hair with abundant eccrine and apocrine sweat glands. Eccrine sweat glands produce a clear, odorless sweat designed to cool the body and prevent overheating. Apocrine sweat glands do not participate in thermoregulation but rather produce a yellowish, scented sweat that provides a perfect growth medium for odor-producing bacteria and yeast. Controlling sweat prevents body odor, skin barrier damage, infection, and emotionally disturbing wetness. This is the realm of deodorants and antiperspirants. Further, hair removal via shaving in the home is challenging in the armpit due to concavity.

Similar challenges for hair removal exist on the arms and legs of both men and women. Shaving these large body surfaces can result in irritation from razor trauma, whereas depilatories and waxing can traumatize the follicular ostia. These areas also receive excess bathing, resulting in eczematous disease that can be minimized by proper cleanser selection and the use of moisturizers.

Perhaps one of the most interesting aspects of cosmetics in dermatology is the difference between the skin structure, biochemistry, and functionality of men versus women because it may explain the gender aspects of dermatologic disease. Although obvious differences exist between men and women concerning hair growth patterns, other subtle discrepancies in skin structure may not be so apparent ([Table II.1](#)). For example, male skin is more deeply pigmented than female skin, perhaps accounting for the saying that women are the “fairer” of the species. Male skin is also thicker and thus contains more collagen. This may explain why women appear to age more quickly than men. Both genders experience the same rate of collagen loss, but women begin with a lower baseline and lose proportionately more collagen. Women also possess more subcutaneous fat, which predisposes to cellulite and creates less muscle definition. Gender-specific fat also distributes in different body areas, with men depositing truncal

TABLE II.1: Gender Differences in Skin Structure

Attribute	Female	Male
Skin color	Lighter	Darker
Red skin tones	Lower	Higher
Yellow skin tones	Higher	Lower
Skin thickness	Thinner	Thicker
Amount of collagen	Less	More
Rate of collagen loss	Same	Same
Subcutaneous fat	More	Less
Fat distribution	Gluteal and femoral	Truncal
Cellulite	More	Less
Appearance of aging	Faster	Slower

TABLE II.2: Gender Differences in Skin Biochemistry

Attribute	Female	Male
Sebum production	Less	More
Fibroblast proliferation	More	Less
Sweat production	Less	More
Sweat evaporation rate	Higher	Lower
Transcutaneous oxygen level	Higher	Lower
Body skin pH	Higher	Lower
Axilla skin pH	Same	Same

fat and women depositing more gluteal and femoral fat. Men also appear to age more slowly than women, not only due to increased skin thickness but also due to the presence of facial hair. As the collagen is degraded with intrinsic and extrinsic aging, the terminal hair bulbs on the male face take up more space and thus prevent the fine cigarette paper wrinkling on female cheeks.

Structural skin differences can be visibly appreciated, but skin biochemical differences are equally important (Table II.2). Male skin secretes more sebum than female skin throughout life. Although female sebum production dramatically decreases after menopause, male sebum secretion continues. Sebum reduction in women is also accompanied by lower levels of stratum corneum lipids, which may be attributed to decreases in estrogen levels with advancing age. Sebum reduction in women with age may explain why mature men have a higher incidence of seborrheic dermatitis than mature women.

There are also differences in the ability of female versus male fibroblasts to proliferate. Female fibroblasts proliferate at a 16% higher rate than male fibroblasts at age 30. This may explain why women tend to heal better than men, especially after facial surgery. Another explanation for superior healing may also be the reduced thickness of female facial skin.

Although differences exist in skin structure between men and women, there are also differences in the substances that are present on the skin surface. Men tend to sweat more than women, creating an environment more conducive to bacterial growth and odor production. Male sweat also remains on the skin longer. In addition, men possess more body hair, which increases the body surface area for bacterial colonization. This may be due to the increased popularity of antibacterial soaps among men. The presence of sweat may also contribute to differing skin pH measurements between men and women. Women have a higher, more alkaline pH, whereas men have a relatively lower pH, but the pH of the axilla is identical in both sexes.

TABLE II.3: Gender Differences in Skin Functionality

Attribute	Female	Male
Transepidermal water loss (TEWL) rate	Lower	Higher
Skin blistering times	Longer	Shorter
Skin elasticity	Same	Same
Stratum corneum stiffness	Higher	Lower
Tape stripping removal of stratum corneum	Same	Same
Skin temperature	Cooler	Hotter
Fingertip temperature	28C	33C
Heat-induced vasodilatation temperature	Lower	Higher
Sympathetic tone	Increased	Decreased
Irritant contact dermatitis incidence	Higher	Lower
Facial lactic acid stinging	Higher	Lower
Minimal erythema dose	Higher	Lower

Finally, women have a higher transcutaneous oxygen level than men. The exact significance of this is not known but may be explained by the thinner epidermis.

In addition to skin biochemical differences, there are also differences in skin functionality (Table II.3). These functional differences can impact how skin care products perform on the skin and may dictate product formulation specifics. It is interesting to note that transepidermal water loss (TEWL) is lower in women than in men, even though women feel that their skin is drier when polled. Women also generally feel that their skin sags more than that of men, but skin elasticity is identical between the sexes. The increased impression of sagging may be due to thinning collagen rather than decreased skin elasticity.

Female skin is more functionally responsive than male skin. This is manifested by the lower temperature at which heat induces vasodilatation. It also presents as an increase in irritant contact dermatitis and increased sympathetic tone. This may explain why women exhibit increased redness and irritation to skin care products, sometimes referred to as “tender” skin, over men, who are characterized as having “tough” skin.

The differences between male and female skin structure, biochemistry, and functionality and the differences in skin of various body areas create opportunities for skin care and cosmetic product development. This section of the book will examine products for skin care of the body, from moisturizers to cleansers, sunless tanners to sunscreens, and cellulite to stretch mark creams, to encompass the entire category of body cosmetics in dermatology.

PERSONAL HYGIENE, CLEANSERS, AND XEROSIS

Optimal personal hygiene has come to mean bathing daily with lots of soap lather and abundant hot water, as hot as the skin can stand. Furthermore, many patients bathe in the morning to “wake up” and bathe in the evening to “go to sleep.” Others bathe a third time after finishing a workout at the gym. Certainly, these personal hygiene habits require lots of cleansers and may result in xerosis and ultimately xerotic eczema. Cleansing the body has become an essential part of personal hygiene, and the desire to bathe daily has created a demand for cleansing products that simply do not cleanse as well. This chapter examines cleanser formulations for the body and how cleanser selection can aid the patient in maintaining their self-perceived personal hygiene standards without creating dermatologic problems.

Cleanser types

Selecting a good cleanser can be a challenge for any patient. The shelves are full of body cleansing products in every color of the rainbow, each with a unique skin-enhancing ingredient like vitamin E, shea butter, jojoba oil, emu oil, cleansing cream, lavender, chamomile, ginger, glycerin, panthenol, and collagen. Every scent imaginable can be found, including kiwi, pineapple, pear, vanilla, raspberry, apple, lemon, sage, rosemary, and mango to name a few. Every scent can also be found in combination with every other scent to create stores selling nothing but hundreds of cleansers, each with a different color and scent combination, but all accomplishing the same end of removing sebum, perspiration, environmental dirt, cosmetics, and medications from the skin surface.

Selecting the proper cleanser is key to maintaining the skin acid mantle and preserving skin health.

Cleansers come in many different formulations for body cleansing including bars, liquids, and scrubs all trying to achieve the optimal clean and fresh feel. There are foaming and nonfoaming cleansers customized to each and every body area. There are scented and unscented cleansers, with some labeled as appropriate for sensitive skin. There are cleansers for women and separate formulations for men. However, in reality, there are some basic categories of cleansers upon which many variations have been manufactured.

The three basic cleansing types are true soaps, syndets, and combars.

Soaps

Soap is the most basic of cleansers and has been a cleansing staple for 4,000 years, ever since the Hittites of Asia Minor cleaned their hands with the ash of the soapwort plant suspended in water and the Sumerians of Ur produced alkali solutions for washing.

Neither of these products, however, is chemically similar to soap as it is known today. The actual modern soap preparation was developed about 600 BC by the Phoenicians, who first saponified goat fat, water, and potassium carbonate-rich ash into a solid, waxy product. The popularity of soap has waxed and waned over the years. During the Middle Ages, soap was outlawed by the Christian Church, which believed that exposing the flesh, even to bathe, was evil. Later, when the idea of bacteria-induced infection surfaced, the sale of soap soared.

The first widely marketed soap was developed by Harley Procter in 1878, who decided that his father's soap and candle factory should produce a delicately scented, creamy white soap to compete with imported European products. He accomplished this feat with the help of his cousin chemist, James Gamble, who made a richly lathering product called “White Soap.” Accidentally, they discovered that whipping air into the soap solution prior to molding resulted in a floating soap that could not be lost in the bathe (1). This resulted in a product known as “Ivory” soap, still manufactured today.

Soap functions by employing a surfactant to lower the inter-skin tension between the nonpolar soil and the rinsing water, which floats away the dirt in the lather. The manufacturing stages in a typical bar soap are listed in Table 15.1 (2).

In basic chemical terms, soap is a reaction between a fat and an alkali resulting in a fatty acid salt with detergent properties (3, 4). Modern refinements have attempted to adjust its alkaline pH, possibly resulting in less skin irritation (5), and incorporate substances to prevent precipitation of calcium fatty acid salts in hard water, known as “soap scum” (6). Nevertheless, modern soap is basically a blend of tallow and nut oil, or the fatty acids derived from these products, in a ratio of 4:1. Increasing this ratio results in “superfatted” soaps designed to leave an oily film behind on the skin. Bar soaps can be divided into three different cleanser types, as listed in Table 15.2.

Soap is a reaction between a fat and an alkali, resulting in a fatty acid salt with detergent properties.

TABLE 15.1: Steps in Soap Manufacture

1. Saponification of natural fats and preparation of milling chips
2. Blending of soap chips with other ingredients
3. Milling and shredding
4. Extrusion into long strips, known as billets, and cutting into appropriate lengths
5. Stamping into the final shape
6. Aging and packaging

TABLE 15.2: Types of Cleansers

1. True soaps composed of long-chain fatty acid alkali salts, pH 9–10
2. Syndets composed of synthetic detergents and fillers, which contain less than 10% soap, pH adjusted to 5.5–7.0 (8)
3. Combars composed of alkaline soaps to which surface active agents have been added, pH 9–10

Soap is a common term used by many as synonymous with cleanser. However, soap is a specific cleanser with a definite chemical composition. The simplest soaps are manufactured in the bar form. There are currently three different types of bar cleansers on the market, all called “soap” by consumers, but with very different skin effects. There are the true soaps, which are composed of long-chain fatty acid alkali salts, with a pH between 9 and 10 (7). This is the original soap formulation developed that revolutionized health care in the United States. Perhaps soap, more than any other invention, has improved the quality of human life by preventing the spread of disease. The high pH of these cleansers is excellent at thoroughly removing sebum, but can also damage the intercellular lipids in diseased or sensitive skin. This formulation also experiences difficulty when used with hard water. The alkali chemically combines with calcium and other minerals in the water to form what is commonly termed “soap scum.” Soap scum decreases the ability of the soap to rinse cleanly from the skin, causing irritant contact dermatitis in susceptible individuals. The only major brand of true soap left on the market today is Ivory soap (Procter & Gamble, Cincinnati, Ohio), as previously mentioned.

Syndets

Following the development of true soaps, came the invention of synthetic detergents. Synthetic detergents are known as syndets and contain less than 10% real “soap.” Rather than possessing a highly alkaline pH, these products can be made with a pH adjusted to 5.5 to 7. This more neutral pH is similar to the normal acid mantle pH of the skin, causing less irritation. The tightness that is experienced following cleansing is actually the perception of altered skin pH. This is not a problem in normal complected individuals, but can be a source of concern in persons with eczema or atopic dermatitis. Unfortunately, many associate the tight feeling with cleanliness, and it can be a challenge to convince a patient that the tight feeling is possibly an indicator of impending skin disease. Most syndet cleansers leave the skin with a smooth, sometimes slimy, feel that indicates that the intercellular lipids have not been removed, and the skin barrier is intact. Syndet cleansers, sometimes known as beauty bars, are the most popular cleansers in use today. They offer milder, yet thorough, cleansing of all body areas.

Syndets are made from synthetic detergents, most commonly sodium cocoyl isethionate, and provide the gentlest cleansing.

The purpose of developing new synthetic detergents over traditional soaps was to provide a product less irritating to the skin. Commonly used detergents in bar type cleansers are sodium cocoate, sodium tallowate, sodium palm kernelate, sodium stearate, sodium palmitate, triethanolamine stearate, sodium cocoyl isethionate, sodium isethionate, sodium dodecyl benzene sulfonate, and sodium coco glyceryl ether sulfonate. Detergents in liquid formulations are sodium laureth sulfate, cocamidopropyl betaine, lauramide diethanolamine, sodium cocoyl isethionate, and disodium laureth sulfosuccinate. The normal pH of the skin is acidic, between 4.5 and 6.5. Applying alkali soap theoretically raises the pH of the skin, allowing it to feel dry and uncomfortable (9). However, healthy skin rapidly

regains its acidic pH (10). The effects and measurement of surfactant-induced irritation remains a controversial area under investigation (11).

Combars

The third form of cleanser is combination bar (combar). Combars combine true alkaline soaps with syndets to create a bar with greater cleansing abilities, but less intercellular lipid damage (8). The majority of the bars in this category are also known as deodorant bars. They contain benzalkonium chloride, a commonly used topical antibacterial, to decrease body odor caused by bacteria, especially in the armpits and groin.

Combars contain soap and synthetic detergents to provide moderate cleansing and are most commonly formulated as deodorant soaps with benzalkonium chloride.

Selecting the proper type of “soap” may be tricky for the physician, but once the three categories of cleansers are identified, the task becomes much easier. In general, all beauty bars, mild cleansing bars, and sensitive skin bars are of the syndet variety (Oil of Olay, Dove, and Cetaphil). Most deodorant bars or highly fragranced bars are of the combar variety (Dial, Coast, and Irish Spring), and very few true soaps are currently on the market (Ivory).

Cleanser additives

Special additives added to the previously discussed formulations allow the tremendous variety of soaps marketed today (Table 15.3). Lanolin and paraffin may be added to a moisturizing syndet soap to create a superfatted soap, whereas sucrose and glycerin can be added to create a transparent bar. Adding olive oil instead of another form of fat distinguishes a castile soap. Medicated soaps

TABLE 15.3: Specialty Soap Formulations

Type of Soap	Unique Ingredients
Superfatted soap	Increased oil and fat; fat ratio up to 10%
Castile soap	Olive oil used as main fat
Deodorant soap	Antibacterial agents
French milled soap	Additives to reduce alkalinity
Floating soap	Extra air trapped during mixing process
Oatmeal soap	Ground oatmeal added (coarsely ground to produce abrasive soap, finely ground for gentle cleanser)
Acne soap	Sulfur, resorcinol, benzoyl peroxide, or salicylic acid added
Facial soap	Smaller bar size, no special ingredients
Bath soap	Larger bar size, no special ingredients
Aloe vera soap	Aloe vera added to soap, no special skin benefit
Vitamin E soap	Vitamin E added, no special skin benefit
Cocoa butter soap	Cocoa butter used as major fat
Nut or fruit oil soap	Nut or fruit oils used as major fat
Transparent soap	Glycerin and sucrose added
Abrasive soap	Pumice, coarse oatmeal, maize meal, ground nut kernels, dried herbs, or flowers added
Soap-free soap	Contains synthetic detergents (syndet bar)

may contain benzoyl peroxide, sulfur, resorcinol, or salicylic acid. Deodorant bars have an added antibacterial, such as benzalkonium chloride. These soaps have a pH between 9 and 10 and may cause skin irritation. Moisturizing syndet bar soaps contain sodium lauryl isethionate with a pH adjusted to between 5 and 7 by lactic or citric acid. These products are less irritating to the skin and are sometimes labeled beauty bars.

Additives to soap are also responsible for a characteristic appearance, feel, and smell. Titanium dioxide is added in concentrations up to 0.3% to opacify the bar and increase its optical whiteness. Pigments, such as aluminum lakes, can color the bar without producing colored foam, a characteristic considered undesirable. Foam builders, such as sodium carboxymethyl cellulose and other cellulose derivatives, can make the lather feel creamy. Finally, perfume in concentrations of 2% or more can be added to ensure that the soap bar retains its scent until completely used (2).

Lipid-free low-foaming cleansers

In addition to soaps, syndets, and combars, there is another category of cleanser that produces minimal foam specially designed for persons with limited sebum production. These cleansers are known as lipid-free low-foaming cleansers. Lipid-free cleansers are liquid products that clean without fats, a point which distinguishes them from the cleansers previously discussed. They are applied to dry or moistened skin, rubbed to produce minimal lather, and rinsed or wiped away (Cetaphil cleanser, Aquanil cleanser, and CeraVe cleanser).

Lipid-free low-foaming cleansers may contain water, glycerin, cetyl alcohol, stearyl alcohol, sodium laurel sulfate, and occasionally propylene glycol. They leave behind a thin moisturizing film and can be used effectively in persons with excessively dry, sensitive, or dermatitic skin. They do not have strong antibacterial properties, however, and may not remove odor from the armpits or groin. They also are not good at removing excessive environmental dirt or sebum. Lipid-free cleansers are best used where minimal cleansing is desired, but can be used to remove face and eye cosmetics in persons with sensitive skin.

Lipid-free low-foaming cleansers are excellent for dry, sensitive skin and effective at removing eye cosmetics.

Body scrubs

Another form of body cleansing combines sebum removal with exfoliation, the removal of the desquamating corneocytes. With advancing age, the ability of the corneocytes to slough is decreased. The retained corneocytes give the skin a rough texture and yellowish appearance. Exfoliation removes the corneocytes, smooths the skin surface, and restores a pinker skin color. Many antiaging cleansers are abrasive scrubs because the exfoliated skin may have a younger appearance. However, an aggressive frequent use of an abrasive scrub can remove too much stratum corneum resulting in sensitive skin and can even provoke eczema.

Body scrubs produce cleansing and exfoliation simultaneously.

Abrasive scrubs use a particulate material rubbed over the skin surface with the hands to mechanically remove the corneocytes. Abrasive scrubs incorporate polyethylene beads, aluminum oxide, ground fruit pits, or sodium tetraborate decahydrate granules to induce various degrees of exfoliation (12). The most abrasive scrub is produced by aluminum oxide particles and ground fruit pits. In general, products containing these rough edged particulates are not appropriate for sensitive skin patients, eczema patients, or atopic dermatitis patients. Polyethylene beads are the most common particle used in body scrubs and produce mild exfoliation without damaging the skin due to the round bead. Recently, concern has arisen about the safety of polyethylene beads in the environment because the beads remain in the water columns for years without degrading. The beads can act as a nidus for the growth of bacteria and may be toxic to some marine life forms. This concern has increased the popularity of dissolving scrubs using sodium tetraborate decahydrate granules.

The main problem with abrasive scrub products for exfoliation is the tendency for overuse by the patient. The harder and longer the patient rubs, the more that the stratum corneum will be removed. Too much stratum corneum abrasion will result in self-induced sensitive skin. One of the best uses of body scrubs is on the anterior shins of patients with ichthyosis vulgaris. The occurrence of ichthyosis vulgaris increases with advancing age due to a desquamatory failure resulting in the appearance of dry skin. Moisturizers can improve the appearance by smoothing down the edges of the desquamating corneocytes, but the effect is cosmetic and temporary. Body scrubs can dislodge the corneocytes revealing the well-hydrated skin beneath. Lactic acid and other hydroxy acid moisturizers have been recommended to chemically exfoliate the skin, but the body scrub is the most efficient way to improve the appearance of ichthyosis vulgaris.

Body washes

A variation on the soap, syndet, and combar detergents discussed earlier is the body wash. Body washes are liquid cleansers with a unique emulsion. The emulsion is characterized as a two-phase liquid with a hydrophobic phase and a hydrophilic phase held together by an emulsifier. The surfactant cleanser is in the hydrophilic phase and binds to the dirt, which is washed down the drain. Vegetable oils, humectants, dimethicone, and petrolatum are in the hydrophobic phase, which bind to the skin surface decreasing TEWL and providing an environment optimal for barrier repair. This is the mechanism of action of body washes claiming to both cleanse and moisturize. These products are of use in atopic patients who either wish to bathe more frequently or those with severe disease.

The key question is, how does the body wash know whether to cleanse away sebum or deposit the moisturizer? This is accomplished by varying the water concentration between the two skin-care events, one being cleansing and the other being moisturizing. During the first phase of washing, the body wash is placed on a puff, to increase the amount of air and water in the emulsion, followed by rubbing it over the body (Figure 15.1). At this time, the concentration of water is very low and the concentration of body wash is very high, and cleansing occurs. During the rinse phase, the water concentration is very high, and the body wash concentration is very low. It is during the rinse phase that the moisturizing ingredients are deposited on the skin surface.



FIGURE 15.1 An example of a puff, which is necessary to introduce air and water into the body wash emulsion.

Body washes are available for extra dry, dry, and normal skin. These products can deposit different amounts of moisturizer based on the construction of the emulsion (Figure 15.2). Large moisturizing ingredient droplets within the emulsion, containing petrolatum, soybean oil, and dimethicone, create a high-depositing body wash. During the rinse phase, these droplets are left behind on the skin surface. A product for normal skin might be a medium-depositing product with smaller droplets leaving behind a lesser amount of moisturizing ingredients. The dry skin body washes are most appropriate for atopic patients because they leave behind



FIGURE 15.2 A body wash designed for dry skin.



FIGURE 15.3 An example of a body wash with two phases for extra dry skin.

significant skin protectant ingredients. Thus, the size of the oil droplets in the emulsion determine the amount of moisturizing ingredient left behind on the skin during the rinse phase of body wash use (Figure 15.3).

It is possible to measure the efficacy of body wash products by examining transepidermal water loss (TEWL) measurements in patients with atopic dermatitis. TEWL measurements are made with an evaporimeter, which consists of two humidity meters placed at a known distance from the skin surface. The distance between the two humidity meters is also known, as well as how much water vapor is going into the probe, allowing the calculation of water loss from the skin surface in terms of grams of water loss per meter square per hour. This water vapor loss is an indirect measurement of the degree of barrier damage, which directly correlates with the skin injury caused by cleansing. Patients with atopic dermatitis have an increased TEWL based on their disease and defective barrier function. The improvement in barrier function following the use of a body wash can be measured by assessing TEWL before and after bathing. Good cleansers for patients with dermatologic disease will not increase TEWL with repeated use.

Body washes can both clean and moisturize the skin using sophisticated emulsion technology.

Moisturinses

A variant of body wash is known as a moisturinse. Body washes are comparable in formulation to 2-in-1 hair shampoos, and moisturinses are comparable to hair conditioners. After the cleansing

has occurred with the body wash, a moisturizer can be applied. The moisturizer is nonfoaming and rubbed over the entire body followed by rinsing. It has a very small amount of surfactant and a large amount of dimethicone and other oils. This contrasts with the body wash that has a large amount of surfactant and a small amount of the skin conditioning agents, dimethicone, and other oils. The moisturizer deposits moisturizing ingredients on the skin during the rinse phase and increases the amount of moisturizer left on the skin during bathing. The goal is to remove sebum, perspiration, and environmental dirt, but replace the lost skin lipids with synthetic and natural oils to decrease the barrier damage.

Moisturizers are of use in patients who insist on bathing frequently despite problems with recurrence eczema. It is possible that the moisturizer will allow daily bathing in some patients, assisting in compliance and minimizing the use of prescription medications, such as topical corticosteroids. Moisturizers also can be used as cleanser in atopic dermatitis patients who need minimal cleansing and maximal moisturization.

Moisturizers are similar in formulation to hair conditioners and can leave a thin moisturizing film on dry skin.

Cleanser mildness testing

Several methods are used to evaluate the effect of various soap and detergent formulations on the skin. One method of measuring the effects of cleansers on the skin is the soap chamber test developed by Frosch and Kligman (13). An 8% soap solution is applied under occlusion to the volar surface of the forearm in human volunteers. The site is evaluated for scaling and erythema several days later (14). This technique has been expanded to include measurements of TEWL. As expected, soaps induce more TEWL than the synthetic detergents listed previously. A modified chamber test is also used, where a 5% solution of the soap or detergent is applied to the forearm and covered with an aluminum chamber for 18 hours. These tests exaggerate the cleanser's contact with the skin; thus an actual use test is required. This is accomplished by having human volunteers wash their forearms for a two-minute duration four times per day for a week. Visual and TEWL assessments are used to evaluate the skin effect. Usually, a new cleanser formulation is first tested in vitro followed by in vivo and use testing prior to marketing because it can be difficult to predict cleanser/skin reactions (15). The most commonly used in vitro screening tests to evaluate the irritant potential of cleansers are the collagen swelling test, (16) pH rise test, (17) and zein test (18).

The collagen swelling test employs a 1-cm² collagen sheet that is incubated for 24 hours at 50°C with a solution of the finished cleanser product at 1% of the dry extract at its own pH. The collagen is weighed before and after exposure to determine the amount of swelling, with more swelling indicating increased product irritation. Another approach to irritation assessment is to examine pH increase by incubating equal volumes of a 2% solution of bovine serum albumin at a pH of 5.6 with a 2% solution of the finished product at room temperature for one hour. The pH of the solution is measured, with greater pH increases indicating increased product irritation. The last method, or the zein test, utilizes a protein that is insoluble in an aqueous solution until denatured by irritating surfactant products. The more protein that is solubilized, the more irritating the product. Successful

mildness determination with in vitro testing is followed up by in vivo testing.

Many human research testing methodologies have been developed to predict the consumer response to cleansers; however, long-term use testing is clearly the most definitive (19–21). The most commonly used in vivo method is the forearm controlled application technique (FCAT) with each company having its own internal testing standards. This test controlled the amount of cleanser applied, the length of cleansing, and the frequency of testing. It is an exaggerated use test because the cleansing is performed twice daily for a test period of four days. If a new cleanser formulation passes the in vitro and FCAT, it is then put into actual use testing in a wider population, sometimes composed of persons with sensitive skin or skin disease.

One of the most important aspects of cleanser interaction with the skin is the ability of the cleanser to thoroughly rinse from the skin surface. Excellent rinsing ensures minimal irritation, but the ability of soap to rinse from the skin depends on the mineral content of the water. As mentioned previously, calcium in the water can interact with soap to form a sticky white film that can adhere to the sink, tub, and even the skin. Soap scum has an alkaline pH that breaks down the skin acid mantle and causes barrier damage. Mild soaps with minimal irritancy must rinse clean from the skin with water to avoid this problem. Thus, tests are commonly performed to assess the rinsability of cleansers under various pH values and water conditions (22). Most soap manufacturers have a laboratory where they can adjust the pH, hardness, and temperature of the water to simulate washing under various conditions that exist throughout the world. Excellent cleansers with minimal irritancy perform superbly under a wide variety of cleansing environments.

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The body is particularly prone to xerosis due to aggressive frequent bathing habits and the decrease in sebaceous gland concentration. Current beliefs regarding hygiene have created the need for bathing followed by moisturization, which may seem paradoxical because cleansers remove the intercellular lipids from the body skin that are then temporarily and artificially replaced by moisturizers. Problems arise because cleansers cannot distinguish between sebum, which has to be removed for hygiene reasons, and intercellular lipids, which should not be removed to maintain a healthy skin barrier. The skin barrier is an essential element of health, separating the body from the external world. Without this barrier, human life cannot exist. Protection is necessary from infectious organisms that might enter the body, causing a serious disease and possibly death. Regulating electrolyte balance, body temperature, and sensation is also part of this barrier's function. Although the barrier is self-maintaining, with replacement on a 14-day cycle, disease states may perturb the barrier delaying repair or altering repair kinetics. This chapter examines body xerosis and the role of moisturizers.

The body skin barrier

The skin barrier is formed by the protein-rich cells of the stratum corneum with intervening intercellular lipids. In the viable epidermis, the nucleated cells possess tight, gap, and adherens junctions with desmosomes and cytoskeletal elements that contribute to the barrier. Moisturizers attempt to mimic the intercellular lipids that are synthesized in the keratinocytes during epidermal differentiation and then exuded into the extracellular domains. These lipids are composed of ceramides, free fatty acids, and cholesterol, which covalently bind to the cornified envelope proteins. It is changes in these intercellular lipids and alterations in epidermal differentiation that lead to barrier defects and ultimately skin disease.

Moisturizers do not moisturize the body. This is a misnomer. The water that is listed as the first ingredient in body lotions does not increase the water content of the skin because the skin cannot be moisturized externally unless the ambient humidity exceeds 70%. Most controlled indoor spaces maintain humidity below 30%, meaning that there is continuous water loss to the environment. Only the protein-rich corneocytes and intercellular lipids prevent the entire body from dehydration. Water that is orally consumed or topically sprayed on the body does not increase skin water content. Moisturizers actually work by preventing evaporation in the short term and providing an environment for barrier repair in the long term. They are composed of oily substances that lower transepidermal water loss (TEWL), the technical term for skin water evaporation, allowing barrier repair to proceed. Only when the skin barrier is intact is TEWL normalized and healthy skin achieved.

Moisturizers do not moisturize the body. They create an environment for barrier repair.

Body moisturizer ingredients

Even though the number of moisturizers available for purchase is astounding, most body moisturizers use the same basic ingredients as the formulation backbone to achieve efficacy. The three main ingredients in most of the modern body moisturizers are petrolatum, dimethicone, and glycerin. These are the substances that provide the barrier repair environment for the healing of body dermatoses that can be characterized by xerosis.

Petrolatum

The most commonly used active agent in skin care products, after water, is petrolatum.

Petrolatum is a semisolid mixture of hydrocarbons obtained through the dewaxing of heavy mineral oils. Pure cosmetic grade petrolatum is practically odorless and tasteless appeared in the US Pharmacopoeia in 1880. It is interesting that it has never been duplicated synthetically.

Petrolatum is the most effective moisturizing ingredient on the market today, reducing TEWL by 99% (1). It functions as an occlusive to create an oily barrier through which water cannot pass. Thus, it maintains cutaneous water content until barrier repair can occur. Petrolatum can penetrate the upper layers of the stratum corneum and aid in the restoration of the barrier, which is initiated through the production of intercellular lipids, such as sphingolipids, free sterols, and free fatty acids (2). Products containing petrolatum increase the rapidity with which these lipids are synthesized.

Petrolatum impacts all phases of skin remoisturization, the first step toward barrier repair and wound healing. Petrolatum allows the water content of the skin to rise by decreasing evaporative losses, which creates the moist environment necessary for fibroblast migration leading to wound healing and eventual barrier restoration. Furthermore, it is hypoallergenic, noncomedogenic, and non-acnegenic.

Petrolatum also decreases the appearance of fine lines on the face and body due to dehydration. It functions to reduce itching and mild pain by creating a protective film over exposed lower epidermal and dermal nerve endings. It acts as an emollient by entering the space between the rough edges of desquamating corneocytes, restoring a smooth skin surface. It can also function as an exfoliant by loosening desquamating corneocytes, which are physically removed as the petrolatum is rubbed into the skin. Petrolatum is also an important component of many other cosmeceutical formulations that contain additional actives.

Petrolatum is the occlusive moisturizing substance most like the intercellular lipids.

Dimethicone

The major drawback with pure petrolatum as a moisturizer is its greasiness, which most patients find unaesthetic. This can be minimized by lowering the petrolatum concentration and adding

dimethicone, known as an astringent moisturizer, to improve product aesthetics. Dimethicone is the second most common active agent in moisturizers today because it too is hypoallergenic, noncomedogenic, and non-acnegenic (3). Dimethicone is one of a family of silicones that form the basis of all oil-free moisturizers and facial foundations.

Silicone originates from silica, which is found in sand, quartz, and granite. It derives its properties from the alternating silica and oxygen bonds, known as siloxane bonds, which are exceedingly strong. These strong bonds account for the tremendous thermal and chemical inertness of silicone. Silicone is resistant to decomposition from ultraviolet radiation, acids, alkalis, ozone, and electrical discharges. The silicone used in topical preparations is an odorless, colorless, nontoxic liquid. It is soluble in aromatic and halocarbon solvents, but poorly soluble in polar solvents. Because silicone is immiscible and insoluble in water, it is used as an active agent in products designed to be water-resistant. To date, there is no report of toxicity from the use of topical silicone.

Dimethicone cannot replace petrolatum, however, as a moisturizer for decreasing fine facial lines of dehydration or for creating an environment optimal for healing skin (4). Although dimethicone is insoluble in water, it is permeable to water vapor. Thus, if the skin barrier is wounded, dimethicone will not reduce transepidermal water loss. However, this water vapor permeability is important in the manufacture of facial foundations and sunscreens because perspiration must evaporate, or the product will contribute to miliaria and leave the skin feeling warm and heavy.

Dimethicone can provide many other skin benefits as an active agent besides moisturization. It can function as an emollient, making the skin smooth and soft to the touch by filling in spaces between the desquamating corneocytes. It can also smooth skin scale from the use of drying acne medications, such as benzoyl peroxide or tretinoin, without creating a greasy shine undesirable in oily-complected patients. Dimethicone also does not easily mix with facial sebum, allowing other ingredients in the formulation to remain in place on the face. This is valuable in sunscreens and facial cosmetics.

Dimethicone is a popular body moisturizer ingredient because it leaves the skin smooth without a greasy feeling.

Glycerin

Glycerin is a commonly used humectant in skin moisturizers. Humectants are substances that attract water from the dermis and viable epidermis into the dehydrated stratum corneum (5). However, if the skin barrier is damaged, the water will immediately evaporate into the lower humidity environment. For this reason, humectants are always combined with occlusive moisturizers that retard water loss, such as the previously discussed petrolatum and dimethicone. Glycerin, petrolatum, and dimethicone form the backbone of most skin care products to which other novel agents are added.

Glycerin offers some unique skin benefits. It is one of the few moisturizers, in addition to petrolatum, that can create a reservoir effect on the skin. In other words, the effect of glycerin appears to persist long after the glycerin is no longer present. Previously, this effect was thought to be due to glycerin affecting the intercellular lipids. It is now recognized that glycerin is capable of modulating water channels in the skin, known as aquaporins.

Aquaporins are highly conserved water channels present in plants, bacteria, and human skin composed of integral membrane proteins from a larger family of major intrinsic proteins (6). The 2003 Nobel Prize in Chemistry was awarded to Peter Agre and Roderick MacKinnon for their research on aquaporins and ion channels. These channels conduct water in and out of the cell while preventing the passage of ions and some solutes. They are composed of a six transmembrane alpha-helical structures arranged in a right-handed bundle. Aquaporins form tetramers in the cell membrane and control the transport of water as well as glycerin, carbon dioxide, ammonia, and urea. Different aquaporins contain different peptide sequences controlling the size of the molecules that are able to pass; however, aquaporins are impermeable to charged species, such as protons. Typically, water molecules and other neutral solutes can only pass a single file through the channel.

The primary aquaporin in the epidermis is aquaporin-3. It is found in the basal and suprabasal layers of the epidermis, but not in the stratum corneum. Aquaporin-3 expression is also increased in human skin diseases with elevated transepidermal water loss. Thus, glycerin is being rediscovered as a moisturizing ingredient with the potential to dramatically affect skin water balance. Because facial lines of dehydration are the easiest sign of aging to rapidly correct, skin care products based on glycerin, petrolatum, and dimethicone are commonly used to rapidly hydrate the skin and improve appearance. However, petrolatum, dimethicone, and glycerin are also present in the vehicle of most facial skin care creams and lotions. Thus, the vehicle is not only responsible for improving skin condition but also delivers other active agents to the skin surface.

Glycerin is a time-tested body moisturizer that modulates cell osmotic balance through aquaporin channels.

Specialty moisturizing ingredients

Many substances can be added to moisturizers to enhance their marketing claims, and possibly their efficacy, which can be characterized as specialty moisturizing ingredients. These ingredients provide for a tremendous variety of body moisturizers available for consumer purchase. This section evaluates the scientific data published regarding the utility of the most popular moisturizer specialty additives.

Ceramides

Ceramides are an important component of the intercellular lipids. The initiating step in barrier repair is ceramide synthesis. Many body moisturizers contain ceramides as a specialty ingredient theorizing that externally applied ceramides may somehow facilitate barrier repair. There are nine different ceramides that have been identified, and three are synthetically available to the cosmetic chemist. Ceramides are oily substances, and it is unclear whether their efficacy is derived from their incorporation into the intercellular lipids or their effect as an occlusive moisturizer. The location of ceramides in the skin has been studied through tape stripping, where the corneocytes are removed layer by layer with an adhesive tape for 20 tape strippings. ZDD's research has shown that externally applied ceramides can be retrieved in the first 5 to 8 corneocyte layers.



FIGURE 16.1 A commercially available over-the-counter moisturizer containing ceramides.

One commercially available body lotion formulation combines ceramides in a multivesicular emulsion (MVE) (Figure 16.1). MVEs are physically constructed by rapid stirring to create a moisturizing entity known as a liposome. Liposomes are discussed more fully in the chapter on facial moisturization, but are briefly spheres composed of phospholipids containing moisturizing ingredients in their interior. MVEs are a liposome within a liposome within a liposome. The multiple vesicles can time-release moisturizing ingredients onto the skin surface, one layer at a time to create a physical sustained delivery system for moisturizers. MVEs are manufactured using a cationic quaternary amine salt emulsifier, such as behentrimonium methosulfate. The active agents, such as ceramides which may be combined with other moisturizing ingredients (hyaluronic acid, phospholipids, and dimethicone) are mixed into either the oil or water phase, depending on the compatibility. High-shear mixing of the active agents with the emulsifier produces an MVE. Behentrimonium methosulfate is the unique emulsifier that allows formation of the multilamellar concentric spheres of oil and water that trap the active agents in either the alternating lamellar lipid layers or within the aqueous sphere compartment.

Ceramides are found along with petrolatum, dimethicone, and glycerin in many higher priced body moisturizers in the mass and prestige markets. As more of the naturally produced ceramides are available synthetically, more ceramide containing products will appear in the marketplace. Most newly synthesized moisturizing ingredients are first used in department store and spa moisturizers that sell for a premium price. As the novelty of the ingredient wears off and manufacturing costs drop, new moisturizing ingredients find their way into products sold at department stores and boutiques. Finally, when the ingredient can be synthesized in mass quantities, it can be found in drug store and mass merchandiser lines. This is the natural history of most cosmetic ingredients, which are affected by fashion trends and marketing efforts.

Synthetic ceramides are found in body moisturizers with the intent to stimulate barrier repair by providing a substance found in the intercellular lipids.

Essential fatty acids

In addition to ceramides, another component of the intercellular lipids is essential fatty acids, such as unsaturated linoleic and

linolenic acid. In the body moisturizing vernacular, these fatty acids are sometimes referred to as vitamin F. The rationale for topical application is to supplement the skin with fatty acids to drive production of the intercellular lipids, though this has never been proven. It is known that fatty-acid-deficient rodents present with skin that resembles xerotic eczema. The topical application of sunflower oil, a rich source of essential fatty acids, on these rodents normalizes the condition (7). It is rare to find fatty-acid-deficient humans, and it is uncertain whether increased fatty acids make for improved skin. Much of the problem with the topical supplementation in body moisturizers is the questionable penetration of the ingredient into the skin and its ability to improve “normal” skin beyond its healthy state.

Vitamins

Vitamins are also a common body moisturizer additive. Their popularity is due to their safety, low cost, and consumer popularity. It seems natural that you should be able to “feed” the skin from the outside. Most consumers understand the need to “eat a healthy diet for healthy skin” so it seems a natural extension that topical vitamins might also be beneficial. Pantothenic acid or vitamin B complex is commonly used in many chemical forms: panthenol, pantethine, or pangamic acid. Many body moisturizers contain bee pollen and jelly, naturally high sources of vitamin B that have a “natural” appeal. Panthenol, also known as vitamin B5, is the most commonly used synthetic form of vitamin B and functions as a humectant to draw water from the dermis and viable epidermis to the stratum corneum. The water must, of course, be trapped in the skin with either an intact skin barrier or occlusive agents, such as petrolatum or dimethicone, as previously discussed.

Niacinamide, also known as the amide form of vitamin B3, is found in body moisturizers for its purported ability to increase cell turnover and lighten skin pigmentation by interfering with melanin transfer. Because niacin is part of the nicotinamide adenine dinucleotide phosphate (NADP) and NADPH energy production pathway in the mitochondria, some believe that niacinamide can make older skin cells behave more youthfully. These are very ingenious consumer appealing concepts, but cosmetic companies can only make appearance claims, such as niacinamide “improves the appearance of aging skin.” This claim does not imply functionality. If niacinamide were claimed to decrease skin pigmentation, it would be considered a drug not allowed in

the cosmetic market. It is this approach to cosmetic development that has limited the ability of manufacturers to more scientifically validate their claims.

Perhaps the most popular vitamin in a body moisturizer is vitamin E. Vitamin E is a fat-soluble antioxidant vitamin that is easily mixed with the occlusive lipids to retard TEWL in body moisturizers. It is inexpensive and widely available. In actuality, vitamin E functions as an emollient to smooth down the desquamating corneocytes making the skin feel smooth and soft. Vitamin E is also said to enhance percutaneous absorption of other oil-soluble substances. Sometimes body moisturizers will contain a cocktail of fat-soluble vitamins including vitamins E, A, and D which are added, but the usefulness of topical vitamins is dubious. Vitamins must be in a water-soluble form to have any chance of penetrating the stratum corneum, and thus oil-soluble preparations are of little value (8). Oral administration of vitamins is far superior to cutaneous administration for the treatment of vitamin deficiencies. It is thought, however, that some vitamins can act as humectants thus enhancing the efficacy of the moisturizing product.

Vitamin E is the most commonly used vitamin in body moisturizers because it functions as an emollient to make the skin smooth and soft.

Natural moisturizing factor

A group of substances that are reported to regulate the moisture content of the stratum corneum is known collectively as the natural moisturizing factor (NMF). The NMF consists of a mixture of amino acids, derivatives of amino acids, and salts. More specifically, it contains amino acids, pyrrolidone carboxylic acid, lactate, urea, ammonia, uric acid, glucosamine, creatinine, citrate, sodium, potassium, calcium, magnesium, phosphate, chlorine, sugar, organic acids, and peptides (9). Ten percent of the dry weight of the stratum corneum cells is composed of NMF. Skin that cannot produce NMF is dry and cracked (10). More recently, it has been discovered that filaggrin breaks down to become the NMF of the skin. It is theorized that abnormalities in filaggrin breakdown may account for the dry skin associated with atopic dermatitis.

A synthetic NMF has been created for use in body moisturizer formulations.

Sodium PCA

Sodium PCA is a sodium salt of 2-pyrrolidone-5-carboxylic acid and has been termed one of the NMFs, along with urea and lactic acid. Experimentally, it has been shown to be a better moisturizer than glycerol (11). Sodium PCA is used as a humectant in many cosmetics in concentrations of 2% or greater. It can prevent a body lotion from desiccating on the store shelf, but also draw water to the stratum corneum. Many of the spray body moisturizers contain water and sodium PCA. It is best to use a body moisturizer that contains both humectants, such as sodium PCA, and occlusive substances, such as petrolatum, mineral oil, or dimethicone. The more mechanisms of moisturization that are employed, the more successful the body moisturizer will be in promoting an environment for barrier repair.

Urea

Another way to increase water in the stratum corneum is to use a substance that can create water binding sites on the protein-rich desquamating corneocytes. Urea is such a substance. It digests keratin and allows water to bind, thus hydrating and softening the rigid corneocyte protein shells. It is for this reason that urea is commonly used in dermatology for the treatment of calluses and cracked heels. Only when the skin is hydrated can the enzymes that promote desquamation function. Thus, urea diffuses into the outer layers of the stratum corneum and disrupts hydrogen bonding, which exposes the water-binding sites on the corneocytes. Urea also promotes desquamation by dissolving the intercellular cementing substance between the corneocytes. In this manner, it can also promote the absorption of other topically applied drugs, functioning as a penetration enhancer (12). However, urea is a challenge to formulate because it must be kept at an acidic pH in formulation, or it will decompose to malodorous ammonia. Problems with irritancy have been somewhat overcome by adsorbing urea onto talc prior to dispersion into the emulsion. Urea is an important therapeutic ingredient in many body moisturizers.

Urea functions as a humectant to increase water binding sites on corneocytes that are not desquamating properly.

Lactic acid

Lactic acid, or sodium lactate, is also considered an NMF in that it enhances water uptake better than glycerin. It is found in many therapeutic moisturizers as it can increase the water-binding capacity of the stratum corneum. Additionally, it can increase stratum corneum pliability in direct proportion to the amount of lactic acid that is absorbed (13). Lactic acid, in the form of ammonium lactate, is found in many body moisturizers recommended for improvement in the feel of keratosis pilaris, a condition where there is retained stratum corneum around the hair as it exits the follicular ostia. Lactic acid is a hydroxy acid that can also enhance desquamation in mature individuals, thus providing treatment for ichthyosis vulgaris when placed in a body moisturizer. Many a time urea and lactic acid have been combined for optimal therapeutic benefit in body moisturizers designed to encourage desquamation.

Body moisturizer formulations

Body moisturizers come in various preparations, including lotion, cream, mousse, and ointment. Lotions are the most popular formulation because they are easy to spread, but lotions typically contain more water and offer less moisturization. Creams and ointments can be used on the body, but are more difficult to spread, especially in hair-bearing areas. Female patients desire a nongreasy body lotion with a rich texture; however, a rich texture does not necessarily identify a superior moisturizer. Richness can be added to a thin lotion with water-soluble gums that impart a silky feel to the skin but do not provide improved moisture retention. Patients should be careful not to equate body moisturizer viscosity with efficacy.

Body lotions are generally oil-in-water emulsions containing 10%–15% oil phase, 5%–10% humectant, and 75%–85% water phase. More specifically, they are composed of water, mineral oil, propylene glycol, stearic acid, and petrolatum or lanolin. Most

also contain an emulsifier, such as triethanolamine stearate. Humectants such as glycerin or sorbitol may also be used along with other vitamin additives, such as vitamins A, D, and E, and soothing agents, such as aloe and allantoin that are anti-inflammatories. Most body lotions contain some “hero” ingredient or a patented combination of ingredients to allow for expanded consumer claims and distinction in the marketplace.

Body lotions are generally oil-in-water emulsions containing 10–15% oil phase, 5–10% humectant, and 75–85% water phase.

The basic recipe for a body moisturizer is water, lipids, emulsifiers, preservatives, fragrance, color, and specialty additives. Interestingly enough, water accounts for 60–80% of any moisturizer, however, externally applied water does not remoisturize the skin. In fact, the rate of water passage through the skin increases with increased hydration (14). The water functions as a diluent and evaporates, leaving the active agents behind. Emulsifiers are generally soaps in concentrations of 0.5% or less and function to keep the water and lipids in one continuous phase. Parabens, the most commonly used preservatives in moisturizers, are combined with one of the formaldehyde donor preservatives to prevent bacteria from growing in the water phase of the body moisturizer (15). All body lotions must contain some type of preservative to prevent contamination. The idea of a preservative-free body lotion is an illusion.

A marketable body moisturizer formulation must fulfill three criteria: it must increase the water content of the skin (moisturization), it must make the skin feel smooth and soft (emollience), and it must protect injured or exposed skin from harmful or annoying stimuli (skin protectant). The formulation designed by the cosmetic chemist must fulfill these three needs to be successful in producing skin appearance improvement. The dermatologist should keep these concepts in mind when assessing body moisturizer efficacy.

The basic recipe for a body moisturizer comprises water, lipids, emulsifiers, preservatives, fragrance, color, and specialty additives.

The skin barrier and ceramide replacement

As mentioned previously, ceramide synthesis is the first step in barrier repair. This recognition has led to various over-the-counter (OTC) creams based on ceramide technology. Nine different ceramides have been identified and synthetically duplicated for inclusion in moisturizer formulations (16). The ceramides are distinguished by their polar head group architecture and by their hydrocarbon chain properties (17). A ceramide dominant, triple-lipid barrier repair formulation was designed to correct the lipid biochemical abnormalities in atopic dermatitis. It contains capric acid, cholesterol, and conjugated linolenic acid. In addition, candelilla in the past, and petrolatum currently, are included to decrease TEWL. It received FDA approval in April 2006 for use as a nonsteroidal lipid barrier emulsion to manage the symptoms of dry skin associated with a variety of dermatologic diseases (18). It was compared with fluticasone cream in 121 patients with

moderate to severe atopic dermatitis for 28 days. The researchers found that the ceramide device reduced SCORAD (SCORing Atopic Dermatitis) scores, decreased pruritus, and improved sleep habits. However, a faster improvement was seen with the topical corticosteroid at day 14 (19). The unique aspect of this cream is that the patented ratio of the triple lipid combination mimics that of physiologic lipids.

Natural hyaluronic acid humectancy and barrier repair

Maintaining proper water balance in the skin is key to human life for surviving in a hostile environment. The skin must have some capacity to hold water, or desiccation would occur immediately. The natural water-holding material in the dermis is primarily hyaluronic acid, which is the same material used for injection as a cosmetic filler. These injectable hyaluronic acids are approved as devices. Topically, hyaluronic acid is known as a humectant, which is the technical name for substances that attract and hold water. Hyaluronic acid can retain between 1,000 and 10,000 times its mass in water and is composed of alternating residues of the monosaccharides glucuronic acid and glucosamine. It is currently being used in combinations of low and high molecular weights to provide moisturization on the skin surface and also within the skin. Lower molecular weight 52 KDa hyaluronic acid penetrates into the stratum corneum while 2,000 KDa hyaluronic acid remains on the skin surface.

Fatty acids, lipid trilayers, and barrier repair

A different approach to skin moisturization is the use of free fatty acids. Free fatty acids are found in the intercellular lipids that reside between corneocytes to create a waterproof, moderately impermeable barrier. Scanning electron micrographs show the intercellular lipid bands as trilayer entities with a dimension of 3.3 nm. These bands usually occur in groups of 6 or 9 and are again essential for human life. It is estimated that the lipid layer has a total thickness of 13 nm and accounts for the inability of particles larger than 13 nm to penetrate the skin. Indeed, nanoparticles smaller than 13 nm can penetrate, causing the health concerns currently debated.

Barrier repair with anti-inflammatory agents

One of the earliest signs of barrier damage is the onset of inflammation, accounting for the redness and itching characteristic of dermatoses manifesting barrier issues. To alleviate symptoms, many barrier repair products incorporate anti-inflammatory agents derived from botanical sources. These anti-inflammatory agents are found in both cosmetic and OTC drug moisturizers. One currently marketed barrier cream contains glycyrrhetic acid and *Vitis vinifera* extracts. In addition, it contains allantoin, alpha-bisabolol, hyaluronic acid, and shea butter. Glycyrrhetic acid is a licorice extract that was reported to be safe by the Cosmetic Ingredient Review. It can block gap junction intracellular communication. However, it is cytotoxic at high concentrations. It is mainly used in moisturizer formulations as an anti-inflammatory agent (20). In an open label multicenter study, the product was shown to reduce the median visual analog scale (VAS) rating for itching in atopic dermatitis from 48.5 mm to 34.1 mm after three weeks of treatment with a further reduction

to 24.6 mm after six weeks of treatment (21). In a second study of 142 pediatric patients at ages 6 months to 12 years, the same formulation was compared to a vehicle cream and found to be statistically more effective in reducing the symptoms of mild to moderate atopic dermatitis (22).

Licorice derivatives are also found in OTC moisturizers, especially those targeted for redness reduction in rosacea patients. One formulation contains an extract of *Glycyrrhiza inflata*. There are many species of licorice extracts, not all of which possess the same cutaneous effects. Some licorice extracts are used for skin-lightening purposes and not primarily as anti-inflammatories. Again, is the anti-inflammatory licorice extract the active agent in the barrier repair cream? Does it function like a naturally occurring topical corticosteroid to reduce the signs and symptoms of atopic dermatitis? Or, is it the hyaluronic acid humectant that is attracting water, which is trapped in the skin by the shea butter occlusive moisturizer? In reality, it may be difficult to tell what is really working unless each of the “active agents” is tested separately in the same vehicle. Even then, it may be difficult to separate the vehicle arm from the vehicle plus single ingredient arms. This is the challenge in designing clinical studies to validate the efficacy of barrier creams.

Licorice extract is a popular anti-inflammatory agent in body moisturizers.

Body moisturizer efficacy

The efficacy of moisturizers can be difficult to assess, but all formulations should be clinically tested for both efficacy and tolerability. The major part of this assessment involves the trained eye and hands of the investigator to assess skin barrier improvement and better tactile qualities. Subjective assessments from the study participants can be used to evaluate the alleviation of noxious sensory stimuli, such as itching, stinging, burning, and tingling. Yet, this objective and subjective data requires the addition of instrumentation to assess the functioning of the skin in real time. A good body moisturizer should yield excellent results with all three assessment methods. The use of instrumentation to study the skin uses probes that noninvasively assess the water leaving the skin and water in the skin. Several methods are commonly used, including regression analysis, profilometry, squametry, twistometry, corneometry, and evaporimetry (23).

Regression analysis is a method of evaluating the moisturizer efficacy under clinical conditions. Here, patients are selected and treated by an objective observer with moisturizers applied at a predetermined test site for two weeks. The test site is evaluated on days 7 and 14. If an improvement is noted, the moisturizer application is discontinued and the test site is evaluated daily for two weeks, or until the baseline pathology has reappeared (24). This method is particularly valuable because the efficacy of all moisturizers is excellent immediately following application, but the true effectiveness can only be assessed with the passage of time (25).

Profilometry involves an analysis of silicone rubber (Silflo) replicas of the skin surface. These silicone replicas are then cast into plastic positives, which are then measured with a computerized stylus instrument that provides a contour tracing of the surface. Thus, a two- or three-dimensional topogram is created. Unfortunately, this method can be inaccurate because the

silicone application to the skin surface tends to flatten and disturb the desquamating skin scale (26). This method is best to assess the skin around the eyes for improvement in wrinkles of dehydration. Profilometry has been replaced in many cases by three-dimensional photography, which can also assess wrinkling and skin contour.

Squametry involves an analysis of skin squames harvested by pressing a sticky tape against the skin, known as a D-squame. The outermost, loosely adherent skin scale is then removed. The tape provides a specimen that retains the topographical relationships of the skin surface and the pattern of desquamation. Image processing is then used to evaluate the scaliness of the skin (27). This evaluation is helpful in assessing the amount of exfoliation induced by a body moisturizer. The skin scale can also be removed from the tape and various lipid fractions are extracted to determine the composition of the intercellular lipids and the presence of various body moisturizer ingredients in the skin scale. Thus, squametry can be used to assess the extent of moisturizer penetration noninvasively without a skin biopsy.

Several other noninvasive skin assessment methods deserve a quick mention, including twistometry, corneometry, and evaporimetry. The twistometer uses torsion to measure in vivo the influence of stratum corneum hydration on skin extensibility. A weak torque is applied to a rotating disk that is placed in contact with the skin. It has been shown that dry skin is much less extensible than well-hydrated skin (28). Skin impedance can also be evaluated through a method known as corneometry. Here, a dry electrode consisting of two concentric brass cylinders separated by a phenolic insulator operating at 3.5 MHz is applied to the skin (29). The impedance drops as the skin is better hydrated. This technique can evaluate the efficacy and the duration of effect of moisturizers by measuring the amount of water in the skin with a device known as a corneometer (30). Finally, evaporimetry can be used to measure the cutaneous TEWL (31). More occlusive substances would be expected to reduce water loss, whereas some humectants, such as glycerin, actually increase water loss (32, 33). Evaporimetry measures the water leaving the skin, whereas corneometry measures the water in the skin. All of these measurements can be used to noninvasively assess the efficacy of a body moisturizer.

Even though these sophisticated noninvasive methods of cutaneous evaluation sound appealing, there is no substitute for the opinion of a trained, unbiased observer when evaluating moisturizer effectiveness. Mechanistic evaluation can be easily biased to produce data that serve the best interests of the manufacturer. Computers cannot yet accurately synthesize all the tactile and visual information that can be obtained with human evaluation. The noninvasive techniques simply present another tool for assessing moisturizer function (34).

Noninvasive assessments can be used to better characterize the behavior of skin before and after application of a body moisturizer.

Adverse reactions of body moisturizers

Many patients with dry skin will claim that they are “allergic” to most moisturizers as a result of skin stinging experienced following application (35). This may represent an irritant contact dermatitis rather than a true allergic contact dermatitis (36). These

patients should avoid moisturizers containing propylene glycol, which may cause burning upon application to damaged skin. Other substances found in facial moisturizers that cause stinging include benzoic acid, cinnamic acid compounds, lactic acid, urea, emulsifiers, formaldehyde, and sorbic acid.

Moisturizing ointments, creams, lotions, and gels should be patch tested “as is.” If an irritant reaction is experienced with closed patch testing, the product should be retested with open patch testing and provocative use testing.

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HAND DERMATITIS AND MOISTURIZATION

The hand is an amazing structure providing the means to write, draw, paint, dance, and express affection. It is frequently said that much can be said about a person from their handshake, which is an assessment of the skin, muscle, and bones that form the hand. The hand can express gender, occupation, and age. Female hands are small, whereas male hands are large and muscular. People who work with their hands outdoors have a much different skin feel than persons who type on a computer for most of the day. Children have soft, doughy, padded hands, whereas the elderly have thin, sinewy, bony, arthritic hands. Hands are what make humans unique from every other creature on Earth.

Hands are particularly vulnerable to xerotic dermatitis because they sustain considerable chemical and physical trauma. They are washed more than any other body area, yet are completely devoid of oil glands on the palmar surface. Although the stratum corneum of the palm is uniquely designed to withstand physical trauma, it is not designed to function optimally when wet or when dehydrated. Thus, adequate moisturization is important to hand health, but overhydration can be disastrous.

Adequate hand moisturization is important to hand health, but overhydration can be disastrous.

The hand responds to trauma by forming a callus. Calluses are formed from retained layers of keratin that form a dead skin pad over the area subjected to repeated physical trauma. For example, the palm of the hand will callus to protect the small bones in persons who use a hammer. The finger will callus in the location where a pencil is held in both children and adults. Although the body forms a callus to protect underlying tender tissues, the callus can also cause dermatologic problems. Because a callus is made of retained keratin, it is dehydrated and inflexible and will fissure readily with trauma. Such are the complexities of design—products for the hands.

Hand dermatoses

Dermatologic disease needs to be divided into conditions that affect the dorsum of the hand and those that affect the palm of the hand. This is an important distinction because the two skin surfaces are quite different. The dorsum of the hand is a thin skin that becomes increasingly thinner with age. After the face, the back of the hand is generally the most photoaged skin location. The skin of the hand loses its dermal strength early, leading to decreased skin elasticity, which can be simply measured by pinching the skin on the back of the hand and watching for the amount of time it takes for the skin to rebound to its original conformation. Skin that takes a long time to return to normal configuration is more photoaged than youthful skin that bounces back energetically. In addition to losing elasticity, photoaged skin also becomes irregularly pigmented, leading to lentigines and

idiopathic guttate hypomelanosis. This irregular pigmentation is also accompanied by skin that is easily injured, exhibiting senile purpura and tissue tears from minimal trauma that heal with unattractive white scars.

The palm of the hand is affected uniquely by inflammatory conditions like eczema and palmoplantar psoriasis. Because the palm is the surface that the body uses to pick and touch, it is more commonly affected by chemical and physical trauma. This trauma may manifest as hand eczema. Highly occlusive and emollient hand creams are necessary to rehydrate damaged keratin and create an optimal environment for barrier repair.

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Hand hygiene needs

The hands receive more cleansing than any other part of the body. The basic ritual of washing the hands before eating is an effective method of preventing disease transmission, but may take its toll on the sebum-lacking skin of the palms. Excessive handwashing can even be considered a medical disease, especially in persons with obsessive-compulsive disorder. There are a variety of methods of washing the hands. Basic handwashing is usually performed with a bar or liquid soap followed by water rinsing. Regimented, timed handwashing routines are used to thoroughly remove all bacteria from the hands before surgery. Lastly, a variety of hand cleansing antibacterial gels have been introduced, usually based on benzalkonium chloride, which can be used without water to clean the hands. In general, it is felt that the physical rubbing of the hands to lather the cleanser followed by rubbing in a running stream of water to rinse away the cleanser is important. Both the physical rubbing of the hands and the chemical interaction of the cleanser and water are necessary for optimal hand hygiene.

Physical rubbing of the hands and the chemical interaction of the cleanser and water are necessary for optimal hand hygiene.

Hand sanitizers

Hand sanitizers are a specialized form of hand cleansers that are waterless and designed to remove bacteria from the hands based on alcohols and quaternary ammonium compounds, which possess different antimicrobial properties and act through different mechanisms (1, 2). The most commonly used hand cleansers contain ethanol, which has excellent efficacy against both gram-positive and gram-negative bacteria and fungal organisms. However, ethanol is not effective against bacterial spores and has variable efficacy in killing enveloped viruses. Ethanol hand

sanitizers are flammable and cannot be used where open sparks are present, such as in the operating room around electrocautery equipment (3).

Quaternary ammonium compounds, such as benzalkonium chloride or benzethonium chloride, adsorb to the cytoplasmic membrane of microbes, causing leakage of cytoplasmic contents. They are bacteriostatic against gram-positive bacteria and some gram-negative bacteria and fungistatic. They are not active against nonenveloped viruses. It is interesting to note that some species of *Staphylococcus aureus* carry a gene that allows resistance to quaternary ammonium compounds. These organisms are also more likely to be antibiotic resistant. Quaternary ammonium compound hand sanitizers may not be the best choice where methicillin resistant *Staphylococcus aureus* (MRSA) is a concern (4).

Although hand sanitizers may be important in limiting the spread of contagious disease, they are not effective against anthrax and *Clostridium difficile* (5). Hand sanitizers are not good at removing visible dirt from the hands and are best used on clean hands that might contain nonvisible dirt (6). Hand sanitizers can solubilize intercellular lipids, but a study in health-care workers demonstrated better skin condition with the use of hand sanitizers as opposed to frequent handwashing (7).

Hand skin care needs

The skin care needs of the hands go beyond basic cleansing to moisturization, healing, photoprotection, and skin lightening. As mentioned previously, hand moisturization is very important due to frequent cleansing. Hand moisturizers should be designed to occlude the skin to reduce transepidermal water loss, rehydrate the skin through the use of humectants, alleviate itch and pain, and smooth the skin surface with emollients. Hand moisturizers with this type of construction can be used for simple dry skin and provide healing qualities for the dermatologic conditions previously discussed.

There are several other ways to minimize hand dryness. Cracked, fissured hands are an excellent way to contract disease. An intact barrier is the best protection. These are ideas to be shared with patients to prevent hand dryness:

1. Turn down the water temperature.
Hot water will damage the skin barrier more than lukewarm water. If the hands are excessively greasy, hot water may be necessary to assist in solubilization of the lipid. Otherwise, the hot water will simply remove more intercellular lipids resulting in more hand dryness.
2. Do not use excessive cleanser.
Unfortunately, the cleanser cannot tell the difference between the lipid dirt on your skin and your intercellular lipids. It will continue to solubilize lipids until the detergent has been exhausted. More cleanser does not necessarily mean cleaner skin. Use only enough cleanser to place a thin coating over the hands. Excess detergent means enhanced barrier damage.
3. Avoid using too much water to rinse the hands.
Water is an excellent solvent by itself without added detergent. Thoroughly rinse the cleanser from the hands, but do use excessive water. Minimize water contact to the greatest degree possible.

In addition to moisturization, the hands also need photoprotection both during sports and while driving a car because

photoaging UVA radiation passes through the windshield of a car. Sun protection is a unique challenge for the hands because they are frequently aggressively washed, removing the sunscreen. However, the need for sun protection is obvious when one considers the thin dyspigmented skin that characterizes mature hands. This means that the hands require aggressive antiaging therapy and skin lightening.

Hand moisturizers should occlude the skin to reduce transepidermal water loss, rehydrate the skin through the use of humectants, alleviate itch and pain, and smooth the skin surface with emollients.

Hand moisturizer formulation

The simplest hand ointment is petroleum jelly, but most patients find this too greasy. To improve cosmetic appeal, the petroleum jelly can be whipped with water, color, and fragrance to make a hand cream. Thus, hand creams are oil-in-water emulsions with 15–40% oil phase, 5–15% humectant, and 45–80% water phase (8). The addition of silicone derivatives can also render the hand cream water-resistant through four to six washings. Some hand creams even include a sunscreen agent.

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One of the most effective hand moisturizing ingredients is glycerin. Glycerin can attract water to dehydrated hand keratin and encourage exfoliation of callused skin around the fingertips. High-glycerin-containing hand creams, identified by glycerin being listed among the first five substances in the ingredient disclosure, are especially effective at night to restore hand moisture balance. Day use of glycerin hand creams is not popular among patients because glycerin is sticky and can leave fingerprints on paper. Because the hands are rested at night, bedtime hand moisturization is the most effective.

Urea can also be effectively used on the hands for the treatment of calluses and enhanced hydration of hyperkeratotic palms. It digests keratin and can increase the binding of water to callused skin. Once the callus is hydrated, it becomes soft and can be easily scrapped away or peeled off. In addition, hydrated callus can begin the natural desquamation process because enzymes involved in hand desquamation only function in a moist environment. Hand creams using 5–10% urea, combined with glycerin and petrolatum, are very effective in treating hyperkeratotic palms.

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HYPERHIDROSIS AND ANTIPERSPIRANTS

The desire to smell pleasant seems to be a basic human need. Olfactory stimulation seems to be an important human input to determine positive or negative evaluations of others. Certainly, the cosmetics and skin care industry understands this well, as careful attention is paid to scent. An area of social concern for odor is the underarms because this moist, dark, warm body area is perfect for the growth of odor-causing bacteria, fungi, and yeast. This chapter *investigates axillary hyperhidrosis and the efficacy of antiperspirants*.

The original deodorant to control axillary odor appeared on the US market in 1888. Later, in 1919, advertising first introduced the notion that body odor was offensive, thus creating a market for deodorants and antiperspirants. The present popularity of such products can be attributed to social consciousness of body odor, the development of nonirritating germicides, and products that do not contribute to fabric deterioration (1). Dermatologists must understand the effect of antiperspirants on the skin and how they function to minimize hyperhidrosis.

Axillary odor

Axillary odor is caused by the action of bacteria on sterile eccrine and apocrine sweat. The apocrine sweat is responsible for a large part of the odor because it is rich in organic material ideal for bacterial growth. Eccrine sweat, on the other hand, is more dilute and does not provide a high concentration of bacterial nutrients (Figure 18.1). However, eccrine sweat indirectly promotes odor by dispersing the apocrine sweat over a larger area and providing the moisture

necessary for bacterial growth. Axillary hair also contributes to odor by acting as a collecting site for apocrine secretions and increasing the surface area suitable for bacterial proliferation (2).

Each person has a unique odor due to a combination of physiologic factors, including sebaceous gland secretions, the combined effect of the foods last eaten, and the physical or psychological state of the body. Once the source of axillary odor is understood, a list of mechanisms to reduce odor may be developed (Table 18.1). These are the goals of all antiperspirant/deodorant products.

Antiperspirants vs. deodorants

The words antiperspirant and deodorant are sometimes used interchangeably in the common vernacular, but to the cosmetic chemist, these are two very different personal care products. Antiperspirants contain ingredients to decrease sweating, whereas deodorants are used solely to manage axillary odor. For this reason, all antiperspirants can be considered deodorants, but not all deodorants are antiperspirants. Most products in the current marketplace are both antiperspirants and deodorants.

Antiperspirants contain ingredients to decrease sweating, whereas deodorants are used solely to manage axillary odor.

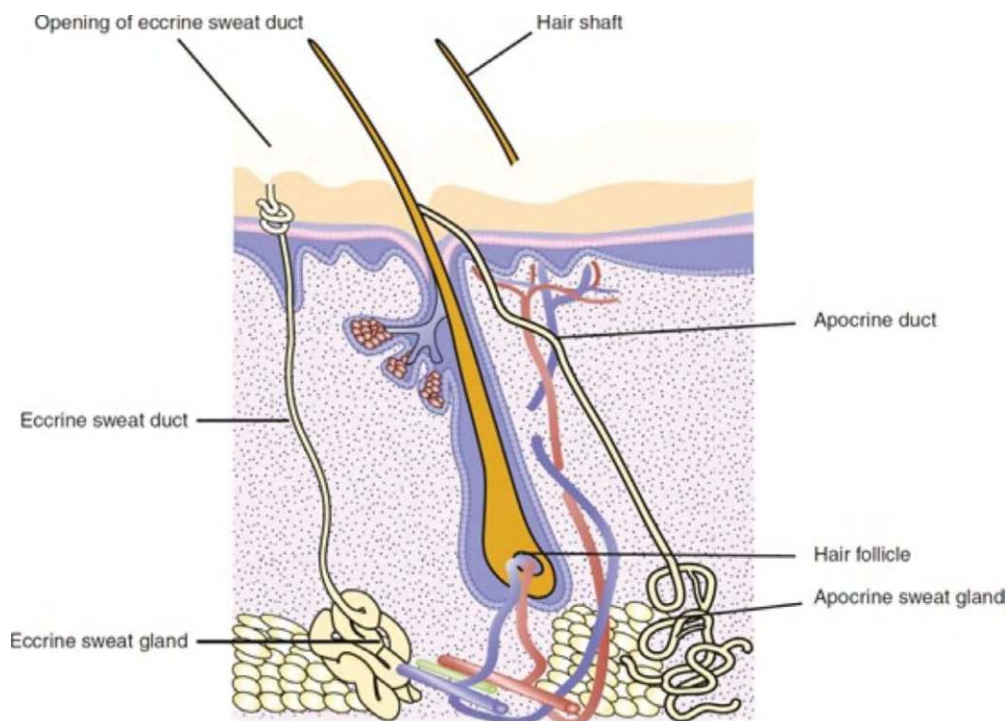


FIGURE 18.1 The anatomy of the apocrine and eccrine glands.

Deodorants

Deodorants function either by masking the axillary odor with a perfume or by decreasing axillary bacteria. Therefore, many deodorants contain antibacterials, such as quaternary ammonium compounds (benzethonium chloride) and cationic compounds (chlorhexidine, triclosan). *Staphylococcus aureus*, *Corynebacteria*, and *Aerobacter aerogenes* are some of the key odor-causing axillary bacteria whose growth can be inhibited simply by decreasing the axillary pH to 4.5 or less (3). Antiperspirants are different in that they physically reduce the amount of sweat in the axilla.

A popular additive of deodorants and deodorant soaps, hexachlorophene, was banned by the US Food and Drug Administration (FDA) in all nonprescription products in September 1972. Many companies were forced to reformulate their deodorant products at that time because it had been shown that brain lesions were produced in test animals fed high doses of hexachlorophene (4). Recently, natural deodorant/antibacterials have made a comeback in organic products containing ethyl alcohol, thyme oil (thymol) and/or, clove oil (eugenol).

The effectiveness of a deodorant can be measured in two ways: bacterial culture plates and the sniff test. Application of a proposed deodorant formulation to a culture plate swabbed with human perspiration can determine the percent reduction of bacterial growth, but this is not the best method to evaluate the consumer acceptability of a deodorant product. Most companies retain several individuals with highly trained noses to “sniff” armpits before and after application of a deodorant. Perspiration is usually induced by placing the subject in a hot room and a cupped hand is waved across the armpit to bring the odor to the trained nose (5).

Mechanism of action of antiperspirants

Antiperspirants attempt to accomplish the daunting task of preventing perspiration release onto the skin surface from 25,000 eccrine glands per axilla capable of secreting in response to heat and emotional stimuli (see Table 18.1). There are several chemical categories of effective antiperspirants listed in Table 18.2 (6). Antiperspirants are considered over-the-counter (OTC) drugs and must use ingredients in the amount specified on the monograph. For this reason, most antiperspirant formulations are similar with different physical appearances and fragrances.

The efficacy of these antiperspirants is based on an understanding of the mechanism of sweat production. Several theories

TABLE 18.1: Mechanisms for Axillary Odor Reduction

1. Reduce apocrine gland secretions.
2. Reduce eccrine gland secretions.
3. Remove apocrine and eccrine gland secretions from the axilla.
4. Decrease axillary bacterial colonization.

TABLE 18.2: Effective Antiperspirant Chemical Categories

1. Metal salts (aluminum chlorohydrate, aluminum zirconium chlorohydrate)
2. Anticholinergic drugs
3. Aldehydes (formaldehyde, glutaraldehyde)
4. Antiadrenergic drugs
5. Metabolic inhibitors
6. Botulinum toxin

have been advanced to explain the efficacy of metal salts, which are the primary antiperspirants used today. Papa and Kligman originally proposed that the metal salts damaged the sweat duct, causing the secreted sweat to diffuse into the interstitial space (7); they have since retracted their theory. Shelley and Hurley proposed that the metal salts combine with intraductal keratin fibrils to cause eccrine duct closure and formation of a horny plug to obstruct sweat flow to the skin surface (8). A second paper by Holzle and Kligman also provided evidence that the metal salts cause a physical obstruction of the duct opening (9).

The most effective antiperspirants are metal salts that cause a physical obstruction of the eccrine duct opening.

Anticholinergic drugs are the most effective antiperspirant agents known. Blockage of the cholinergic innervation of the eccrine sweat glands effectively stops the sweating. Agents such as scopolamine and atropine have been studied in this regard; however, skin penetration is poor unless administered via injection or iontophoresis. Furthermore, their action is nonspecific and allows for side effects such as dry mouth, urinary retention, and mydriasis. No antiperspirants containing anticholinergic drugs are available for OTC purchase in the United States at this time.

Aldehydes, such as formaldehyde and glutaraldehyde, can effectively decrease axillary sweating (10, 11). It is believed that these chemicals also result in the blockage of the eccrine sweat duct. They are not in any OTC formulations at this time due to the sensitizing potential of formaldehyde and the brownish-yellow skin staining associated with glutaraldehyde.

Antiadrenergic drugs could also, theoretically, decrease sweating. Adrenergic neurotransmitters such as epinephrine and norepinephrine have been shown to decrease sweating in humans when they are injected intradermally. This is perhaps due to some adrenergic nerve fibers providing dual innervation to the sweat glands in addition to the cholinergic fibers. However, this aspect of sweating is poorly understood. There are no commercially marketed antiperspirants of this type in the United States. Lastly, metabolic inhibitors may decrease perspiration. Because the process of sweating is dependent upon a supply of energy, drugs that interrupt $\text{Na}^+/\text{K}^+ - \text{ATPase}$, such as ouabain, might also be effective. These substances are only of academic interest.

Perhaps the most promising antiperspirants are topical botulinum toxin formulations that interrupt nervous innervations of the sweat gland. It is unlikely that these formulations will enter the OTC market, however, making the metal salts the safest and most efficacious antiperspirants. The rest of our discussion will focus on these metal salts.

Antiperspirant formulation

Metal salts of aluminum, zirconium, zinc, iron, chromium, lead, and mercury have astringent properties on the skin. The only two metal salts that are presently used in antiperspirants are aluminum and zirconium (12). Zirconium salts, however, have had an interesting safety profile over the last 35 years. In 1955, sodium zirconyl lactate was used in deodorant sticks but was found to cause axillary granuloma formation (13, 14). In 1973, aerosol zirconium-based products were voluntarily removed from the

market by several manufacturers who had received reports of skin irritation. Aerosol zirconium-based products were banned by the FDA in 1977, but no such products were left on the market at that time. Nonaerosol formulations at concentrations less than 20% are still allowed, but the incidence of axillary granulomas has greatly decreased (15, 16).

The original antiperspirant formulation developed in 1914 was a 25% solution of aluminum chloride hexahydrate in distilled water (17). This solution was so effective that application every second or third day reduced axillary moisture. However, the solution was extremely irritating to skin, and its high acidity damaged clothing. Newer, less irritating aluminum formulations are more popular today, but they are also less effective. The FDA did express some concern in 1978 regarding long-term inhalation of aluminum-containing aerosol preparations (18).

Commonly used active agents in antiperspirants include aluminum chloride (concentration of 15% or less in an aqueous nonaerosol dosage form), aluminum chlorohydrate (concentration of 25% or less in an aerosol and nonaerosol dosage form), aluminum zirconium chlorohydrate (concentration of 20% or less or a nonaerosol dosage form), and buffered aluminum sulfate (concentration of 8% or less aluminum sulfate buffered with an 8% concentration of sodium aluminum lactate in a nonaerosol dosage form) (19). Other additives are employed to package the product as a stick, roll-on, or spray antiperspirant. Stick antiperspirants are packaged in a roll-up tube and consist of waxes, oils, volatile silicones, antibacterials, and aluminum or aluminum/zirconium complexes (Figure 18.2). Roll-on products are an emulsion or clear liquid applied with a rolling ball mechanism to the armpits. These consist of aluminum chlorohydrate as the active ingredient in combination with gelling agents, emollients,

and antibacterials. The spray antiperspirants are aluminum chlorohydrate complexes, oils, solvents, and antibacterials propelled by hydrocarbon gases (20, 21).

Antiperspirant efficacy

To be effective, an antiperspirant must reduce axillary sweating by 20% or more. Interestingly enough, antiperspirant effectiveness is dependent upon both the formulation and the form in which the product is applied, as demonstrated in Table 18.3. Efficacy is defined as the percentage reduction in the rate of sweating achieved after application of the antiperspirant product. The percentage sweating reduction can be determined gravimetrically, where a human volunteer holds an absorbent pad in the armpit while in a hot room, or hygrometrically, where the water content of dry gas sprayed in the armpit of a human volunteer is measured and the rate of sweating calculated (22).

Antiperspirants are considered OTC drugs and thus must follow the rules set forth in the monograph covering their formulation. The types of materials that can be incorporated in antiperspirants and their concentration are carefully controlled by the FDA. This accounts for the similarity in formulation by a variety of manufacturers; however, the effectiveness of antiperspirants varies by formulation, as demonstrated in Table 18.3.

Twice-daily application of antiperspirants is the key to enhanced efficacy of clinical strength products.



FIGURE 18.2 Stick products are presently the most popular in the marketplace.

Products in a newly introduced category of antiperspirants are labeled as “clinical strength” products. These products have a slightly higher concentration of active ingredients and must reduce sweat by 30% to substantiate the highly effective claim on package labeling, but are also recommended for twice daily use. The twice-daily use is actually the key to their enhanced efficacy. The antiperspirant must remain in the axillary vault long enough to form or maintain the plug in the acrosyringium. If heavy sweating is occurring during application, the antiperspirant is washed away and ineffective. Because the armpit is generally at rest at night, bedtime application of antiperspirants allows the ingredients to contact the skin longer and create a better plug, which translates into enhanced efficacy. Increased efficacy can be achieved with any antiperspirant that is used morning and evening.

The most effective antiperspirants create a deep plug in the acrosyringium. The more superficial the plug, the less sweat control is obtained. Unfortunately, there is a direct connection

TABLE 18.3: Antiperspirant Effectiveness by Form US FDA OTC Antiperspirant Review Panel

Dosage Form	Percent Sweat Reduction (%)
Aerosols	20–33
Creams	35–47
Roll-ons	14–70
Lotions	28–62
Liquids	15–54
Sticks	35–40

between skin irritation and acrosyringial plug depth. Efficacious formulations must address both issues to create a skin-friendly product. Some manufacturers are including skin-protectant ingredients, such as dimethicone, in antiperspirant formulations to increase efficacy while counteracting the inherent possibility of irritant contact dermatitis.

Perspiration control requirements

Antiperspirants reduce axillary moisture by employing aluminum salts to create a plug within the acrosyringium to occlude eccrine and apocrine ducts. Sometimes the aluminum is combined with zirconium to enhance efficacy. It takes about 10 days to create the plug, which physically blocks the transport of sweat from the gland to the skin surface. Conversely, it takes 14 days for the plug to dissolve. It is for this reason that best results with antiperspirants are achieved with daily use to maintain the plug.

In order for the antiperspirant to work, it must physically contact every sweat duct. An even and thorough application to the entire axillary vault is necessary for optimal results. Some antiperspirants have a grid to encourage even application and metered dosing administered through turning a knob at the bottom of the stick container. Using the amount of antiperspirant recommended on the packaging is important.

Adverse reactions

The major drawback of aluminum and zirconium salt antiperspirants is their acidic pH (pH 1.8–4.2), which can irritate the skin, cause clothing discoloration, and weaken natural fabrics such as linen and cotton. Aluminum and zirconium chlorohydrates have the least skin irritancy. The sulfate forms are intermediate, and chloride forms are the most irritating. Zinc oxide, magnesium oxide, aluminum hydroxide, and triethanolamine may be added to reduce irritancy in some products.

Many patients who develop underarm irritation to aerosol antiperspirants/deodorants find they can tolerate the roll-on type better, or possibly need a product designed for sensitive skin in a cream or stick form. Certainly, these products are a common cause of irritant contact dermatitis in abraded underarm skin (23). A variety of different ingredients in antiperspirants and deodorants have been reported as causes of dermatitis such as vitamin E (24), propantheline (25), and quaternary ammonium compounds (26). These products are open patch tested “as is.” Stick antiperspirants that contain dimethicone appear to be the least irritating in consumer trials.

Maximizing antiperspirant efficacy

Antiperspirants can and do fail to meet patient expectations for sweat control. As a matter of fact, most of the patients who enter a dermatologist’s clinic for the purpose of discussing sweat control have experienced antiperspirant failures. Following are a few easy tips that the dermatologist might wish to share with patients in need of assistance (Table 18.4):

1. Apply the antiperspirant to a dry armpit.
The antiperspirant must remain in physical contact with the acrosyringium long enough to create a plug. If the

TABLE 18.4: Patient Recommendations for Optimal Antiperspirant Performance

1. Apply the antiperspirant to a dry armpit.
2. Do not shave the armpit aggressively.
3. Apply the recommended amount of antiperspirant.
4. Apply the antiperspirant daily.

antiperspirant is applied to an armpit that is wet from showering or from perspiration, it will be diluted and not as effective. The armpit can be dried with a hair dryer before antiperspirant application if necessary.

2. Do not shave the armpit aggressively.
The plugs created in the acrosyringium can be physically removed by shaving if they are located close to the skin surface. Persons who shave repeatedly over the armpit skin or shave multiple times daily may notice a decreased antiperspirant efficacy. It is best to shave the armpits weekly by dragging the razor once over the skin and avoid pulling the skin tight. This minimizes the chance of removing the sweat duct plug.
3. Apply the recommended amount of antiperspirant.
Many antiperspirants recommend twisting the knob at the bottom of the container three times and applying this amount to the axilla. This is the dose needed to obtain the optimal efficacy. Encourage patients to read the instructions and understand that just like medicines that do not work if enough is not ingested, antiperspirants also require the proper dose for optimal efficacy. The recommended amount should be thoroughly massaged throughout the armpit, especially over hair-bearing skin where the concentration of sweat glands is the greatest.
4. Apply the antiperspirant daily.
Compliance is the key to many things in medicine, including antiperspirant efficacy. As with any topical dermatologic, if you do not use it, it does not work. People who apply their antiperspirant sporadically will not get good sweat control. Daily application is necessary for efficacy, and twice-daily application is even better, as previously discussed. Consecutive application for 10 days is necessary to determine the optimal benefit that can be achieved from a given antiperspirant formulation.

Summary

Antiperspirants remain the most widely used method for controlling axillary perspiration. Proper application is the key to achieving the best results. The antiperspirant should be applied liberally to the entire axilla morning and evening to reduce sweating. In general, roll-on cream products offer the best efficacy, but care should be taken to apply the dose recommended on the packaging. Remember that shaving can decrease antiperspirant efficacy by physically removing the plug from the acrosyringium. For this reason, aggressive armpit shaving by pulling the skin and shaving repeatedly over the skin should be avoided. Finally, compliance is important because daily application is necessary to maintain the acrosyringial plug. The optimal effect for any antiperspirant can only be assessed after 10 consecutive days of use. Perhaps these are a few ideas that the dermatologist can share with patients in search of better topical axillary sweat control.

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Fragrance is an interesting part of any skin care, cosmetic, cosmeceutical, hair care, and nail care product. In many instances, the fragrance is the most expensive part of the formulation and accounts for much of the consumer enthusiasm regarding product use. Although fragrance is often viewed as the most problematic part of any formulation from a contact dermatitis or vasomotor rhinitis standpoint, it is important to the consumer's perception of beauty. Certainly, fragrance-free products have more dermatologic appeal, but many products without a scent fail in the marketplace even though they offer the same degree of efficacy as scented products. The ingredients used to construct a formulation have a chemical smell that may not be pleasant; thus fragrances are used to mask unappealing scents, neutralize minimally noxious odors, and heighten the consumer product experience. This chapter analyzes fragrances from a dermatologic perspective.

Perfumes and fragrances appeal to the most primordial part of the brain and can produce feelings of well-being, lassitude, affection, disgust, and so on. The use of fragrance to affect mood or induce relaxation is known as "aromatherapy" (1). Perfumery, the art of fragrance development, involves blending and mixing with more than 6,000 possible ingredients to obtain a special scent.

Originally, perfume was used in the form of incense for religious purposes. The word itself is Latin for "through the smoke" (2). Incense was invented to mask the smell of burning flesh when an animal was sacrificed to the gods. The transition from incense to perfumes for adornment occurred about 6000 BC, both in the Far East and the Middle East. By 3000 BC, the Sumerians and Egyptians were bathing in oils and alcohols of jasmine, iris, hyacinth, and honeysuckle. Cleopatra is said to have anointed her hands with an oil of roses, crocus, and violets and her feet with a lotion of almond oil, honey, cinnamon, orange blossoms, and tinting henna. Greek and Roman men both embraced perfumes and considered a soldier unfit for battle unless he was duly anointed with fragrances.

The concept of cologne was introduced by an Italian barber, Jean-Baptiste Farina, who arrived in Cologne, Germany, in 1709 to develop a fragrance trade. He concocted an alcoholic blend of lemon spirits, orange bitters, and mint oil from the bergamot fruit that became the first cologne. Soon, perfume meant any mixture of ethyl alcohol with 25% or more essential fragrant oils; toilet water contained 5% essential oils, and cologne contained 3% essential oils. These definitions are still used in the manufacture of modern fragrances.

Perfume is any mixture of ethyl alcohol with 25% or more essential fragrant oils; toilet water contains 5% essential fragrant oils, and cologne contains 3% essential oils.

Although fragrances are powerful modulators of emotion and mental functioning, they can also cause problems such as allergic contact dermatitis, irritant contact dermatitis, and vasomotor rhinitis. The development of hypoallergenic

fragrances has helped minimize contact dermatitis to some extent, but vasomotor rhinitis remains a problem. Modern fragrance trends are combinations of scents to produce complex mixtures, such as vanilla, lavender, pineapple, and kiwi. Further, fragrance has transcended body use and extended to candles, potpourri, air fresheners, jar oil wicks, soaps, shampoos, lipsticks, and hand lotions. Beauty products simply cannot be beautiful without a fragrance.

Fragrance formulation

The raw materials for perfume formulation fall into two categories: natural and synthetic. Natural components are of animal or plant origin, whereas synthetic products are produced from a wide range of raw materials. The use of animal extracts in perfumery has declined due to animal rights activism. However, animal-derived products include musk from the musk deer, castoreum from the beaver, civet from the civet cat, and ambergris from the sperm whale. Most of these substances have been chemically analyzed and are now synthesized (3).

Most substances used in perfumery are plant products. These extracts can be obtained through steam distillation, expression, and extraction. Distillation is the method used for the removal of geranium, lavender, rose, and orange blossom scents. Expression is used to squeeze oil from the peel of bergamot, lemon, lime, and other citrus fruits. If the aromatic substance is unstable at the higher temperatures required for distillation or the yield of the oil is minimal through expression, then extraction is employed.

Extraction can be accomplished by enfleurage, maceration, or the use of volatile solvents. Enfleurage involves the use of animal fats or vegetable oils to extract the scent at room temperature. The flower petals are sprinkled on glass plates encased in wooden frames that have been brushed with fats or oils. The wooden frames are then stacked to sandwich the petals between two glass plates. Fresh petals are added daily until the grease, known as pomade, absorbs a sufficient amount of perfume. This method is used for extracting the perfume of jasmine, orange blossom, jonquil, and lily (4). If heat is added, then the extraction technique is termed maceration. Here, the flowers are mixed with hot liquid fats or oils at 60–70°C and stirred until the cells containing the fragrance rupture. The mixture is then poured on a screen, allowing the scented grease to drain. Rose, acacia, and violet perfumes are obtained in this manner. Volatile solvents and percolators are used to extract the essential oils of mimosa, carnation, heliotrope, stock, and oakmoss (5).

Steam distillates are called "essential oils," whereas solvent extracts result in a nearly solid perfume wax referred to as "concretes." Ethanolic extractions of concretes yield "absolutes," but if raw materials are subjected to ethanolic extraction, "tinctures" are produced. Organic solvent extraction yields "resinoids," which can be further extracted with ethanol to yield "resin absolutes" (6). All parts of the plant, including roots, fruits, leaves, flowers, bark, and rind, can be used in perfume production. Of the 250,000 species of flowering plants, only 2,000 contain essential oils appropriate for fragrance production.

TABLE 19.1: Common Fragrance Materials

Fragrance Material	Characteristics
Benzyl acetate	Light floral, slightly fruity
Benzyl salicylate	Warm, balsamic
Isobornyl acetate	Fresh, piney
p-t-Butyl cyclohexyl acetate	Soft, woody
Cedryl acetate	Sharp, woody
Citronellol	Rosy
Dihydro myrcenol	Citrus
Geraniol	Floral, rosy
Heliotropine	Sweet, floral, powdery
Hexyl cinnamic aldehyde	Light, delicate
Indole	Floral, animalic
Gamma-methyl ionone	Woody, floral
Musk ketone	Musky, animalic, warm
Phenyl ethyl alcohol	Floral
Vanillin	Sweet, powdery, vanilla

Source: Adapted from Ref. 7.

Synthetic fragrances are becoming more popular due to the cost and inability to obtain natural animal and plant sources. Table 19.1 lists some of the more common aroma chemicals used in perfumery today (7). Organic chemists are using “head-space analyses” to examine the air above flowering plants to more accurately mimic the fragrance synthetically. Synthesized fragrances are less expensive, less allergenic, and more sustainable. Common fragrance materials that are primarily synthetically derived include vanillin, musk ketone, citronellol, and hexyl cinnamic aldehyde.

Fragrance classification

A special vocabulary is used to describe the fragrances briefly outlined in Table 19.2. The perception of smell is very subjective, accounting for the tremendous number of popular perfumes presently on the market. A successful formulation is a prized secret among fragrance manufacturers. Generally, perfumes fall into three categories:

1. Simple notes representing naturally occurring aromas, such as fruits, herbs, spices, flowers, and animal smells
2. Complexes representing combinations of odors, such as green floral, spicy citrus, and fruity floral
3. Multicomplexes representing up to 12 identifiable fragrance themes

Perfumes are further described by the manner in which their smell changes with time (8). The top note of a perfume refers to the rapidly evaporating oils that are discernible when the bottle is opened but disappear shortly after skin application. The middle note is the smell of the dried perfume on the skin, and the end note is the ability of the perfume to diffuse fragrance over time (9).

Fragrance release

The fragrance must be released into the air to be perceived. There are three main methods of releasing fragrance: delayed release, sustained release, and burst release. Delayed release is a controlled release technique whereby the smell is released at some

TABLE 19.2: Odor Descriptors

Odor	Description
Aldehydic	Sharp, fatty, or soapy
Amber	Sweet, warm
Animalic	Redolent of animal odors
Balsamic	Warm, sweet, and resinous
Camphoraceous	Medicated
Chemical	Harsh, aggressive, and basic
Citrus	Fresh, tangy, and zesty
Earthy	Green, rooty, and dank
Fatty	Odor of animal or vegetable oil
Floral	Odor of flowers
Fresh	Used subjectively
Fruity	Odor of natural fruit
Green	Odor of grass or leaves
Herbal	Odor of fresh plants
Leather	Phenolic, warm, and animalic
Light	Discrete
Medicinal	Pungent
Mossy	Earthy, mossy, phenolic, or green
Nutty	Odor of natural nuts
Pine	Odor of fine wood, needles, and resin
Powdery	Soft, gentle
Resinous	Warm, sweet, balsamic
Spicy	Pungent, hot, culinary
Sweet	Heavy, cloying
Warm	Ambery, animalic, sweet
Woody	Odor of natural wood

Source: Adapted from Ref. 7.

time after application, whereas sustained release maintains a constant fragrance level over time. Sustained release is used for most perfumes. Burst release is a rapid and fleeting release of fragrance. Burst release is used for shampoos and spray formulations. These types of controlled release can be accomplished with encapsulation, where the scent is surrounded with a layer of material that prevents release until desired. Release can be activated by an increase in body temperature, a change in skin pH, or contact with sweat.

Fragrance-induced dermatitis

Irritant and allergic contact dermatitis to perfumes and fragrances is a well-known phenomenon (10–13). In fact, fragrances have been reported as the most common cause of cosmetic-related allergic contact dermatitis (14). The North American Contact Dermatitis Group reported that cinnamic aldehyde, a fragrance material, was one of the 10 most common allergens on the standard dermatology patch test tray (15). Table 19.3 lists some of the more common fragrances and their irritancy potential as represented in the fragrance literature (16). Table 19.4 lists some of the common fragrances and their allergenic potential as represented in the dermatologic literature (17). The North American Contact Dermatitis Group found the following fragrance materials to be sources of allergic contact dermatitis in order of decreasing frequency: cinnamic alcohol, hydroxycitronellal, musk ambrette, isoeugenol, geraniol, cinnamic aldehyde, coumarin, and eugenol (18, 19).

TABLE 19.3: Irritant Potential of Perfumes

Irritating perfumes
Benzylidene acetone
Methyl heptin carbonate
Methyl octin carbonate
Moderately irritating perfumes
Cyclamen aldehyde
Ethyl methylphenyl glycinate
Eugenols gamma-nonyl lactone
Balsam of Peru
Phenyl acetaldehyde
Vanillin
Least irritating perfumes
Benzaldehyde
Benzoin resin
Benzyl benzoate
Cinnamic acid and cinnamates
Citrus oils
Cresol and methyl cresol
Diethyl phthalate
Heliotropin
Higher aliphatic aldehydes
Hydroxycitronellal
Menthol
Salicylates

Source: Adapted from Ref. 16.

The most allergenic fragrances are cinnamic alcohol, hydroxycitronellal, musk ambrette, isoeugenol, geraniol, cinnamic aldehyde, coumarin, and eugenol.

Fragrance sensitivities can be detected by patch testing with a fragrance mixture containing the most common fragrance allergens. It consists of a 2% concentration of cinnamic alcohol, cinnamic aldehyde, eugenol, isoeugenol, hydroxycitronellal, oakmoss absolute, geraniol, and alpha-amyl cinnamic alcohol in

petrolatum (20). Unfortunately, irritant reactions can occur (21). This mixture detects approximately 70–80% of fragrance sensitivities (17). Further evaluation of the allergic contact dermatitis needs to be carried out with individual fragrances (22). The patient's perfume can also be used for patch testing if diluted to a 10–30% concentration in alcohol or petrolatum. Interestingly enough, balsam of Peru, one of the standard substances on a patch test tray, serves as a marker for fragrance sensitivity and is patch test positive in about 50% of perfume allergy cases.

Determining the source of fragrance allergies can be quite complex (23). The average soap contains 50–150 fragrance ingredients, the average cosmetic contains 200–500 fragrance ingredients, and the average perfume contains 700 fragrance ingredients (24). The concentration of fragrance ingredients also varies. Fine perfumes contain 15–30% fragrance, colognes contain 5–8% fragrance, and scented cosmetics contain 0.1–1% fragrance, whereas masking fragrances are used at concentrations below 0.1% (25). Most of the cosmetic houses are able to provide fragrance products for testing (26).

Fragrance and vasomotor rhinitis

Although patch testing is effective for the detection of contact dermatitis, it is not effective for the understanding of vasomotor rhinitis. Vasomotor rhinitis occurs when a fragrance is first perceived by a patient and consists of tearing, sneezing, a runny nose, nasal congestion, and headache. The symptoms appear to be autonomic because the patient cannot control them. Problems can arise from fragrances found in perfumes, air fresheners, candles, laundry detergents, potpourri, and so on. Sometimes the symptoms can be controlled with antihistamines such as cetirizine, or nasal decongestants such as oxymetazoline. Scent avoidance is the best treatment for this condition, which can be disabling for the patient. Vasomotor rhinitis does not appear to be related to asthma and is not found with increased incidence in patients with atopy. It occurs with many diverse fragrances that are different from those found on patch test trays. The phenomenon of vasomotor rhinitis has recently been identified by the fragrance industry.

Unscented products

Unscented products are not fragrance-free but rather contain a masking fragrance. They may not be suitable for patients with fragrance allergies. Masking fragrance is a fragrance designed to blend with the natural odor of a formulation, attempting to offset the poor smell. Unscented formulations typically possess minimal smell and are intended to be used with other strongly scented products. For example, a body wash may be unscented, knowing that the user will apply a scented body lotion. Unscented products eliminate fragrance combinations that might interfere with one another to create a poor smell, but they definitely contain fragrance ingredients.

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TABLE 19.4: Allergic Potential of Perfumes

Perfume	Allergic Potential	Patch Test Concentration in Petrolatum (%)
Cinnamic alcohol	High	5
Cinnamic aldehyde	High	1
Hydroxycitronellal	High	4
Isoeugenol	High	5
Eugenol	High	5
Oakmoss absolute	High	5
Alpha-amyl cinnamic alcohol	Moderate	5
Geraniol	Moderate	5
Benzyl salicylate	Moderate	2
Sandalwood oil	Moderate	2
Anisyl alcohol	Moderate	5
Benzyl alcohol	Moderate	5
Coumarin	Moderate	5
Musk ambrette	Photoallergen	5

Source: Adapted from Ref. 17.

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BODY PHOTOPROTECTION

The sun provides energy that drives our solar system, but it also produces UVB and UVA radiation that damages our DNA and activates our collagenase. To maintain this delicate balance between the life-giving qualities of the sun and sun protection, our bodies have evolved an elaborate system of endogenous defenses. Sunscreens simply represent an extension and an amplification of these natural defensive mechanisms. This chapter examines body photoprotection. Some of the basic principles of sunscreen formulation and use have already been discussed under facial sunscreens in [Chapter 9](#).

Sunscreen formulations are based on natural endogenous body protective mechanisms.

Natural photoprotective mechanisms

The natural protective mechanisms of the body begin at the stratum corneum and extend into the dermis. They are summarized in [Table 20.1](#). In each layer of the skin, there are various techniques used to reflect ultraviolet radiation, quench oxygen radicals, and repair the resultant cellular damage. Beginning at the outermost structure of the skin with the stratum corneum, ultraviolet radiation is scattered and reflected by the corneocytes. This is why the endogenous sun protection factor (SPF) of the skin is lower through procedures that induce exfoliation. The use of topical hydroxy acid body moisturizers also removes the corneocytes, further decreasing the SPF of the skin. This concept of light scattering is built upon by the inorganic sun filters, such as zinc oxide and titanium dioxide. Most currently marketed beach sunscreens for body application include an inorganic filter for this reason.

The next natural defense against UV radiation is melanin. Melanin performs numerous functions to convert UV into heat. Melanin itself is a free radical scavenger and undergoes oxidation

in the 300–360 nm range. It is this oxidation of melanin that results in the immediate pigment darkening phenomenon associated with the dermatologic use of therapeutic UVA exposure. In many ways, organic sun filters function like melanin, absorbing a photon of UV radiation and undergoing a chemical reaction to diffuse the energy and prevent DNA and collagen damage. Cinnamates, salicylates, oxybenzone, and avobenzone function similarly ([1](#)).

Melanin absorbs UV radiation and dissipates the energy as heat.

Finally, the body relies on antioxidants to prevent UV photo-damage. Endogenous body antioxidants include the carotenoid pigments, urocanic acid, and superoxide dismutase, which quench oxygen radicals and stabilize cell membranes. No sunscreen can duplicate the protection of these endogenous substances. There are oral and topical supplements that claim to enhance this mechanism of photoprotection, but none have been proven effective. Two of the most important antioxidants in the body are vitamins C and E, but an increased dietary intake of these vitamins has not been shown to increase the antioxidant capacity of the skin. For this reason, clothing and sunscreens are important in body photoprotection.

Body photoprotection

Sunscreens for the face and body are very similar in composition. [Table 20.2](#) lists the approved sunscreens for use in the United States and their maximum allowable concentration. There is no difference in the composition of sunscreens for different body areas, but the attributes of sunscreens for the body are different from those for the face. Body sunscreens may be selected with a higher SPF, and it may also be desirable for the formulation to have some water-resistant capabilities ([2](#)). The reader is referred to [Chapter 9](#) on facial sunscreens for an ingredient discussion.

Sunburn protection factor

The dermatologic community is anxiously awaiting the final version of the sunscreen monograph ([3](#)). Sunscreens are considered over-the-counter drugs and are therefore regulated by the monograph concerning the filters that may be used, in which combination and in which amounts. This need to stick to the monograph allows for less variation in formulations and provides for less formulation ingenuity. One of the anticipated changes in the final sunscreen monograph is the relabeling of SPF from *sun* protection factor to *sunburn* protection factor. This is probably a worthwhile change because SPF only reports the UVB photoprotective properties of the sunscreen. A rating system for UVA photoprotection is anticipated, but the details have not been finalized.

SPF has been redefined as *sunburn* protection factor.

TABLE 20.1: Natural Ultraviolet Protective Mechanisms

Cutaneous Structure	Sun Protective Mechanism
Compact horny layer	Absorbs and scatters UV
Keratinocyte melanin	1. UV-absorbing filter 2. Free radical scavenger 3. Dissipates UV as heat 4. Undergoes oxidation in the 300–360 nm range to produce immediate pigment darkening
Carotenoid pigments	1. Membrane stabilizers 2. Quench oxygen radicals
Urocanic acid	Oxidized to stabilize UV-induced oxygen radicals
Superoxide dismutase	1. Oxygen radical scavenger 2. Protects cell membrane from lipoprotein damage
Epidermal DNA excision repair	Repairs UV-induced DNA damage

TABLE 20.2: Category 1 Monographed Sunscreen Active Ingredients

Active Sunscreen Ingredient	Maximum Concentration (%)
Aminobenzoic acid (p-Aminobenzoic acid, PABA)	15
Avobenzene	3
Cinoxate	3
Dioxybenzone (benzophenone-8)	3
Homosalate	15
Menthyl anthranilate	5
Octocrylene	10
Octyl methoxycinnamate	7.5
Octyl salicylate	5
Oxybenzone (benzophenone-3)	6
Padimate-O (octyl dimethyl PABA)	8
Phenylbenzimidazole sulfonic acid	4
Sulisobenzene (benzophenone-4)	10
Titanium dioxide	25
Trolamine salicylate	12
Zinc oxide	25

The SPF is currently the only comparative rating available for determining the superiority of one product over another in terms of possible sun protection. Patients are misled, however, when they purchase products based on SPF alone. There is no substitute

for a quality formulation from a reputable manufacturer. Further, the only way a consumer would know that they are getting adequate UVA photoprotection is by looking for products with an SPF above 30 and finding the words “broad spectrum” on the label (Figure 20.1). It is not possible to make a sunscreen with an SPF above 30 that does not have some UVA photoprotection. The current inflation in SPF values is an attempt by the manufacturers to report their superior UVA photoprotective qualities. Although a higher SPF means little in terms of UVB photoprotection, it is an important indicator of UVA photoprotection. Patients should currently be encouraged to use higher SPF formulations in the range of 40–55 for excellent body photoprotection.

Both chemical and biologic methods are used to determine the SPF; however, only the biologic evaluation will be discussed in this chapter. Most commonly, the lower back of untanned individuals is divided into small test sites and exposed to UVB light until a minimum amount of erythema develops, known as the minimal erythematous dose (MED). Lightproof barriers are placed around the test sites to prevent light contamination from one test site to another. Once the MED for the test subject has been determined, the subject is invited to return to the test site the next day for application of sunscreen. The sunscreen is placed on the test sites and allowed to dry. The skin is then exposed to UVB light at the expected SPF of the sunscreen product. The expected SPF is roughly determined by spectrophotometric absorption. The amount of UVB light required to obtain the same degree of erythema as the preceding day is determined and the SPF calculated.

**FIGURE 20.1** A sunscreen label containing the wording “broad spectrum” with an accompanying high SPF.

This measurement is the optimum SPF the product can deliver under optimum conditions. The subjects have a measured amount of the product rubbed into the skin by a skilled technician. This eliminates the complicating factor of too little sunscreen applied in an erratic manner. Subjects are also evaluated indoors, eliminating the effects of wind, humidity, and perspiration due to high temperatures. From clinical experience, the biologic SPF determined under laboratory conditions in human test subjects should be halved to give an approximation of what can be expected under actual use conditions.

Water resistance

Water-resistant qualities are very important in body photoprotection, where sweating and water contact are common. Separate testing must be conducted to meet criteria required by the FDA to place the water-resistant label on a body sunscreen bottle. Water resistance is determined by applying the sunscreen with a predetermined SPF to human volunteers over a body surface area of 50 cm². The product is allowed to dry for 20 minutes and reapplied with another 20 minutes allowed for drying. The subjects are then asked to swim in an indoor pool for 20 minutes. The skin is then dried, and the subjects sit outside the pool and rest for 20 minutes. The subjects then re-enter the pool for another 20 minutes. Thus, a total of 40 minutes of water contact is required to substantiate water-resistant claims (4).

Sunscreen water resistance is determined by two 20-minute water exposures.

The SPF of the product is determined after this routine of water contact and skin drying. If the SPF following water contact is the same as the SPF prior to water contact, the product is considered to be water-resistant. This testing also maximizes the water-resistant characteristics of the sunscreen. Notice that two applications of the sunscreen are performed prior to water contact. Also notice that the sunscreen is allowed to dry for 20 minutes prior to water contact. Double application ensures good coverage, while the drying period maximizes the substantivity of the product for the skin. Substantivity is a term used by the cosmetic chemist to explain the ability of the sunscreen to remain in place on the skin. This is the advice that should be given to patients who expose themselves and their children to the sun at the beach. The patient should do everything possible to maximize the water-resistant qualities of the sunscreen. The product will not perform up to standards in real life at the beach because the effects of wind and sand are eliminated in the indoor pool environment used to perform the testing.

Water-resistant sunscreen formulations

There is a great deal of chemical science that goes into the development of a successful water-resistant sunscreen. The basic methods of imparting water resistance are listed in Table 20.3. All the technologies for imparting water resistance are predicated on the fact that water-soluble and oil-soluble substances do not mix, meaning that water can dissolve water-soluble substances but not oil-soluble substances. Thus, if a sunscreen is predominantly oil with minimal water, it will not solubilize in the presence of water

TABLE 20.3: Water-Resistant Sunscreens

Chemical Technology	Mechanism of Efficacy
Water-in-oil emulsions	Oil is the main ingredient and resists removal by water.
Silicones	Hydrophobic oily liquid that resists removal by water and forms a film over the skin surface.
Acrylate crosspolymer	No emulsifier is required, which prevents water from dissolving the sunscreen; used in titanium dioxide preparations.
Liquid crystal gels	Hydrophobic emulsifiers are used that resist water; used in titanium dioxide preparations.
Phospholipid emulsifiers	Substances engineered to mimic natural sebum (potassium cetyl phosphate) with water-resistant properties.
Film-forming polymers	Thin polymer film formed over the skin with inherent water resistance.

or perspiration. However, oil-dominant sunscreens are greasy and sticky. This has led to the development of silicone liquid-based sunscreens because silicone is an oil that is not greasy or sticky but has excellent water-resistant properties.

Another method of creating water resistance is to alter or eliminate the emulsifier. Remember that the function of an emulsifier is to allow water- and oil-loving substances to mix into one continuous phase. The emulsifier in the sunscreen formulation can allow perspiration or swimming pool water to mix with the oily ingredients, facilitating removal. Thus, acrylate crosspolymers and liquid crystal gels are being used where no emulsifier or hydrophobic emulsifiers can prevent solubilization of the sunscreen film by water.

The last methods used to confer water resistance are predicated on creating a film that is resistant to water removal. One technique involves the use of phospholipids, which are structurally similar to natural sebum and create a thin oily film on the skin. The other technique involves the use of polymers that leave a thin, water-resistant film on the skin surface.

Water-resistant sunscreen failure

Unfortunately, water-resistant sunscreens fail. All dermatologists have seen patients who have experienced severe, blistering, second-degree sunburns at the beach while wearing sunscreen. The methods by which sunscreens can be removed from the skin by water are listed in Table 20.4 (5). It is important to understand why body sunscreens fail to better advise patients on superior sunscreen selection and use (Figure 20.2).

Sunscreens are removed by water due to emulsification, rubbing, and separation of the sunscreen film.

TABLE 20.4: Methods of Sunscreen Removal by Water

1. Emulsification of the sunscreen film by water
2. Removal of the sunscreen film by rubbing
3. Separation of the UV filters from the sunscreen film



FIGURE 20.2 A sunscreen with labeling that indicates it is water-resistant.

There are three primary mechanisms that account for the removal of sunscreens from the skin surface. One method is water, which actually dissolves the oily sunscreen film by interacting with the emulsifier in the formulation. This means that the emulsifier in water-resistant sunscreens must be of low concentration or possibly eliminated. For this reason, many of the best water-resistant and waterproof sunscreens are anhydrous, meaning they contain no water. Anhydrous products do not require an emulsifier. This point should be emphasized to patients when selecting water-resistant sunscreens. Even though the patient may prefer a lighter feel in sunscreens, money and application time are wasted if the product is immediately removed upon water contact.

The second manner in which water-resistant sunscreens can fail is with friction. This can be the case if the sunscreen does not stick well to the skin, a quality known as substantivity. The rubbing of water over the sunscreen film on the skin can also mechanically remove the product by lifting it off the skin surface. This quality of a sunscreen is tested in part by the evaluation of the SPF following two 20-minute swims. Dermatologists who are interested in personally testing the ability of a sunscreen to remain in place on the skin should apply the sunscreen to a glass slide and allow it to thoroughly dry. The glass slide should then be swirled in a glass of water. If the sunscreen film is even and continuous, it will remain on the slide, and the water will remain clear. If a thin film is seen in the glass or the water becomes cloudy, the sunscreen has failed the test.

Finally, the sunscreen film can physically degrade, a phenomenon most commonly seen with particulate sunscreens containing micronized titanium dioxide or microfine zinc oxide. In this case, the oily sunscreen film or polymer film adheres well to the skin, but the water-soluble titanium dioxide or zinc oxide does not remain contained within the film. Water washes away the

water-soluble particulates, leaving behind a film lacking some of the ingredients required to achieve the labeled SPF. This problem can be overcome by using hydrophobic grades of titanium dioxide.

Sunscreen degradation and incompatibilities

Sunscreen failure can also occur from degradation or interaction between the filters. This is why sunscreens have expiration dates and outdated sunscreen should not be used by the patient. Sunscreens are complex formulations without an unlimited shelf life. Some of the unwanted interactions can be suspected by the patient if the normally white sunscreen discolors to a pale yellow or brown color. These discolored products will not provide optimal sun protection and should be discarded. Discoloration may be seen in sunscreens containing octyl methoxycinnamate, which can undergo a photochemical reaction to form an intensely yellow pigment when exposed to sunlight. This can be prevented by packaging the sunscreen in an opaque container. Adding other UV absorbers, such as benzophenone-3 or zinc oxide, can stabilize the octyl methoxycinnamate while acting as active sunscreens and increasing the product SPF.

Degradation of another sort can occur with particulate sunscreens, such as micronized titanium dioxide or microfine zinc oxide. To be an effective sunscreen, the particles must be dispersed evenly within the sunscreen lotion. If the particles coalesce, an even film of the active sunscreen is not achieved on the skin, and the SPF of the product is that of the unprotected skin. It is important to use physical sunscreens within their expiration period so that the suspension remains intact. The suspension should be a white color, and discolored products should also be discarded. The fragrance of particulate sunscreens can also disappear with time in suboptimal formulations because it is absorbed by the titanium dioxide or zinc oxide. One of the newest developments that improved the feel, water resistance, and SPF of physical sunscreens is the incorporation of film-forming polymers, such as acrylate copolymers or polyvinyl pyrrolidone (PVP).

UV filters can also be absorbed by plastic packaging or the cap inserts. For example, polystyrene and low-density polyethylene can absorb the UV filters. For this reason, high-density polyethylene or high-density polypropylene must be chosen for packaging.

Sunscreens can interact with plastic packaging, making bottle construction important in sunscreen efficacy.

Sunscreen compliance

Compliance is key to sunscreen efficacy. Sunscreens do not work if they remain in the bottle. It is estimated by sunscreen manufacturers that an average US adult uses less than one bottle of sunscreen per year. Clearly, this is indicative of poor compliance because one bottle, if applied as directed on a daily basis, should last one month. The major issues in sunscreen compliance are examined next and presented in [Table 20.5 \(6\)](#).

TABLE 20.5: Methods of Improving Sunscreen Compliance

1. Begin developing habits during childhood for good hygiene: brush teeth, wash face, apply sunscreen.
2. Select sunscreen formulations that are appropriate for the body area of application.
3. Use sunscreen-containing moisturizers instead of plain moisturizers on face, neck, upper chest, and hands.
4. Select a sunscreen-containing facial foundation for a female face.
5. Use a sunscreen-containing lip balm or lipstick.
6. Use a gel sunscreen as an aftershave on the male face.
7. Apply a quarter-sized dab of sunscreen to the hand and use the entire amount on the face, neck, and ears.
8. Develop a routine for sunscreen application that includes the face, front of neck, back of neck, ears, behind the ears, and central chest.
9. Select separate products with different aesthetics for daily wear and beach wear.
10. Use clothing effectively in the form of long pants, long sleeves, hats, scarves, and umbrellas as photoprotection.

Issue 1. Sunscreens are sticky

One of the most common reasons patients do not like sunscreens is because they can be sticky (Figure 20.3). Perhaps it may be helpful to obtain more insight into this issue. Most of the chemical sunscreen actives are sticky oils, such as methyl anthranilate. A sunscreen formulation will usually combine at least two to three different actives to get broader-spectrum coverage and a higher SPF. The SPF is increased as the concentration of the active is increased. Thus, higher SPF products are typically stickier. Sunscreens with an SPF of 30 or higher are usually stickier than sunscreens with an SPF of 15 or lower. Yet, an SPF of 15 blocks about 93% of the UVB radiation, whereas an SPF of 30 blocks out 97% of the UV radiation. This is only a 4% difference in UVB photoprotection, which may be the difference



FIGURE 20.3 Some spray sunscreen formulations may offer an alternative for patients who do not like sticky creams.

between an aesthetically pleasing sunscreen and one that is undesirable. For this reason, dermatologists should reconsider advising patients to use the highest SPF product possible. Lower SPF products generally have better aesthetics and may yield better compliance. My recommendation is that patients should use an SPF 30+, which provides excellent photoprotection and optimal aesthetics.

Issue 2. Sunscreens make you hotter in the sun

Another common complaint regarding sunscreen use is that patients feel hot and sweaty while wearing them. Although some of this may be due to the fact that sunscreens are worn in the hot sun, chemical sunscreens such as octyl methoxycinnamate, benzophenone, methyl anthranilate, and homosalate, actually function by converting UVB radiation to heat. This generation of heat by the sunscreen contributes to the feeling of skin warmth. This should not be a deterrent to wearing sunscreen; physical sunscreen agents, such as zinc oxide or titanium dioxide, do not produce heat. Selecting the proper sunscreen can help minimize this problem, which may lead to decreased compliance.

Issue 3. Sunscreens cause acne

Many patients have the perception that sunscreens cause acne. The acne is typically in the form of inflammatory papules, not open or closed comedones, and presents within 48 hours after initial application. This is not true acne because sufficient time has not passed since the sunscreen application for follicular rupture to occur. The acne seen with sunscreens is more of an acneiform eruption, which is likely indicative of irritant contact dermatitis. Some of the more extended-wear water-resistant sunscreens are more occlusive by nature and may cause difficulty at the follicular ostia. The solution to this problem is sorting through a variety of sunscreen formulations by trial and error. Major problems can be avoided by applying the sunscreen for five consecutive nights to a small area of skin in front of the ear. The skin should be observed for the presence of inflammatory papules and pustules. Another helpful tip is the avoidance of long-wearing sunscreen products. For daily use, long-wearing products are not necessary, and a sunscreen-containing moisturizer may be a good alternative. If a beachwear product is desired, the vehicle of gel sunscreens, which may contain a polymer, should be avoided. Instead, a lightweight cream formulation should be selected and then applied frequently to obtain maximal protection.

Issue 4. Sunscreens sting when applied

It is true that some sunscreens sting when applied; this is more common in gel sunscreen formulations with a high concentration of a volatile vehicle, such as alcohol. Creamy sunscreens are a possible solution to this problem (Figure 20.4). Sunscreens may also sting when they enter the eye. One option is to use one of the waxy stick sunscreens in the eye area that will not melt or run when combined with sweat. These sunscreens can be stroked above the eyebrows and on the upper and lower eyelid. One of the methods for improving compliance is to pick the proper sunscreen for the proper skin site. No single sunscreen formulation will work in all body areas. One possible way to minimize stinging is to select either a pigmented facial foundation or a pigmented sunscreen (Figure 20.5) (7). The iron oxide pigment is an excellent protectant against visible radiation that can also cause skin darkening. When combined with titanium dioxide or zinc oxide and no organic filters, the incidence of stinging may be reduced.



FIGURE 20.4 Many moisturizing sunscreens do not sting when applied to patients with sensitive complexions.

Issue 5. Sunscreens do not work

There are some who are skeptical of sunscreen efficacy from the start. This concern may be well-founded because sunscreens can fail. How does this occur? It is important to remember that sunscreens do not work unless present on the skin surface. Thus, failure to coat the entire exposed skin surface with sunscreen and sunscreen removal from rubbing or sweating are two of the most common causes of sunscreen failure. Sunscreens may also fail if the film applied to the skin is too thin. A thin film, created by failure to apply the proper amount of sunscreen, yields skin areas that are unprotected. Formulation issues are also important. Some sunscreens have better skin substantivity. Not all bottles of sunscreen with an identical SPF are equivalent. There is no substitute for the formulation knowledge of an experienced sunscreen manufacturer. By law, all products labeled with an SPF of 15 will provide consistent sun protection under optimal conditions. These optimal conditions include minimal perspiration, no water contact, low humidity, minimal activity, no wind, thick film application, and so on. In reality, sunscreens are not worn under these conditions. The sunscreen in the bottle may be an SPF 15, but its performance on the skin may differ depending on formulation.

Sunscreen safety

Sunscreen safety is an increasingly important issue. It should also be mentioned that there is some concern about the systemic absorption of organic sunscreen filters, especially when applied to



FIGURE 20.5 For female patients who experience problems with many sunscreen formulations, an opaque facial foundation can be used for photoprotection.

large body areas in children (8, 9). Oxybenzone, a very effective, frequently used filter, may have estrogenic effects on the body. There has also been media concern about the bleaching effects of oxybenzone on the coral reefs in Australia and the increased incidence of photoallergy attributed to oxybenzone.

Summary

It is evident from this discussion that tremendous science, art, chemistry, and testing must be combined to achieve a successful sunscreen product. The UV filters selected must be placed in a stable vehicle that not only creates an even water-resistant film on the skin to maintain the labeled SPF but is also perceived by the patient as aesthetically pleasing. The best sunscreen formulations combine oil-soluble and water-soluble UV filters that are attracted to both the hydrophobic and hydrophilic areas of the skin to provide maximum coverage. The packaging is selected to maintain the integrity of the sunscreen. Dermatologists should be aware of these factors when considering sunscreen recommendations.

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Skin color has always been a source of preoccupation for the human race. There are reports of ancient humans using burnt ashes to blacken the skin, Egyptians applying burnt ochre and beetle shells to adorn the face, and Native Americans decorating their bodies with vivid pigments. This concept of self-adornment persists in the form of recreational tanning. The desirability of a tan was popularized by Coco Chanel, who was famous for her couture fashions. She conceived of the idea of using tanned women in advertisements designed to promote her clothing and perfume. Prior to this time, women had shunned the sun because tanned skin indicated that a woman performed manual labor outdoors. Society women, who dwelled indoors, used their fair skin color as a sign of class status. With the industrial revolution, more and more women were leaving their jobs in the fields to live in the city and work indoors in factories. These women had little time for recreational sunning. Thus, skin tanning became popular as a sign that northerners were able to vacation in a sunny locale.

Despite the known risks of premature aging and skin cancer associated with tanning, this remains a popular practice. Tanning from natural sun exposure or from artificial tanning booth light poses a health risk that is ignored by many. Because the societal desirability of tanned skin among Caucasians has not decreased, skin care manufacturers have searched for ways of achieving tanned skin without photodamage. Products designed to simulate a tan without sun exposure are known as sunless tanning creams.

Sunless tanning creams utilize dihydroxyacetone (DHA) as the active agent (1). This chemical was originally discovered in the 1920s as a possible substitute for sweetener in diabetic diets by Procter & Gamble, Cincinnati, OH. When DHA was chewed in concentrated form as a candy, it was noted that the saliva turned the skin brown without staining clothing or the mouth. This side effect made the chemical unsuitable as a glucose substitute, yet DHA was eventually marketed in the 1950s when the first sunless tanning cream was introduced to the marketplace.

Sunless tanning cream formulation

DHA is a 3-carbon sugar that is manufactured as a white, crystalline hygroscopic powder. It interacts with amino acids, peptides, and proteins to form chromophores known as melanoidins (2). Structurally, melanoidins have some similarities to skin melanin (3). The browning reaction that occurs when DHA is exposed to keratin protein is known as the Maillard reaction (4). DHA is technically categorized as a colorant or colorless dye that glycates the protein found in the stratum corneum.

Dihydroxyacetone (DHA) glycates proteins in the outer stratum corneum to produce a brown stain, known as melanoidins.

DHA is usually added to a creamy base in concentrations of 3–5% (5). Lower concentrations of DHA produce mild tanning, whereas higher concentrations produce greater darkening (6).

This allows sunless tanning creams to be formulated in light, medium, and dark shades. The depth of color produced by sunless tanning creams can be enhanced by increasing the protein content of the stratum corneum. This is accomplished by applying a sulfur-containing amino acid, such as methionine sulfoxide, to the skin just before applying the DHA.

As might be expected, skin areas with more protein stain a darker color. For example, keratotic growths such as seborrheic keratoses or actinic keratoses will hyperpigment. Protein-rich areas of the skin, such as the elbows, knees, palms, and soles, also stain more deeply. For this reason, it is advisable to remove all dead skin through exfoliation prior to applying the sunless tanning cream. DHA does not stain the mucous membranes, but will stain the hair and nails.

The chemical reaction is usually visible within one hour after DHA application but maximal darkening may take 8 to 24 hours (7). Many sunless tanning preparations contain a temporary dye to allow the user to note the sites of application and to promote even application, but this immediate color should not be confused with the Maillard reaction.

Sunless tanning creams have enjoyed a renewed popularity since their original introduction in the 1950s. The original self-tanners produced a somewhat unnatural orange skin color. This problem has been corrected through the use of more purified sources of DHA that yield a more natural golden color. Yet, for persons with pink skin tones, the sunless tanning creams may still appear unnatural.

Sunless tanning and photoprotection

DHA is a nontoxic ingredient, both for ingestion and topical application. It has a proven safety record, with only a few reported cases of allergic contact dermatitis (8). Unfortunately, the browning reaction does not produce adequate photoprotection. At most, sunless tanning preparations may impart an SPF of 3 to 4 to the skin for up to one hour after application (9). The photoprotection does not last as long as the artificial tan. The brown color imparts limited photoprotection at the low end of the visible spectrum with overlap into the UVA portion of the spectrum (10). DHA used to be approved as a sun protective agent in combination with lawsone; however, the new sunscreen monograph has removed this ingredient, largely due to its lack of popularity.

Sunless tanning creams confer no photoprotection and must be used with sunscreen when going outdoors.

The staining reaction that occurs with DHA is limited strictly to the stratum corneum and can be readily removed with tape stripping and exfoliation. Thus, the product must be reapplied daily to maintain optimal skin darkening. There are no known side effects, except for possible irritation, from frequent

application. The DHA does have a distinct odor, which is difficult to mask with fragrances.

Sunless tanning cream application

Sunless tanning creams can produce a natural-appearing tan if artistically applied (11). One of the problems is that the cream will stain everything it touches, including the palms of the hands that do not tan with sun exposure. It will also stain hair and clothing. There are several tips summarized in Table 21.1 that can assist in achieving an even application. The key to a good result is aggressive exfoliation of the skin with an abrasive scrubbing cream. These creams contain particulates, such as polyethylene beads, which mechanically remove desquamating corneocytes from the surface. An accumulation of corneocytes will stain the area darker because there is more protein for the DHA to glycate. Gloves should be worn during application. The cream has to be applied in an even, thin layer. Less cream should be applied to areas where the skin is hyperkeratotic, such as the wrists, back of the neck, ankles, toes, fingers, antecubital fossae, and popliteal fossae. These areas tend to stain unnaturally darker. The brown stain will last about two weeks until the stained corneocytes have sloughed.

A newer technique of applying sunless tanning cream is known as a spray tan. Spray tans are applied professionally in hair salons, nail salons, and artificial UV tanning booths. The client is placed

in a booth naked, surrounded by a curtain, and the DHA solution is sprayed on the body for a more even application. Petroleum jelly is placed over the easily overstaining areas mentioned above to more closely simulate a natural tan. Professional application eliminates the mess and odor of at-home application.

Summary

Sunless tanning creams are a safe, cost-effective, and efficient manner to obtain temporary skin darkening. They should not be used in place of sunscreen, however (3). A natural simulated tan can be achieved by applying the sunless tanning cream evenly to the desired areas. Care should be taken to apply less cream to the easily stained areas, such as the ankles, knees, elbows, and toes. Because a tan remains fashionable in our modern society, tanning creams should be used to stain the skin rather than risking sun exposure that will ultimately result in premature skin aging and skin cancer.

References

TABLE 21.1: Tips for Sunless Tanning Cream Application

1. Bathe the areas for application to eliminate any other creams or sebum from the skin surface. Always start with clean skin.
2. Use an abrasive scrub with polyethylene beads to thoroughly exfoliate the skin after bathing.
3. Dry the skin thoroughly.
4. Apply petroleum jelly to these areas of the body that will overstay with the sunless tanning cream: wrists, back of the neck, ankles, toes, fingers, antecubital fossae, and popliteal fossae.
5. Put on disposable gloves to avoid staining the palms.
6. Squeeze out of the bottle a small amount of cream and rub evenly between the palms. Rub the palms over the application area. Rub until the cream is evenly distributed to avoid streaking. Apply to one body area at a time working from the arms to the legs.
7. Remain still until the cream has thoroughly dried to avoid removal and unintentional application to hair and cloth items.
8. Repeat every two weeks or as necessary.

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22

CELLULITE

Definition

Cellulite is the most common, poorly understood aesthetic condition affecting women worldwide (1). This can be verified by the many names ascribed to this uneven bumpy skin texture appearing on the buttocks and thighs (Figure 22.1), including adiposis edematosa, dermopanniculosis deformans, status protrusus cutis, and gynoid lipodystrophy (2). Under ultrasound visualization, cellulite appears as low-density fat herniations into the denser dermal tissue (3). There are many theories purported to describe the pathophysiology of cellulites; none can be verified, however. These theories include dietary influences, genetically determined fat deposition, vascular insufficiency, excess adipose tissue, and chronic inflammation (Table 22.1) (4). Although there are various treatments for cellulite, none can permanently erase the unattractive dimpled skin. Yet, a sizeable number of cosmetic products can be purchased that promise smoother skin. This chapter is presented largely for informational purposes to assist the dermatologist in discussing cellulite with patients.

Dietary influences

The theory that diet contributes to the pathophysiology of cellulite has been popularized by the consumer press. Articles abound stating that a low-carbohydrate, low-fat, low-salt, high-fiber diet can minimize cellulite. A controlled medical study to verify the effect of diet on cellulite minimization has never been conducted. A low-calorie diet, which might be low in high-calorie carbohydrates and fats, however, may decrease adipose tissue and improve

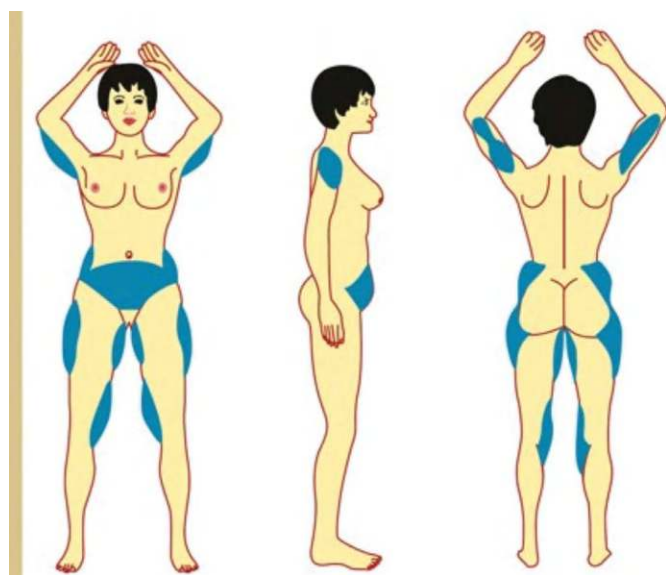


FIGURE 22.1 The most common location for cellulite is the upper posterior thighs. It may also occur on the upper posterior arms, buttocks, and anterior thighs.

TABLE 22.1: Cellulite Pathophysiology Controversy

Cellulite Theory	Pros	Cons
Dietary influences	Asian women who consume phytoestrogens in soy exhibit less cellulite.	80% of women worldwide exhibit cellulite regardless of diet.
Genetically determined fat deposition	Daughters of mothers with cellulite are also likely to exhibit cellulite.	Cellulite can be minimized by less body fat, which is self-determined.
Vascular insufficiency	Deterioration of dermal vasculature results in increased fluid retention and cellulite appearance.	Ultrasound imaging of cellulite shows adipose tissue impinging on the dermis, not only fluid.
Excess adipose tissue	Women with more body fat tend to exhibit more cellulite.	Weight loss does not eliminate cellulite.
Chronic inflammation	Inflammation from collagenase breaks down dermal collagen, allowing for adipose herniations.	Not all menstruating women exhibit cellulite to the same degree.

cellulite (5). Low salt, high-fiber diets may indeed decrease extracellular fluid volume, thus minimizing vascular effects.

When considering how diet affects the pathophysiology of cellulite, it is interesting to look at how cultural eating habits may contribute. Cellulite is more commonly seen in Caucasian women than Asian women. It is true that visualization of skin texture irregularities is easier in fair skin, yet Asian women seem to demonstrate less cellulite. One theory regarding the pathophysiology of cellulite is the effect of diet on circulating estrogens. The consumption of cow's milk in Asia is low, and much of the milk consumed in the United States contains estrogens that enter the milk from the food that is fed to the cows. Another possible explanation is reduced endogenous estrogen production in Asian women, who consume large amounts of fermented soy in the form of tofu or soy nuts. Fermented soy is high in phytoestrogens, which may suppress adrenal and ovarian estrogen production, which is not the case with the estrogens ingested in cow's milk.

Thus, one explanation for cellulite is a poor diet leading to the deposition of excess fat, fluid retention, and a high circulating estrogen level (6). Another theory is that cellulite is present due to predetermined genetic influences.

Genetically determined fat deposition

Many researchers believe that the pattern of adipose deposition that leads to cellulite is genetically determined (7). Thus, women will age and deposit fat in the same areas as their mothers regardless of diet or estrogen stimulation (8). This may be

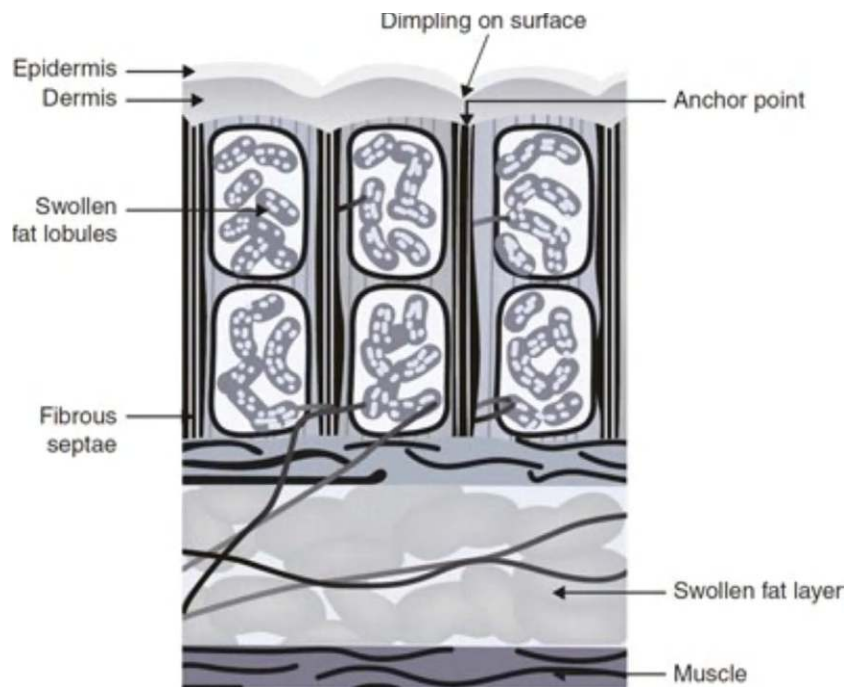


FIGURE 22.2 Shrinking of the fibrous septae has been argued to result in the dimpling of the skin characteristic of cellulite.

due to a hormone receptor allele that determines the receptor number and sensitivity to estrogen, which ultimately determines the distribution of subcutaneous fat. Pierard espoused this theory, noting that cellulite is not a result of increased body mass but rather can be influenced by the inherited waist-to-hip ratio (9).

Vascular insufficiency

One of the most widely held theories about the pathophysiology of cellulite is the effect of vascular insufficiency. Smith postulates that cellulite is a degradation process initiated by the deterioration of the dermal vasculature, particularly loss of the capillary networks (10). As a result, excess fluid is retained with the dermal and subcutaneous tissues (11). This loss of the capillary network is thought to be due to engorged fat cells clumping together and inhibiting the venous return (12).

After the capillary networks have been damaged, vascular changes begin to occur within the dermis, resulting in decreased protein synthesis and an inability to repair tissue damage. Clumps of protein are deposited around the fatty deposits beneath the skin, causing an “orange peel” appearance of the skin as it is pinched between the thumb and forefinger. At this stage, however, there is no visual evidence of cellulite.

The characteristic appearance of cellulite is only seen after hard nodules composed of fat surrounded by hard reticular proteins form within the dermis. Ultrasound imaging of skin affected by cellulite at this stage reveals thinning of the dermis with subcutaneous fat pushing upward, which translates into the rumpled skin known as cellulite.

This theory holds that hormonally mediated fat deposition, fat lobule compression of capillary vasculature, decreased venous return, formation of clumped fat lobules, and deposition of protein substances around clumped fat lobules lead to the appearance of cellulite.

Excess adipose tissue

Some investigators have observed that cellulite is more common in overweight and obese women. This was felt to be due to the presence of copious fat lobules within the subcutaneous tissue, encased in fibrous septae with dermal attachments (13) (Figure 22.2). These fibrous attachments surrounding abundant fat lead to the rumpled appearance of the skin characteristic of cellulite (14). Thus, weight loss, which reduces the size of the fat lobules and removes the metabolic influences of excess adiposity, improves the appearance of cellulite (15). Improvement can also be achieved with exercise because improved muscle tone creates a better foundation to support the overlying fat.

Chronic inflammation

The final theory espouses that cellulite is an inflammatory process resulting in the breakdown of the collagen in the dermis, providing for the subcutaneous fat herniations seen on ultrasound (Figure 22.3). The onset of cellulite with puberty and menstruation has caused some researchers to evaluate the hormonal changes necessary for sloughing of the endometrium (16). It appears that menstruation requires the secretion of metalloproteases (MMPs) such as collagenase (collagenase-1, MMP-1) and gelatinase (gelatinase A, MMP-2) (17). The endometrial glandular and stromal cells secrete these enzymes to allow menstrual bleeding to occur. Collagenases cleave the triple helical domain of fibrillar collagens at a neutral pH and are secreted just prior to menstruation. However, the collagenase may break down the fibrillar collagens present in the endometrium and the dermis.

Furthermore, gelatinase B is produced by stromal cells or mast cells during the late proliferative endometrial phase and just after ovulation. Gelatinase B is associated with an influx of polymorphonuclear leukocytes, macrophages, and eosinophils, which also contribute to inflammation (18). A marker for this inflammation

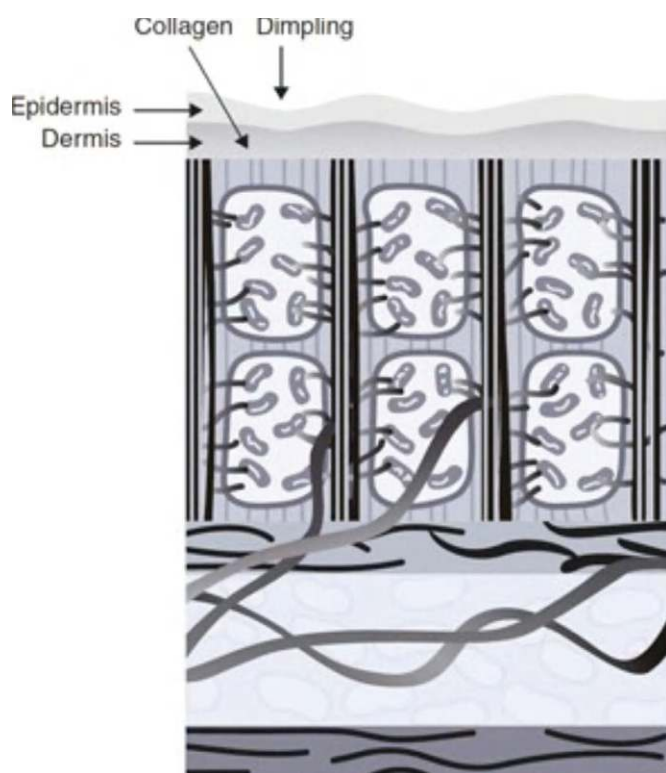


FIGURE 22.3 Chronic inflammation leading to degrading of collagen is another theory proposed for the development of cellulite.

is the synthesis of dermal glycosaminoglycans, which enhance water binding, further worsening the appearance of the cellulite through swelling. The presence of these glycosaminoglycans has been observed on ultrasound as low-density echoes at the lower dermal/subcutaneous junction (19).

The secretion of endometrial collagenase to initiate menstruation also provides for collagen breakdown in the dermis (20). With repeated cyclic collagenase production, more and more dermal collagen is destroyed, accounting for the worsening of cellulite seen with age. Eventually, enough collagen is destroyed to weaken the reticular and papillary dermis and allow subcutaneous fat to herniate between the structural fibrous septa found in female fat. Obviously, if more subcutaneous fat is present, more pronounced herniation can occur.

Cellulite treatments

A variety of cellulite treatments are available for consumer purchase. None of them can completely resolve cellulite, but a discussion of the options is useful to better understand how to scientifically discuss cellulite with inquiring patients. Presently marketed over-the-counter (OTC) treatments include topical herbals, wraps, devices, massage, and oral supplements, which are discussed next. Surgical and laser interventions are beyond the scope of this cosmetic text.

Topical herbals

Topical herbals are placed in creams designed to improve the appearance of cellulite in the OTC market. They can only claim to improve the appearance of cellulite, or they would be classified

as drugs. It is very challenging for any topical agent to reach the subcutaneous tissue because it must be both water- and fat-soluble to traverse the skin and then affect the adipocyte. Herbals such as caffeine, theophylline, and *Coleus forskohlii* are found in moisturizing cellulite creams to stimulate the breakdown of the lipids into triglycerides. Most of these creams make claims of skin smoothness and softness based on their ability to moisturize the skin, not reduce cellulite.

Herbals such as caffeine, theophylline, and *Coleus forskohlii* are found in moisturizing cellulite creams.

Wraps

Wraps are used for cellulite at home, in spas, and in body slimming franchise businesses to reduce the appearance of cellulite. Cloth strips are impregnated with herbal solutions and wrapped around the legs, buttocks, or any other area exhibiting cellulite. Sometimes the wraps are warmed, and sometimes the wrap environment is set to a high temperature to encourage sweating for “fat detoxification” treatment. Herbs that are used in the wraps include gotu kola, Paraguay tea, *C. forskohlii*, and fennel. Again, it is doubtful that these herbs can actually reach the subcutaneous tissue. In some cases, the tight wrap may reduce the extracellular fluid in the leg to minimize cellulite, and weight loss may be seen due to sweating. It is doubtful that the wrap has any permanent effect, and even spas state that weekly sessions are necessary to maintain any result.

Devices

Several OTC devices have purportedly improved the appearance of cellulite. These devices usually manipulate the skin by suction, rolling, or pressure. The suction devices draw up the skin and claim to “break up” the cellulite, as if the lumps were due to something that could be crushed. Sometimes the suction is combined with rolling and pressure. If extracellular fluid is present due to poor venous return in the legs, removal of this fluid can improve the appearance of cellulite. Support stockings or reclining has much the same effect. Of course, the effect is temporary unless something is done to prevent fluid re-accumulation. These devices attempt to mimic the effect of massage, which is discussed next.

Massage

One common method adopted by aestheticians for improving cellulite is massage. Deep venous massage can remove extracellular fluid and improve lymphatic drainage. Sometimes herbals that produce vasoconstriction, such as wild horse chestnut, are used in the massage cream as “circulation enhancers” and said to have “venotonic” effects. Massage can be relaxing and enjoyable, but 20 mmHg or higher compression support stockings produce the same effect.

Massage can improve lymphatic drainage and temporarily improve the appearance of cellulite.

Oral Supplements

The recent market has seen the introduction of oral supplements for cellulite, some of which have been challenged by consumer groups for false advertising claims. Cellulite claims are always

very carefully worded to avoid promising too much. One category of compounds found in oral cellulite supplements are xanthines. Xanthines are found in foods containing caffeine, such as coffee, tea, and chocolate. Xanthines inhibit phosphodiesterases, which degrades cyclic adenosine monophosphate (cAMP) and presumptively stimulates lipolysis to decrease cellulite. The most effective xanthine is aminophylline, but no reduction in cellulite has been noticed in persons taking this drug for respiratory disease.

Another oral supplement for cellulite contains bioflavonoids, such as proanthocyanidins, which are derived from berries and extensively studied in animals as caloric restriction mimetics and as potent antioxidants. In mice, proanthocyanidins have been shown to reduce the breakdown of collagen and elastin, possibly through modulation of collagenase and elastase. This has not been demonstrated in humans.

Xanthines and proanthocyanidins are found in some oral cellulite supplements.

Summary

The etiology of cellulite is still unknown, and the efficacy of cellulite treatments is highly controversial. Perhaps if the pathophysiology were understood, more effective treatments could be developed. It is most likely that cellulite is due to a combination of all the factors discussed, including hormones, genetics, adipose tissue, microcirculation, and chronic inflammation. It cannot be denied that cellulite is a widespread human condition that is more commonly observed in women, worsens with advancing age, and may even represent part of normal human anatomy. Only prepubertal women are without cellulite. Patients frequently ask for cellulite treatments, and it is unfortunate that we have little to offer in dermatology.

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Perhaps the most difficult challenge for dermatologists is discussing the presence of stretch marks with a recently pubertal female. It is disappointing for both the patient and her parents to see the presence of stretch marks, medically known as striae distensae, on the breasts, abdomen, hips, and thighs (1). Stretch marks may appear due to the rapid hormonal changes and growth associated with puberty, during pregnancy, or with medical diseases, such as Cushing's syndrome. Under the microscope, they appear as dermal atrophy accompanied by loss of the rete ridges, a finding similar to scar tissue. No curative treatment has been developed. However, moisturizers, massage, microdermabrasion, and laser resurfacing may improve their appearance.

Histologically, stretch marks appear as areas of dermal atrophy accompanied by loss of the rete ridges, a finding similar to scar tissue.

Causes of stretch marks

Stretch marks may occur during various phases of life but may be related to increased cortisol secretion or increased body mass. The most common cause of stretch marks is pregnancy, when the stretch marks are medically known as striae gravidarum. It is thought that the rapid growth of the baby may play a role, but not all pregnancies produce stretch marks. A relationship between pregnancy, obesity, and increased stretch marks has been reported (2). In obesity, it is thought that the stretching of the skin with weight gain causes the scars, but stretch marks have also been observed in persons who experience a rapid increase in muscle mass with weight lifting (3). Some medications, such as systemic and topical corticosteroids, may also produce stretch marks.

Increased stretch marks are related to pregnancy and obesity.

Stretch marks: Signs and symptoms

Stretch marks do not generally produce any symptoms but have a characteristic visual appearance, no matter when they appear or what causes them. They initially appear as raised, pink to purple lines longitudinally arranged over the abdomen, lateral upper thighs, inner arms, or upper breasts. With time, the purplish-pink color lightens, and they appear as silvery lines on the skin, similar to a scar. The purplish-pink scars are termed striae rubra, whereas the silvery lines are termed striae alba. Stretch marks can also occur in dark-complected persons, where they appear as dark brown lines, in which case they are termed striae nigra (4). In short, stretch marks are scars that are permanent once formed (5).

Stretch marks: Treatments

The treatment for stretch marks is limited (6). The most invasive therapies for stretch marks involve a physician-administered laser surgery. Improvement in stretch marks with laser therapy is accomplished by wounding the scarred skin and hoping that the newly healed skin will have a more normal, cosmetically acceptable appearance (7). Medical reports of Nd:YAG laser (8), radio-frequency devices (9), and fractional photothermolysis (10, 11) have shown some degree of stretch mark appearance improvement but not resolution.

The earlier the stretch mark is treated, generally, the better the result. Red immature stretch marks are more amenable to treatment than those that have matured to a silvery white. This is because the reddish stretch marks are still healing, and the healing can be modified by intervention. Sometimes camouflage is the best option for treatment to hide the scars (12).

A spa treatment for stretch marks is the use of microdermabrasion. Microdermabrasion uses a spray head to bombard the skin with tiny salt, baking soda, or aluminum particles to exfoliate the skin and smooth stretch marks, possibly encouraging collagen production through mild wounding. Although microdermabrasion can temporarily smooth the skin surface, it cannot remove the stretch mark.

A variety of products can be purchased over-the-counter for improving the appearance of stretch marks. There are anecdotal stories of cocoa butter, emu oil, vitamin E, onion extract, and other oils aiding in the prevention and treatment of stretch marks. The most common dermatologist-recommended treatment for scars, such as stretch marks, is massage. Massaging the skin in a circular motion with oil using the fingers to reduce friction is helpful in stretching the skin collagen and elastin, making it more pliable and have a more normal appearance.

Topical moisturizers for stretch marks contain ingredients such as cocoa butter, emu oil, vitamin E, and/or onion extract.

The prevention of stretch marks is challenging. It appears that stretch marks do not occur when the stretching of the skin is gradual rather than abrupt. Thus, rapid changes in body size should be avoided, if possible. Because stretch marks represent small scars, the rapid growth of the body can result in more stretch marks, whereas slower changes in body size may allow the skin to adjust more gradually. Persons with better skin elasticity and less rigid collagen are less likely to develop stretch marks, but it is not possible to modify these skin characteristics at present (13). The presence of stretch marks during pregnancy has been associated with pelvic relaxation, resulting in prolapse of the pelvic organs with advancing age (14). Other medical associations, outside of endocrinologic disease, have not been demonstrated. In summary, stretch marks remain a treatment enigma.

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Section III

Hair

Introduction

Hair is believed to serve no current physiological function in humans, but it is of considerable importance in appearance and social concern. Hair washing, grooming, styling, coloring, waving, and straightening are the focus of attention and require the dedication of considerable financial resources. Both men and women desire a full head of perfectly coifed hair that complies with all the current fashion ideals. Hair is a nonverbal indication of our gender, health, style, and self-obsession. A great head of shiny long hair is synonymous with health, because hair is one of the first structures lost with illness or chemotherapy administration. A face full of dirty, stringy hair may be the first indication of a disturbed youth. A woman who is constantly pulling, primping, and grooming her hair in front of every mirror may be the first indication of insecurity or emotional instability. Hair says a lot about who we are and what we aspire to be.

Hair is a fibrous protein structure that consists of at least three different proteins. The basic structure of the hair arises from a series of six concentric rings in the hair bulb, which arise from a single stem cell group called the matrix of the hair bulb. The three major structures of the hair relevant to hair cosmetics are the medulla, the cortex, and the cuticle (Figure III.1). Permanent hair dyes, hair straightening, and permanent hair waving affect the medulla and the cortex, whereas all hair grooming procedures affect the cuticle. Beautiful hair is defined as hair with an intact cuticle, making the cuticle the most important structure in hair cosmetics (Figure III.2).

The cuticle provides strength to the hair shaft and is lost with aggressive grooming and chemical hair processing. Loss of the



FIGURE III.2 Cuticle cross section viewed under electron microscopy: healthy, tightly overlapping cuticular scale.

cuticle is inevitable over time, and this process is known as weathering. When the cuticle is lost, the fragile cortex is exposed. Exposure of the weak cortex leads to splitting of the hair, especially at the ends of the hair shaft, which is commonly known as a split end. The function of the medulla in the hair is unknown, and not all hairs possess a medulla. With advancing age, the medulla is lost from the hair.

The physical properties of the hair shaft are related to its geometric shape and the organization of its constituents. The most common mechanical stress hair must withstand is stretching, due to the trauma of grooming. This requires that the hair possess

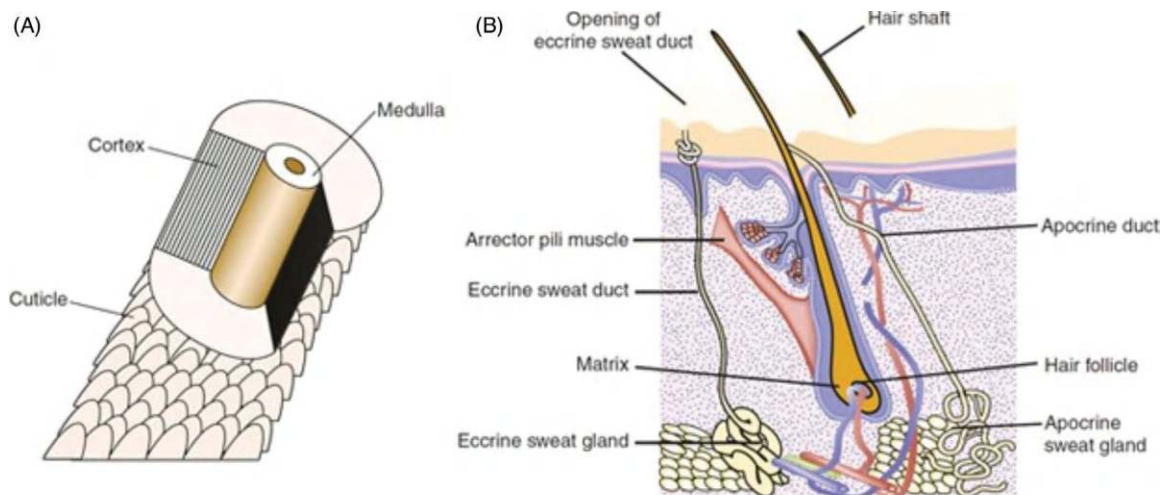


FIGURE III.1 (A) The layers of the hair shaft. (B) The structures of the hair unit.

elastic properties that provide for stretch deformation followed by a return to a normal configuration. Hair can be stretched to 30% of its original length in water and experience no damage, but irreversible changes occur when hairs are stretched to between 30% and 70% of their original length. Stretching to 80% of the original length generally results in hair shaft fracture.

In addition to undergoing stretch deformation, the hair shaft must also withstand repeated wetting and drying experienced as part of the hair cleansing process. It is water within the hair shaft that provides for optimal elasticity, but water can also be absorbed externally. The porosity of the hair shaft is about 20%, allowing a weight increase of 12–18% when soaked in water. The absorption rate is very rapid, with 75% of the maximum absorbable water entering the hair shaft within 4 minutes.

Another important physical characteristic of hair is the interaction between adjacent hair shafts in the form of friction. It has been shown that wet straight hair possesses higher combing friction than dry straight hair. This is an interesting observation that leads to the idea that hair should not be combed when wet to avoid stretching the hair shafts to the brittle breaking point. Another interaction between the hair shafts is the production of static electricity. Static electricity preferentially affects dry hair because the ions are poorly conducted down the hair shaft. This is in contrast to wet hair, which is an excellent conductor due to the presence of water. Static electricity creates a hair grooming problem because the hair shafts repel one another, creating “flyaway” hair that sticks away from the scalp. Static electricity between hair shafts can be reduced by decreasing hair friction, combing hair under cooler conditions, or decreasing the resistance of hair fibers by increasing hair moisture.

The last issue to consider regarding the physical characteristics of hair is cross-sectional shape. The degree of hair curl is determined by its cross-sectional appearance. Caucasian hair has an elliptical cross section that accounts for a slight curl, whereas Asian hair has a

symmetrical circular cross section, leading to straight hair. African American hair has an asymmetrical flattened elliptical cross section, leading to its irregular kinky appearance. The shape of the hair shaft also determines grooming ease. Straight hair is the easiest to groom because combing friction is low and the hair is easy to style. Kinky hair, on the other hand, demonstrates increased grooming friction, resulting in increased hair shaft breakage.

A further consideration is the hair growth rate. Hair grows at varying rates in different regions of the body. Scalp hair grows about 0.37 mm a day, making it the fastest growing hair on the body. In women, hair on the scalp grows faster than in men, but men have faster growing body hair. An individual hair grows for a period of about three years in the anagen phase before entering the catagen phase and finally falling out and entering the telogen phase (Figure III.3). The length of time the hair remains in the growth phase determines how long a person can grow their hair. People who have hairs that remain in anagen longer than five years can grow hair below their waist, whereas people who have hairs that remain in anagen for only two years can grow hair of shoulder length or less. About 100–150 hairs a day are shed asynchronously, accounting for the replacement of shed hairs in telogen being replaced with growing hairs in anagen. Without this cyclic loss and regrowth of hair, humans would be bald every three years.

This section of the book examines all the cosmetic procedures used to modify the hair appearance according to personal grooming desires. It explores shampoos and conditioners to maintain scalp hygiene and beautify the hair. It examines chemical processing resulting in color and shape changes to the hair shaft. It discusses hair removal techniques and evaluates the use of hair cosmetics in common scalp diseases. Even though the hair is a useless, nonliving structure, patients frequently visit the dermatologist requesting hair care advice. It is hoped that this section will provide ideas for dealing with the challenges posed by patients looking for assistance in obtaining that great-looking head of hair.

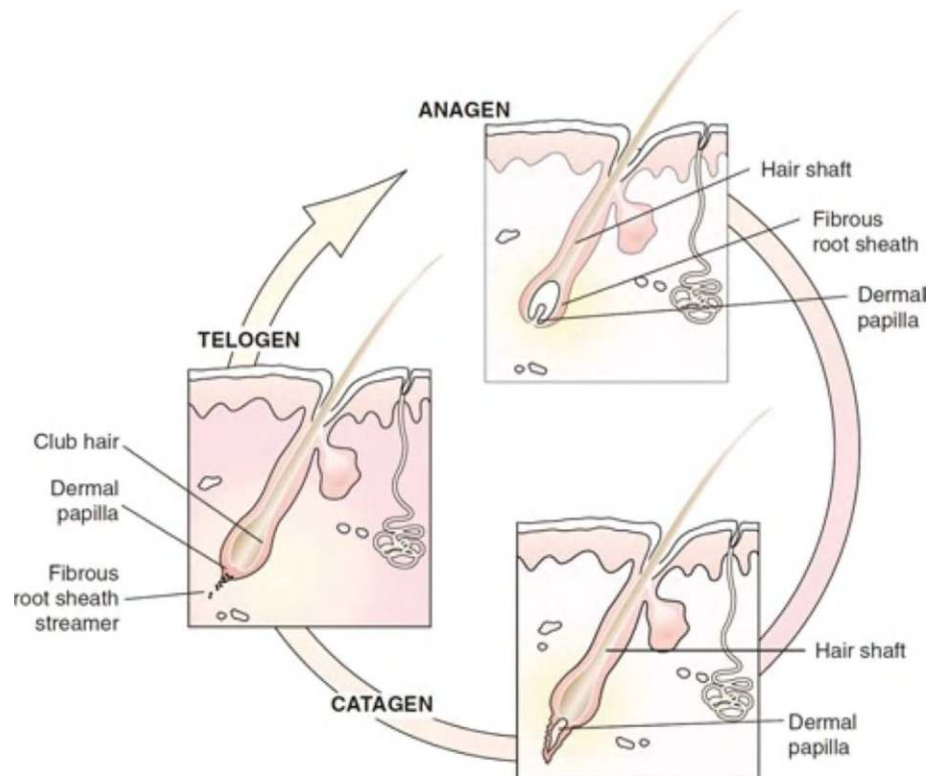


FIGURE III.3 The hair cycle through anagen (active growth phase), catagen (transitional phase), and telogen (resting phase).

24

SHAMPOOS FOR HAIR HEALTH

Shampoo is a specialized cleanser designed to beautify the hair and to either treat or prevent scalp disease. Although this sounds like a simple task, the average woman has 4 to 8 m² of hair surface area to clean (1). Shampoos are intended to remove sebum, sweat components, desquamated stratum corneum, styling products, and environmental dirt deposited on the hair and to maintain scalp health (2). It is very easy to formulate a shampoo that will remove sebum and dirt to ensure scalp health, but studies have shown that consumers do not favor a shampoo that only cleans efficiently without beautifying the hair. Hair that has been thoroughly cleaned and is devoid of sebum is dull in appearance, coarse to touch, subject to static electricity, and more difficult to style. Therefore, consumers want a shampoo that cleans the scalp but also beautifies the hair, which is a formulation challenge. This challenge is not optimally met by any one shampoo, which has led to the tremendous variety of shampoo formulations on the market for various hair types and amounts of sebum production.

Shampoo is a relatively new concoction because bar soap was used to clean the hair and scalp until the middle 1930s. Bar soap was an unsatisfactory hair cleanser because hard water in combination with soap formed a nonrinsable scum that dulled the hair and irritated the scalp. Early shampoo formulations were liquid coconut oil soaps that lathered and rinsed better than bar soap, but shampoos really came of age with the development of synthetic detergents (3). This chapter examines shampoos and their appropriateness for the various therapeutic requirements of the dermatologist.

Formulation

Shampoos are complex formulations containing detergents, foaming agents, conditioners, thickeners, opacifiers, softeners, sequestering agents, fragrances, preservatives, and specialty additives (4). These ingredients and their functions are summarized in Table 24.1. Detergents are the primary sebum and dirt removal shampoo components. However, excessive removal of sebum leaves the hair dull, susceptible to static electricity, and difficult to comb. Furthermore, consumers equate cleansing ability with foaming ability, thus demanding shampoos that produce abundant, long-lasting foam. Excessive bubbles are not a technical requirement for good hair cleansing and bacteria removal, but shampoo manufacturers add increased amounts of detergents, in addition to foam boosters, to obtain the foam that consumers desire (Figure 24.1). This increased concentration of detergent creates the need for conditioners and other additives in shampoos to improve their cosmetic acceptability.

Shampoos are complex formulations that contain detergents, foaming agents, conditioners, thickeners, opacifiers, softeners, sequestering agents, fragrances, preservatives, and specialty additives.

TABLE 24.1: Basic Shampoo Ingredient Formulation and Function

Ingredient Formulation	Function
Detergents	Remove environmental dirt, styling products, sebum, and skin scale from the hair and scalp
Foaming agents	Allow the shampoo to suds because consumers equate cleansing with foaming, even though the two are unrelated
Conditioners	Leave the hair soft and smooth after sebum removal by the detergent
Thickeners	Thicken the shampoo because consumers feel that a thick shampoo works better than a thin shampoo
Opacifiers	Make a shampoo opaque rather than translucent for aesthetic purposes, unrelated to cleansing
Sequestering agents	Prevent soap scum from forming on the hair and scalp in the presence of hard water; the basic difference between a liquid shampoo and a bar cleanser
Fragrances	Give the shampoo a consumer-acceptable smell
Preservatives	Prevent microbial and fungal contamination of the shampoo before and after opening
Specialty additives	Treatment ingredients or marketing aids added to impart other benefits to the shampoo besides hair and scalp cleansing

Our discussion now turns to an evaluation of each of the shampoo ingredients to better understand how shampoos can be formulated to assist in the maintenance of scalp health and the improvement of scalp disease.



FIGURE 24.1 Abundant foam is not necessary for good hair cleansing, but is a consumer requirement.

Shampoo detergents

Shampoos function by employing detergents, also known as surfactants, which are able to bind both oil-soluble dirt and water. The oil-soluble dirt binds to the detergent, which is then washed down the drain with water. Cleansing occurs when the oil-soluble, or lipophilic, sebum and oily hair care products bind to the detergent, whereas the water-soluble, or hydrophilic, styling products and environmental dirt are removed along with the emulsified oils during the rinse phase. Thus, detergents are amphiphilic substances that can emulsify oils in water (5). A tremendous variety of detergents is available to the cosmetic chemist formulating a shampoo (Table 24.2), including those listed in Table 24.3 (6), which are the most common detergents in use today.

Shampoo detergents can be chemically characterized as anionics, cationics, amphoteric, nonionics, and natural surfactants.

Shampoo detergents can be chemically characterized as anionics, cationics, amphoteric, nonionics, and natural surfactants (Table 24.4). Anionic detergents are named for their negatively charged hydrophilic polar group. The commonly used anionics are fatty alcohols that clean well but may leave the hair harsh (7). There are several detergents contained within the anionic group:

1. Lauryl sulfates (sodium lauryl sulfate, triethanolamine lauryl sulfate, ammonium lauryl sulfate) are found in most shampoos as the main surfactant because they work well in both hard and soft water, produce rich foam, and are easy to remove. This group produces good cleansing but is hard on the hair.

TABLE 24.2: Shampoo Detergents by Chemical Category

1. Alkyl sulfates
2. Alkyl ether sulfates
3. Alpha-olefin sulfonates
4. Paraffin sulfonates
5. Isethionates
6. Sarcosines
7. Taurides
8. Acyl lactylates
9. Sulfosuccinates
10. Carboxylates
11. Protein condensates
12. Betaines
13. Glycinates
14. Amine oxides

TABLE 24.3: The Most Common Shampoo Detergents

1. Sodium laureth sulfate
2. Sodium lauryl sulfate
3. TEA lauryl sulfate
4. Ammonium laureth sulfate
5. Ammonium lauryl sulfate
6. DEA lauryl sulfate
7. Sodium olefin sulfonate

TABLE 24.4: Shampoo Detergent Characteristics

Surfactant Type	Chemical Class	Characteristics
Anionics	Lauryl sulfates, laureth sulfates, sarcosines, sulfosuccinates	Deep cleansing, may leave hair harsh
Cationics	Long chain amino esters, ammonioesters	Poor cleansing, poor lather, impart softness and manageability
Nonionics	Polyoxyethylene fatty alcohols, polyoxyethylene sorbitol esters, alkanolamides	Mildest cleansing, impart manageability
Amphoterics	Betaines, sultaines, imidazolinium derivatives	Nonirritating to eyes, mild cleansing, impart manageability
Natural surfactants	Sarsaparilla, soapwort, soap bark, ivy, agave	Poor cleansing, excellent lather

2. Laureth sulfates (sodium laureth sulfate, triethanolamine laureth sulfate, ammonium laureth sulfate) produce rich foam, provide good cleansing, and leave hair in good condition. They are also a common main surfactant.
3. Sarcosines (lauryl sarcosine, sodium lauryl sarcosinate) are poor cleansers but are excellent conditioners. This group is commonly used as a secondary surfactant.
4. Sulfosuccinates (disodium oleamine sulfosuccinate, sodium dioctyl sulfosuccinate) are strong degreasers and commonly used as a secondary surfactant in oily hair shampoos.

Cationic detergents are named for their positively charged polar group. They are relatively poor detergents and do not lather well, but their unpopularity is largely due to their incompatibility with other anionic surfactants. Some shampoos designed for dyed or bleached hair use cationic detergents because they are excellent at imparting softness and manageability (1).

Shampoos designed for dyed or bleached hair use cationic detergents because they impart hair softness and manageability.

Nonionic detergents are the second-most popular and have no polar group. These are the mildest of all surfactants and are used in combination with ionic surfactants as a secondary cleanser (8). Examples include polyoxyethylene fatty alcohols, polyoxyethylene sorbitol esters, and alkanolamides.

Amphoteric detergents contain both an anionic and a cationic group such that they behave as cationics at lower pH values and anionics at higher pH values. Detergents that fall within this group are the betaines, sultaines, and imidazolinium derivatives. Ingredients such as cocamidopropyl betaine and sodium lauraminopropionate can be found in baby shampoos because they are nonirritating to the eyes. These surfactants foam moderately well and leave the hair manageable, making them a good choice for chemically treated and fine hair.

The last group of detergents is the natural surfactants, such as sarsaparilla, soapwort, soap bark, and ivy agave. These natural saponins have excellent lathering capabilities but are poor

cleansers. They consequently must be present in high concentration. Usually, saponins are combined with the other synthetic detergents outlined above (5).

Foaming agents

Foaming agents in shampoos introduce gas bubbles into the water. Many consumers believe that shampoos that generate copious foam are better cleansers than poorly foaming shampoos. This is not true. As the shampoo removes sebum from the hair, the amount of foam will decrease because sebum inhibits bubble formation. This accounts for the increased foam seen on the second shampooing, when most of the sebum has been removed.

As the shampoo removes sebum from the hair, the amount of foam will decrease because sebum inhibits bubble formation.

Thickeners and opacifiers

Thickeners and opacifiers have no part in hair cleansing; they simply make the product more appealing to the consumer. Many people incorrectly believe that a thick shampoo is more concentrated than a thin shampoo; others want a shampoo that appears opaque or pearlescent.

Conditioners

Conditioners impart manageability, gloss, and antistatic properties to the hair. They are found in most shampoos for dry, damaged, or treated hair. These are usually fatty alcohols, fatty esters, vegetable oils, mineral oils, or humectants. Many conditioners are used in dry hair shampoos, including hydrolyzed animal protein, glycerin, dimethicone, simethicone, polyvinylpyrrolidone, propylene glycol, and stearylalkonium chloride (9). Other protein sources, such as lanolin, beer, and egg yolk, containing lecithin and cholesterol, are also used in dry hair shampoos that claim to be “natural.” Of all these conditioners, hydrolyzed animal protein is probably the best for extremely dry hair because it has some substantivity for keratin and can mend split ends (trichoptilosis) (10).

Sequestering agents

Sequestering agents make shampoos function better than bar soaps in cleansing the hair. They chelate magnesium and calcium ions so that other salts or insoluble soaps known as “scum” are not formed. Without sequestering agents, shampoos would leave a film on the hair, rendering it dull. For this reason, patients should be encouraged to use shampoo and not bar soap when cleansing their hair. In areas of extremely hard water, the film that remains may contribute to scalp pruritus.

Sequestering agents are the major difference between a shampoo and bar soap, and function to prevent soap scum from adhering to the hair shafts.

pH adjusters

Some shampoos contain ingredients designed to alter pH, allowing the marketing claim of “pH balanced.” Most shampoos are alkaline, which can swell the hair shaft and render it more susceptible to damage. This is not a problem for patients with healthy,

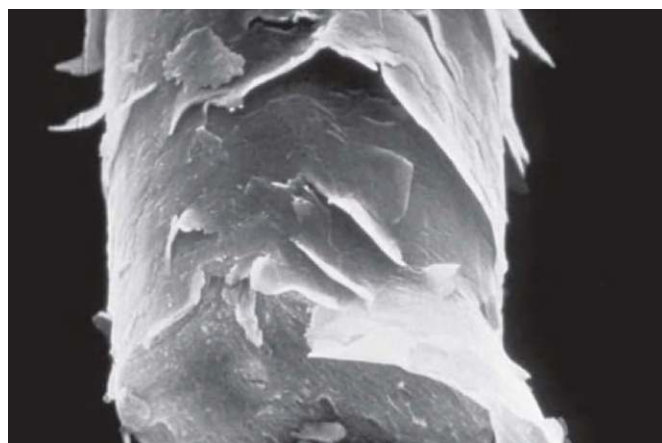


FIGURE 24.2 High pH results in cuticle swelling and excessive hair damage, and thus most shampoos are formulated at a slightly acidic pH.

nonporous hair containing an intact cuticle. Patients with damaged or chemically treated hair with a fragmented cuticle may wish to avoid hair swelling by selecting a shampoo that has an acid added to balance the pH (Figure 24.2).

Specialty additives

The key differences between similar-purpose shampoos manufactured by various personal care product companies are the fragrance and special care additives. Additives such as wheat germ oil (containing vitamin E) and panthenol (a form of vitamin B) are added mainly for marketing reasons but are thought to leave hair more silky and manageable. Other producers add fatty substances such as plant extracts or mink oil. Proteins such as ribonucleic acid, collagen, and placenta may be added to act somewhat as conditioners. Some shampoos now include a chemical sunscreen.

Types of shampoo

Shampoos have been formulated in liquids, gels, creams, aerosols, and powders. Only the liquids will be discussed because they are the most popular. Several different types of shampoos are also available: basic shampoos (normal, dry, oily, and chemically treated hair shampoos), baby shampoos, conditioning shampoos, medicated shampoos, and professional shampoos.

Basic shampoos

Basic shampoos may be selected from several formulations depending on the amount of scalp sebum production, hair shaft diameter, and hair shaft condition. The label usually defines the intended consumer by stating normal hair, oily hair, dry hair or damaged hair, or color-treated hair. Some companies alter the concentrations of detergents and conditioners to make the different formulations, so the ingredient lists may be identical for all formulations. Other product lines have different formulations for each type.

Normal hair shampoos use lauryl sulfate detergents, giving them good cleansing and minimal conditioning characteristics. These products work well for adults with moderate sebum production and coarse hair; however, they do not work well for persons with fine, unmanageable hair.

Oily hair shampoos have excellent cleansing and minimal conditioning properties. They may use lauryl sulfate or sulfosuccinate detergents and are intended for adolescents with oily hair or persons who have extremely dirty hair. They can be drying to the hair shaft if used daily. Following an oily hair shampoo with a heavy conditioner is self-defeating.

Dry-hair shampoos provide mild cleansing and good conditioning. Some companies recommend the same product for dry hair and damaged hair. These products are excellent for mature persons and those who wish to shampoo daily. They reduce static electricity and increase manageability in fine hair; however, some products provide too much conditioning, which may result in limp hair. Dry hair shampoos may also cleanse so poorly that the conditioner can build up on the hair shaft. This condition has been labeled as the “greasies” in popular advertising, and may account for the observation that hair sometimes has more body after using a different shampoo.

Dry-hair shampoos provide mild cleansing and good conditioning to prevent further drying of the hair.

Damaged-hair shampoos are intended for hair that has been chemically treated with permanent hair colors, hair bleaching agents, permanent waving solutions, or hair straighteners. Hair can also be damaged physically by overcleansing, excessive use of heated styling devices, and vigorous brushing or combing. Longer hair is more likely to be damaged than shorter hair because it undergoes a natural process known as “weathering,” whereby the cuticular scales are decreased in number from the proximal to distal hair shaft (Figure 24.3). As mentioned previously, damaged hair shampoos may be identical to dry hair shampoos or may contain mild detergents and increased conditioners. Hydrolyzed animal protein is the superior conditioner for damaged hair because it can minimally penetrate the shaft and temporarily plug surface defects, resulting in hair with a smoother feel and more shine. It is important that the protein is hydrolyzed; larger protein molecules cannot penetrate the hair shaft.

Weathering is the loss of cuticular scale from the shaft due to trauma from combing, brushing, wind, and so on.

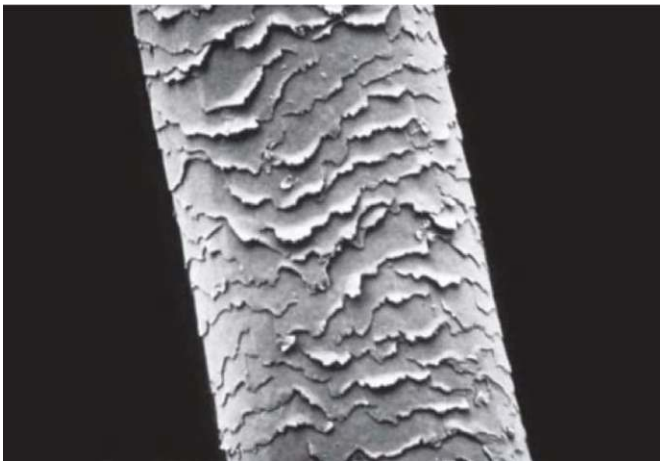


FIGURE 24.3 Weathering of the hair shaft as evidenced by an uplifted cuticle leads to the feel and appearance of damaged hair.

Baby Shampoos

Baby shampoos are nonirritating to the eyes and designed as mild cleansing agents because babies produce limited sebum. These shampoos use detergents from the amphoteric group (11). Baby shampoos are also appropriate for mature hair and for individuals who wish to shampoo daily.

Baby shampoos are nonirritating to the eyes due to their anesthetic effect.

Conditioning shampoos

Conditioning shampoos may be labeled as such, or may be labeled as shampoos for dry or damaged hair. These products may actually be self-defeating because the shampoo is intended to remove sebum, the body's natural conditioner, and replace it with a synthetic conditioner, which consumers somehow interpret as cleaner. As a consequence, conditioning shampoos neither clean nor condition well (12). Detergents used in conditioning shampoos are generally amphoteric and anionics of the sulfosuccinate type. These products are sometimes known as one-step shampoos because a conditioner need not be applied following shampooing. Patients should not use a conditioning shampoo prior to permanent dyeing or permanent waving because maximum color uptake or curling may be inhibited.

Medicated shampoos

Medicated shampoos, also known as dandruff shampoos, contain additives such as tar derivatives, salicylic acid, sulfur, selenium disulfide, polyvinylpyrrolidone-iodine complex, chlorinated phenols, or zinc pyrithione (13). Medicated shampoos have several functions: to remove sebum efficiently, to remove scalp scale, to decrease scalp scale production, and to act as an antibacterial/antifungal. The shampoo base removes sebum, while mechanical scrubbing removes scalp scale. Tar derivatives are commonly used as anti-inflammatory agents. Sulfur and zinc pyrithione are used for their antibacterial/antifungal qualities. Menthol is added to some shampoos to produce a tingling sensation some patients find aesthetically pleasing (Figure 24.4).

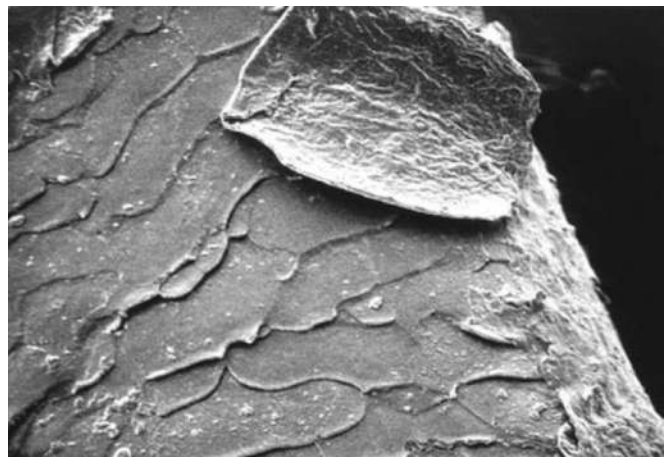


FIGURE 24.4 Dandruff shampoos are designed to remove skin scale from the scalp and hair.

Professional shampoos

There are two types of professional shampoos: those intended for hair washing prior to cutting or styling and those intended to precede or follow a chemical process. Professional shampoos for hair washing are of the same formulation as the over-the-counter (OTC) varieties, except that they are more concentrated and must be diluted 8 to 10 times before use. Special anionic, acidic professional shampoos are used after bleaching to neutralize residual alkalinity and prepare the hair for subsequent dyeing. Acidic, cationic shampoos are used after dyeing to act as a neutralizing rinse. A subset of these shampoos includes those designed to maintain the color of bleached or dyed hair. These shampoos are only available to licensed cosmetologists.

Our attention now turns to shampoos for scalp conditions that require both medical and cosmetic treatment. These conditions include dry postmenopausal scalp, thinning hair, seborrheic dermatitis, and scalp psoriasis.

Shampoos for dry postmenopausal scalp

Dry postmenopausal scalp is a challenging condition for the dermatologist to treat. Postmenopausal women will note extreme itching, stinging, and burning of the scalp, but there is little to see on physical examination except a few powdery dry flakes on the scalp and perhaps a few excoriations. The thick silvery scales of scalp psoriasis and the yellow sticky scales of seborrheic dermatitis are absent. At first glance, the clinician might be tempted to wonder if the scalp symptoms are either nonexistent or a sign of depression. They are neither. Dry postmenopausal scalp, a descriptive term for the condition that will not be found as a scalp dermatosis in a dermatology textbook, is a self-describing term. It is found in postmenopausal women, who usually have accompanying body eczema. It can be best described as scalp eczema, where the lack of sebum production results in the powdery dry scale and the clinical symptoms of barrier disruption.

The problem in postmenopausal dry scalp is underproduction of sebum and overlying aggressive removal of sebum. The best solution is to recommend a 2-in-1 shampoo for dry hair containing dimethicone and cool water when shampooing and rinsing to minimize further scalp dryness. The 2-in-1 shampoo will remove less sebum and leave behind a thin film of dimethicone on the hair and scalp. Dimethicone will not leave the scalp or hair feeling greasy, and also will not support the growth of bacteria or malassezia organisms. The shampoo should be followed by a dimethicone-containing instant conditioner, which is applied in the shower and rinsed again with cool water. Finally, a leave-in conditioner should be applied again with dimethicone and massaged into the scalp. The leave-in conditioner remains on the scalp as a moisturizer and is not rinsed. The next chapter provides more information on conditioners.

Shampoos for thinning hair

There are various scalp conditions that can be characterized as thinning hair. They include lichen planopilaris, alopecia areata, central centrifugal cicatricial alopecia, and androgenetic alopecia. No matter what the cause of hair thinning, the shampoo recommendations are the same. Most people with thin hair like to maximize the appearance of the hair remaining by grooming it to stand away from the scalp as much as possible because the appearance of full hair is measured by the distance the hair

protrudes above the scalp. Aggressive shampooing that removes all the sebum from the hair shafts and slightly damages the cuticle will produce the “fluffiest” hair because the hair will be more subject to static electricity and friction effects. Although this is the appearance of damaged hair, it is felt to be desirable by those with thinning, which is somewhat of a contradiction. Healthy hair lays flat and smooth on the scalp, whereas damaged hair is frizzy and unmanageable.

Shampoos for persons with hair loss should be selected from those labeled for fine hair. Fine hair shampoos do not have heavy conditioning agents that can make the hair heavy and limp. They clean away the sebum modestly but do not deposit much conditioner on the hair. Baby shampoo is also an excellent selection for persons with thinning hair who are on a limited budget.

Shampoos for seborrheic dermatitis

Seborrheic dermatitis is a shampoo challenge! The ideal shampoo will contain salicylic acid, tar derivatives, and zinc pyrithione. This will provide excellent control of the condition because the salicylic acid will remove the scalp skin scale, the tar derivatives will function as anti-inflammatory agents, and the zinc pyrithione will keep the fungal organisms at bay, addressing all three causative factors. This combination is not possible because dandruff shampoos are considered OTC drugs and only one active agent from the monograph can be placed in a shampoo. It is for this reason that the best control of seborrheic dermatitis is achieved by rotating shampoos. Salicylic acid is excellent at removing scalp scale, but it can also remove the hair shaft cuticle, resulting in hair that feels harsh. Every third shampoo exposure to salicylic acid limits this damage. Tar is a good anti-inflammatory, but it can stain light-colored hair if it has not been purified to remove the creosote. Many believe that the creosote is the key natural anti-inflammatory, but it will change white or silver hair to a yellowish-brown color that is not easily removed. Using purified tar is best and also reduces the topical carcinogen exposure. Finally, zinc pyrithione is an excellent antifungal, but it must be left behind on the scalp to be effective. The newer zinc pyrithione shampoos contain a smaller particle size material that can deposit on the scalp during the rinse phase of shampooing. In addition, conditioners that contain zinc pyrithione can increase the deposition. Because recolonization with malassezia occurs very rapidly in seborrheic dermatitis patients, the ability of the zinc pyrithione to prevent the release of free fatty acids by the malassezia can result in better symptom control.

Shampoos for scalp psoriasis

There is no doubt that the most challenging scalp condition to treat with shampoos is psoriasis. The thick, silvery scale resists detergent breakdown and removal. Salicylic acid is best at removing the scale, but it only works in an oily environment, making it less effective in persons with thick, dry scalp scale. In these patients, it is best to first soften the scale with an oily substance, such as mineral oil or peanut oil, for one hour prior to shampooing with a salicylic acid shampoo. The oil softens the scale and enhances the ability of the salicylic acid to dissolve the clumped corneocytes. Many psoriasis sufferers aggressively scrub their scalp to remove the scale, but this should be avoided as the scalp is subject to the Koebner effect and damage to the scalp can result in worsening psoriasis. Gentle rubbing with the fingertips and

fingernails is best because the amount of pressure exerted is felt. Scalp brushes and other implements should be avoided.

Shampoos and contact dermatitis

Shampoos do not represent a common cause of cutaneous irritant or allergic contact dermatitis due to their relatively brief contact with the skin prior to rinsing. Eye irritation, however, can be a problem that some shampoos overcome with the addition of imidazoline-type amphoteric surfactants, succinic ester sulfonates, silicone glycols, and fatty acid–peptide condensates (3). Ingredients in shampoos that are possible sensitizers include formalin, parabens, hexachlorophene, and miranols (14).

Ingredients in shampoos that are possible sensitizers include formalin, parabens, hexachlorophene, and miranols.

Shampoos should be diluted to form a 1–2% aqueous solution for closed patch testing and a 5% aqueous solution for open patch testing. However, it should be recognized that false-positive reactions due to irritation may still occur. A better assessment may be obtained by patch testing individual ingredients separately (15).

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25

HAIR CONDITIONERS

The need for hair conditioners arose following the development of shampoos with extremely good detergent action (1). These new shampoos cleaned too well; they removed sebum from the hair shaft so thoroughly that the hair became unmanageable, dull, and harsh to touch. The role of a conditioner is to mimic sebum in making the hair manageable, glossy, and soft. Conditioners also attempt to recondition hair that has been damaged by chemical or mechanical trauma (2). Common sources of trauma include excessive brushing, hot blow-drying, detergent shampoos, alkaline permanent waves, bleaching, etc. Obviously, because hair is a nonliving tissue, any reconditioning that occurs is minimal and temporary until the next shampooing.

Hair conditioners were developed during the early 1930s when self-emulsifying waxes became available. These waxes were combined with protein hydrolysates, polyunsaturates, and silicones to give the hair an improved feel and texture. Early sources of the proteins included gelatin, milk, and eggs (3). The discovery of silicone and its adaptation to the hair care industry has revolutionized hair conditioners. Silicone is found in hair conditioners in several different forms, including dimethicone, cyclomethicone, and amodimethicone. This chapter examines hair conditioners and their use in beautifying the hair.

Conditioner mechanism of action

Healthy, undamaged hair is soft, resilient, and easy to disentangle (4). Unfortunately, the trauma caused by shampooing, drying, combing, brushing, styling, dyeing, and permanently waving damages the hair, making it harsh, brittle, and difficult to disentangle (5). Hair conditioners are designed to reverse this hair damage by improving sheen, decreasing brittleness, decreasing porosity, increasing strength, and restoring degradation in the polypeptide chain. Damage to the hair shaft can also occur through environmental factors such as exposure to sunlight, air pollution, wind, seawater, and chlorinated swimming pool water (6). This type of hair damage is technically known as “weathering” (7).

The natural hair shafts possess their own layer of protective conditioner, known as 18-MEA, so named for the major lipid component 18-methyleicosanoic acid that coats the hair. The 18-MEA layer is covalently bonded to the hair and has many functions, including imparting hair shaft shine, protecting the cuticle, reducing inter-hair shaft friction, and imparting water-repellent properties to the hair. It is the 18-MEA layer that prevents tangling of wet hair, allows the hair shafts to lay smoothly against the scalp, and prevents the hair from becoming frizzy under high humidity conditions. The 18-MEA layer is removed by the trauma of grooming and any chemical treatment applied to the hair, especially permanent waving and permanent dyeing/bleaching. Hair conditioners attempt to restore the 18-MEA layer but can only do so temporarily until the next shampooing or water contact.

Hair conditioners are designed to reverse hair damage by improving sheen, decreasing brittleness, decreasing porosity, and increasing strength.

Hair conditioners improve manageability by decreasing static electricity. Following combing or brushing, the hair shaft becomes negatively charged, thus repelling one another to prevent the hair from lying smoothly in a given style. Conditioners deposit positively charged ions on the hair shaft, neutralizing the electrical charge. Improved manageability also derives from cuticle alterations and reduction of friction between hair shafts by as much as 50% (8). This leads to enhanced disentangling of the hair as well.

Weathering is damage to the hair shaft that occurs over time from any external source, including grooming, wind, sun, and tangling.

Hair gloss results from light reflected by individual hair shafts. The smoother the hair surface, the more light reflected (9). Conditioners increase hair gloss primarily by increasing the adherence of cuticular scale to the hair shaft (Figure 25.1A). Gloss is also related to the hair structure. Maximum gloss is produced by large-diameter, elliptical hair shafts with a sizable medulla and intact, overlapping cuticle scales. Hair softness too results from an even overlap of cuticular scales (10).

Conditioners attempt to mend the split ends resulting from missing cortex, the structural component responsible for hair shaft strength. The resulting exposure of the soft keratin medulla results in a condition known as trichoptilosis, or split ends (Figure 25.1B). Conditioners temporarily reapproximate the frayed remnants of the remaining medulla and cortex.

All the problems associated with damaged hair are magnified if the hair is fine in texture. There are more fine hair fibers per weight than coarse hair fibers, so the net surface area of fine hair is greater. Proportionally, more irregular cuticle scales can develop, and more of these fine hair fibers are subject to static electricity. Thus, special conditioner formulations are designed to meet the grooming needs of fine hair.

Formulation of a conditioner

Hair conditioners may contain as many as nine different conditioning agents from the chemical classes listed in Table 25.1 (11).

Of these, the quaternaries, protein derivatives, and alkanolamides are the most frequently used (12). Each of these categories is discussed in detail next (Table 25.2).

The quaternaries, protein derivatives, and alkanolamides are the most frequently used compounds in modern hair conditioners.

Quaternary conditioning agents

The cationic detergents, also known as quaternaries, quaternary ammonium compounds, or quats, are conditioning agents



FIGURE 25.1 (A) Conditioned hair demonstrates smoothing of the cuticle and less cuticular uplifting with hair shaft bending. (B) Unconditioned hair demonstrates cuticular uplifting with hair bending precipitating cuticle loss and hair shaft weakening. (C) Split ends occur when the cuticle is lost, resulting in exposure of the cortex and medulla and the resultant hair fiber fraying. (D) An instant conditioner for damaged dyed hair containing quaternary ammonium compounds.

TABLE 25.1: Chemical Classes of Conditioners

- Alkanolamides
- Glycols
- Lipids
- Protein derivatives
- Quaternaries
- Surface active agents
- Specialty ingredients

TABLE 25.2: Hair Conditioner Formulations

Type	Ingredient	Advantage	Hair Type
Cationic detergent	Quaternary ammonium compounds	Smooth cuticle, decrease static	Chemically processed hair
Film former	Polymers	Fill shaft defects, decrease static, add shine	Dry hair, not fine hair
Protein-containing	Hydrolyzed proteins	Penetrate shaft	Temporarily mend split ends

found in both shampoos and hair conditioners (13). They are excellent at increasing the adherence of the cuticular scales to the hair shaft, which increases the light-reflective abilities of the hair, adding shine and luster. Additionally, they are able to electrically neutralize static electricity based on the negative (anionic) charge of processed or damaged hair, which attracts the positively (cationic) charged quaternary compound to adhere to the hair shaft, thus improving manageability (14). These qualities make them an excellent conditioner choice in patients with permanently dyed or permanently waved hair (Figure 25.1).

Film-forming conditioning agents

Film-forming conditioners apply a thin layer of polymer, such as polyvinylpyrrolidone (PVP), over the hair shaft (15). The polymer fills hair shaft defects, creating a smooth surface to increase shine and luster while eliminating static electricity due to its cationic nature. The polymer also coats each individual hair shaft, thus “thickening” the hair shaft. Film-former conditioners should not be used on fine hair because the added weight of the polymer decreases the ability of the hair to hold a style. They are excellent, however, on normal to dry hair.

Protein conditioning agents

Protein-containing conditioners are the only product that can actually penetrate and alter the damaged hair shaft. These proteins, derived from animal collagen, keratin, placenta, and so on, are hydrolyzed to a particle size (molecular weight 1,000 to 10,000) able to enter the hair shaft (16). Hydrolyzed protein conditioners can temporarily strengthen the hair shaft and mend split ends until the subsequent shampooing, when the product must be reapplied. The source of the protein is not as important as the protein particle size (17).

Hair conditioners are available in three forms: instant conditioners and rinses, deep conditioners, and leave-in conditioners.

Conditioner types

Hair conditioners are available in three forms: instant conditioners and rinses, deep conditioners, and leave-in conditioners (Table 25.3). Their names describe their use because instant conditioners and rinses are applied and immediately removed in the shower. Deep conditioners remain in contact with the hair for 30 minutes, and leave-in conditioners remain in place until the subsequent shampooing.

Instant conditioners

Instant conditioners are so named because they are applied following shampooing, left on the hair for five minutes, and subsequently rinsed. These products provide minimal conditioning due to their short contact time with the hair and are basically useful to aid in wet combing and manageability. Their ability to repair damaged hair is somewhat limited. Nevertheless, they are the most popular type of conditioner for both home and salon use. Instant conditioners contain water, conditioning agents, lipids, and thickeners. The conditioning agents consist of combinations of cationic detergents, film formers, and proteins.

Rinses

Rinses are similar to instant conditioners in that they are applied immediately following shampooing and removed prior to drying the hair. There are two types: clear rinses and cream rinses. Clear rinses, formed from lemon juice and vinegar, were used prior to the development of pH-balanced shampoos with sequestering agents designed to prevent soap scum formation on the hair. These acidic chemicals removed calcium and magnesium

soap residue and returned the hair to a neutral pH following the use of an alkaline shampoo. Residue removal restores hair shine, while pH neutralization restores hair manageability. Clear rinses work well for patients with oily hair but are not recommended for patients with normal to dry hair.

Cream rinses use cationic quaternary ammonium compounds, such as stearylalkonium chloride and benzalkonium chloride. Cream rinses are thinner than conditioners, but the differences in formulation are small. Some companies even label their products as “cream rinse/conditioners.” As a general rule, cream rinses provide less conditioning than conditioners and are intended for oily to normal hair.

Deep conditioners

Deep conditioners are creams, compared to instant conditioners, which are liquids. They contain the same conditioning agents as instant conditioners but are more concentrated (18). They remain on the hair for 20 to 30 minutes and may include the application of heat from a hair dryer or warm towel. The extended application time allows more conditioner to coat the hair shaft, while heat causes hair shaft swelling and allows increased conditioner penetration. These products are intended for extremely dry hair. Deep conditioners used prior to some permanent coloring or permanent waving procedures are called “fillers.” Fillers are designed to condition the distal hair shaft and reverse some of the effects of weathering, allowing even application of the subsequent coloring or waving procedure.

Some salons offer a deep conditioning treatment known as trichotherapy or aromatherapy. Aromatherapy involves several steps, the first of which is to condition the hair and scalp with rare oils and herbal extracts. The scalp is then vigorously brushed. A scalp and facial massage are also performed with fragrant oils to release tension and soothe the senses. The hair is then shampooed and conditioned. The value of this treatment is primarily aesthetic.

Leave-in conditioners

Leave-in conditioners are applied following towel drying of the hair and designed to remain on the hair shaft through styling. They are removed with the next shampooing. Products designed for straight hair are known as blow-drying lotions or hair thickeners. Blow-drying lotions are massaged through the scalp after towel drying and prior to heat drying. Because they contain no oils, they are not rinsed from the hair. They contain the same conditioning agents previously described for instant conditioners. The thin coating of conditioner on the hair only minimally prevents heat damage (Figures 25.2 and 25.3).

Hair thickeners are another form of leave-in conditioner. They do not thicken hair by increasing the number of hair shafts, but rather provide a coating on each shaft that increases its diameter minutely. These products are protein-containing, conditioning liquids that are massaged through a towel-dried scalp before styling to increase shine, improve manageability, and impart softness. A hair thickener is thicker than a blow-drying lotion and is intended for persons with dry, damaged hair. Some newer hair thickeners are dimethicone-containing liquids (Figure 25.4).

Special leave-in conditioners are used by Black and Asian individuals with tightly kinked hair to aid in combing, provide additional shine, improve manageability, and enhance styling options. These products are discussed more fully in the chapter on ethnic hair.

TABLE 25.3: Hair Conditioner Products

Type	Use	Indication
Instant	Apply after shampoo, rinse	Minimally damaged hair, aids wet combing
Deep	Apply for 20–30 min, shampoo, rinse	Chemically damaged hair
Leave-in	Apply to towel dried hair, style	Prevent hair dryer damage, aid in combing and styling
Rinse	Apply following shampoo, rinse	Aid in disentangling if creamy rinse, remove soap residue if clear rinse



FIGURE 25.2 A leave-in cream conditioner that is applied to towel-dried hair.



FIGURE 25.3 A leave-in conditioner designed to reduce the frizziness of curly hair.



FIGURE 25.4 A hair thickener and hair shine formulation based on dimethicone that can be applied to wet or dry hair.

Adverse reactions to conditioners

Because hair conditioners are applied to the hair and eventually rinsed, they must be nonirritating to the eyes as well as the skin (19). The most popular instant conditioners only remain in contact with the skin for a brief period of time, and are therefore infrequent causes of allergic or irritant contact dermatitis. These products can be patch tested “as is” in an open or closed manner.

The leave-in conditioners based on film-forming polymers too are infrequent causes of contact dermatitis; however, contamination with monomeric impurities, such as acrylamide, ethyleneimine, or acrylic acid, can cause problems. Acrylamide is highly toxic, ethyleneimine is carcinogenic, and acrylic acid is highly irritating to the skin. The safety and performance of polymers used in hair conditioners are related to their purity (20).

There have been some reports of reactions to proteins in some conditioners in the form of contact urticaria (21). Although this is rare, it should be considered when evaluating the patient with the elusive chronic case of urticaria.

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26

HAIRSTYLING AIDS

Nothing beats a great-looking head of hair, and styling aids are an important part of this quest for men and women. Preparations for hair adornment are some of the oldest cosmetic products known. Even the ancient Assyrians invented elaborate hairstyles with layered cuts combined with oiling, perfuming, and hot iron curling. Hairstyles assumed great significance in their society because the more elaborate coifs were indicative of a high social status (1). Still today, many products and devices are used to groom, shape, mold, fix, set, and rearrange hair into a fashionable personal statement discussed in this chapter.

Hair grooming devices

The most basic of hair grooming devices are combs and brushes. Many different configurations of combs and brushes have been developed for different hair types and different hair needs. The first comb typically used by women is a detangling comb, used following shampooing and before hair drying to remove tangles from wet hair. The tips of the hair teeth are coated with a smooth plastic to reduce friction because wet hair is more easily fractured (Figure 26.1A). Figure 26.1B shows several of the different comb designs, with a fine-toothed comb at the top for fine female hair and a broader toothed comb in the middle for male hair and a specialized comb for haircutting at the bottom. Very broad combs, known as hair picks, are used by

persons with natural kinky hair for grooming (Figure 26.1C). Brushes are used usually after combing to further style the hair and groom unruly hair. Figure 26.1D shows a variety of brushes, including flat and round varieties. Specialized brushes, such as those designed for blow-drying the hair, are pictured in Figure 26.1E. These brushes have stiff bristles inserted into a round fenestrated metal tube. The stiff bristles pull the hair around the brush for drying in loose curls and the fenestrations allow the hot air to pass through the brush, preventing exposure of hair to high heat.

Specialized scissors are also available for cutting various types of hair. Figure 26.1F shows short-handled, straight-edged scissors, the main cutting device used by hairdressers to shape male and female hair. The scissors must be sharp to cleanly cut the hair without crushing the fibers. For individuals with very thick hair, especially children, it may be difficult to cut the hair, so thinning shears (Figure 26.1G) may be used with a toothed blade on one side to cut the hair irregularly. Finally, there are various special haircutting devices that are commonly used. Razor haircuts are created with a replaceable single-edged razor, with the advantage that the razor blade may be sharper than scissors, which get dull with use and are harder to sharpen (Figure 26.1H). Single-edged razor blades in a handle are also used to shave the male face and neck (Figure 26.1I). Mechanized haircutting devices, such as clippers, can be used to shave the neck and create short haircuts of various lengths as desired by the customer (Figure 26.1J).

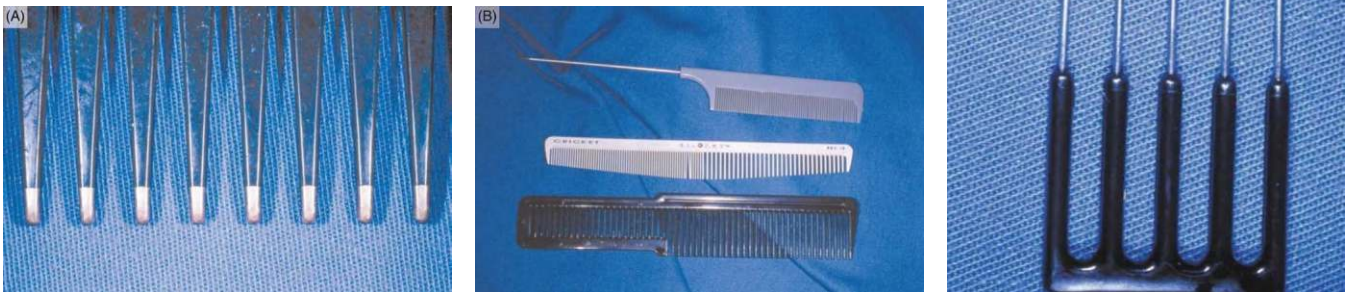


FIGURE 26.1 (A) Detangling comb to minimize friction when grooming wet hair. (B) Combs are available in many different configurations to meet the needs of various hair types and hair grooming activities. (C) Hair picks have widely spaced teeth with coated tips to minimize friction and resulting breakage in natural, kinky hair. (D) Circular and flat brushes are designed for various grooming needs. Flat brushes pull the hair straight, whereas round brushes are designed to groom loosely curled hair. (E) Blow drying brushes are vented to allow the hot air to pass through the brush and prevent hair burning. (F) Straight scissors. (G) Thinning shears. (H) A single-bladed hair razor used to create razor cut hair. (I) Single-bladed razor in a handheld mount for shaving hair from the male face and neck. (J) Mechanized clippers used to shave male heads at various hair lengths based on the length of the black plastic guard. (*Continued*)

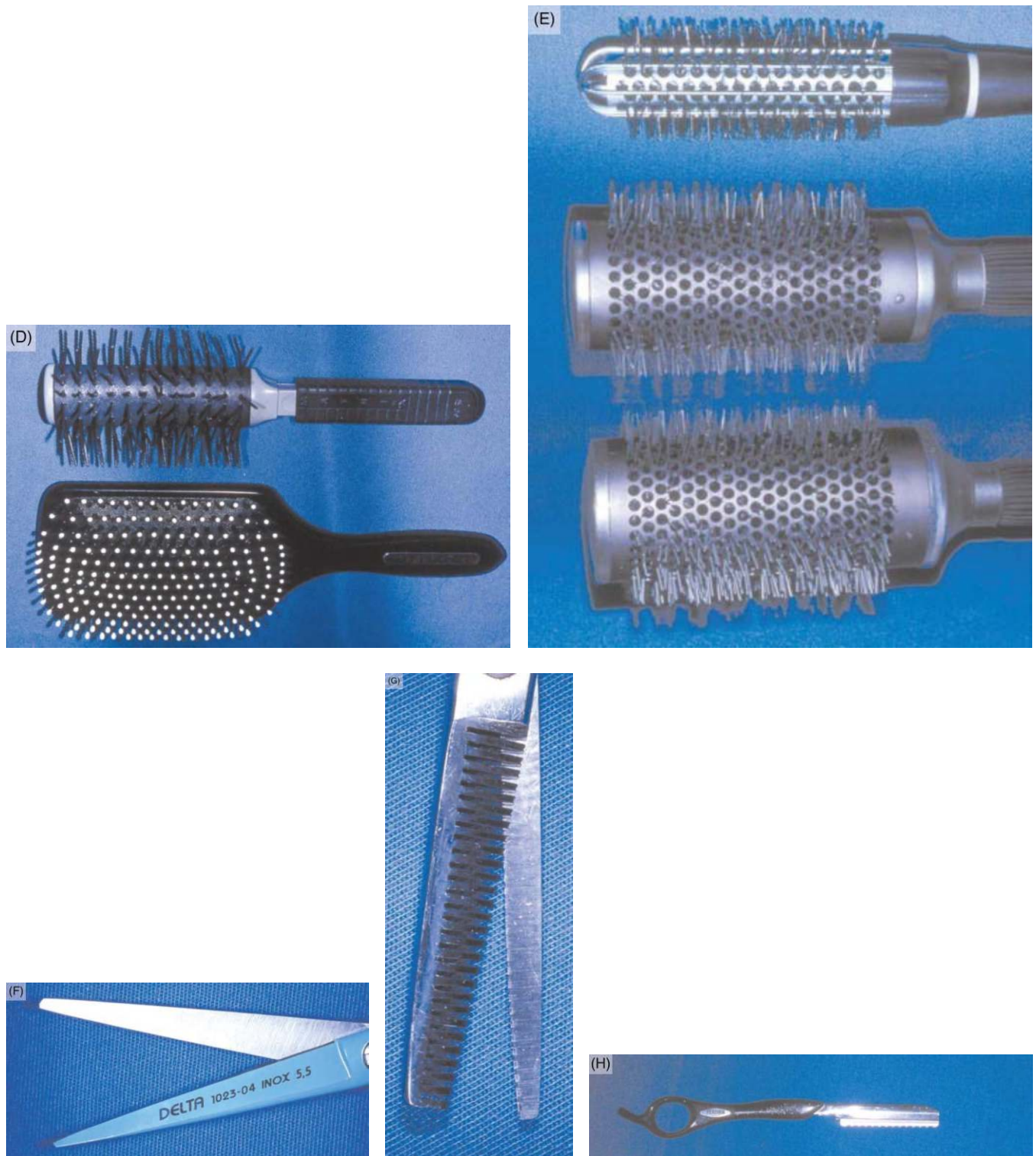


FIGURE 26.1 (Continued)

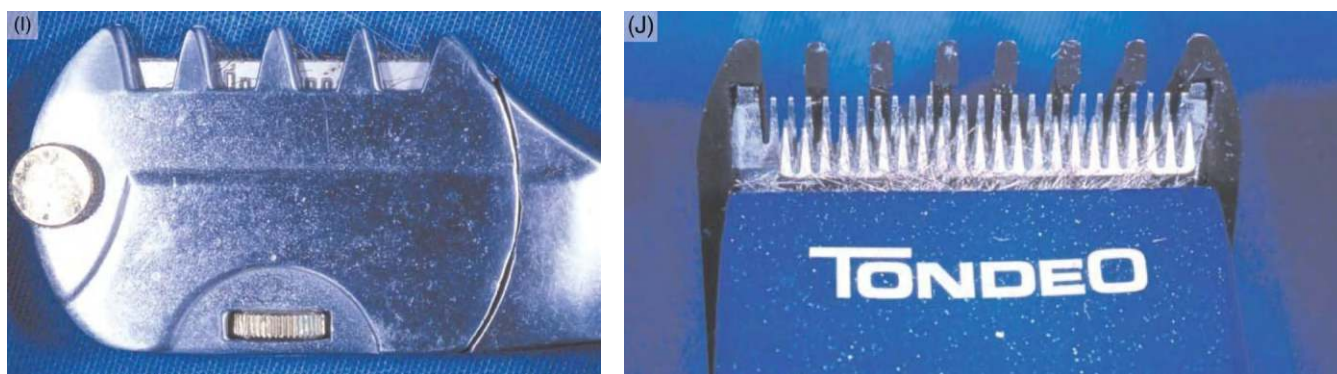


FIGURE 26.1 (Continued)

Hairstyling products

Hairstyling products are applied following shampooing and are completely removed with the subsequent shampooing. There are four categories of modern styling products: sprays, mousses, gels, and serums (Table 26.1).

Hair spray

Hair sprays are used to keep the hair in a desired style (Figure 26.2). They are a temporary water removal fixative that can hold hair in gravity-defying positions or simply smooth a few fly-away hairs, depending on their composition. Early hair sprays were aerosolized shellac, a natural resin composed of polyhydroxy acids and esters. Shellacs are no longer used because they form insoluble films that are not easily removed. In addition, chlorinated propellants have not been used since the 1979 US Food and Drug Administration ban, and states have imposed limits on volatile organic compound emissions from hair sprays and other personal care products (2). Copolymers such as polyvinyl pyrrolidone (PVP) are the main ingredient in hair sprays, now widely available in aerosol pumps. PVP is a resin that is soluble in water and easily removed by shampooing. However, it is also hydroscopic: the film becomes sticky upon water contact from rain, humidity, or perspiration. Once wet, the film loses its holding ability. Vinyl acetate (VA) was added to PVP to make the product less hydroscopic, but this also made the removal difficult. Most hair sprays now combine PVP/VA and use anywhere from 30%–70% PVP (3). Other newer polymer combinations are constantly being developed, such as copolymer resins of vinyl methyl ether and maleic acid hemiesters (PVP/MA) or copolymer resins of vinyl acetate and crotonic acid or dimethyl hydantoin-formaldehyde resins, with a few products now containing methacrylate copolymer (polyvinylpyrrolidone dimethyl aminoethyl methacrylate or PVP/DMAEMA) (4, 5).

In addition to polymer resins, hair sprays also contain plasticizers (mineral oil, lanolin, castor oil, and butyl palmitate), humectants (sorbitol and glycerol), solvents (SD alcohol 40, isopropyl alcohol, etc.), and conditioners (panthenol, plant proteins, hydrolyzed animal proteins, quaternium-19, and so on). More expensive hair sprays contain panthenol and quaternium-19, which are more expensive conditioners, whereas low-priced conditioning hair sprays use hydrolyzed animal protein (6). High-priced hair sprays may also include a more costly fragrance than the low-priced brands.

Hair sprays are usually applied following hairstyling, but may also function as a setting lotion, although this is not recommended. Hair sprays are available in several formulations, providing varying degrees of hold. Regular-hold hair sprays are simply designed to keep the hair in place (Figure 26.2A). Super- or extra-hold hair sprays, hairstyling fixes, and hair spritzes contain more copolymer than regular-hold products and afford tremendous gravity-defying hold (Figure 26.2B). Flexible-hold hairsprays are also available that prevent hair stiffness and hair breakage (Figure 26.2C). These products also contain a less volatile vehicle than standard hair sprays, thus prolonging the drying time and allowing complex hair styling.

There was some concern in the 1960s regarding inhalation of PVP/VA aerosolized particles. These copolymers were originally developed in the medical industry for use as plasma diluents and were subsequently adopted by the cosmetics industry. Some reports indicated that thesauritis was due to hair sprays, and inhalation of PVP solid particles could induce foreign body granuloma formation in the lung. After extensive animal testing, it was concluded that PVP resin did not provoke pulmonary lesions (7, 8). Nevertheless, persons who are predisposed to lung conditions or those with allergic tendencies should use hair spray products with care (9).

TABLE 26.1: Hair Styling Aids

Styling Aid	Type	Main Ingredients	Purpose
Hair spray	Aerosol	Solution of film-forming resin	Hold finished hairstyle
Styling fix	Aerosol	Solution of film-forming resin	Add strong hold to finished hairstyle
Spritz	Aerosol	Solution of film-forming resin	Add strong hold to finished hairstyle
Styling gel	Gel	Gel of film-forming resin	Add moderate hold before styling
Sculpturing gel	Gel	Gel of film-forming resin	Add extreme hold before styling
Mousse	Foam	Aerosolized foam of film-forming resin	Add mild hold before styling

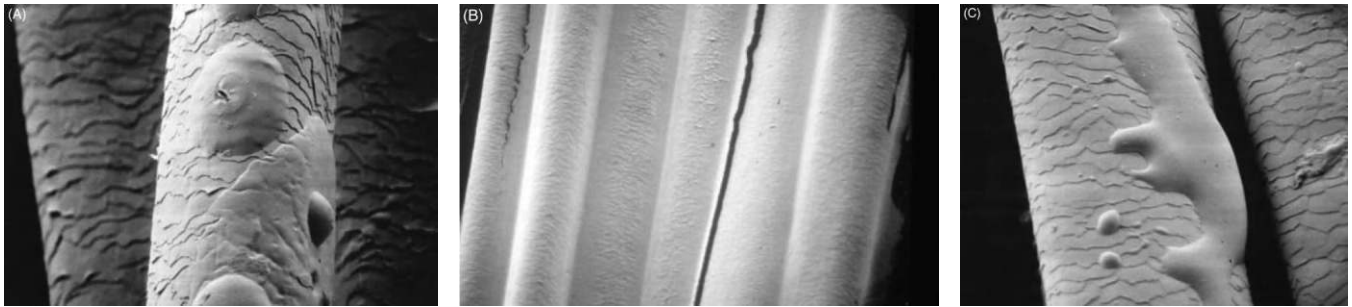


FIGURE 26.2 (A) An electron micrograph of a regular-hold hair spray. (B) Electron micrograph of a high-hold hairspray, demonstrating the bridging between hair shafts. (C) Electron micrograph of a flexible-hold hair spray demonstrating lack of hair shaft bridging.

Hair sprays are applied to dry hair and designed to maintain the hair in a desired style after the hair has been groomed.

Hair sprays may produce dermatologic problems, such as nail damage (10). Patients who have their hair done weekly in a salon, especially if styled with an excessive amount of hair spray, may develop hair spray buildup, resulting in hair shaft dullness. If applied as a coarse mist, the hair spray can bead on the hair shaft, resembling pediculosis capitis or trichorrhexis nodosa. The hair spray will also attract dirt, causing scalp irritation. Finally, once-weekly shampooing may not be adequate to control seborrheic dermatitis in predisposed patients. There is some debate in cosmetic circles as to whether alcohol, an inexpensive evaporating solvent, also contributes to hair shaft dryness.

Hair gel

Hair sprays are applied once the hair has been combed into a final position as the last step in hairstyling (Figure 26.3). This is in

contrast to hair gels that can be applied to both wet and dry hair. Hair gels are stronger fixatives used to hold the hair in more difficult to maintain positions. They contain the same PVP-type copolymers as hair sprays, except they are formulated into a gel and packaged in soft plastic squeeze tubes. The goal is to place a thin, even coating over the hair shaft (Figure 26.4A). They are available in both alcohol-containing and alcohol-free forms and contain glossing agents that coat the hair shaft and restore shine. Conditioning agents, such as hydrolyzed animal proteins, panthenol, keratin polypeptides, and amino acids, are also incorporated into some hair gels for added appeal. Two formulations are available: styling gels and sculpturing gels (Figure 26.4B). As the names suggest, sculpturing gels afford more hold than styling gels.

Hair gels can be applied to dry or wet hair to create gravity-defying hairstyles.

Hair gels may contain synthetic color, usually in unnatural shades, such as blue, red, or purple. The colored gel coats the hair

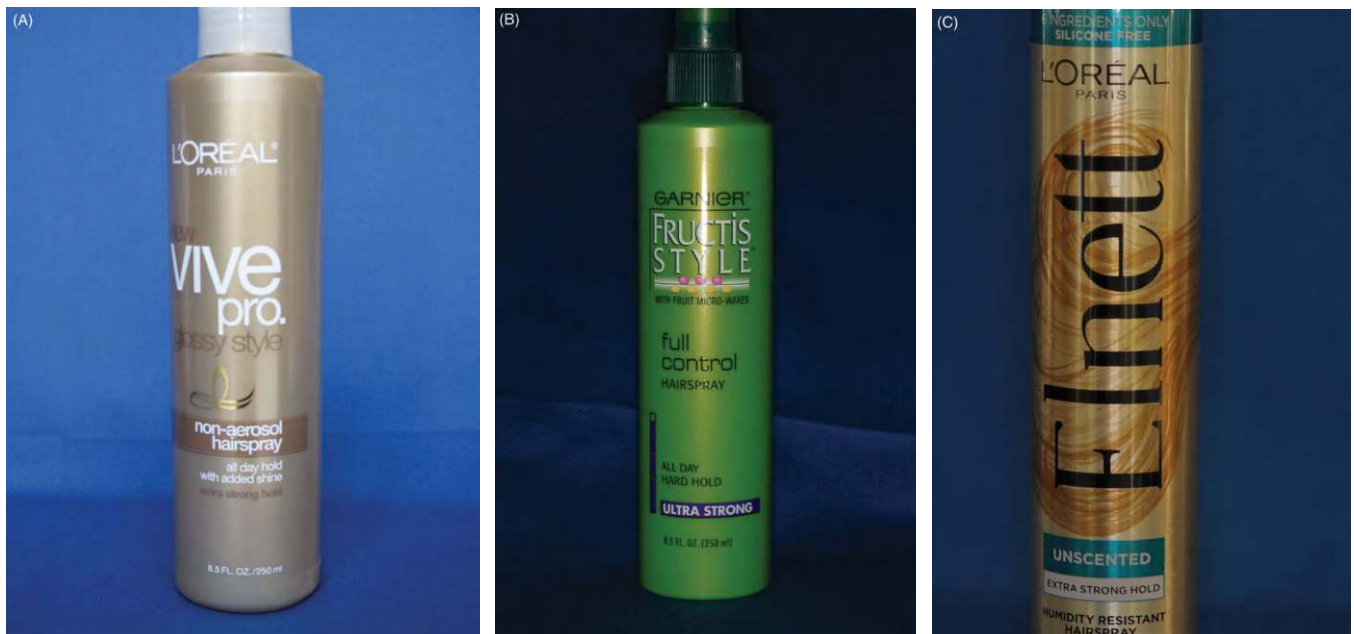


FIGURE 26.3 (A) A typical nonaerosol hair spray to maintain the hair in a desired style. (B) A high-hold nonaerosol hair spray designed to maximally stiffen hair. (C) A high-hold aerosol hair spray.

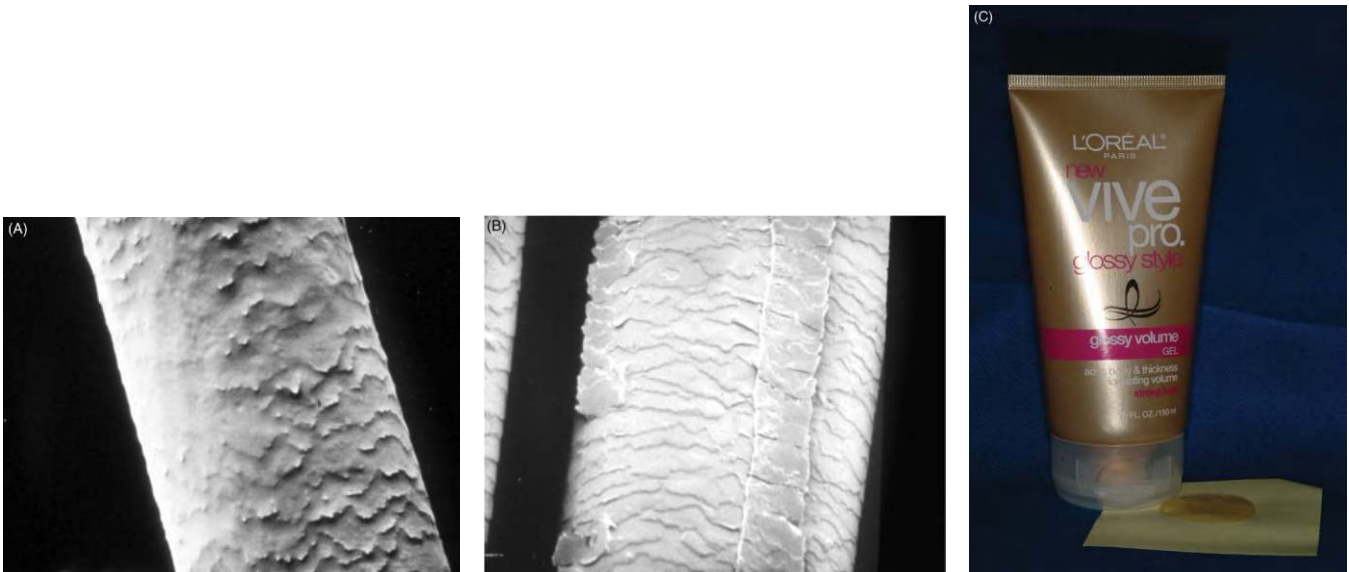


FIGURE 26.4 (A) Polymer coating from hairstyling gel over hair shaft demonstrated by electron micrograph. (B) Electron micrograph of a hair sculpturing gel stiffening the hair shaft to hold a desired shape. (C) A clear hair gel contains a fixative that dries and stiffens the hair to add body and maintain a desired style.

shaft, imparting tones of the color that is selected. The color molecules are too large to penetrate the undamaged hair shaft, so the colored coating can be removed with one shampooing. However, persons with chemically dyed or waved hair have a porous shaft that may semi-permanently absorb color molecules, requiring four to six shampooings for removal. Glitter may also be added to hair gels for effect.

Hair gels can be applied to towel-dried wet hair, damp hair, or distributed selectively on certain hair shafts depending on the desired style. If an increased hold of a hairstyle is desired, the gel can be combed thinly over all hair shafts prior to blow-drying. If a small amount of gel is applied, the hair will have a natural look and feel. If a large amount is applied, the hair will have a wet, “spiky” look and a stiff feel. The product can also be applied to completely dry hair to get the hair to stand straight up. This is a currently popular look among teenage men.

Hair gels can be used in persons with thinning, dull hair to enhance hair fullness and restore cosmetic acceptability. The eye interprets hair thickness by the hair elevation over the crown, lateral displacement at the sides, and the extent of the visible scalp (11). Hair gels can hold the hair away from the scalp, creating the illusion of fullness (12). Glossing agents can bring shine, the visual clue to hair health based on light reflection from an intact cuticle.

These products adhere well to the hair shaft because PVP/VA has some substantivity, or increased affinity, for keratin. The films are flexible and colorless on the hair shaft but can be removed by combing and brushing. This results in white polymer flakes in the hair that may resemble seborrheic dermatitis. The high concentration of PVP/VA also makes these products sticky with water contact. Persons who are exposed to moisture, such as athletes who perspire, should not use these styling products because the PVP/VA will fix the hair upon redrying, possibly in an undesirable position.

Hair gels can be both open and closed patch tested “as is,” but they should be allowed to dry prior to occlusion. They are of low irritant potential but may cause allergic contact dermatitis in

methacrylate-sensitive patients who choose a product containing a methacrylate-based polymer.

Hair mousse

Hair gel is very similar in formulation to hair mousse, except hair gel is squeezed from a tube whereas hair mousse is a foam released under pressure from an aerosolized can. Both contain the same copolymer-containing hairstyling aids to provide gloss to the hair and add an additional application of conditioner. Hair mousses can also be purchased tinted to temporarily cover gray hair. For example, persons with less than 15% gray hair can use colored mousse with brown or auburn hues to blend gray hair. Unnatural colors such as yellow, green, red, orange, purple, and blue are also available. The color is temporary and removed with one shampooing, unless applied to chemically treated hair.

Hair mousse is similar in formulation to hair gel, except that it is aerosolized foam.

Hair mousse is applied in the same manner as a hair gel to towel-dried hair. It can also be applied to dry hair to create a wet “spiky” look. Hair mousse yields a lighter copolymer application and does not provide as strong a hold as gel formulations. It also produces less flaking and less stickiness under moist conditions due to the low concentration of polymer. Many of the styling hold products for men are hair mousses because a lighter application is desirable.

Hair styling mousses can be used to create natural-appearing fullness more easily than hair gels due to their low moisture content. A half-dollar-sized mound of mousse is placed in the palm. Small amounts are then dabbed onto the fingers and massaged into the proximal hair shaft. Drying occurs almost immediately. The mousse adds stiffness to the hair shaft, creating the illusion of fullness. This technique can be used by both men and women with thinning hair to create hair that is more attractive. A small

amount of mousse applied to the palms and lightly touched to a finished style can smooth unmanageable hairs. Mature persons will probably find hair mousse more satisfactory than hair gel as a styling aid.

Hair Serums

The newest category of hair care products is hair serums. These are clear, viscous liquids squirted from a non-aerosolized jar onto the palm. Hair serums are hair moisturizers based on dimethicone (Figure 26.5). Hair becomes brittle when devoid of water, just like skin. This occurs until low humidity conditions, such as in the western United States, or when the hair has been chemically processed by permanent dyeing, waving, or straightening. The disruption of the cuticle that occurs with chemical processing allows water to evaporate from the hair shaft into the environment. Moisturization of the hair can occur with dimethicone just like moisturization of the skin, with dimethicone functioning as an occlusive agent to retard water loss (Figure 26.6).

Hair serums are based on dimethicone and function as a hair shaft moisturizer.

Hair serums can be useful in maintaining the health of the hair shaft in persons with damaged hair. The hair serum is best applied to dry hair by rubbing the hands together and then pulling the



FIGURE 26.5 A hair serum designed to add shine and decrease hair frizz by imparting a water-resistant dimethicone layer to each hair shaft.



FIGURE 26.6 A hair cream designed to both moisturize and stiffen hair.

hands through the hair to distribute an even thin film on each hair shaft. The serum can be applied daily prior to hairstyling. Dimethicone smooths down the cuticle, restoring shine and manageability, and prolongs the life of hair dye by preventing passive loss of the hair dye. It also makes the hair smooth and soft, just like on the skin. For patients who complain of “unhealthy” hair, hair serum is the quickest way to restore the appearance of healthy hair.

Edge stylers

An edge styler is a fixative product that is a variant of hair spray packaged like mascara for controlling and styling the fine transitional and broken hairs around the anterior hairline. It is a quick-drying clear polymer that is withdrawn from a tube on a comb-like brush and stroked over the short hairs. The edge styler can be used to comb the fine hairs back into the hairline to create a defined anterior hairline. Or, the edge styler comb can be creatively swirled to pull the fine hairs forward to create pin curls or other designs on the skin around the hairline.

Edge stylers are commonly used with lace front wigs, which are frequently used by women with natural kinky hair. A lace front wig has the hair woven on a lace-type mesh where the lace extends beyond the front of the wig. The lace is glued down to the skin to assist in fixing the wig in place. The tiny hairs that poke out from the wig are then affixed to the skin with the edge styler to give the hair a more natural appearance and blend the wig into the natural hair. Edge stylers can also be used to groom and tame eyebrows in persons with natural kinky hair.

Hair wax

Hair waxes are products designed to add increased hold to hair. They rely on polymers, but the polymers are designed to soften at body temperature, allowing the hair to be easily reformed and reshaped. These products are known for their ability to create the “bed head” look, where the hair stands straight on end away from the scalp but has a rather greasy appearance (Figure 26.7A). These products are scooped from a jar by the fingers and allowed to soften in the palm prior to application. They are massaged along the length of the hair shafts to provide a thin, even coating. Hair waxes are popular among men with short hair.



FIGURE 26.7 (A) Hair wax designed to create a “bed head” hair appearance. (B) Hair pomade that can also be used as a pressing oil in straightening natural kinky hair. (C) Sulfur-containing pomade designed to improve scalp scaling. (D) Oil spray designed to add shine and condition natural kinky hair. (E) Hair oil.

Hair pomade

Hair pomades are designed to straighten, condition, moisturize, and add shine to kinky hair natural African American hair. Pomades, also known as cream brilliantines, are anhydrous products containing petrolatum, waxes, lanolin, and vegetable or mineral oils (Figure 26.7B). Treatment pomades may also contain sulfur, vitamins, or tar derivatives to minimize the recurrence and symptoms of dandruff or seborrheic dermatitis (Figure 26.7C). The thick pomade ointment helps to minimize combing friction in tightly kinked hair, preventing hair breakage with styling through lubrication. The petrolatum also prevents water evaporation, decreasing hair dryness, a common unwanted side effect of hair straightening. The pomade can also act as a styling product to allow the hair to remain close to the scalp with some curl reduction.

One possible problem associated with pomade use is pomade acne, as reported by Plewig et al. (13). Pomade acne is comedonal acne along the hairline, frequently seen in patients using olive oil-containing pomades. Petrolatum and mineral oil are not the cause of the acne.

Rather, it is the presence of comedogenic olive oil that is problematic. Individuals who are prone to the formation of acne should avoid hair products containing olive oil and other vegetable oils.

Hair brillante

Pomades are ointments, whereas hair brilliantines are liquids. Liquid brilliantines are popular for maintaining natural, kinky hairstyles. These products allow ease of styling and provide shine without causing an oil buildup. Traditionally, they contain mineral and vegetable oils and may be comedogenic (14, 15). Newer formulations contain silicone to add lubricity, castor oil to aid in manageability, and soluble glycoprotein to maintain proper moisture balance and enhance shine (16).

Hair oil spray

Hair oil spray is an aerosolized oil containing mineral oil and silicone derivatives, which is sprayed onto the hair on a daily basis to moisturize and decrease combing friction (Figure 26.7D). It may

also contain stearyltrimonium chloride, hydrolyzed animal protein, and a di-fatty cationic amino acid derivative for additional shine and moisturization. Hair oil spray is frequently used for natural kinky hair that has been straightened to moisturize the porous hair.

Hair oil

Hair oil can be rubbed through the hair and applied to the scalp in persons with dry scalp and dry hair (Figure 26.7E). Hair and scalp oiling is a popular hygiene practice for men and women in many countries of the world, including India and the Middle East, where shiny glistening hair is a sign of health. Argan oil and other botanical oils are used, sometimes to impart a fragrance to the hair, in combination with either mineral oil or dimethicone. Hair oils are excellent at decreasing hair frizz, waterproofing the hair so it is less susceptible to the effects of humidity, minimizing hair static electricity, decreasing combing friction, improving manageability, and increasing hair shine. More viscous formulations are available for African American hair, and higher dimethicone formulations are available for curly hair.

Hairstyling devices

Two types of modern hairstyling devices are available: nonelectric and electric. Nonelectric styling devices include dry rollers, combs, brushes, and a variety of hair clasps. Electric styling devices include hair dryers, curling irons, electric curlers, and crimping irons.

Nonelectric hairstyling devices

Nonelectric rollers function to impart curl and add body to create a desirable hairstyle. A variety of sizes and styles are available; larger rollers form looser curls whereas smaller rollers form tighter curls (Figure 26.8). Toothed rollers are designed to hold the hair without the aid of a hairpin, but may fracture the hair shaft on removal. Hair breakage can be minimized by using toothless smooth rollers held in place with hairpins and a hair net.

Pulling and rolling wet hair onto curlers allows partial transformation of the normal alpha-keratin structure to a beta-keratin structure of the hair shaft, allowing the curling of straight hair.

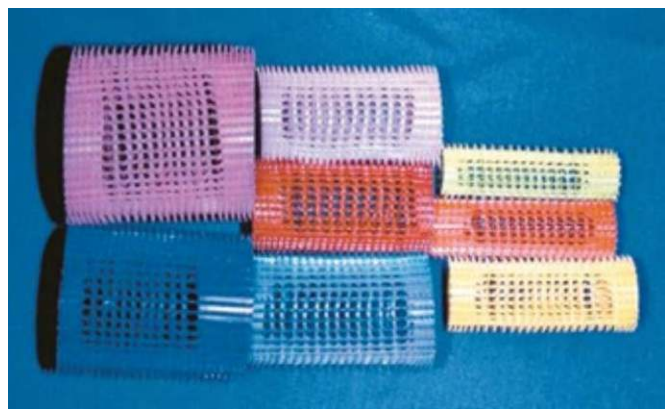


FIGURE 26.8 Nonelectric hair rollers come in a variety of sizes to create different curl sizes.

Wet hair is required to produce optimal curls with nonelectric rollers. Physically, wet hair is more elastic than dry hair, allowing partial transformation of the normal alpha-keratin structure to a beta-keratin structure under tension. This transformation shifts the relative position of the polypeptide chains and brings about a disruption of ionic and hydrogen bonds. During the drying process, new ionic and hydrogen bonds are formed, hindering return to the natural alpha-keratin configuration and allowing the hair to remain in its newly curled position. Wetting the hair, however, returns hair bonds immediately to the natural alpha configuration (17). Hair must be rolled under tension to provide the load required for bond breakage, but hair should not be stretched beyond the point at which more than one-third of the alpha-keratin bonds have been unfolded to beta-keratin bonds. Excessive stretching will result in permanent deformation, causing the inelastic hair to fracture (Figure 26.9).

Electric hairstyling devices

Electric styling devices operate on the principle that heat can temporarily reform hydrogen bonds within the hair shaft. The style can be maintained until the next water exposure, when the bonds will return to their natural conformation. Electric styling devices are used by professionals in the salon and consumers at home. This section highlights the use and misuse of these devices.

Hair dryer

The most popular electric styling device is the hair dryer, which can be hooded or hand-held. Hooded hair dryers are mainly seen in professional salons and can be used for two purposes. The first is to dry the hair after it has been placed on rollers, and the second is to process chemical hair treatments, such as permanent hair dyes or hair straightening. Hooded dryers are more efficient at drying the hair than blow dryers, but can cause more hair and scalp damage, especially if excess heat is present between the hood and scalp (Figure 26.10). Second-degree scalp burns have been reported when a hood hair dryer is used to process dyed hair that has been wrapped in aluminum foil to contain the hair dye only to certain hair shafts. This dyeing technique is used to artificially dye the hair several different colors to mimic the natural variation seen in some individuals. Problems can arise when the foil is heated against the scalp, resulting in scarring and baldness.

Blow-dryers are the most popular method of hair drying but should be used on low heat to avoid damaging the hair protein.

Handheld blow-dryers do not dry the hair as efficiently as a hooded hair dryer but also cannot produce scalp burns as easily (Figure 26.11). To avoid burning the skin or the hair, the handheld blow-dryer should be positioned at least 8 inches from the scalp. High temperatures can denature hair protein, resulting in permanent damage to the hair shafts perceived as easily fractured hair. A vented styling brush can be used to shape hair while blow-drying to minimize overheating the hair.

Curling iron

The second-most popular hair appliance is the curling iron, which is a modern version of the oven-heated metal rods that were wrapped with hair in the pre-electric era (18). Modern curling irons are thermostatically controlled to prevent overheating, but temperatures capable of producing first- and second-degree burns are still attainable. Some irons come with variable temperature



FIGURE 26.9 The hair is tightly wrapped around the rollers and dried to create temporary curls.

settings, but most patients prefer the hottest setting because the curls produced are tighter and longer lasting. It is recommended that patients remove excess heat from the curling iron prior to use by placing it in a moist towel. This lowers the rod temperature, preventing burns of the hair and scalp (Figure 26.12).

Hot curling irons can cook the water in the hair shaft, causing irreversible damage in the form of bubble hair.

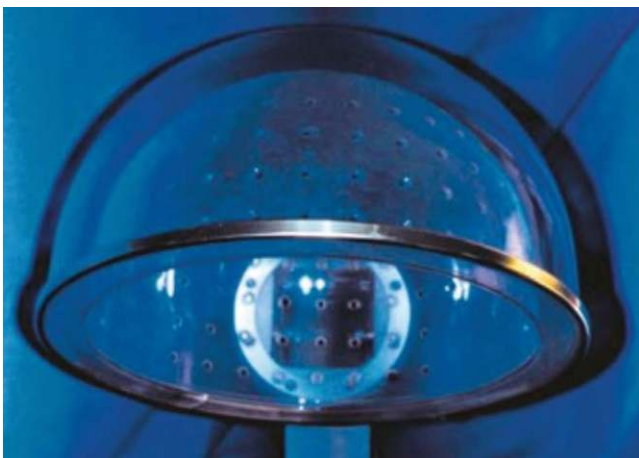


FIGURE 26.10 A hooded hair dryer is used in a professional salon to rapidly dry wet hair into a desired style after setting on the curlers illustrated in Figure 26.9.



FIGURE 26.11 A handheld blow-dryer should be held at least 8 inches from the head to avoid burning the scalp and the hair.

Removal of hair from the curling iron is another frequently encountered problem. Most curling irons have a spring-loaded clip to hold the hair to the rod. Failure to release the clip completely can cause hair breakage. Newer rods are now coated with nonstick materials to facilitate hair release, or made of ceramic. However, certain styling products, such as hair spray, can melt and glue hair to the rod. Thus, patients should curl their hair first and then add hair spray or other styling products.

Electric curlers

Electric curlers are individually heated, plastic-coated rods of varying sizes (Figure 26.13). A curler set is more expensive than a curling iron, but the chance of burning is lessened because hot metal does not come in contact with the hair or scalp. Many patients prefer curling irons because they have a shorter heating period, but fast, 60-second heating curlers are available. A variation on the firm, molded electric roller is a smaller-diameter, rubber-coated, bendable rod or disk. The shapes and types of curlers available are dictated by fashion.

Electric hair curlers can curl dry straight hair by affecting the water-deformable bonds.



FIGURE 26.12 A curling iron can cause second-degree burns if not properly handled.



FIGURE 26.13 Electric curlers are less likely to cause skin burns, but to avoid hair damage, only dry hair should be placed in contact with the warm curlers.

Crimping iron

The last major type of electric hairstyling appliance is a variation on the old-fashioned hair iron, known as a crimping iron or a straightening iron. This device contains two hinged metal plates that are heated with hair placed between them. If the plates are corrugated, the device is called a crimping iron and produces tight bends in the hair shaft. If the plates are smooth, the device is known as a hair straightener for those with kinky hair. This type of iron can be used to straighten mildly curly hair but cannot be used to straighten kinky hair (Figure 26.14). Heat straightening methods for kinky hair are covered in the chapter discussing ethnic hair.

Crimping irons are used to straighten mildly curly hair.

It is important for the physician to consider electric styling device burns in the patient with scarring alopecia, especially of the frontal and vertex areas. In these locations, it is easier for the heated device to rest on the head. Also, most women curl this area more frequently than the sides of the head, increasing the



FIGURE 26.14 A crimping iron uses heat to straighten the hair by pressing between two warm ceramic plates.

opportunity for burns. However, scalp scarring from burns must be distinguished from frontal fibrosing alopecia and central centrifugal cicatricial alopecia.

Summary

It is the artful combination of hairstyling products and devices that yields a fashionable coif. From smooth and straight to curly and fluffy, all things are possible with the right sprays, gels, mousses, serums, curlers, and irons. The different hairstyles that can be attained are only limited by the imagination of the artist. The many variations in hairstyles can be appreciated by examining a portrait art book, followed by a visit to a local mall. This chapter has educated dermatologists on the possibilities and identified issues where possible.

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HAIRSTYLING WITH PROSTHESES

The prior chapters have focused on methods of optimizing the appearance of the patient's natural hair through proper shampoo selection, conditioner application, and the use of styling aids and devices. Natural hair can be optimized through all of these cosmetic manipulations. However, the dermatologist may encounter patients with substantial temporary or permanent hair loss that may require the use of hair prostheses. Patients with temporary hair loss, such as chemotherapy-induced hair loss or alopecia areata, or persons with permanent scarring alopecia, such as lichen planopilaris or central centrifugal cicatricial alopecia, are grateful for the advice a dermatologist can provide regarding the use of prostheses. This chapter presents knowledge on hair techniques for the patient in need of reassurance and compassion.

Hairpieces have been a part of history since the Egyptians invented them in 3000 BC, many of which still survive today. Hairpieces were popular among both ruling men and women and were fashioned from human and vegetable fibers coated with beeswax. Blond wigs were popularized by the Romans in the first century BC, made of hair taken from German captives. Eventually, however, blonde wigs became the trademark of Roman prostitutes and were outlawed by the Christian Church. By 1580, wigs were again fashionable due to the influences of the English queens, who developed female pattern hair loss. Even Mary, Queen of Scots, wore a wig, a fact unknown by her followers until she was beheaded. The popularity of wigs spread to France by the 18th century, such that the French Court of Versailles employed 40 resident wigmakers. Today, wigs remain a part of the formal attire of some judges (1).

Hairpieces

The use of hairpieces can restore a positive self-image in those patients who have temporary or permanent hair loss. Both natural human hair and synthetic fiber types are available. The custom-made natural human hair products are more expensive (\$200–\$4,000) and have a short life (2–3 years) due to hair breakage. Synthetic hair products are less expensive (\$100–300) and have a longer life (3–5 years), but are limited in their styling possibilities. Synthetic fibers are designed to have a permanent curl and require less maintenance than natural fibers, making them a better choice for most patients.

Hairpieces are constructed by attaching individual fibers by hand-tying or machine-wefting to a meshwork designed to fit a specific scalp location.

A hairpiece is formed by attaching individual fibers to a meshwork designed to fit a specific scalp location. Two methods of attaching hair fibers to the mesh are used: hand-tied and machine-wefted. Hand-tied hairpieces are more expensive because the fibers are individually knotted to the mesh. Machine-wefted wigs are made by sewing the fibers onto strips of material and then attaching wefts to the mesh.

TABLE 27.1: Types of Hairpieces

1. *Wigs*: Constructed on a flexible cap-shaped mesh designed to cover the entire head
2. *Falls*: Long locks of hair attached to a firm, contoured mesh designed to rest on the scalp vertex (Figure 27.1A)
3. *Cascades*: Curled locks or buns attached to a firm, oblong contoured base designed to rest on the posterior scalp (Figure 27.1B)
4. *Toupees*: Custom-fitted hairpiece on a woven base to cover the top of the head (Figure 27.1C)
5. *Demiwigs*: Flexible cap-shaped mesh designed to cover the entire scalp except the front hairline (Figure 27.1D)
6. *Wiglets*: Localized hairpieces designed to create bangs or add additional hair on the top of the head (Figure 27.1E)
7. *Switches*: Long strands of hair in the form of braids or ponytails secured together at one end (Figure 27.1F)

Synthetic and natural fiber hairpieces are cleaned in much the same manner as a head of hair. The hairpiece is turned inside out, and a drop of mild shampoo is placed in the center and gently agitated under a stream of warm water. Once the shampoo is completely removed, a drop of instant conditioner is placed in the wig and again rinsed. The hairpiece is allowed to air dry while inside out by attaching it with a clothespin to an indoor clothesline. Once dry, the hairpiece may be styled with a specially designed wig brush.

Hairpieces come in seven basic types, depending on the scalp area to be covered. Table 27.1 and Figure 27.1 show these types.

Patients with severe alopecia areata, alopecia totalis, alopecia universalis, or chemotherapy-induced anagen effluvium require complete wigs. It is recommended that the patient select a wig prior to complete hair loss, thus allowing the patient to emotionally adjust and aid in selecting a wig that mimics the patient's natural hair color and style. If this is not possible, a picture of the patient prior to hair loss is helpful to the wig artist.

Most patients, however, only require supplementation of their natural hair by a hairpiece selected to cover areas of thinning or loss. For example, female pattern alopecia can be covered with a demiwig known as a "hair thickener." This hairpiece is attached to a loosely woven mesh through which the patient pulls her own hair, allowing blending of the hair fibers and also firmly securing the hairpiece to the scalp. Women who note that their hair will no longer grow to a length desired may wish to consider a fall to add length or a cascade to add a bun or mass of curls.

Toupees are specifically designed for balding men and are available in a variety of colors with the appropriate percentage of gray hair to match the patient's state of canities. Natural part line toupees, which add a small insert of sheer plastic in the part line to expose the natural color of the underlying scalp, may create a more natural appearance. Some toupees come uncut, allowing the patient to take the toupee to the barber for styling along with the patient's natural hair. Attachment of toupees to the scalp, however, remains challenging and relies on clips or adhesives (Figure 27.2).

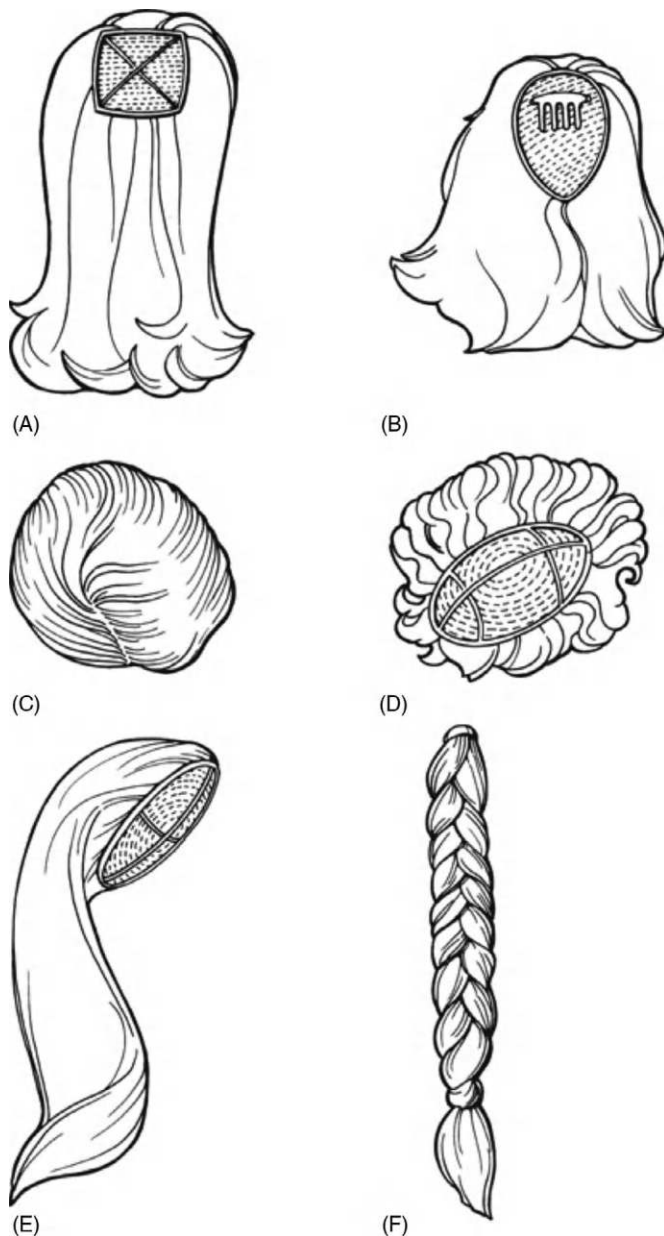


FIGURE 27.1 Types of artificial hairpieces. (A) Fall. (B) Cascade. (C) Toupee. (D) Demiwig. (E) Wiglet. (F) Switch.

Chemotherapy patients with scalp tenderness or patients undergoing immunotherapy utilizing contact sensitization for alopecia may wish to cover their head with a soft terry cloth turban. A more natural appearance can be achieved by adding a wiglet of bangs.

Hair additions

Another semi-permanent approach to thinning or locally absent scalp hair is the use of hair additions. Hair additions are worn continuously for approximately eight weeks, remaining in place while swimming, bathing, sleeping, and exercising. The technique utilizes synthetic or natural human hair fibers to supplement existing hair where needed. Hair additions can be tied, woven, or glued to the scalp or existing hair and may be obtained

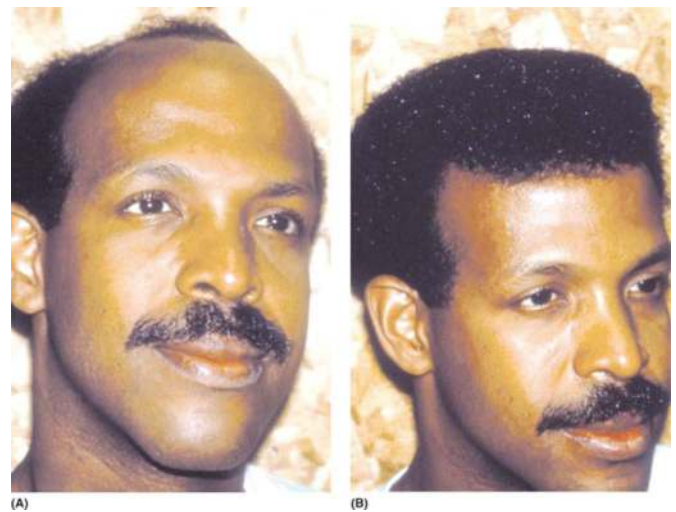


FIGURE 27.2 A patient before (A) and after (B) application of a toupee.

in full-service beauty salons or at salons specializing in the technique. Augmentation of hair through additions is widely used in the entertainment industry, by African Americans who wish to achieve a longer hair length, by men who wish to camouflage androgenetic alopecia, and by women who desire special effect hairstyles.

Hair additions and wigs can be formed from synthetic modacrylic fibers or natural human hair.

There are several different types of fibers that can be used for temporary hair additions or for the construction of wigs. Synthetic fibers are manmade and natural hair fibers are obtained from women who sell their hair. Most human hair comes from Asia and is dyed and mixed from multiple donors to obtain a swatch that is then made into a wig. Synthetic fibers are formed from modacrylic, composed of two polymerized monomers: acrylonitrile and vinyl chloride. The polymer is drawn through a multihole metal disk, dried, and stretched. The disk design is such that fibers with an irregular cross-section and surface variations are produced to more closely mimic natural human hair. Dye may be added to the polymer either before or after extrusion to create any hair color desired. Various colored hair fibers are then combined to make a more realistic-looking wig.

The art of making a hairpiece is to artistically combine fibers of varying diameters and color hues because not all natural hair shafts are of the same thickness or color. Additionally, the fiber thickness should be varied to more accurately simulate hair shaft size in African American, Caucasian, and Asian hair. The modacrylic can also be permanently heat-formed to reproduce the appropriate amount and tightness of curl unique to the hair of different ethnic groups. Synthetic hair offers some advantages over natural human hair for use in hair additions. First, synthetic fibers are of lighter weight than natural human hair, thus exerting less pull on existing scalp hairs. Second, synthetic fibers are less expensive than human hair. Third, synthetic fibers can be melted to bond to existing scalp hair.

As mentioned previously, human hair obtained from Indian or Chinese women who grow their hair for sale is used for hair additions and wigs. Indian hair has a fine diameter and a slight natural wave, whereas Chinese hair is coarser and straighter. Usually, the human hair is lightened and redyed to obtain a range of colors and may also be permanently waved to obtain the desired amount of curl. Coloring and curling of hair used in additions may be performed both before and after the added hair is attached to the scalp using standard salon products.

Human hair does not require the color and fiber diameter mixing of synthetic hair fibers because natural variation is already present. Thus, the main advantage of human hair additions is their ability to blend with existing scalp hair. Disadvantages include the weight of the natural fibers and the cost, which increases with longer lengths of hair.

Methods of hair attachment

Hair additions use existing scalp hair to anchor the synthetic or natural human hair fibers. The added fibers may be affixed by braiding, sewing, bonding, or gluing. The attachment method selected depends on the amount of natural hair and the number or length of fibers to be added.

Hair fibers can be attached to the scalp by braiding, sewing, bonding, or gluing.

Braiding on the scalp

The most popular method of hair addition employs braiding on the scalp, adapted from the African American hairstyle known as “cornrows.” Cornrows are plaited on the scalp in geometric designs with tension applied to the hair shafts, exposing the scalp between the braids. This is a popular hairstyle among African American individuals because it allows organization of tightly kinked hair. Braiding on the scalp can also be used to attach a toupee (Figure 27.3). Individual hair fibers can be woven into the braids to either thicken their appearance or, more commonly, to



FIGURE 27.3 Braiding (A) can create an attachment site for sewing a toupee to the hair braid (B).



FIGURE 27.4 Braiding off the scalp can be used to weave in synthetic hair strands to create the illusion of long hair in African American individuals with short hair.

add length. Wefted hair, or hair fibers sewn together in a strip, can be sewn with a needle and thread to the cornrows to quickly add large amounts of hair.

Braiding off the scalp

Braiding off the scalp employs a standard plaiting technique to which individual hair fibers are added. Fibers are attached by working them securely into the braids and leaving the loose ends for curling and styling (Figure 27.4). This technique is popular among individuals with short kinky hair who wish to have long straight hair, but long-term use can result in traction alopecia (Figure 27.5).

Bonding

Bonding employs a hot glue gun to fuse individual synthetic hair fibers to the base of clumps of existing scalp hair. Only a few fibers can be attached at a time due to the weight of the additions. This technique is used in both men and women to thicken the hair. The bonds are intended to remain in place for eight weeks. However, individuals with excessive sebum production may notice early loosening and loss of the added hair.



FIGURE 27.5 Traction alopecia is a possible permanent side effect of braiding off the scalp.

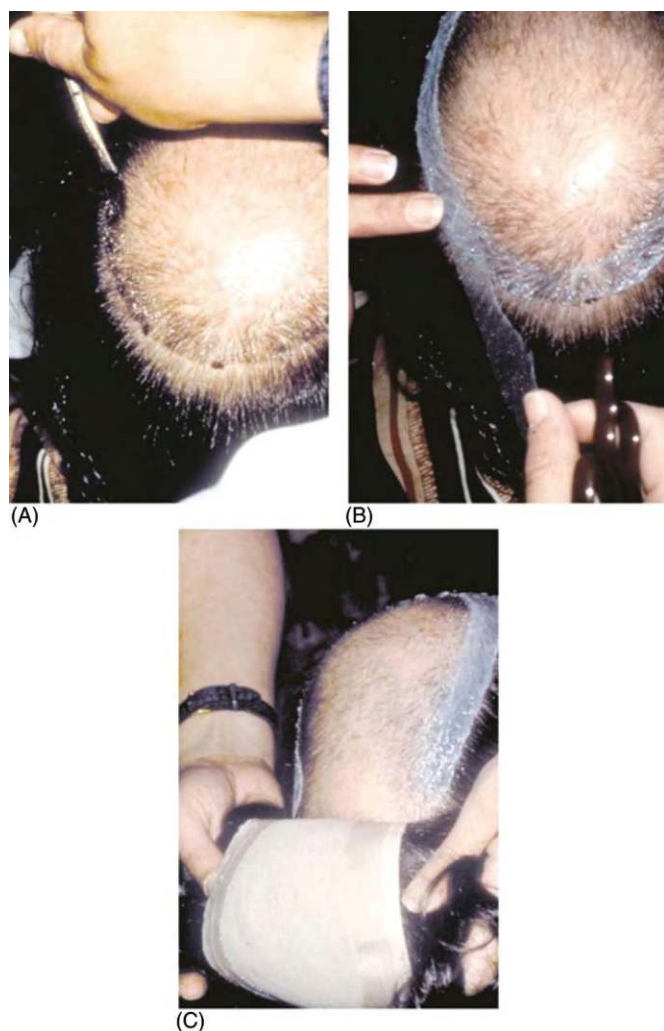


FIGURE 27.6 Glue can be used to affix a toupee to the scalp. (A) Glue application followed by attachment of a woven mesh in (B), and finally the toupee is glued to the woven mesh in (C).

Gluing

This hair addition technique combines braiding on the scalp with adhesive attachment. The existing hair is initially braided into concentric arcs on the posterior scalp, known as “tracks.” These tracks serve as anchors to which wefted hair is glued. The adhesive employed is a cold latex-based glue that is subject to removal by scalp sebum production (Figure 27.6).

Care of hair additions

Hair additions are worn continually for a period of eight weeks or less, at which time they must be removed. Individuals with slowly growing hair may wear the hairstyle longer, whereas those with rapidly growing hair notice the added hair fibers loosen more quickly. The additions are shampooed along with the individual’s existing hair, using the same cleansing products and cleansing frequency. Many individuals are afraid to wash the additions because they fear loosening will occur, but good hygiene is important.

Hair additions must be removed at eight weeks to avoid hygiene problems and traction alopecia.

Hair additions must be removed at eight weeks to avoid hygiene problems and other complications such as traction alopecia. If the hair and scalp have been properly cleansed, hair additions begin to loosen and look ungroomed at eight weeks. Removal of braided additions simply requires undoing the braid and removing the added strands of hair, which may be reused in later procedures. Bonded additions are removed by melting the hot glue with the tip of the glue gun and pulling out the individual or wefted hair fibers. Peanut oil is then rubbed through the scalp to facilitate removal of any remaining material. Latex-based glue is removed with a specially designed solvent. Lastly, sewn additions can be removed by cutting the attachment thread.

It is understandable that individuals would like to wear the additions as long as possible because the cost may vary between \$250 and \$1,000 depending on the complexity of the hairstyle, the amount and length of the added hair fibers, the salon time required, and whether synthetic or human hair fibers are used. The average hair addition requires three to five hours in a salon.

Successful use of hair additions requires a hairstylist who is trained in the technique and a client who will put forth the effort to maintain the added hair. Braided and sewn hair additions pose the least problem because no adhesives are used; however, the added hair fibers put increased pull on existing scalp hair, augmenting the pull already exerted by the tight braids. For these reasons, traction alopecia is a problem arising in individuals who continually wear hair additions. The traction alopecia is identical to that seen in African American patients who wear tightly pulled hairstyles. Initially, only loss of the hair shaft is observed, but with continued traction, the process can result in loss of the follicular ostia and permanent alopecia. Extensive traction alopecia will eventually preclude the use of hair additions because no existing scalp hair will be available to anchor added hair.

Glued additions employ adhesives, which must be patch tested prior to use. Additionally, the hairstylist must take care not to carelessly apply glue throughout the scalp, which may increase hair breakage because hair combing is impeded by glue. The hot bonding gun must be separated from the scalp to avoid scalp burns, which could result in permanent alopecia, if severe.

High standards of hygiene must be maintained to prevent inflammation of the scalp, in the form of seborrheic dermatitis, and infection of the scalp, in the form of bacterial folliculitis. The individual who chooses to have hair additions must realize that the new hairstyle requires more grooming and upkeep than natural scalp hair.

Hair integration systems

Hair integration systems are a useful method of allowing the patient to supplement hair loss only where necessary. These hairpieces are custom-made by fashioning a loose net to fit the scalp. Synthetic or natural human hair fibers are tied to the meshwork in the desired location, amount, length, color, and texture. Any hairstyle can be easily created (Figure 27.7). The patient puts the integration system over their scalp and pulls their existing hair through the fenestrations in the net. This affixes the hairpiece securely to the scalp and also allows a natural appearance.

YES

"HAIR INTEGRATION SYSTEM"

CLIENT CONSULTATION AND ANALYSIS CHART

Client's Name: _____

Designer: _____

Address: _____

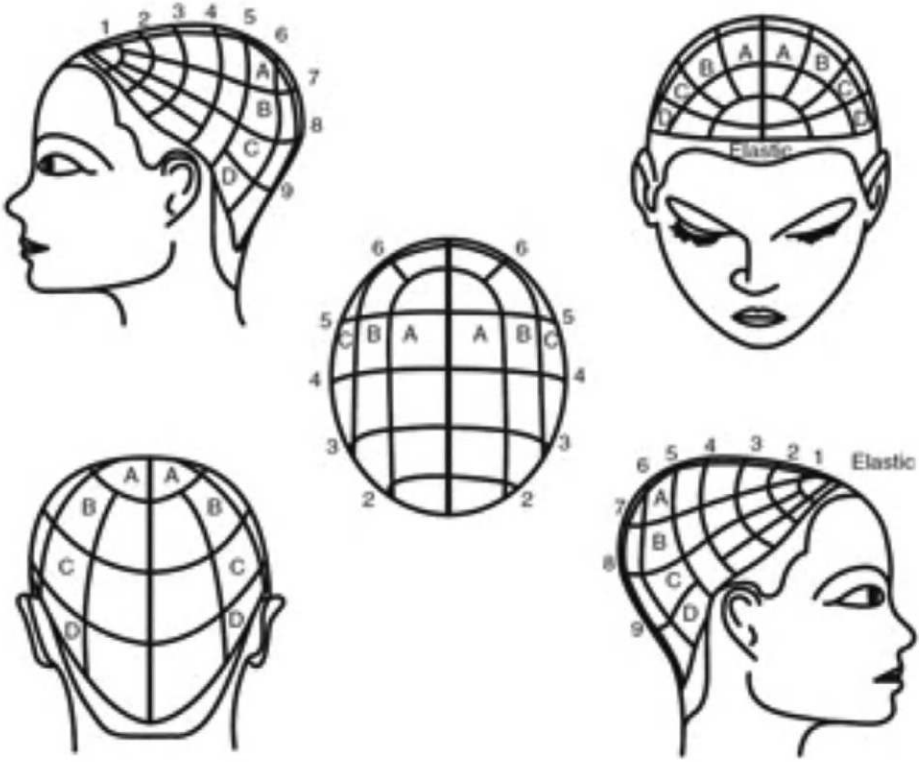
Technician: _____

Phone: _____

Order Date: _____

Fitting Date: _____

Amount Enclosed : \$ _____



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FIGURE 27.7 Hair integration systems are custom-designed to add hair where needed to camouflage loss.

Integration systems can be rather costly, depending upon the amount and length of hair attached. They are extremely versatile for patients with alopecia areata, androgenetic alopecia, scarring, or radiation hair loss.

Hair integration systems are custom-made by fashioning a loose net to fit the scalp, to which synthetic or natural human hair fibers are tied.

Crepe hair techniques

Crepe hair can be used to temporarily camouflage very small, localized areas of scalp hair loss. Its utility is in patients who have recent-onset alopecia areata with an excellent prognosis for hair regrowth who need an inexpensive, short-term camouflage. Crepe hair is made from wool and purchased as braids in a variety of colors. The wool strands are pulled from the braid and artistically glued to the scalp with adhesive. The process must be redone with each shampooing and the adhesive removed with a specially formulated product.

Crepe hair is composed of wool fibers that can be glued to the scalp and dusted onto the hair with a fixative.

Other more modern uses of crepe hair are fibered hair sprays or fibered powders containing the wool fibers. The fibers are charged with static electricity to allow them to adhere to the natural hair fibers and create the illusion of fuller hair. Some products also have a hair spray fixative in the formulation to increase the ability of the crepe hair to stay in place. Products are available in seven different shades to match most hair colors. These crepe hair products are popular among men to camouflage vertex balding. The product is removed with shampooing and must be reapplied as needed.

Scalp camouflage techniques

Many times, it is the contrast between the pale bald scalp and the dark hair that accentuates hair loss. This contrast can be minimized by coloring the scalp to match the hair temporarily with wax crayons or vegetable dyes or permanently with tattoo pigment. The wax crayons are stroked over the scalp artistically to mimic hair, and the color is easily removed with shampoo. Tattoo pigment can also be placed in streaks to mimic hair shafts. The

tattoo looks realistic when combined with hair, but if all the hair is lost in an area, the tattoo looks quite unusual. Patients should consider their natural hereditary pattern of balding prior to undergoing scalp tattooing.

Scalp camouflaging can be performed with wax crayons, vegetable dyes, or tattoo pigment.

Summary

Hair prostheses can be quite effective in camouflaging temporary or permanent alopecia. Many patients are not familiar with the options available to restore scalp hair and appreciate unbiased advice from their trusted dermatologist. This chapter has presented the basics of hair prostheses utilization. There are other cosmetic methods that can be used to optimize the appearance of thinning hair presented in the chapter on alopecia and cosmetic considerations.

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HAIR PERMANENT WAVING

The idea of making straight hair permanently curly is appealing to both men and women who want to achieve fashionable hairstyles. It always seems that those with straight want curly hair and those with curly hair want straight hair! A whole industry is predicated on changing the conformation of hair to the likes of the individual. Hair permanent waving is a complex chemical process based on altering the 16% cysteine incorporated into disulfide linkages between polypeptide chains in the hair keratin filament. These disulfide linkages are responsible for hair elasticity and can be re-formed to change the configuration of the hair shaft.

Methods of waving and curling straight hair have been practiced since ancient Egyptian times, when water and mud were applied to hair wound on sticks and allowed to dry in the sun. The ancient Greeks refined the technique with hot irons, which were wrapped with hair. The use of hot irons to curl hair was rediscovered by Marcel in 1872 and is still a popular technique among African American men and women. The first hair waving solution was developed by Nessler in 1906 and consisted of borax paste, which produced longer-lasting waves but was very damaging to the hair. This method utilized external heat in the form of electrically heated hollow iron tubes or a chemical heating pad that was attached to the curling rods with a clamp. Temperatures reached about 115°C and heating continued for 10 to 15 minutes (1).

In the 1930s, the first cold wave was introduced, which virtually replaced heat methods of curling. The solution was based on ammonium thioglycolate containing free ammonia and a controlled pH. The original US patent was granted to E. McDonough on June 16, 1941. Interestingly, this cold wave solution, with slight variations, is still popular today for both salon and home use. It is estimated that more than 65 million permanent waves are sold in salons and 45 million home waves are performed on an annual basis in the United States (2).

Hair permanent waving is a complex chemical process based on altering the 16% cysteine incorporated into disulfide linkages between polypeptide chains in the hair keratin filament.

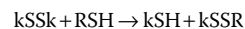
Chemistry

Permanent waving is a complex chemical process with three distinct steps: chemical softening, rearranging, and fixing (3). The basic chemistry involves the reduction of the disulfide hair shaft bonds with mercaptans (4). The process can be chemically characterized as listed in Table 28.1 (5).

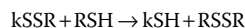
Permanent waving is a complex chemical process with three distinct steps: chemical softening, rearranging, and fixing.

TABLE 28.1: Permanent Waving Process

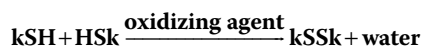
1. Penetration of the thiol compound into the hair shaft.
2. Cleavage of the hair keratin disulfide bond (kSSk) to produce a cysteine residue (kSH) and the mixed disulfide of the thiol compound with the hair keratin (kSSR).



3. Reaction with another thiol molecule to produce a second cysteine residue and the symmetrical disulfide of the thiol waving agent (RSSR).



4. Rearrangement of the hair protein structure to relieve internal stress, which is determined by curler size and hair wrapping tension.
5. Application of an oxidizing agent to re-form the disulfide crosslinks.



Application technique

Cold permanent waves can be administered at home or in a salon but involve the same application technique (6). It usually takes about 90 minutes to complete the entire process, depending on the length of the hair.

The standard procedure involves initial shampooing of the hair to remove dirt and sebum. This wetting process is the first step in preparing the hair for chemical treatment because the water enters the hair's hydrogen bonds and allows increased flexibility. The hair is then sectioned into 30 to 50 areas, depending on the length and thickness of the hair, and wound on mandrels or rods. The size of the rod determines the diameter of the curl with smaller rods producing tighter curls (Figure 28.1). A sufficient amount of tension must be applied to the hair as it is wound around the rod to provide the stress required to encourage bond breaking. If too much tension is applied, the hair can be stretched beyond its elastic range, transforming it into a brittle substance that will easily fracture. Tissue paper squares about 5 × 5 cm, known as "end papers," are applied to the distal hair shafts to prevent irregular wrapping of the ends around the rod. Failure to use end papers can result in a frizzy appearance of the distal hair shaft (Figure 28.2).

Next, the waving lotion is applied and left in contact with the hair for 5 to 20 minutes, depending on the condition of the hair (Figure 28.3). The reducing action of the waving lotion is said to "soften" the hair and contains a disulfide bond-breaking agent, such as ammonium or calcium thioglycolate, and an antioxidant, such as sodium hydrosulfite, to prevent the lotion from reacting with air before it reaches the hair. Sequestering agents, such as tetrasodium EDTA, are added to prevent trace metals such as iron in tap water from reacting with the thioglycolate lotion. Other ingredients include pH adjusters, conditioners, and surfactants to remove the remaining sebum from the hair (Figure 28.4). Coarse hair requires a longer processing time than fine hair, and undyed hair requires a longer processing time than permanently dyed or bleached hair. A "test curl" is then checked to determine if the desired amount of curl has been obtained and overprocessing avoided (Figure 28.5).

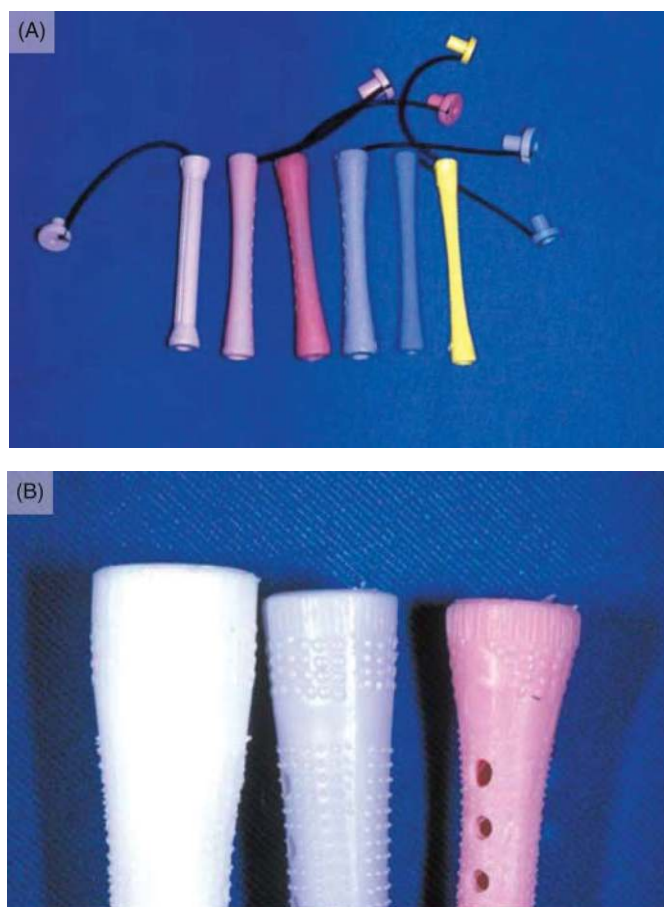


FIGURE 28.1 Hair is wound on mandrels of various sizes with (A) smaller rods producing tighter curls and (B) larger rods producing looser curls.

The hair disulfide bonds are subsequently re-formed with the hair in the new curled conformation around the perming rods. This process is known as neutralization, fixation, or “hardening” (Figure 28.6). The neutralization procedure, chemically characterized as an oxidation step, should involve two steps. First, two-thirds of the neutralizer should thoroughly saturate the hair with the rods in place and allowed to set for five minutes. The rods are then removed and the remaining one-third of the neutralizer applied for an additional five minutes. The hair is then carefully rinsed. Patients who complain of an undesirable odor following permanent waving, especially after shampooing, have undergone incomplete neutralization. Repeating the neutralization process as outlined above will reduce the excessive odor (7).

The newly curled hair is now ready for drying and styling. Most companies recommend avoiding shampooing or manipulating the hair for one to two days following the cold wave procedure to ensure long-lasting curls.

A permanent wave is designed to last three to four months. Curl relaxation occurs with time as the hair returns to its original conformation. Hairdressers generally will therefore select a curl tighter than the patient desires with this fact in mind. Most of the curl relaxation occurs within the first two weeks after processing, a fact that is reassuring to the patient who has had an undesirable result. Curl relaxation can be increased slightly by frequent shampooing beginning immediately following the permanent waving

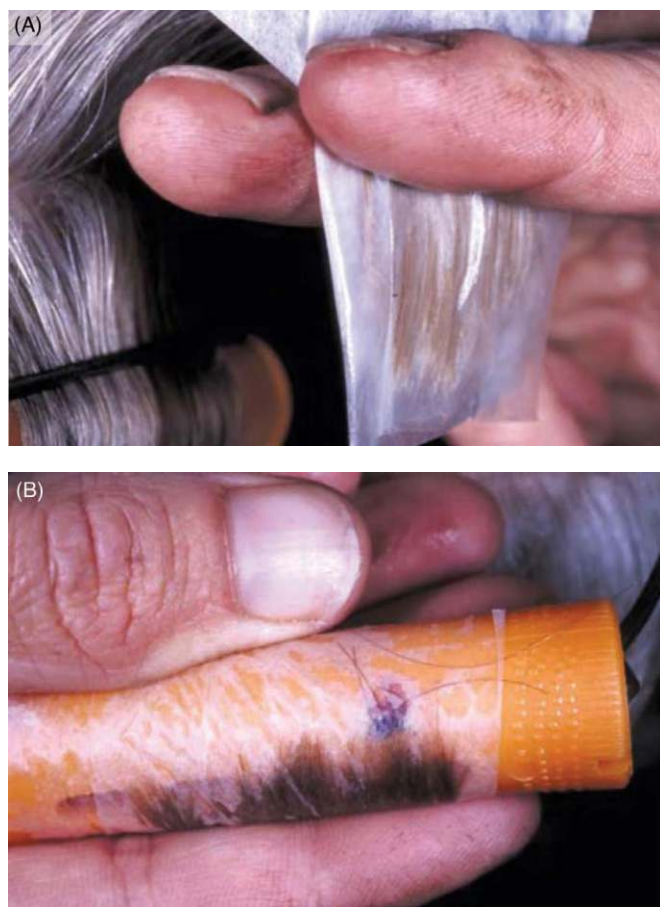


FIGURE 28.2 The ends of the hair are wrapped in end papers (A) to be sure all the hairs are wound around the mandrel to prevent hair frizziness (B).

procedure. Some strong detergent shampoos, such as those recommended for seborrheic dermatitis, will cause curl relaxation more rapidly than conditioning shampoos. New hair growth also decreases the curled appearance of the hair. Patients with rapidly growing hair need to repeat the permanent waving procedure more frequently. Increased hair growth during pregnancy



FIGURE 28.3 The hair is wrapped around the mandrel ready for waving lotion application.



FIGURE 28.4 The waving lotion is evenly applied to cause disulfide bond breaking in each hair shaft for an even curl.



FIGURE 28.5 A test curl must be performed to ensure adequate curl formation and avoid overprocessing of the hair shafts.



FIGURE 28.6 Each hair shaft must come in contact with the neutralizer to reform the disulfide bonds in the new curled shape and restore hair strength.

could account for the fact that some hairdressers note permanent waves do not “take” in pregnant women. Hair at the nape of the neck also has a decreased “take.” However, permanently waved hair does not fully reproduce the appearance on naturally curly hair picture in [Figure 28.7](#).



FIGURE 28.7 Naturally curly hair has better curl formation than permanent waved hair.

Factors influencing permanent waving

There are several factors that determine the success or failure of a cold waving procedure. Most of the suboptimal results that cause patients to seek dermatologic help result from failure to consider the key points listed in [Table 28.2](#) while performing the procedure (8).

Assessing the permanent wave effectiveness

Several methods are used by manufacturers of cold waving products to determine wave efficiency and degree of hair shaft damage. These are known as the deficiency in tightness (DIT) value, the curl length, and the 20% index (8).

The DIT value is determined as follows:

$$\text{DIT} = \frac{\text{diameter of curl (mm)} - \text{diameter of rod (mm)}}{\text{diameter of rod (mm)}} \times 100$$

The higher the DIT value, the greater the effectiveness of the curling solution. In other words, weak cold wave solutions have low DIT values.

The curl length is evaluated by suspending a fresh curl and observing the spring of the formed coil. The degree of laxity is indicative of the efficiency of the wave and also of the degree of hair shaft damage. Thus, longer curls are indicative of greater hair shaft damage.

The 20% index is determined by stretching freshly permed hair with a uniformly increasing load. The ratio of the load required after perming to the load required prior to perming to stretch a wet strand of 12 hairs to 20% of their original length is known as the 20% index. The higher the index, the lower the reduction in hair strength due to the cold wave procedure.

Cold wave chemists use these three criteria to determine the success of the permanent wave procedure and the degree of hair shaft damage. Factors affecting the efficacy of a permanent waving product are processing time, processing temperature, concentration of reducing agent, ration of lotion to hair quantities, penetration of the lotion, pH and the nature and condition of the untreated hair (10). A marketable permanent wave solution must produce the best curl with the least amount of hair damage (11).

TABLE 28.2: Permanent Waving Guidelines

1. The hair must not be wound with excessive tension around the rods, or increased breakage may occur (9).
2. Smaller rods will produce smaller curls, which are more damaging to the hair shaft.
3. The hair must fit around the rod at least once for complete curl formation in patients with short hair.
4. A stronger waving lotion will not produce a tighter curl. The curl diameter is determined by the rod diameter.
5. Weak waving lotions with shorter processing times should be used for damaged hair.
6. It may be necessary to use different strengths of waving lotions on new proximal growth and previously waved distal growth, especially in patients with bleached hair.
7. A test curl should be performed to avoid overprocessing the hair. Long processing times can excessively damage hair and increase breakage.
8. Discoloration of the hair may occur in patients who have used para-phenylenediamine-based permanent dyes that have been incompletely oxidized.

Factors affecting the efficacy of a permanent waving product are processing time, processing temperature, concentration of reducing agent, ration of lotion to hair quantities, penetration of the lotion, pH, and the nature and condition of the untreated hair.

Hair alterations following permanent waving

Following the permanent waving process, the hair has been irreversibly altered. These changes contribute to some of the dermatologic problems noted in chemically waved hair. First, the dry waved hair shaft is shorter than the original hair shaft (12). This may account for the perception by many patients that their hair was cut too short following a perming procedure. Second, the chemically treated hair shaft is 17% weaker and thus less able to withstand the trauma of combing and brushing (13). Patients comment that their hair is falling out following permanent waving when in actuality the hair shaft fractures more readily. Third, the hair demonstrates more frictional resistance following permanent waving (3). This means it is more difficult to comb. Finally, the hair demonstrates increased swelling capacity, which is evidence of cortical damage (14). This swelling accounts for the increased penetration of other chemicals applied to the hair, such as dyes, yielding unexpected results ([Figure 28.8](#)).

Types of permanent waves

Waving lotions consist primarily of a reducing agent in an aqueous solution with an adjusted pH (15). [Table 28.3](#) summarizes waving lotion ingredients and their function (1). The most popular reducing agents are the thioglycolates, glycerol thioglycolates, and sulfites. On the basis of waving lotion type, permanent waves can be classified into the following groups (4, 16):

1. Alkaline permanents
2. Buffered alkaline permanents
3. Exothermic permanents
4. Self-regulated permanents
5. Acid permanents
6. Sulfite permanents

Alkaline Permanents

Alkaline permanents utilize ammonium thioglycolate or ethanolamine thioglycolate as the reducing agent in the waving lotion. The pH is adjusted to between 9 and 10 because the thioglycolates are not as effective at lower pH. These products process extremely rapidly and produce a tight, long-lasting curl, although they are harsh on the hair. The alkalinity allows hair shaft swelling, which can cause problems in individuals with color-treated hair, especially bleached hair. For this reason, the concentration of the thioglycolate waving lotion is adjusted from 7% (used on natural hair) to 1% (used on heavily bleached hair).

Buffered Alkaline Permanents

To decrease hair swelling from the high pH of alkaline permanent waves, a buffering agent such as ammonium bicarbonate is



FIGURE 28.8 (A) A tight permanent wave as evidenced by tightly curled hair. (B) A medium permanent wave showing relaxed ringlets. (C) A loose permanent wave, also known as a body wave, demonstrating loose curls.

TABLE 28.3: Permanent Waving Lotion Ingredients

Ingredient	Chemical Examples	Function
Reducing agent	Thioglycolates sulfites	Breaks disulfide bonds
Alkaline agent	Ammonium hydroxide, triethanol-amine	Adjusts pH
Chelating agent	Tetrasodium EDTA	Removes trace metals
Wetting agent	Fatty alcohols	Improves hair saturation with waving lotion
Conditioner	Proteins, humectants, quaternium compounds	Protects hair during waving process
Opacifier	Polyacrylates, polystyrene latex	Opacifies waving lotion

Source: Adapted from Ref. 1.

TABLE 28.4: Function of Neutralizer Ingredients

Ingredient	Chemical Examples	Function
Oxidizing agent	Hydrogen peroxide, sodium bromated	Re-forms broken disulfide bonds
Acid buffer	Citric acid, acetic acid, lactic acid	Maintains acidic pH
Stabilizer	Sodium stannate	Prevents hydrogen peroxide breakdown
Wetting agent	Fatty alcohols	Improves hair saturation with neutralizer
Conditioner	Proteins, humectants, quaternium compounds	Improves hair feel
Opacifier	Polyacrylates, polystyrene latex	Makes neutralizer opaque

Source: Adapted from Ref. 1.

employed. These products are known as buffered alkaline permanents and result in a tight curl at a pH of 7 to 8.5. Their advantage is the production of a tight, long-lasting curl with less hair damage.

Exothermic Permanents

Exothermic permanent waves produce heat as a by-product to increase client comfort because some individuals may feel chilled during the permanent waving process. Heat is produced when an oxidizing agent, such as hydrogen peroxide, is mixed with the thioglycolate-based waving lotion immediately prior to scalp application. The reaction of the thioglycolate with the peroxide produces dithiodiglycolate (the disulfide of thioglycolate), which limits the extent to which the permanent wave can process. Irreversible hair damage will result if the waving lotion is not mixed with the oxidizing agent prior to application. For this reason, exothermic permanent waves are mainly available for professional use only.

Self-Regulated Permanents

Self-regulated permanent waves are designed to limit the amount of hair disulfide bond breakage so that irreversible hair damage is prevented. Overprocessing, due to leaving the permanent wave solution on the hair longer than recommended, causes extensive hair breakage and acts like a depilatory. It is not unusual for a busy beautician to have three to four permanent waves processing at the same time. Self-regulated permanent waves are designed to form a chemical equilibrium such that the disulfide bond breakage is stopped. This is accomplished by adding dithioglycolic acid to the thioglycolate-based waving lotion. This is the same chemical reaction discussed for exothermic permanent waves.

Acid Permanents

Acid permanent waves occur in an acidic environment with a pH of 6.5 to 7. They are based on thioglycolate esters, such as glycerol monothioglycolate. The lower pH is an advantage because less hair

shaft swelling occurs than at basic pH, minimizing hair damage. These products result in a looser, shorter-lasting curl but leave the hair soft. They are ideal for bleached or color-treated hair. It is possible to achieve a tighter curl if the permanent wave is processed with added heat under a hair dryer, but more hair shaft damage results.

The glycerol monothioglycolate in this type of permanent wave is responsible for allergic contact dermatitis in both beauticians and clients (17), and the hair may continue to be allergenic even after all products have been thoroughly rinsed from the hair.

Glycerol monothioglycolate found in acid permanent waves is responsible for allergic contact dermatitis in both beauticians and clients.

Sulfite Permanents

Sulfite permanent waves are mainly marketed for home use and have not found popularity among salons in the United States. These products differ in that the reducing agent is a sulfite or bisulfite, instead of a mercaptan. This accounts for the reduced odor, which is their primary advantage. They require a long processing time at a pH of 6 to 8 and result in loose curls. A conditioning agent must be added to the formulation because the sulfite permanent waves can leave the hair feeling harsh.

Digital permanents

Digital permanent waving of the hair utilizes a thioglycolate solution to break the disulfide bonds in straight hair, which are then reformed when the hair is wrapped around a cylinder. The unique aspect of a digital perm is that the perming rods are heated, and the heat from within the rods is used to process the permanent wave. The temperature can be modified to create different curl tightness in addition to modifying the diameter of the rods. Digital perms produce more relaxed curls and waves in the hair.

Home permanents

Home permanents are designed for the nonprofessionals and are of two types: ammonium thioglycolate permanents and sulfite permanents. The ammonium thioglycolate permanents have the same characteristics as the salon solutions, except they are one-third strength. This is to prevent excessive hair damage by the novice. Thus, home thioglycolate permanents produce looser curls that are not as long-lasting as salon permanents.

As mentioned previously, sulfite permanents are manufactured only for home use and have no professional counterpart. The major advantage of this type of permanent wave is decreased odor. The head is covered with a plastic cap to use body heat for processing, and an alkaline rinse is applied as a neutralizer. The mild curls produced are not long-lasting.

Neutralizers

Neutralizers function to reform the broken disulfide bonds and restore the hair to its original condition. Two methods are available: self-neutralization and chemical neutralization. Both methods rely on oxidation. Self-neutralization allows air to oxidize the permanent wave, but this requires 6 to 24 hours. During this time, the hair must be left on the permanent wave rods. This method is rarely used. Chemical neutralization is more popular, due to its speed, and relies upon the use of an oxidizing agent. The oxidizing agent is usually 2% hydrogen peroxide adjusted to an

acidic pH. Bromates may also be used, but are more expensive. The ingredients found in a chemical neutralizer and their functions are summarized in Table 28.4 (1).

Adverse reactions

The use of permanent wave solutions is considered safe, although both irritant and allergic contact dermatitis has been reported to thioglycolate-containing waving lotions (18). Irritant contact dermatitis is more common and can be avoided by minimizing skin contact with the solution (19). This is especially important in patients using topical tretinoin, who seem to experience skin irritation more readily with permanent waving. Prior to application of the waving lotion, a layer of petroleum jelly should be applied to the margins of the scalp and covered with a band of absorbent cotton. This provides a protective covering for the skin without hair that might contact any waving lotion running over the scalp. Patients with a sensitive scalp can even apply petroleum jelly to the scalp as protection. The petroleum jelly contacts the proximal hair shaft, however, preventing curling in this region.

Allergic contact dermatitis can occur immediately after permanent waving or can persist due to an allergen in the hair of patients who undergo permanent waving procedures involving glyceryl monothioglycolate (17, 20). The North American Contact Dermatitis Group found this chemical to be the fifth most common cause of dermatitis (21). The substance should be patch tested at a 1% concentration in petrolatum (22).

Summary

Permanent waving is a popular hairstyling technique for both men and women. The increased curl makes straight hair appear fuller and provides for fashionable styles. Unfortunately, there is no such thing as a body-building permanent wave or a hair-restorative permanent wave. All permanent wave processes damage and weaken the hair fiber. This chapter has evaluated the chemistry of the various permanent waves on the market for their effect on the hair shaft, enabling the dermatologist to understand the procedure and counsel patients when they present with problems from permanent waving.

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29

HAIR STRAIGHTENING

Hair straightening is truly an art. It is a commonly practiced procedure among persons with wavy and curly hair to allow versatility in hairstyling that otherwise could not be achieved (1). Hair straightening requires skill, dexterity, and knowledge to obtain an optimal result. Skill is required to apply the straightening cream evenly to the entire hair shaft in an organized, methodical fashion. Dexterity is required to apply the straightening cream, comb the hair straight, and remove the cream within a 20-minute time period. Finally, knowledge is required to select the hair straightening chemical that will break enough disulfide bonds in the hair shaft to allow straightening to occur without weakening the hair shaft to the point of fracture. There is no substitute for the skill of a well-trained beautician when it comes to straightening hair. It is infinitely more difficult than permanent waving or dyeing hair.

Permanent hair straightening is a procedure technically known as lanthionization.

Hair can be straightened with heat or chemical techniques (2). Heat straightening techniques are temporary and have already been covered. This chapter shall discuss the permanent method of hair straightening, also known as lanthionization. Hair straightening is undertaken for many reasons, including those listed in Table 29.1 (3).

The first permanent hair straighteners, also known as hair relaxers or perms, were developed around 1940 and consisted of sodium hydroxide or potassium hydroxide mixed into potato starch. Once the disulfide bonds were broken, the hair was pulled straight and the disulfide bonds reformed in their new configuration. This section examines the physical and chemical differences between African American hair and Caucasian hair, discusses the chemistry of hair straightening, reviews the unique aspects of the hair straightening techniques, and presents the relevant dermatologic considerations.

Hair straightening characteristics

There are some unique differences between Caucasian hair and African American hair. Table 29.2 summarizes some of the key differences (4). It is interesting to note that African American hair has a greater thickness but requires less strength to break than Caucasian hair. Notice that Asian hair grows the longest and is the most resistant to breakage. This may account for the fact that most human hair wigs for African Americans are woven

TABLE 29.1: Rationale for Permanent Hair Straightening

1. Hair manageability is improved.
2. The hair can be more easily combed and styled.
3. Hair breakage may be decreased due to less combing friction.
4. Hair shine is improved with a straighter hair shaft.
5. Fashion may dictate the need for straight hair.
6. Versatility in straightening techniques allows multiple styling options: completely straightened, minimally straightened, texturized, or straightened and recurled.

TABLE 29.2: Comparative Physical Characteristics of African American Hair

Property Evaluated	African American	Caucasian	Asian
Maximum length (mm)	15–30	60–100	100–150
Thickness	High	Medium	Low
Shape	Kidney	Oval	Round
Force (g)	33	43	63
Breaking strength dry (N/m ²)	0.153	0.189	
Breaking strength wet (N/m ²)	0.089	0.165	
Elongation at breaking point wet (%)	42	62	
Elongation at breaking point dry (%)	39	50	

Source: Adapted from Vermeulen S et al. Ethnic hair care. Cosmet Toilet 2002; 117: 69–78.

from treated Asian hair. There are also subtle differences in the chemical substances such as amino acid, sulfur, and ammonia between African American and Caucasian hair (Table 29.3).

African American hair has a greater thickness than Caucasian hair but requires less force to break.

TABLE 29.3: Comparative Chemical Amino Acid Characteristics of African American Hair

Amino Acids and Other Hair Components	African American Hair Content	Caucasian Hair Content
Glycine	541	539
Alanine	509	471
Valine	568	538
Leucine	570	554
Isoleucine	277	250
Serine	672	870
Threonine	615	653
Tyrosine	202	132
Phenylalanine	179	130
Aspartic acid	436	455
Glutamic acid	915	871
Lysine	23	213
Arginine	482	512
Histidine	84	63
Sulfur	1380	1440
Half cystine	1370	1380
Cysteic acid	10	55
Proline	662	672
Ammonia	935	780

Source: Adapted from Vermeulen S et al. Ethnic hair care. Cosmet Toilet 2002; 117: 69–78.

In summary, it can be said that African American hair has fewer cuticle layers than Caucasian hair, 7 as compared to 12. The hair shafts have a larger diameter but tend to break where the hair begins to kink at pinch points (5). Finally, African American hair has a lower moisture content than Caucasian hair, which reduces the hair shaft elasticity and encourages breakage.

African American hair has a lower moisture content than Caucasian hair, reducing the hair shaft elasticity and encouraging breakage.

Hair straightening chemistry

Hair relaxing, also known as lanthionization, is a chemical process whereby extremely curly hair is straightened through the use of metal hydroxides, such as sodium, lithium, potassium, or guanidine hydroxide, to change about 35% of the cysteine contents of the hair to lanthionine along with minor hydrolysis of the peptide bonds. Chemical relaxing can be accomplished with lye-based, lye-free, ammonium thioglycolate, or bisulfite creams (6).

Lye-based, or sodium hydroxide straighteners, are alkaline creams with a pH of 13. Sodium hydroxide is a caustic substance that can damage hair, produce scalp burns, and cause blindness if exposed to the eye. These products are generally restricted to professional or salon use and may contain up to 3.5% sodium hydroxide. The basic chemistry of hair relaxing with lye products is depicted in Table 29.4, and the hair rearrangement schematic is presented in Table 29.5 (7).

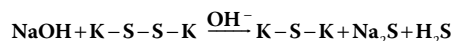
Lye-based hair straighteners are the most popular straighteners and are alkaline creams with a pH of 13.

Lye relaxers are available in “base” and “no-base” forms (Table 29.6). The “base” is usually petrolatum that is applied to the scalp and hairline prior to application of the sodium hydroxide. This prevents scalp irritation and burns. The “base” relaxers contain between 1.5% and 3.5% sodium hydroxide, and therefore require that the scalp and hairline be coated with a petrolatum base prior to application. These high-concentration lye products are necessary for hard-to-straighten hair. “No-base” relaxers, on the other hand, contain 1.5–2.5% sodium hydroxide and only require base application to the hairline (8). They are more popular because it is time-consuming for the beautician to apply the base to the scalp, and most individuals are re-straightening hair that has already been chemically weakened.

Other strong alkali chemicals sometimes used in place of sodium hydroxide are guanidine hydroxide and lithium

TABLE 29.4: Chemistry of Hair Relaxing

Strong alkali chemical relaxing

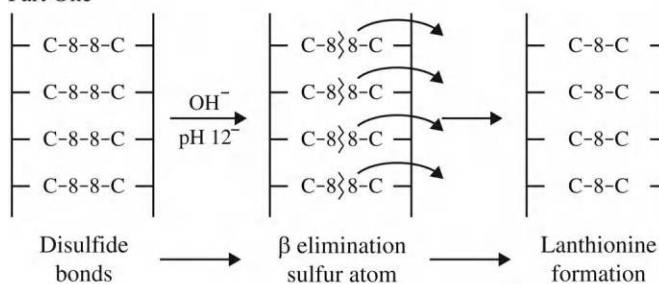


(Alkali can be Na⁺, K⁺, or Li⁺)

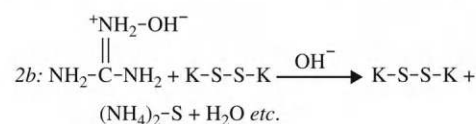
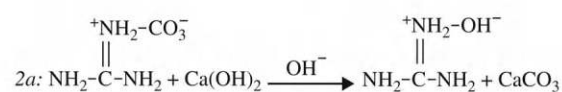
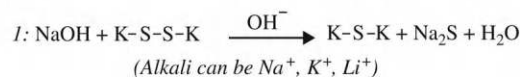
Source: Adapted from Obukowho P, Birman M. Hair curl relaxers: a discussion of their function, chemistry, and manufacture. Cosmet Toilet 1995; 110: 65–9.

TABLE 29.5: Two-Part Guanidine Carbonate Relaxing

Part One



Part Two



Source: Adapted from Obukowho P, Birman M. Hair curl relaxers: a discussion of their function, chemistry, and manufacture. Cosmet Toilet 1995; 110: 65–9.

hydroxide, which are known as “no-lye” chemical hair straighteners (Table 29.7). These relaxing kits contain 4–7% cream calcium hydroxide and liquid guanidine carbonate. The guanidine carbonate activator is then mixed into the calcium hydroxide cream to produce calcium carbonate and guanidine hydroxide, the active agent. These products do not require basing of either the scalp or the hairline. The chemical reaction that occurs with a guanidine hydroxide product is illustrated in Table 29.5.

No lye relaxers are based on guanidine hydroxide and lithium hydroxide, which may be more damaging to the hair shaft than lye relaxers, if not properly applied.

Table 29.8 compares the lye and no-lye relaxers in terms of their effect on the hair shaft.

Thioglycolate can also be used as an active agent in hair straightening (9). These are the same thioglycolate chemicals that were described as permanent wave solutions, except that they are

TABLE 29.6: Ingredients in a Lye No-Base Relaxer

Petrolatum
Mineral oil
Fatty alcohol
Emulsifying wax
Simethicone
Water
Propylene glycol
Sodium lauryl sulfate
Sodium hydroxide (lye)

TABLE 29.7: Ingredients in a No-Lye Cream Relaxer

Cream Relaxer Components	
Petrolatum	
Mineral oil	
Fatty alcohol	
Emulsifying wax	
Simethicone	
Water	
Propylene glycol	
Calcium hydroxide	
Liquid Activator Components	
Water	
Propylene glycol	
Xanthan gum	
Guanidine carbonate	

formulated as thick creams rather than lotions. The cream adds weight to hair and helps to pull it straight. Also, instead of the hair being wound on mandrels, it is combed straight while the thioglycolate cream is in contact with the hair shaft. Thioglycolate hair straighteners are extremely harsh on the hair and are the least popular of all the relaxing chemicals for this reason. The thioglycolate cream has a pH of 9.0 to 9.5, which removes the protective sebum and facilitates hair shaft penetration. Chemical burns can also occur with this variety of chemical hair straightener (10).

The least damaging of all hair straightening chemicals are the ammonium bisulfite creams. These products contain a mixture of bisulfite and sulfite in varying ratios depending on the pH of the lotion. Many of the home chemical straightening products are of this type but can only produce short-lived straightening. These are very similar to the home sulfite permanent waves, except here again the hair is combed straight instead of being wound on curling rods.

Chemical hair straightening chemicals that produce the longest-lasting hair straightening are also the most damaging to the hair shaft.

TABLE 29.8: Comparison of Lye and No-Lye Chemical Relaxers

Hair Quality	Lye Chemical Relaxer	No-Lye Chemical Relaxer
Relative strength on a scale of 1–3 (higher no. is stronger)	3	1
Alkaline relaxing agent	NaOH or KOH	Guanidine hydroxide
Chemical agent	OH	OH
PH	12.5–14	12.5–13.5
Hair shaft penetration	Faster	Slower
Processing time	Shorter	Longer
Irritation	High	Low
Hair drying potential	Less drying to hair and scalp	More drying to hair and scalp

Source: Adapted from Obukowho P, Birman M. Hair curl relaxers: a discussion of their function, chemistry, and manufacture. *Cosmet Toilet* 1995; 110: 65–9.

TABLE 29.9: Considerations for Selecting a Hair Relaxer

1. Relaxer must effectively straighten hair.
2. Relaxer must contain adequate petrolatum and other oils to protect against scalp and hairline irritation.
3. Relaxer must be stable at room temperature.
4. Relaxer must be an easy-to-apply cream that spreads over hair with sufficient weight to pull hair straight.
5. Relaxer must rinse easily with warm water.
6. Relaxer must not damage hair beyond acceptable limits.

As a general rule, the chemicals that produce the greatest, longest-lasting hair straightening are also the most damaging to the hair shaft. Table 29.9 presents the important considerations when selecting a relaxer product.

Application technique

This section presents the basic chemistry involved in hair relaxing and now presents the application technique. Whether the patient chooses to utilize lye-based, no-lye, thioglycolate, or sulfite chemicals to induce the straightening, the application technique is similar (Table 29.10) (11). The relaxing process is illustrated in Figure 29.1. Shampooing is the first step in the permanent waving technique for straight hair, but the hair is not shampooed when straightening is undertaken. This is because hair straightening chemicals are far more irritating, and shampooing would remove the protective sebum from the scalp. As a matter of fact, the protective sebum is supplemented with a petrolatum base applied to the scalp and hairline to prevent skin burns. Following application of the base, the hair is divided into quadrants, allowing the hairstylist to work systematically. For previously untreated hair, the chemical straightener is applied from the hair root to the distal end, beginning at the nape of the neck and moving forward to the anterior hairline. The hair at the nape of the neck receives the chemical first because it is subject to less weathering, resulting in the presence of more cuticular scale. This means it will be more resistant to the lanthionization process. The chemicals are left in contact with the hair for only 20 to 30 minutes, during which time the hairstylist is combing the hair straight. The hairstylist must work quickly to get the straightening cream worked through all areas of the scalp quickly. Longer contact of the chemicals with the hair shafts will result in irreversible damage.

The hairstylist must work quickly to get the hair straightening chemicals in and out of the hair as quickly as possible to avoid overprocessing, which irreversibly weakens the hair shafts.

TABLE 29.10: Hair Relaxing Steps

1. Do not shampoo.
2. Apply petrolatum base to scalp and hairline.
3. Section the hair.
4. Apply cream relaxer from the hair root to the end, beginning at the nape of the neck.
5. Gently comb the hair straight for 10 to 30 min until the degree of relaxation is achieved.
6. Rinse thoroughly with water.
7. Apply neutralizer.
8. Shampoo.
9. Apply conditioner.
10. Style.
11. Apply styling conditioner.



FIGURE 29.1 (A) A petrolatum base is applied to the entire hairline and scalp. (B) The hair is divided by parting into quadrants. (C) The cream is scooped from its jar and applied to the scalp with a stiff brush. (D) Application of the straightener to the hair close to the scalp at the nape of the neck. (E) The straightener is applied to the hair next to the scalp over the entire head. (F) A protective rubber glove is worn to prevent the strong alkali from producing cutaneous burns. (G) The relaxer has been applied to the entire scalp within 10 minutes. (H) The hair is combed and pulled straight.

For previously treated hair, the chemical straightener is applied to the new growth only, taking care to minimize scalp contact. Usually, the straightening cream is applied to the hair closest to the scalp first and then combed through the previously relaxed distal ends for the last 10 minutes of the process. The hair is combed to pull it straight concurrently with the straightening cream application. The hairstylist should completely remove all the straightening chemicals within 20 minutes. This requires skill and organization. It is for this reason that hair straightening should not be attempted by someone without education and experience.

When the hair has relaxed to the desired degree of straightening, the cream must be thoroughly removed with water rinsing (Figure 29.2). A neutralizer is then smoothed on the hair, taking care to keep it straight and untangled because the hair shafts can very easily fracture until the neutralization process is complete. Once the hair has been thoroughly neutralized, it is shampooed with a nonalkaline shampoo to minimize hair shaft swelling. A conditioner must be applied immediately following shampooing to decrease water loss from the hair shaft. The hair straightening chemicals produce holes in the hair shaft cuticle through which the hair shaft water evaporates, leaving the hair shaft dry and inelastic. The remoisturizing poststraightening conditioner minimizes hair shaft brittleness and breakage. The formulation presented in Table 29.11 contains panthenol as a humectant, stearylkonium chloride and dicetyldimonium chloride as conditioners, cetearyl alcohol and mineral oil as emollients, and octyl

dimethyl PABA as a UV protectant. The hair is then dried and styled. Following styling, a second conditioner is applied to further condition the hair shafts. The formulation presented in Table 29.12 contains petrolatum, mineral oil, and beeswax to prevent water loss and add hair shaft shine.

If the hair is not properly neutralized, it will easily break after the relaxing procedure because the disulfide bonds have not been restored.

There are two other styling variations of hair relaxers known as blow-out relaxers and texturizing relaxers. The chemicals employed and the lanthionization process are identical to those previously discussed. The blow-out relaxers minimally straighten the hair shaft, leaving it more manageable, but preserving some of the curl. Texturizing relaxers leave the hair wavy and not completely straight. Both of these relaxer varieties are most popular among men with short hair.

The key to successful hair relaxing is an experienced beautician who can quickly apply and remove the chemicals and determine when the desired degree of disulfide bond breaking has occurred. It is estimated that virgin hair loses about 30% of its tensile strength following a properly performed chemical straightening procedure. It also becomes more porous, allowing future relaxing procedures to process more quickly (12). Hair relaxing is a careful



FIGURE 29.2 (A) The neutralizer lotion. (B) The neutralizer has a pH indicator and turns pink when applied to any hair that still contains the alkaline lye. (C) The hair has been shampooed and conditioned. (D) The appearance of the newly straightened hair.

TABLE 29.11: Remoisturizing Post-Straightening Conditioner

Water
Methyl paraben
Imidazolidinyl urea
Panthenol
Sodium PCA
Cetearyl alcohol
Dicetyldimonium chloride
Mineral oil
Polysorbate-20
Propyl paraben
Octyl dimethyl PABA
Fragrance

balance between achieving the straightening of kinky hair and minimizing irreversible hair shaft damage.

It is estimated that virgin hair loses about 20% of its tensile strength following a properly performed chemical straightening procedure.

Hair keratin treatment

Hair keratin treatments, also known as Brazilian hair keratin treatments, are intended to straighten and smooth wavy hair, enhance color and shine, and decrease curly hair frizz. They are a method of hair straightening lasting between 6 weeks and 5 months, depending on the strength of the treatment. Hair keratin treatments cannot fully straighten kinky natural hair and are used primarily for curly to wavy hair.

The original hair keratin treatment involves washing the hair followed by the application of a serum that contains hydrolyzed keratin and a formaldehyde derivative. The solution is applied to small sections of the hair until the entire hair is saturated. The hair is then blow-dried and exposed to the high heat of a flat iron. The hair must not be combed or washed for 48–72 hours, or the hair straightening may be reversed.

Hair keratin treatments are so named as they are based on keratin, the protein that forms human hair. Hydrolyzed keratin is used, meaning the protein has been chopped up into small pieces, and is usually obtained from wool. The small keratin molecules are able to penetrate the hair shaft, allowing rapid diffusion to the

TABLE 29.12: Ingredients in Oil Moisturizing Lotion Styling Conditioner

Petrolatum
Mineral oil
Propyl paraben
Beeswax
Stearic hydrazide
Sorbitan sesquioleate
Polysorbate-80
Water
Methylparaben
Imidazolidinyl urea
Sodium borate
Fragrance

hair cortex. The hydrolyzed keratin becomes cross-linked to the hair keratin in the presence of formaldehyde, which specifically cross-links the keratin fragments with lysine, arginine, histidine, and tyrosine. Heat increases the ability of the formaldehyde to interact with the hair keratin and also smooths the cuticle, increasing hair shine. Hair shine is also increased because the hydrolyzed keratin can fill areas where the cuticle scale is missing.

During the heating process of a keratin hair treatment, formaldehyde is released, which can be an irritant to the lungs and nose and also a mutagen. In the search for a formaldehyde alternative for keratin hair straightening, glutaraldehyde was introduced. Glutaraldehyde is a common preservative for skin care products and can be used in concentrations up to 0.2%. However, the mutagenicity of glutaraldehyde is similar to formaldehyde. This concern led to the introduction of carbocysteine, which is a dibasic amino acid, for treatments known as “heat sealing” or “plastic hair.” Although carbocysteine can smooth the cuticle and reduce frizz, it is not as good at hair straightening. These treatments combine glyoxyloyl carbocysteine and glyoxyloyl keratin amino acids. The solution is applied to the hair like a hair keratin treatment; however, the carbocysteine interacts with the hair hydrogen and salt bonds strengthening the cysteine hair bonds when heated.

Hair perming application technique

Another technique for relaxing kinky hair is known as hair perming. The products used are similar to Caucasian permanent waves in that they are based on ammonium thioglycolate, which is neutralized with ammonium hydroxide. The main differences between a straight hair perm and a kinky hair perm are the level of the active ingredients and the application technique. Perming is performed in four stages consisting of rearranging, boosting, neutralizing, and conditioning (Table 29.13).

Permanent waving of kinky hair begins by shampooing and sectioning the hair as described for hair straightening. A cream is then applied containing high levels of ammonium thioglycolate in the range of 7–7.5%. This cream is known as the reducing cream or rearranger. It is applied from the hair root to the distal end on virgin hair starting at the nape of the neck and

TABLE 29.13: Kinky Hair Permanent Waving Technique

1. Shampoo hair.
 2. Section hair into quadrants.
 3. Apply rearranger from the hair root to the distal hair shaft, starting with hair at the nape of the neck and moving forward.
 4. Rinse the rearranger with water.
 5. Apply booster from the hair root to the distal hair shaft, starting with the hair at the nape of the neck and moving forward.
 6. Section hair.
 7. Wrap hair around rods.
 8. Place patient under hooded hair dryer for 15–20 minutes.
 9. Perform a test curl.
 10. Rinse hair thoroughly.
 11. Apply neutralizer to each rod for 15–20 minutes.
 12. Remove curling rods.
 13. Rinse hair thoroughly.
 14. Apply conditioner for 10–20 minutes.
 15. Dry hair.
 16. Apply glycerin curl activator.
 17. Style hair.
-

proceeding to the anterior hair line. In previously chemically treated hair, the rearranger is only applied to new growth. Its purpose is to straighten the hair in preparation for the curling procedure. The rearranger is then rinsed, and a reducing lotion or curl booster is applied from the hair root to the distal end. The hair is then sectioned and wrapped around perming rods. The patient is placed under a hooded hair dryer to increase the rate of the chemical reaction with heat. After 15–20 minutes, a test curl is performed to determine whether the desired amount of curl has been obtained. This is assessed by unwrapping several rods and observing whether the hair makes a complete “s,” meaning that the desired amount of curl has been achieved. This is identical to the reducing step in a permanent wave on straight hair. The hair is then thoroughly rinsed.

Next, the hair is ready for neutralization with an oxidizing solution containing 10–13% sodium bromate for 15 to 20 minutes. This sets the curls, and the rods are removed. The hair is then thoroughly rinsed. A variety of conditioners and glycerin curl activators are now applied to prevent excessive hair shaft water loss and hair brittleness. The hair is then dried and styled as desired.

These kinky hair perm products, known as the “Jheri” curl after the company that pioneered the technology, were introduced in the late 1970s. They have recently lost some of their original appeal because the curling procedure is extremely damaging to African American hair, leaving it frizzy, dry, and brittle. Daily use of propylene glycol and glycerin curl activators is required prior to styling to maintain the hairstyle and decrease breakage. Unfortunately, glycerin styling products leave the hair sticky and tend to stain clothing and pillowcases. It is also necessary to repeat the procedure every 12 weeks, further weakening the hair shafts and predisposing to hair loss through breakage.

Addressing patient problems

The dermatologist may frequently encounter patients who are experiencing problems related to the use of hair straighteners. Most patients will complain of hair loss immediately following a relaxing procedure. It is important to verify that the relaxer is indeed the cause. Hair that has been relaxed has undergone a significant insult to the disulfide backbone of hair strength. As previously mentioned, the disulfide bonds must be broken to straighten the hair, and not all of them can be reconnected, resulting in weaker hair. The dermatologist can verify whether the hair has been damaged by grasping the end of the hair and pulling. If the hair breaks, it has been over-relaxed and chemically damaged. The hair should also be pulled where it exits the scalp. If breakage occurs, the damage induced by chemical relaxing can be confirmed.

Once it has been confirmed that the hair loss is due to chemical straightening, the dermatologist should offer some helpful suggestions. Of course, the damaged hair cannot repair itself. The brittle hair must be trimmed, and overprocessing of the new growth should be avoided. Overprocessing can be avoided by decreasing the strength of the solution and, more importantly, leaving the chemicals on the hair for a shorter period of time. The beautician must get the chemicals applied quickly and removed quickly for best results and minimum hair weakening. Hair around the face experiences more trauma, a phenomenon known as weathering, than hair in other locations. For this reason, the relaxer should be applied first at the nape of the neck and

moved forward. This minimizes the time the relaxer remains on this damaged hair because it is applied last and removed first. In addition, worsening hair damage can be avoided by allowing as long as possible between hair straightening procedures.

Hair breakage can be minimized by combing or styling the hair as little as possible, applying moisturizing conditioning agents, and avoiding any further chemical treatments such as permanent hair dyeing or bleaching.

Hair breakage can be minimized by combing or styling the hair as little as possible, applying moisturizing conditioning agents, and avoiding any further chemical treatments such as permanent hair dyeing or bleaching (13). Protein-containing deep conditioners may be helpful to temporarily strengthen the damaged hair by 5–10%. The holes that are created in the cuticle by the straightening chemicals never completely seal and can be used to passively diffuse small-molecular-weight proteins into the hair shaft. Protein-containing deep conditioners are thick creams applied to the hair and left in contact for 20–30 minutes, sometimes under a hair dryer set at low. The prolonged contact and heat encourage the proteins to enter the hair shaft. Weekly protein pack leave-in conditioners may minimize hair breakage.

Hair that has been over-relaxed may also break due to decreased water content. When holes are created in the hair shaft by the relaxer to break the disulfide bonds in the cortex, water is released from the hair. Water allows the hair to behave as an elastic material. Although the water cannot be replaced, moisturizing the hair shaft to restore protein flexibility may decrease breakage. Heavy occlusive hair conditioners that contain petrolatum, glycerin, and dimethicone can minimize water loss, decrease combing friction, and add shine to relaxed hair. These products were originally known as pomades but are now called hair conditioners. It is impossible to overcondition relaxed hair. Because sebum is the best conditioning agent, once weekly or every other week shampooing also minimizes hair damage but can compromise hair hygiene.

Dermatologists should also recognize that hair straightening chemicals are all well-known cutaneous irritants. It is for this reason that a petrolatum cream is applied as a base to the scalp and hairline. This process, known as “basing,” is important not to damage the scalp skin. Hair straightening solutions are not suitable for patch testing, and chemical burns are possible if a novice is performing the straightening procedure. Patients should select only experienced, salon-trained professionals to perform hair straightening to avoid adverse reactions.

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Hair dyes represent a major hair cosmetic used by both men and women. It is estimated that 40% of women regularly use hair dyes to blend gray tones, cover gray hair, add colored highlights, produce unnatural temporary colors, and either lighten or darken the original hair color. Hair dyeing is used to cover gray and achieve a more youthful appearance, but it is also used to change the natural hair color based on personal preference. A number of different hair dye cosmetics have been developed to fulfill all of these needs: gradual, temporary, semipermanent, and permanent. Approximately 65% of the hair dye market is for permanent hair colorings, 20% for semipermanent colorings, and 15% for the remaining types.

Hair coloring is an ancient tradition that was common among the ancient Persians, Hebrews, Greeks, and Romans. The use of henna, a naturally occurring plant dye, dates to the third dynasty of Egypt 4,000 years ago. The Egyptians mixed the *Lawsonia* plant from which henna is derived with hot water and placed the material on the head to produce an orange-red hair color. Metallic dyes containing lead acetate, obtained by dipping lead combs in sour wine, were used by Roman men to cover gray hair (1). Roman women, on the other hand, attempted to lighten their hair by applying lye, followed by sun exposure.

The modern concept of permanent hair dyeing dates back to 1883, when Monnet patented a process for coloring fur using *p*-phenylenediamine and hydrogen peroxide. Feathers and hair were later dyed in 1888; the first human application occurred in Paris in 1890 and in St. Louis, Missouri, USA, in 1892 (2). Temporary and semipermanent dyes were not developed until the 1950s, when they were incorporated from the textile industry into the cosmetic industry. Bleaching of the hair with hydrogen peroxide was first demonstrated at the Paris Exposition of 1867 by Thillary and Hugo (3). All of these products form the basis for modern hair coloring, which can produce a myriad of hair colors (Figure 30.1).

Hair color physiology

Pigment comprises less than 3% of the fiber mass of hair, yet is one of the most important hair cosmetic aspects (4). Three pigment types produce the tremendous variety of colors seen in human hair: eumelanins, pheomelanins, and oxymelanins. Eumelanins are insoluble polymers accounting for the brown and black hues consisting mainly of 5,6-dihydroxyindole with lesser amounts of 5,6-dihydroxyindole-2-carboxylic acid. Pheomelanins are soluble polymers accounting for the yellow to red hues containing 10–12% sulfur and 1,4-benzothiazinyl-alanine. Eumelanin contains less sulfur than pheomelanin (5). A lesser pigment, known as oxymelanin, is yellow or reddish in color and probably represents bleached eumelanin pigment arising from partial oxidative cleavage of 5,6-dihydroxyindole units. Oxymelanin is distinct in that it contains no sulfur (6). Hair dyes attempt to mimic these pigments in reproducing a natural appearing hair color.

The tremendous variety observed in natural-human hair color is due to three pigments: eumelanin, pheomelanin, and oxymelanin.

The principal aim of hair dyeing is to cover gray hair. The mechanism of graying is not totally understood, however. It is thought that the death of some melanocytes within the hair-melanocyte unit triggers a chain reaction resulting in the death of the rest of the unit melanocytes in a relatively short period (7). A possible mechanism of death is the accumulation of a toxic intermediate metabolite, such as dopaquinone (8).

Hair dyes can be divided into several types based on their formulation and permanency: gradual, temporary, semipermanent, and permanent.

Types of hair dyes

Hair dyes can be divided into several types based on their formulation and permanency: gradual, temporary, semipermanent, and permanent (Table 30.1).

Gradual

Gradual hair dyes, also known as metallic or progressive hair dyes, require repeated application to result in gradual darkening of the hair shaft. This product will change the hair color from gray to yellow-brown to black over a period of weeks (Figure 30.2) (9). There is no control over the final color of the hair, only the depth of color, and lightening is not possible. They employ water-soluble metal salts, which are deposited on the hair shaft in the form of oxides, suboxides, and sulfides. The most common metal used is lead, but silver, copper, bismuth, nickel, iron, manganese, and cobalt have also been used. In the United States, 2–3% solutions of lead acetate or nitrate are used to dye the hair, whereas 1–2% solutions of silver nitrate are used to dye eyelashes and eyebrows (10).

Gradual hair dyes employ water-soluble metal salts, which are deposited on the hair shaft in the form of oxides, suboxides, and sulfides.

Metallic hair dyes are inexpensive and do not require a professional operator for application. Their disadvantages include poor color quality and stiff, brittle, or dull hair that may not withstand further chemical processing. In addition, the trace metals left on the hair will cause permanent dyes or permanent waving solutions to perform poorly. The metal can cause breakdown of the hydrogen peroxide in bleaching or permanent waving products,



FIGURE 30.1 Hair coloring technology can produce a myriad of hair colors.

resulting in the rupture of the hair shaft. The hair that has been treated with the gradual hair colorant must, therefore, grow out before other dyeing or waving procedures are used to guarantee an optimal result (11).

The gradual color change induced by metallic dyes requires continued use if the color is to be maintained; however, the hair shaft damage induced by the product is permanent. Therefore, metallic dyes are not appropriate for female patients who desire more color darkening than the product can provide and who are likely to undergo permanent waving. These products are most appropriate for male patients who cut their hair frequently, only need minimal darkening, and are unlikely to process their hair further (12).

Temporary

Temporary hair coloring agents are designed to be removed in one shampoo washing (13). They are used to add a slight tint, brighten a natural shade, or improve an existing dyed shade. Their particle size is too large to penetrate the cuticle, accounting for their temporary nature (1). Temporary dyes can be easily rubbed off the hair shaft, however, and will run onto clothing if the hair gets wet from rain or perspiration. They can be formulated as a liquid, mousse, gel, or spray (Figure 30.3).

Temporary hair dyes are designed to be removed in one shampooing to tint, brighten, or improve hair color.

TABLE 30.1: Types of Hair Dye

Hair Dye Type	Chemical Reaction	Anticipated End Result	Duration of Effect	Advantages	Dis-advantages
Gradual	Deposition of metal salts	Gradual brown hair darkening	Requires continuous application	Inexpensive, easy to apply	Cannot be combined with other chemical hair processing
Temporary	Acid textile dyes	Blending of hair tones	One shampoo exposure	Short-lived, inexpensive	May rub off on clothing or run with water exposure
Semi-permanent Vegetable	Henna with metal salts	Reddish hues to hair	4–6 shampoo exposures	Low incidence of allergenicity	Leave hair somewhat harsh
Semi-permanent Textile	Textile dyes	Tone hair, minimally cover gray	4–6 shampoo exposures	Add color highlights	Short-lived color
Demi-permanent	Deeper penetrating textile dyes	Tone hair, minimally cover gray	10–12 shampoo exposures	Longer lasting with no obvious hair grow out	Cannot completely cover gray
Permanent	Oxidation/reduction reaction	Darken hair color, cover gray	Permanent	Excellent coverage of gray hair	Color is permanent
One-step bleaching	Oxidation/reduction reaction	Lighten hair color, cover gray	Permanent	Achieve light blonde hair shades	Damaging to hair
Two-step bleaching	Oxidative alkaline reaction	Dramatically lighten hair color, cover gray	Permanent	Achieve dramatic hair color lightening	Very damaging to hair

Liquid temporary hair colorants are also referred to as “hair rinses” because they are frequently applied in the shower following shampooing, with the excess dyestuff removed by rinsing. They contain acid dyes of the same type used to dye wool fabrics and belong to the following chemical classes: azo, anthraquinone,



FIGURE 30.2 Gradual hair dyes are popular in male patients who wish to darken hair color slowly over time.



FIGURE 30.3 Spray temporary coloring agents are popular among teens wanting a pink, blue, or green lock of hair for fashion purposes.



FIGURE 30.4 Unwanted yellow overtones in graying hair can be minimized by using a purple rinse, but in some cases the rinse can inadvertently dye the hair purple, as demonstrated in this image.

triphenylmethane, phenzainic, xanthenic, or benzoquinoneimine (14). These dyes are known as FDC and DC blues, greens, reds, oranges, yellows, and violets. No damage is imparted to the hair shaft by these dyes because they are composed of large molecules that are deposited on the surface of the hair and are unable to penetrate due to size.

The liquid rinse formulation is most popular, especially among mature patients with gray hair who wish to remove undesirable yellow tones and achieve a purer platinum color. A sample product for this purpose may contain a 0.001% concentration of methylene blue, acid violet 6B, and water-soluble nigrosin in an aqueous preparation (Figure 30.4). Temporary hair colorants are recommended for mature patients because the hair shaft is not damaged and many patients only require weekly shampooing. The liquid rinse can also be used by patients who have achieved an undesirable permanent dye color and wish to tone the bad result until the poorly colored hair grows out and is cut.

Mousse formulations of temporary hair colorants are available in both natural and party colors. They are applied soon after shampooing to towel-dried hair and are not removed. Because the coloring agent is dispersed in a styling polymer, such as polyvinylpyrrolidone/vinyl acetate, the mousse serves both as a styling agent and temporary colorant. This product may be used to add highlights or blend gray hair in brunette patients with less than 15% gray hair. Mousse temporary coloring agents are ideal for the female patient with minimal bitemporal graying. These products are also available in party colors such as yellow, orange,

blue, green, purple, and red, which can be used to create special multicolored effects.

Gel formulations of temporary hair colorants are identical to mousse formulations, except that they are packaged as a gel in a tube rather than as foam released from an aerosol can. Gel temporary hair colorants also combine a styling aid with coloring; however, the hold provided by the gel is generally superior to that provided by the mousse. These products are only available in party colors, with some lines including a hair glitter. Gel temporary hair colorants are only appropriate for creating unusual hairstyles.

Spray formulations of temporary hair colorants are also available to professional cosmetologists. A pressurized aerosol spray is used to apply the temporary liquid dyestuff to the hair (15).

Another form of temporary hair dyeing among younger females is known as Jello hair. It is possible to use any color of Jello to create a homemade vivid hair dye, but the colors are more pronounced on lightly pigmented hair. Also, the more porous the hair shaft, the deeper the color. Thus, previously dyed, straightened, or permanently waved hair will hold the color up to 5 weeks, but virgin hair will lose the Jello color more quickly.

This do-it-yourself hair dyeing technique uses two boxes of Jello in the desired color, thick hair conditioner, and petroleum jelly. The two boxes of Jello are mixed with thick hair conditioner to create a paste. The petroleum jelly is put around the area for dyeing so the skin and surrounding hair are not also dyed. The hair is divided into four sections and held back with clips. The Jello mixture is spread over the hair with a brush and then covered with a shower cap. The shower cap will trap heat from the body and allow the Jello to penetrate more deeply into the hair shafts. The Jello must be left on the hair for 1 hour, but may be left on longer for bolder color. The Jello is then rinsed out with lukewarm water. No shampooing is allowed immediately following hair coloring, or the Jello color will be removed. The hair is then dried and styled as usual.

If the Jello hair color requires removal, it can be easily shampooed away with a clarifying or deep cleaning shampoo. The Jello color is not fast, so it can discolor towels and pillowcases after dyeing. It is an inexpensive way to dye hair that does not damage the hair shaft as much as traditional semipermanent or permanent dyes.

Temporary hair coloring agents should be used with care in patients with damaged or chemically treated hair because the hair shaft has increased porosity due to loss of the cuticular scale. The porous hair shafts allow entrance of the color molecules into the hair shaft, rendering them more permanent. Under these conditions, it may take more than one shampooing to remove the color.

Semipermanent

Textile dyes

Semipermanent hair coloring is popular with both men and women. Formulated for use on natural, unbleached hair, it can cover gray, add highlight, or rid hair of unwanted tones (Figure 30.5). Semipermanent hair dyes are removed in four to six shampooings due to their intermediate-sized particles that can both enter and exit the hair shaft (16). Recently, longer-lasting products within this category incorporating hydrogen peroxide have become available. The dyes are retained in the hair shaft by weak polar and van der Waals attractive forces; thus dyestuffs with increased molecular size will remain longer. The formulation of a typical semipermanent hair dye comprises these: dyes (nitroanilines, nitro phenylenediamines, nitro aminophenols, azos-, and anthraquinones), alkalizing agent,



FIGURE 30.5 Semipermanent hair coloring is used in persons with minimal gray hair to add red or blonde highlights.

solvent, surfactant, thickener, fragrance, and water (17). Usually, 10 to 12 dyes are mixed to obtain the desired shade (18).

Semipermanent hair dyes are removed in 4 to 6 shampooings and can cover gray, add highlights, or rid hair of unwanted tones.

Semipermanent dyes are available as lotions, shampoos, and mousses. The shampoo-in process is most popular for home use. The dyestuff is combined with an alkaline detergent shampoo to promote hair shaft swelling so that the dye can penetrate, a thickener so that the product will remain on the scalp, and a foam stabilizer so that the product will not run and stain facial skin. The mousse formula incorporates the dyestuff in aerosolized foam. Both products are applied to wet, freshly shampooed hair and are rinsed in 20 to 40 minutes. Semipermanent dyes can become more permanent if applied to porous, chemically treated hair.

Semipermanent dyes produce tone-on-tone coloring rather than effecting drastic color changes, so their role is actually in toning rather than dyeing the hair. The less color change required by the patient, the more satisfied he or she will be with the semipermanent dye result. Semipermanent dyes are best suited for patients with less than 30% gray hair who want to restore their natural color (19). This is done by selecting a dye color that is lighter than the natural hair color because the dye will penetrate both the gray and nongray hairs, resulting in an increased

darkening of the nongray hairs. It is not possible to lighten hair with semipermanent dyes because they do not contain hydrogen peroxide, nor is it possible to darken hair more than three shades beyond the patient's natural hair color. Thus, in the cosmetic industry, semipermanent dyes are known as suitable only for staying "on shade." Demipermanent dyes are semipermanent dyes that are slightly longer lasting than semipermanent dyes and last 10–12 shampooings.

Stains

A newer type of semipermanent hair coloring is hair stain. Hair stain is a synthetic polymer, usually in unnatural shades such as reds, blues, purples, or yellows, that imparts a hue or highlight to the hair. For example, brunette hair with a red stain will have a reddish glow, or blond hair with a yellow stain will have a yellow glow. The stain appears transparent so that it blends with the underlying hair color. The stain does not cover, but only tones. If heat is added to the staining process, the stain is more resistant to shampoo removal, and if both heat and hydrogen peroxide are added to the staining process, the stain can penetrate the hair shaft deeply and become permanent.

Semipermanent hair stains are synthetic polymers designed to add hues and highlights to the hair.

Rarely, individuals with multiple dye sensitivities may wish to stain hair with natural agents, such as walnut stain (Herbasol, extract of walnut leaves; Cosmetochem USA, Clifton, NJ). This extract of black walnut leaves produces a deep brownish-black color when applied to the hair.

Vegetable dyes

Vegetable dyes, the first form of hair coloring developed, fall under the semipermanent category because they minimally penetrate the cuticle, although four to six shampooings are required for removal (Figure 30.6). The only vegetable dye remaining today is henna, derived from the *Lawsonia alba* plant. As originally used, the dried plant leaves were ground to form a powder that was activated with water to form an acidic naphthoquinone dye that was then applied as a paste to the hair for 40 to 60 minutes.



FIGURE 30.6 Henna has recently seen an increase in popularity as a hair dye because it is a natural dye of plant origin.

The henna imparted a reddish hue to the hair. Metallic salts were combined with henna to produce what was termed a “compound henna,” to provide a wider range of colors. Today, natural henna dyes have been replaced by synthetic henna-type products with dye shades ranging from auburn to blonde to gray. These synthetic henna products combine a conditioning agent with the dye, but they are still powders mixed with water to form a paste that remains in contact with the hair for 40 minutes. Hennas can be used for darkening, but not lightening, of the original hair color. Natural hennas are inferior to synthetic hennas because they leave the hair stiff and brittle after repeated applications. Henna has not been reported to cause allergic contact dermatitis when used as a hair dye.

Semipermanent vegetable dyes from henna are used to create red hair tones, but most modern hennas contain synthetic coloring ingredients.

Permanent

Permanent hair coloring accounts for \$3 of every \$4 spent on hair dyeing in the United States. It is more popular with women than men because women are more likely to effect a complete hair color change than men. Permanent hair coloring is so named because the dyestuff penetrates the hair shaft to the cortex and forms large color molecules that cannot be removed by shampooing (Figure 30.7) (20). It can be used to both cover gray and produce a completely new hair color. Redyeing is necessary every four to six weeks, as new growth, known in the cosmetic industry as “roots,” appears at the scalp.

Permanent hair dyes contain colorless dye precursors that chemically react with hydrogen peroxide inside the hair shaft to produce colored molecules.

This type of hair coloring does not contain dyes but rather colorless dye precursors that chemically react with hydrogen



FIGURE 30.7 Professional salon permanent hair dyes can produce more dramatic color changes than those designed for at-home use.

peroxide inside the hair shaft to produce colored molecules (21). The process entails the use of primary intermediates (p-phenylenediamine, p-toluenediamine, and p-aminophenols), which undergo oxidation with hydrogen peroxide. These reactive intermediates are then exposed to couplers (resorcinol, 1-naphthol, m-aminophenol, etc.) to result in a wide variety of indo dyes. These indo dyes can produce shades from blonde to brown to black with highlights of gold to red to orange. Variations in the concentration of hydrogen peroxide and the chemicals selected for the primary intermediates and couplers produce this color selection (22). Red is produced by using nitro para phenylenediamine alone or in combination with mixtures of para-aminophenol with meta phenylenediamine, alpha naphthol, or 1,5-dihydroxynaphthalene. Yellow is produced by mixtures of ortho aminophenol, ortho phenylenediamine, and nitro-ortho phenylenediamine. Blue has no single oxidation dye intermediate and is produced by combinations of para phenylenediamine, phenylenediamine, methyl toluylenediamine, or 2,4 diaminoanisole (23).

Permanent dyeing allows shades to be obtained both lighter and darker than the patient's original hair color. Higher concentrations of hydrogen peroxide can bleach melanin, thus the oxidizing step functions both in color production and bleaching. Due to the use of hydrogen peroxide in the formation of the new color molecules, hair dyes must be adjusted so that hair lightening is not produced with routine dyeing (24). However, hydrogen peroxide cannot remove sufficient melanin alone to lighten dark brown or black hair to blonde hair. Boosters, such as ammonium persulfate or potassium sulfate, must be added to achieve great degrees of color lightening. The boosters must be left in contact with the hair for one to two hours for an optimal result. Nevertheless, individuals with dark hair who choose to dye their hair a light blonde color will notice the appearance of reddish hues with time. This is due to the inability of the peroxide/booster system to completely remove reddish pheomelanin pigments, which are more resistant to removal than brownish eumelanin pigments.

Permanent hair dyes are sold as two bottles containing colorless liquid within a kit. One bottle contains the dye precursors in an alkaline soap or synthetic detergent base, and the other contains a stabilized solution of hydrogen peroxide. The two bottles are mixed immediately prior to use and applied to the hair. The dye precursors and hydrogen peroxide diffuse into the hair, where the new color is created.

Permanent hair dyes are the most damaging to the hair. This type of hair dye alters the internal hair shaft structure and thereby decreases its strength. Several key points should be remembered to minimize hair shaft damage:

1. If both permanent waving and permanent dyeing are to be performed, the hair should be permanently waved first and permanently dyed second. Ten days should be allowed between the procedures.
2. Lightening, or bleaching, the hair is more damaging than dyeing the hair to a darker color.
3. Each redyeing procedure further damages the hair shaft; thus, the period between redyeing should be as long as possible, and the dye should be concentrated on the new proximal hair growth, not the previously dyed distal hair shaft.

Permanent hair coloring agents are available for both home and professional salon use. The chemistry is identical for both home and salon products, except that more drastic color changes require a salon product (Figure 30.8). Permanent hair coloring

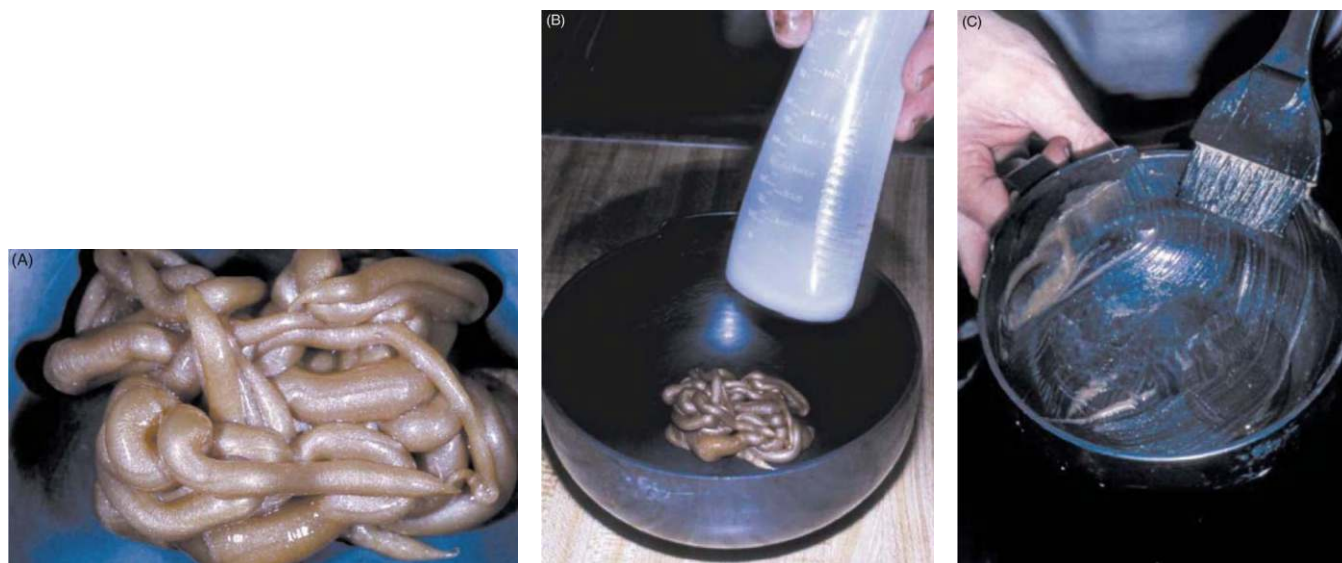


FIGURE 30.8 (A) The appearance of a cream professional permanent hair dye. (B) The permanent hair dye is mixed with hydrogen peroxide. (C) The hair dye and hydrogen peroxide are mixed to begin the chemical reaction and are now ready for hair application.

agents for home use are available in several different formulations: liquid, cream, and gel. The liquid shampoo-in formulas are the most popular. All formulations come with a hair color tint and developer that must be mixed immediately before application on dry hair. The product must saturate the hair, with thicker cream formulations requiring parting and sectioning of the hair to ensure an even application (Figure 30.9). The excess dye is then rinsed, and frequently a conditioner is applied. Home permanent dye products can be purchased to lighten or darken the hair by three shades. Products that lighten the hair contain ammonia and more hydrogen peroxide, thus bleaching as well as dyeing the hair. Most home products are designed to achieve 35% coverage of gray hair. More dramatic color changes require professional products.

Even though oxidation dyes are said to be permanent, some color drift or “off-shade fading” does occur. This is due to slow chemical changes in the indo dyes, which produce a reddish to yellowish cast. Thus, permanent hair colors may become “brassy” with age. Semipermanent hair colorings may be used

to cover the brassy tones until redyeing occurs. Sometimes, undesirable reddish and yellowish tones develop immediately following dyeing. In this case, “drabbers” are used to remove the harshness from a color. Examples of drabbers are resorcinol to yield dark green to brown colors, pyrocatechol to yield deep gray, pyrogallol to yield gold, alpha naphthol to yield bright violet, beta naphthol to yield red brown, and hydroquinone to yield yellow brown (23).

One- and two-step processing

Professional permanent hair dyeing techniques can be classified into one- and two-step processing (25). One-step processing permanently darkens the hair color, whereas two-step processing permanently lightens the hair color. In one-step processing, a cream tint is used in a shampoo formulation. Often a conditioner or filler must be used prior to processing to ensure even uptake of the dye by the entire hair shaft. Damaged distal hair shafts or previously treated hair will absorb or “grab” color more quickly. The filler prevents the distal hair shaft from dyeing darker than the proximal hair shaft. However, in extremely damaged hair, a filler cannot ensure an even dye uptake. In these cases, the dye-stuff is applied to the scalp first and the ends last so that the distal hair shafts have a shorter dyeing time. The cream tint is then rinsed, and a post-dyeing conditioner may be applied. Sometimes the hydrogen peroxide used in the oxidation dyeing process can lighten the existing hair color, a phenomenon known as “lift.” Hair cosmetic companies formulate one-step permanent oxidation dyes to avoid lift.

Hair bleaching

Two-step hair processing involves bleaching or lifting the natural hair color, with subsequent redyeing to the desired lighter shade. This technique is used when patients wish to dye their hair much lighter than their natural color (26). The bleaching is achieved with an alkaline mixture of hydrogen peroxide and ammonia,



FIGURE 30.9 The hair dye must thoroughly saturate the hair to achieve even color.

which causes swelling of the hair shaft to allow easier penetration of the dye, known as a toner (27). A toner must be used as the hair, when completely stripped of its color, has an undesirable appearance. The toner can be either a permanent or semipermanent dye.

Hair bleaching to lighten hair color is achieved with an alkaline mixture of hydrogen peroxide and ammonia, which causes swelling of the hair shaft to allow easier penetration of the dye, known as a toner.

The hair must be lightened to the desired color group and then dyed to the desired shade. There are seven levels of lightening:

1. Black
2. Brown
3. Red
4. Red gold
5. Gold
6. Yellow
7. Pale yellow

A patient with a black natural hair color would have to go through all seven stages of lightening to become a pale yellow blonde, whereas a patient with a natural gold hair color would have to go through three stages of lightening to become a pale yellow blonde. The more stages of lightening required to achieve the end result, the stronger the bleaching agent used and the more damaging the process is to the hair (26). A “booster” such as ammonium persulfate or potassium persulfate may be added to the hydrogen peroxide and ammonia solution for patients who desire an extreme lightening of hair color (27). Allergic reactions to ammonium persulfate have been reported (28). The eumelanin pigments in the hair are easily bleached by hydrogen peroxide, but the pheomelanins are somewhat resistant. This accounts for the increased difficulty in bleaching the hair of persons with reddish hair. It is difficult to formulate a solution strong enough to degrade hair pigment without damaging the hair keratin structure.

Some patients do not wish to lighten the hair on the entire scalp. For example, if only selected hairs are lightened in color, using a technique known as “highlighting,” a cap with holes is applied to the scalp, and only certain hairs are pulled through and exposed to the bleaching and dyeing process. If only the tips of the selected locks of hair are treated, the process is known as “tipping,” whereas “streaking” involves treating the entire hair shaft of certain locks of hair. “Frosting” the hair entails bleaching a larger proportion of entire hair shafts than streaking. Fashion trends dictate the proportion of bleached to unbleached hairs in the scalp. One popular method of lightening the hair and dyeing to different shades is known as hair “foiling” (Figure 30.10). Figure 30.10A demonstrates the foiled hair appearance on blonde hair.

There is no doubt that the two-step processing is the most damaging form of hair coloring. Hair that has been bleached is extremely porous, and as a result, is brittle, difficult to untangle, and lacking in luster. Conditioners can do very little to improve the appearance of hair that has sustained damage this severe. Most patients with double-processed hair who are dissatisfied with the appearance and texture of their hair are best advised to cut the damaged portion of the hair shafts and await new growth. Unfortunately, once the hair has been bleached many shades

lighter than the natural hair color, the proximal dark regrowth is cosmetically unattractive. This further encourages the patient to reprocess the hair. Perhaps patients can be encouraged to change to a shorter hairstyle or wear a wig during the regrowth period. Another alternative is to use a semipermanent dye to blend the bleached and naturally colored areas of the hair shaft, but if a color difference of more than three shades is present, the result will be suboptimal. Two-step processing should be minimized. It is recommended that patients stay within their own color group to maintain a natural appearance and prevent extensive hair shaft damage. Generally, a patient’s natural hair color group will complement the eye color and skin tone for an overall attractive blend. Patients who distort this balance create many cosmetic problems.

Two-step processing, however, can be successful and attractive in the mature patient who had dark brown hair and now has more than 60% gray hair. If the patient does not like the appearance of this hair coloring, some dyeing procedure is required. The patient is faced with the dilemma of whether to restore the original dark brown color or to lighten the remaining dark brown hairs and redye the hair blonde. This is a personal decision because both hair color changes require permanent dyeing. Restoring the entire scalp to a dark brown might increase the contrast between the lighter scalp and darker hair in a mature woman with female pattern alopecia. In addition, the problem of new hair growth will be magnified due to the color difference between the natural gray color and the dark brown dyed color. Lightening the hair by two shades followed by a toner could give the patient dark blonde hair with excellent coverage of the gray hair, a minimal scalp contrast, and a decreased color difference between dyed hair and new growth.

Melanin pigment is very resistant to reducing agents but is easily degraded by oxidizing agents. Therefore, hair bleaching can be considered an oxidative alkaline treatment. Hydrogen peroxide is the major oxidizer in the process, causing oxygen to be released from the hair keratin. The amount of hair lightening obtained is related to the amount of oxygen released, a quantity expressed as volumes by the cosmetic industry. The volume of a hydrogen peroxide solution is the number of liters of oxygen released by a liter of the bleaching solution. For example, a 20-volume solution contains 6% hydrogen peroxide and a 30-volume solution contains 9% hydrogen peroxide (29). Home bleaching products generally contain 6% hydrogen peroxide and professional bleaching products may contain up to 9% hydrogen peroxide. The hydrogen peroxide solution is mixed with an alkaline ammonia solution immediately prior to application to speed the reaction. The pH of the final solution is between 9 and 11. The amount of alkaline material added must be limited, however, because excess keratin damage and scalp irritation may result.

The hair should not be washed prior to bleaching because scalp sebum provides protection from the harsh chemicals. The hair should be shampooed following the bleaching process to remove excess solution. This is best accomplished with an acid-pH shampoo with minimal detergent action. The shampooing should be done gently to avoid scalp irritation.

The ease with which pigment bleaching occurs differs throughout the length of the hair shaft, with the hair near the scalp bleaching more easily than the distal shaft. This is thought to be due to the acceleration of the bleaching process by body heat radiating from the scalp. Proper bleaching requires that the solution be applied at the ends first and then the roots to ensure an even color throughout the hair shaft.

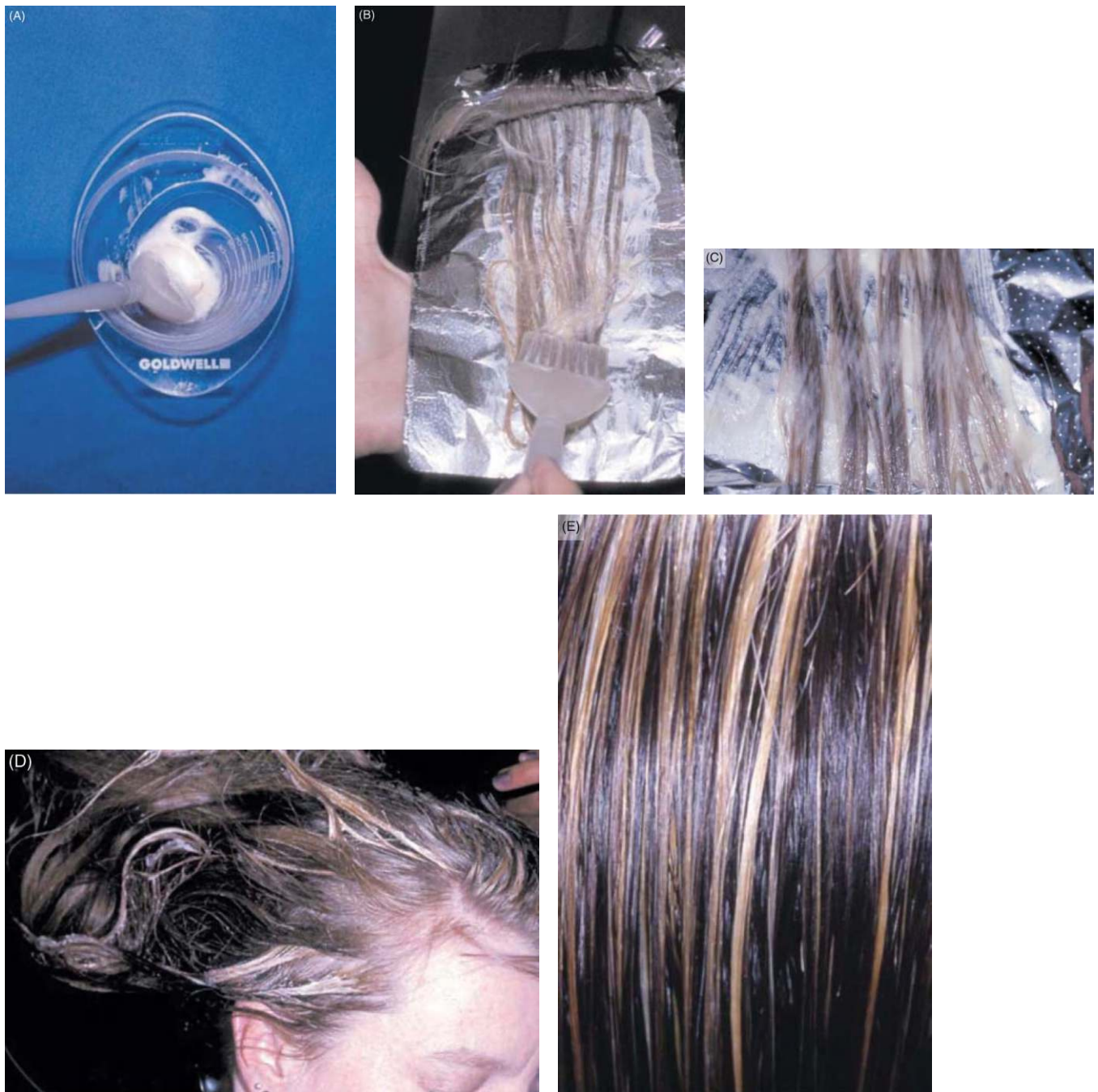


FIGURE 30.10 (A) The hair bleach is placed in a bowl for easy application. (B) The bleach is applied to selected hair strands and wrapped in foil for about 20 minutes. (C) The foil is unwrapped to expose the newly bleached hair. (D) The hair is rinsed to remove excess bleach, and the appearance of the lightened hair is immediately apparent. (E) The dried hair demonstrates selectively bleached blonde strands among brunette strands, which is a popular hair fashion.

As mentioned previously, bleaching is extremely damaging to the hair shaft. This damage results in a 2–3% weight loss from the individual shaft, which causes weakening and promotes an increased hair breakage. Small amounts of the amino acids tyrosine, threonine, and methionine are degraded. It is estimated that 15–25% of the hair's disulfide bonds are degraded during moderate bleaching, with up to 45% of the cystine bonds broken during severe bleaching (30). This weakening of the hair shaft is more pronounced in wet hair; thus the hair should be handled minimally until dry (31). Bleached

hair is also more porous and tends to absorb increased water, making it more susceptible to humidity changes and prolonging the drying time. Decreased overlapping of the cuticular scales also leads to increased hair friction, which allows the hair to tangle more readily. Finally, an increased porosity allows a better penetration of permanent dyeing and waving preparations, so bleached hair will dye to a darker shade than natural hair and will curl more readily than untreated hair. All further chemical processing requires weaker solutions to obtain desirable results.

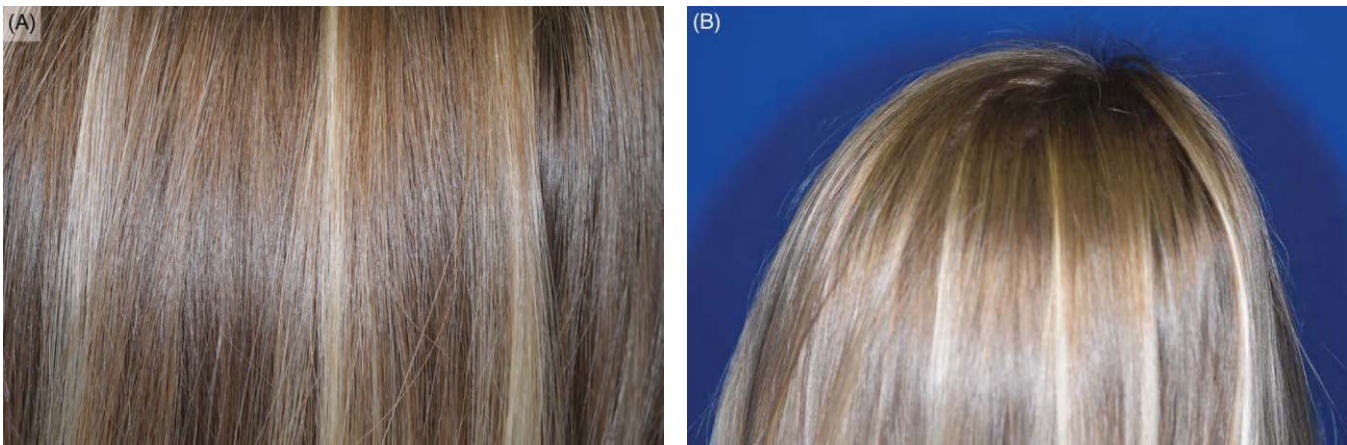


FIGURE 30.11 Sombre hair coloring where the hair is dyed darker at the proximal hair shaft (A) and lighter at the distal hair shaft (B).

Hair coloring combinations

Hair coloring combinations are popular fashion statements among young women. The techniques involve the use of several different colors of hair dyes to create light and dark, artistically placed tresses of hair. The hair dyeing procedures are known as balayage, ombre, and sombre, which are most frequently utilized on longer tresses. Balayage, which is a French word meaning “to sweep,” utilizes a slightly lighter dye color that is custom placed on the hair by hand in sections. It creates the look of grown-out dyed hair with different colored “roots” and thus does not need to be redyed as rapidly as other dyeing techniques. The hand application of the dye creates a more custom look, which is preferred, but does not cover gray hair. Ombre, which means “shaded” in French, leaves the hair darker at the roots with progressive lighting toward the distal hair shaft. Finally, sombre is a softer version of ombre where the hair is darker at the roots and lighter at the distal hair shaft, but only by one or two shades (Figure 30.11).

Hair dye removal

Removal of hair dye depends upon the type of coloring process used. As discussed previously, temporary hair dyes are removed with one shampooing, whereas semipermanent hair dyes are removed in four to six shampooings. The amount of time for a dye to wash out is equal to the time required for the dye to color the hair shaft. For example, if it takes 20 minutes for a semipermanent dye to penetrate from the cuticle to the cortex, then it will also take 20 minutes for the dye to exit the hair shaft. Thus, if the hair is shampooed for five minutes, the dye will be removed in four shampooings for a total elapsed time of 20 minutes.

The amount of time for a hair dye to remove from the hair shaft is equal to the time required for the dye to color the hair shaft.

Permanent hair dye removal is a much different matter, however. It is actually easier to bleach hair than to remove these unnatural pigments. Permanent dyes can be removed with reducing agents or oxidants, such as high-strength peroxide. Reducing agents, such as sodium hydrosulfite or sodium formaldehyde

sulfoxylate, are dissolved in water to form a 2–5% solution followed by an alkaline rinse (26). Special salon removal products are available (Clairol, Metalux). This procedure is extremely damaging to the hair, leaving it largely cosmetically unacceptable. If at all possible, the hair should be appropriately trimmed and possibly toned with other dyestuffs.

Metallic dyes should not be removed with peroxide because the hair can become darkened or discolored. Sulfonated castor oil with the addition of salicylic acid or chelating agents may be effective (32).

Adverse reactions

Hair coloring is generally regarded as a safe product with low risk of mutagenicity and oncogenicity (33–35). A prospective study of permanent hair dye use found no increase in hematopoietic cancers (36). Furthermore, the skin penetration is minimal and limited to 0.02–0.2% of the quantity of dye applied to the head (37). Gradual and temporary hair dyes represent minimal risk for irritant and allergic contact dermatitis. However, semipermanent dyes can cause contact allergic contact dermatitis because they may contain “para” dyes (diamines, aminophenols, and phenols) or dyes that cross-react with the “para” dyes (Figure 30.12). Paraphenylenediamine (PPD) is the sensitizer in permanent hair dyeing (38), with an estimated incidence of allergic contact dermatitis of 1 in every 50,000 applications (Figure 30.12) (39). However, patch testing may overestimate the incidence of reactions to PPD-containing hair dyes. This is due to the limited contact time during dyeing and the less than 3% concentration of PPD. Furthermore, PPD combines with oxidizing agents in hair dyes, which quickly react to create a new chemical moiety (40).

Para phenylenediamine (PPD) is the sensitizer in permanent hair dyeing, with an estimated incidence of allergic contact dermatitis of 1 in every 50,000 applications.

Permanent and semipermanent hair dyes must be tested on the patient prior to use, preferably using a small swatch of hair and skin hidden on the posterior neck. The testing is necessary to avoid the possibility of an overwhelming allergic contact



FIGURE 30.12 Allergic contact dermatitis due to hair dye occurs 1 in every 50,000 hair dye applications.

dermatitis to the dye stuff. The hair dye should be tested in addition to the following substances (41):

Para-phenylenediamine, 1% in petrolatum
 Para-toluylenediamine, 1% in petrolatum
 Ortho-nitro-para phenylenediamine, 1% in petrolatum
 Meta-toluylenediamine, 1% in petrolatum
 Resorcinol, 2% in petrolatum
 Meta-aminophenol, 2% in petrolatum
 Hydroquinone, 1% in petrolatum

In addition, the dye should be tested on the hair to prevent undesirable color results. Virgin, untreated hair does not accept the dyestuff as readily as previously treated hair. Untreated hair with an intact cuticle may even be so resistant to coloring as to require an alkaline agent to loosen the cuticle or increase porosity prior to dyeing. This type of hair is termed “dye resistant.” Previously treated hair will absorb or “grab” the color readily, which can result in over dyeing if the beauty operator is careless. Hair previously treated with metallic dyes or conditioners may not respond as expected. A color test area, known as a “strand test,” allows the beautician to determine if the appropriate color has been applied to the hair for the appropriate amount of time.

Once the hair has been semipermanently or permanently dyed, it is no longer allergenic (42). However, all excess dye must be removed with a final acidic shampoo, known as a neutralizing rinse. Sometimes patients with a tremendous paraphenylenediamine allergy, who have previously used home dyeing preparations, develop swelling and bullae formation immediately upon application of the dye product. In their haste to come to the dermatologist’s office, they may neglect to remove all the excess dye. Schueller recommends a chloride peroxide rinse to neutralize the excess dye, which is formulated as follows (43):

Sodium chloride, 150 g
 Hydrogen peroxide (20 volume), 50 mL
 Water q.s. 1,000 mL

This preparation can be mixed by the pharmacist and applied to the patient’s hair to remove any remaining allergen. It is not necessary for the patient to cut his or her hair, but further hair dyeing should be avoided.

TABLE 30.2: Minimizing Hair Dye Damage

1. Do not attempt to lighten or darken hair more than three shades.
2. Minimize the exposure of the hair to dye by prolonging the interval between dyeing sessions.
3. If possible, always dye hair darker not lighter. Bleaching is more damaging than dyeing.
4. If both permanent waving and permanent dyeing are to be performed, the hair should be permanently waved first and permanently dyed second.
5. Allow 10 days between permanent dyeing and permanent waving procedures.
6. Minimize shampooing to prolong the life of the hair dye.

Hair bleaching has been reported to cause hair breakage, skin irritation, allergic sensitization, and scarring alopecia (44). Cutaneous and respiratory allergic reactions have been reported to ammonium persulfate, mentioned previously as a booster in the hair bleaching process. Reported reactions include allergic contact dermatitis, irritant contact dermatitis, localized edema, generalized urticaria, rhinitis, asthma, and syncope (45, 46). Some reactions are thought to be truly allergic, whereas others appear to be due to nonimmunologic histamine release (47). Patch testing may be performed with a 2–5% aqueous solution of ammonium persulfate (48).

The cancer risk of hair dyeing is likened to the cancer risk of smoking one cigarette.

There has been some concern over the carcinogenicity of hair dyes and their appropriateness for use during pregnancy (49). There has been no link between hair dye and cancer in humans, but the cancer risk has been likened to smoking one cigarette each time the hair is dyed. Thus, the desire of the patient to dye their hair must be balanced with the chemical exposure (50, 51). Pregnant women frequently ask if hair dyeing is safe during pregnancy. There are no restrictions placed on hair dyes during pregnancy, but again, the risks should be weighed. Patient suggestions for minimizing hair dye issues are presented in Table 30.2 for easy reproduction.

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Shaving is an important grooming procedure with tremendous dermatologic ramifications. Shaving removes not only hair but also more or less of the stratum corneum depending on the quality of the shave. A successful shave requires an excellent implement, good skin conditioning, and superb hair removal. The idea of shaving was popularized by Alexander the Great, who required his Greek soldiers to shave to prevent the beard from being used as an aid for throat slashing or decapitation. Shaving products necessarily developed as the practice of shaving became more common. From the 14th century to World War I, shaving soaps were the main preparation available. Lathering shaving creams were introduced in 1936 and continue in popularity (1).

Many dermatologic conditions are related to problems with unwanted hair growth, necessitating some form of hair removal. Although shaving can exacerbate eczema, pseudofolliculitis barbae, folliculitis, impetigo, verruca planae, and sensitive skin, most dermatologists know relatively little about this grooming activity. This chapter investigates common shaving practices and offers practical tips to optimize hair removal while minimizing dermatologic complications. The topics for consideration are razor selection, razor design, razor care, shaving cream selection, shaving technique, spread of infection, and shaving of special skin areas.

Razor selection

Razor selection is perhaps one of the most important considerations for achieving an excellent hair removal result. Without good tools, a good result cannot be obtained. Many people with dermatologic problems complain that shaving causes pain, discomfort, and razor burn, which could be minimized through proper razor selection.

Razors can be purchased with a disposable blade and handle or only with a disposable blade. The completely disposable razors should not be selected for the dermatologic patient with folliculitis. First, the disposable razors are made of a thin plastic shell and are not heavy. A good razor with replaceable cartridge blades will have good weight in the handle to ensure that the blades strike the skin at the proper angle. When the razor is held in the hand, the head angles the blade to meet the skin for optimal hair removal while minimizing skin removal (Figure 31.1). Second, disposable razors generally do not have high-quality, laser-cut, spring-mounted blades.

As of late, there has been inflation in the number of blades found on the razor. The first razors to enter the market were single-edged. These old-fashioned blades are used by some dermatologists to remove seborrheic keratoses and nevi when longitudinally broken. Although these blades may function well as a scalpel, they are not a good choice for hair removal. The double-edged razor replaced the single-blade razor when it was recognized that the first blade lifts the hair from the skin surface for cutting by the second blade. This lifting of the hair increases the chances for a close shave while minimizing the unnecessary removal of skin, a condition commonly known as razor burn.



FIGURE 31.1 A razor blade handle with a good weight is important to allow the razor to touch the skin at the proper angle to cut the hair optimally without cutting the skin.

The next development in razor design was the addition of a glide strip to the top of the razor blade and rubber fins to the bottom of the razor blade. The glide strip placed on the leading edge of the blade was intended to reduce friction when the razor was dragged across the skin, leading to fewer problems when shaving over curved surfaces. The strip was later loaded with skin conditioning agents, such as aloe, to provide additional skin benefits. The loaded glide strip was problematic in some of the early razor designs because the moisturizer became stringy and clogged the blades. This problem has now been overcome by the use of a thinner, more flexible glide strip (Figure 31.2). The rubber fins below the razor blade are designed to stretch the skin slightly during shaving to allow the hairs to stand up for a cut closer to the skin, resulting in a closer shave.

The most significant development in razor design has been the development of five-blade razors (Figure 31.3). The hair is lifted and successively cut by each of the blades to produce a very close shave without using undue razor pressure on the skin. Blade pressure on the skin leads to razor burn. The multiblade razor produces a close shave without the requirement of pressure, causing less razor burn, less skin irritation, and fewer skin cuts. Further shaving pressure reduction can be created by vibrating the razor and manually dragging it over the skin surface. This is the rationale behind the new battery-operated razors.

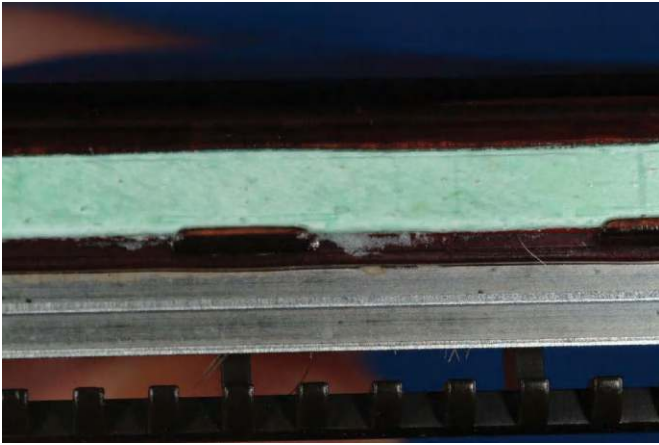


FIGURE 31.2 The green glide strip shown on this razor blade decreases friction between the razor blade cartridge and the skin to reduce razor burn.

The multiblade razor produces a close shave without the requirement of pressure, causing less razor burn, less skin irritation, and fewer skin cuts.

The most expensive razor blades also have laser-cut blades with spring mounts, in addition to multiple blades. The laser cut blades have a more accurate edge with fewer defects, providing for less razor burn and a closer shave. The springs help to allow the blades to rotate over the skin surface, reducing cuts and providing a close shave over curved surfaces, such as the chin or the knees. Although the high cost of the blades may deter some patients, the extra expense is well justified. There is no substitute for a blade that is designed for optimal performance. A blade with an angle of 28 to 32° between the blade and the skin produces the closest shave with the least amount of irritation (2).

Another method of reducing friction between the skin and the razor blade is to produce vibration or micropulses in the razor handle. These micropulses do not encourage hairs to stand up from the skin because this claim has been debunked, but rather

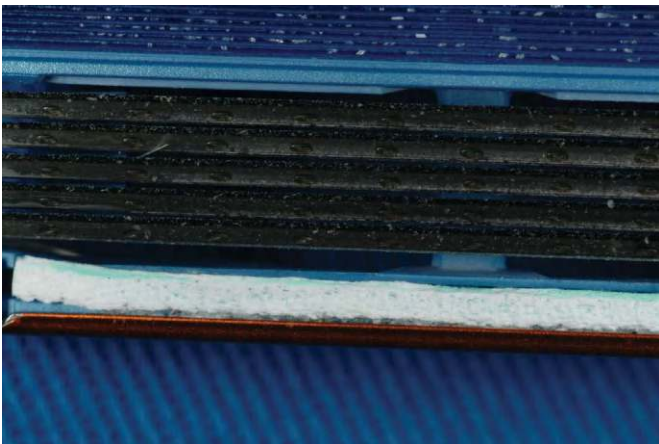


FIGURE 31.3 This five-blade razor produces a close shave by allowing each successive blade to cut the hair closer and closer to the skin.

reduce friction between the skin and razor. Some vibrating razor handle users do claim that the vibration decreases the pain of shaving and is also aesthetically pleasing. For patients with sensitive skin, it might be worth suggesting a vibrating razor handle to improve the shaving experience.

Razor care

An expensive blade requires excellent care to deliver a superior shave over the blade's lifetime. It is important to counsel patients on good blade care to prevent blade damage that compromises the shave quality. Razor blades should not be stored in the wet environment of the shower. They should be allowed to dry between shaves and kept in a dry location, such as the counter top or the drawer. Prior to drying, the blades should be thoroughly rinsed of hair and skin debris to prevent the material from sticking to the blade and compromising the sharp edge.

It is also important not to drop the blade or bang it into other objects. Dropping the razor on the blade creates a dull spot on the edge. There is a saying in razor blade technology that "the patient always shaves with the duller portion of the blade." This means that razor burn results from the damaged blade areas, not the sharp blade areas. If the blade is only 5% damaged and 95% undamaged, razor burn will still occur even though most of the blade is still in optimal condition. Most razor blades are designed to be used for five to seven shaves, meaning that the blade should be replaced at least on a weekly basis.

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Shaving product selection

Shaving preparations are intended to decrease the amount of trauma that results from using a sharp metal blade to remove hair from the body. Proper shaving product selection is necessary to achieve the optimal shave, and the currently available products include preshave products, shaving products, and aftershave products, discussed next.

Preshave products

Preshave products, popular among men who use an electric razor, are designed to reduce friction between the shaver and the beard, thus allowing a greater pressure to be applied on the shaver. This allows a closer shave, but with reduced irritation. These are mainly fragranced alcoholic solutions that reduce surface friction by reducing surface moisture and dry the hair, allowing it to stand more upright. Some products also contain volatile silicones to function as lubricants (3).

Shaving products

Shaving products may be formulated as soaps, sticks, powders, and creams. However, aerosol shaving creams have virtually replaced the other forms (4). Shaving creams are essentially a modern version of fatty acid shaving soaps, but with an increased amount of water and additives to ensure stability. The goal of a shaving cream is to allow a close shave without removing excess stratum corneum or promoting corrosion of the razor blade. This can only be accomplished if the hair is softened through adequate



FIGURE 31.4 An example of a postfoaming shave gel designed for men. It dispenses as a gel and then turns into foam when rubbed into the skin.

hydration and the skin is lubricated. The force required to cut water-saturated beard hair is about 65% less than that for dry hair (5, 6). Thus, an effective shaving cream should possess low solution viscosity, high foam density, small molecular diameter, low solute concentration, good detergent action, low film strength, and high diffusivity (7).

The force required to cut water-saturated beard hair is about 65% less than that for dry hair.

Shaving creams are formulated as foaming shaving creams and postfoaming shave gels. There is some evidence that post-foaming shave gels are superior lubricants over shave foams (Figure 31.4). The reason for this is not clear, but may be related to the orientation of the fatty acids into the lamellar layers necessary to form a gel (8).

Shaving creams contain either sodium or potassium hydroxide, a superfatting agent (stearic acid, vegetable oils, mineral oil, or lanolin), and glycerol or propylene glycol to allow the cream to remain soft and improve lather by aiding moisture retention. Menthol is added to some preparations to provide both fragrance and a cooling effect on the skin. Beard softeners are wetting agents such as sulfuric acid esters of lauryl alcohol or fatty acid amides.

Aftershave products

Aftershave products function to relieve the discomfort induced by shaving. They are designed to soothe and cool the skin while imparting a feeling of well-being. The fragranced alcoholic lotions are the most popular. Other additives may include menthol for its cooling effect, an antibacterial to prevent infection, and glycerol or propylene glycol to act as an emollient and humectant (9). These products have enjoyed a renewed popularity as they are now formulated to cross over into the fragrance market for men.

Application of shaving products

Proper shaving cream application is important in patients who are prone to developing irritant contact dermatitis. These patients generally do not allow the skin and hair shaft to absorb sufficient moisture prior to shaving. A shaving cream left in contact with the skin

for at least four minutes will decrease razor trauma in most patients. Some patients will require additional lubrication and softening, which can be provided by applying a lipid-free cleanser to the area for an additional 15 minutes, followed by shaving cream application.

A good, well-maintained blade is part of the equation for a superior shave, but the shaving cream is equally important. The shaving cream creates the interface between the blade and the skin. A good interface sets the stage for a good shave, and a poor interface sets the stage for a poor shave. Many patients feel that a shaving cream is extraneous and use nothing or other items handy in the bath such as bar soap, shampoo, or hair conditioner. It is important to remember that all personal care products are carefully designed for their intended purpose and are not well suited for any other use. Bar soaps, shampoo, and hair conditioner leave a film on the blade, hastening blade dulling, and do not optimally alleviate friction between the blade and the skin. Shaving cream is specially designed for this purpose.

There are many shaving products on the market. Some of them are old-fashioned soaps applied with a brush, some are dispensed and warm when rubbed on the face, others are foams squirted from a can, and the best are gels dispensed from an aerosol can that foam when rubbed on the face. The latter are known as postfoaming shave gels. The postfoaming shave gel is the best choice for persons with shaving challenges because they entrain water better than any other type of shave product. Entraining water is the event that occurs when the hair shaft becomes hydrated. Hydration is the first step in preparing the hair for cutting because the keratin softens and can be cut with less force. A dry hair is likened to a similar-diameter copper wire, whereas a wet hair is likened to an aluminum wire. Aluminum is much easier to cut than copper. These metals are used to model the physical dynamics of shaving.

The proper way to prepare the skin for shaving is by washing the face and then thoroughly wetting the face with lukewarm water. This wetting step places a thin layer of water over the hair and skin. Next, the shaving gel should be dispensed from the can and placed in the palm. The palms should be rubbed together to generate a rich foam, which is generously applied to the premoistened face. The shaving gel should remain on the face for three to four minutes before commencing shaving (Figure 31.5). This allows time for more water to enter the hair shaft. At this point, the hair and skin are ready for shaving.



FIGURE 31.5 The shave gel will turn into foam when rubbed on the skin and should be left in place for three to four minutes before beginning to shave to soften the hair.

The shaving gel should remain on the face for three to four minutes before commencing shaving.

Optimal shaving technique

Once the skin has been properly prepared, it is necessary to execute the proper shaving technique. The blade should gently glide over the skin surface with minimal pressure. The quality of a shave is measured as the ratio of the amount of hair removed to the amount of skin removed. If the ratio is high, the shave is good. Conversely, if the ratio is low, the shave is poor. The blade should be dragged over each area for shaving only once. If the blade is rubbed multiple times over the same area, the chance for razor burn increases. Any areas that are not shaved as closely as desired should be left for shaving on the following day.

Shaving should occur in parallel strokes, even though the hair may grow in many different directions. The newer multiblade razors provide for excellent shaving of hairs that demonstrate different skin exit angles. It is also important to rinse the blade after each stroke to remove hair, skin, and shaving gel debris.

Infection prevention

A common dermatologic problem related to shaving is the spread of disease. Bacterial diseases, such as impetigo and methicillin-resistant *Staphylococcus aureus* infection, can be spread on a razor blade in addition to viral diseases, such as verruca and molluscum contagiosum. A good razor and shaving cream can help in minimizing skin trauma and the opportunity for infection, but it may be necessary for shaving to be discontinued in infection areas until treatment is complete.

Razor blades can pass bacterial and viral infection to various sites on an individual patient or between family members who all use the same razor. It is best not to share razors for hygiene reasons but also for optimal blade performance. Blades that are used to shave a male face experience razor wear in a different manner than blades used to shave female legs. Different patterns of blade wear can lead to increased razor burn.

Allowing the razor to dry between uses can minimize the spread of infection. Soaking the razor head and blade in rubbing alcohol for a minute can also decrease spread but can reduce razor blade life. Patients can put 2 inches of isopropyl alcohol in a jar and let the razor sit in the jar for 60 seconds, remove, and allow to dry if recurrent infection is a problem.

Patients can put 2 inches of isopropyl alcohol in a jar and let the razor sit in the jar for 60 seconds, remove, and allow to dry if recurrent infection is a problem.

Shaving of special skin areas

Special skin areas, such as the female underarms and bikini area, deserve special mention. The underarms are unique because they are concave instead of convex, like most other shaved body areas.

TABLE 31.1: Ten Tips for a Successful Shave

1. Select a multiblade razor with replaceable blades and a glide strip.
2. Purchase a postfoaming shave gel.
3. Change the razor blade weekly.
4. Always clean the face prior to shaving.
5. Wet the face with lukewarm water prior to shaving.
6. Leave the shave gel on the face for three to four minutes before shaving.
7. Shave with minimal pressure.
8. Never shave with a damaged blade.
9. Shave daily.
10. Store the razor out of the bath in a dry location.

Likewise, the bikini area requires shaving areas that may be difficult to visualize again with tight concave areas that the razor must reach. There are razors designed for male and female use. Male razors are designed to shave the small curved areas of the face. Female razors are designed to shave the straight, long surfaces of the legs and not necessarily the armpits and the groin. It is important to pick a razor that fits nicely in the hand of the user. For patients with shaving challenges, it is well worth the money to buy several different handles with a few blades to see which one provides the best shave. Just like many people have a favorite pen, it is also necessary to find that one favorite razor.

Summary

This chapter discussed the finer points of shaving, from blade design to shaving gel selection to shaving technique to minimize the presence of folliculitis. These points are summarized in Table 31.1. Shaving is a daily event for both male and female patients. Understanding the physics behind blade and razor design accompanied by the physiology of hair and skin is necessary to achieve the optimal shave (10).

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32

HAIR REMOVAL

Hair removal is an important hygiene undertaking with both social and religious underpinnings. For example, Roman soldiers shaved all body hair prior to entering a battle as part of their worthiness for combat. Women shave their legs and underarms in Western culture, as it is felt that women should be devoid of terminal body hair for physical attractiveness. Men, on the other hand, sport chest hair in Mediterranean culture as a sign of virility, whereas the present trend among young men in the United States is for shaving of chest and pubic hair. No single method of hair removal is appropriate for all body locations and all circumstances. Thus, there are several methods of hair removal that are presently available. [Chapter 31](#) presented a discussion of wet shaving with a razor, and this chapter discusses the remaining hair removal techniques that can be used for basic grooming and for the cosmetic treatment of hirsutism. The various methods of hair removal are summarized in [Table 32.1](#). Methods discussed include dry shaving, plucking, epilating, waxing, hair-removing gloves, abrasives, threading, chemical depilatories, electrolysis, and laser hair removal.

Dry shaving

Shaving is the most widespread method of hair removal due to its rapid speed, effectiveness, and low expense. Shaving is the preferred removal technique for facial hair in men and underarm or leg hair in women. A major limitation of this technique is rapid, bristly regrowth due to a hair shaft now devoid of a naturally tapered tip ([1, 2](#)). Shaving can be accomplished with a razor blade combined with a shaving cream, a hair removal technique known as wet shaving, or with an electric shaver without moisture or shaving cream, a technique known as dry shaving. The electric

shaver contains multiple blades, which rotate or vibrate, thereby cutting the hair shaft. In general, an electric shaver cannot cut the hairs close to the skin surface as nearly as a razor, but skin abrasion is not as great a problem. Skin irritation and the spread of cutaneous infections may still occur ([3](#)).

Many factors influence the closeness of a dry shave, mainly achieved by the optimum interaction between the moving blades and the skin. Skin factors that contribute to dry shave closeness, which are identical to wet shave closeness, include abundant facial subcutaneous fat (resulting in improved resiliency), the absence of deep pits around hair ostia, and ostia containing only one hair ([4](#)). Factors that lead to increased dry shaving irritation are old razor blades, a large shaving angle, thin lathers, high skin tension, shaving against the direction of hair growth, repeat shaving over a given facial area, and increased shaving pressure ([5](#)).

Advantages of dry shaving include the rapidity and the ease with which the hair can be removed. Large surface areas can be shaved with minimal effort, as long as the hair shafts are short. Clippers, a variant of the electric razor, can be used to easily shave longer hairs. It is difficult to injure the skin with dry shaving, which can be an advantage for persons with poor vision or poor manual dexterity. However, in areas where rapid hair regrowth or bristly hair is a problem, such as the face of women, dry shaving should not be used. Furthermore, the sharp regrowing hair shafts may cause irritation in intertriginous areas such as the underarms or inguinal folds ([Figure 32.1](#)). Dry shaving may also cause irritation of the follicular ostia, resulting in perifollicular pustules, a problem seen especially in the female pubic area, and the regrown hair shafts have a sharp tip, which may re-enter the skin, resulting in pseudofolliculitis barbae, commonly seen in the neck area of African American patients ([6, 7](#)).

TABLE 32.1: Methods of Hair Removal

Technique	Equipment	Cost	Regrowth period	Body sites for use	Advantages	Disadvantages
Shaving	Razor or shaver	+	Days	Face, arms, legs, axilla	Fast, easy	Irritating, rapid regrowth
Plucking	Tweezers	+	Weeks	Eyebrows, facial hair	Longer regrowth period	Painful, slow
Epilating	Epilator	+	Weeks	Arms, legs	Longer regrowth period, fast	Painful, irritating
Waxing	Wax and melting pot	++	Weeks	Face, eyebrows, groin	Longer regrowth period	Painful, slow
Hair-removing gloves	Sand-paper gloves	++	Days	Legs, male face	None	Irritating, slow
Abrasives	Pumice stone	++	Days	Legs, male face	None	Irritating, slow
Threading	Thread	+	Days	Legs, arms	None	Painful, slow
Depilatories	Depilatory	++	Days	Legs, groin	Quick	Irritating
Electrolysis	Trained professional	++++	May be permanent	All	May be permanent	Painful, time consuming, expensive
Bleaching	Peroxide bleach	++	Does not remove hair	Female facial and arm hair	Quick	Irritating
Laser	Selective photothermolysis with laser	++++	Permanent	All body areas, does not work on unpigmented hair	Long lasting	Expensive



FIGURE 32.1 The rough-cut end of a male beard hair accounts for the harsh feel of hair cut by a mechanized shaver.

The biggest problem with dry shaving is failure of the patient to use sharp blades.

The biggest problem with dry shaving is the failure of the patient to use sharp blades. Because the shaver blades cannot be replaced, it is important that the patient sharpen the blades as needed. Shaver blades are not designed to stay sharp for the lifetime of the electrical device. Also, the blades can be difficult to clean, and the hair debris can clog the proper contact of the blade with the skin. Finally, it is possible to transmit an infectious disease from the moist skin and hair debris that remains under the protective screens in the shaver head. Proper shaver care is the secret to successful dry shaving.

Plucking

Plucking of the hair is a method of removing the entire hair shaft, including the bulb, with a pair of tweezers (8) (Figure 32.2). It is an easy, inexpensive method of hair removal requiring minimal



FIGURE 32.2 Various tweezers are shown. Tweezers with a flat, smooth tip are recommended over those with a pointed tip, shown in the middle, which can break the hair prior to complete removal.



FIGURE 32.3 Plucking is an inexpensive method to remove unwanted eyebrow hairs, but overplucking should be avoided to minimize permanent hair loss.

equipment, but is tedious and mildly uncomfortable. Plucking does not encourage rapid regrowth. Removal of hair from large areas is not feasible, but plucking is effective for removal of stray eyebrow hairs or isolated coarse hairs on the chin of postmenopausal women. Only terminal hairs can be efficiently plucked because vellus hairs usually break close to the skin surface.

Plucking produces little skin damage and provides a longer regrowth period due to complete hair shaft removal. It should be remembered, however, that repeated plucking of a given hair may result in ingrown hairs or failure of the hair to regrow due to follicular damage (9). For this reason, overplucking of the eyebrow area should be avoided (Figure 32.3).

Only terminal hairs can be efficiently plucked because vellus hairs usually break close to the skin surface.

Epilating

Epilating has now come to refer to a mechanized method of plucking hair (10). Most electric hand-held epilating devices are stroked over the skin, much like an electric shaver. They consist of a rotating, tightly coiled spring that traps the hair and pulls it out at the level of the hair bulb. Retail cost for the device is \$30 to \$50. This efficient plucking of the hair provides a long regrowth period but is somewhat painful. Additionally, the device functions poorly on curved surfaces, such as the underarms, and can do considerable damage to body areas with thin skin, such as the face.

Epilating is best used on large flat surfaces such as the arms and legs, but the hair must be of sufficient length for entrapment in the coiled spring. Follicular disruption is a problem that can result in ingrown or coiled hairs beneath the skin surface (11, 12). Infection may also be a problem, so use of an antibacterial agent prior to and following hair removal is recommended. If the epilator is pressed too firmly against the skin, purpura may result.

Follicular disruption is a problem that can result in ingrown or coiled hairs beneath the skin surface, following traumatic epilating.

Waxing

Waxing is another variation on plucking of the hair. Two waxing techniques are available: hot waxing and cold waxing. Hot wax is composed of rosin, beeswax, paraffin wax, petrolatum, and mineral or vegetable oil. Some products are mentholated. The wax is melted in a double boiler or professional wax pot and applied to the hairs with a wooden spatula (Figure 32.4). Hair becomes embedded within the wax, which is allowed to cool and harden. The hair is then pulled out at the level of the hair bulb as the wax is ripped from the skin. Care must be taken not to burn the skin.

Cold waxing, a newer method, employs a wax-like substance that is squeezed as a liquid from a pouch, thus eliminating the need for melting. Sometimes cold waxing uses a cloth piece that is initially placed on the hair removal area, followed by liquid application. The cloth is then ripped from the skin with the hair and the wax (Figure 32.5). The advantage of the cloth is that it provides strength, so the wax can theoretically be removed in one piece rather than numerous smaller pieces.

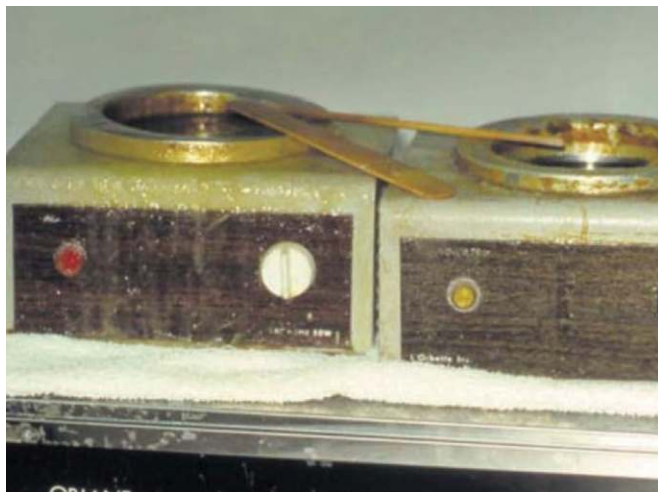


FIGURE 32.4 A typical hot wax pot as photographed in a salon, illustrating the poor hygiene standards that may be present.

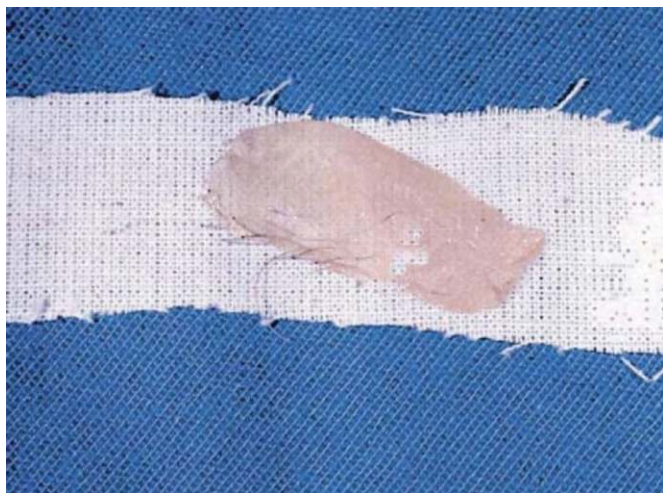


FIGURE 32.5 The eyebrow hairs are shown attached to the adhesive, which is affixed to the cloth. Cold waxing is an efficient method of plucking multiple hairs simultaneously.

Waxing has the advantage of adequate removal of both terminal and vellus hairs. This works well on the upper lip, chin, eyebrows, cheeks, and groin of women where removal of all hair is desirable. Men generally do not find waxing of facial hair acceptable because the hair has to grow to at least one-sixteenth inch before it can be reliably removed by waxing. Excess hair present in Becker's nevi, congenital hairy nevi, and benign hairy nevi can be removed in both men and women with this technique.

The major disadvantages of waxing are discomfort and poor removal of hairs shorter than one-sixteenth inch. Patients may also need to tweeze a few hairs that still remain and a thick hair growth may require two treatments for complete removal.

The results of waxing are identical to those of hair plucking. The two-week regrowth period is longer than that for shaving because the hair is removed by the root. When regrowth occurs, the hair has a tapered tip rather than the sharp, blunt tip produced by shaving. No damage to the surrounding skin occurs, but patients must test the heated wax prior to application to avoid a burn. Waxing can be done professionally in a salon or at home. Professional fees vary depending on the size of the removal area. For example, it costs about \$20 to have the eyebrows professionally waxed. Home waxing is much less expensive: \$4 will purchase sufficient wax to remove excess eyebrow hair for 30 treatments.

Waxing has the advantage of adequate removal of both terminal and vellus hairs on the face.

Hair-removing gloves

Hair-removing gloves consist of a mitten of fine sandpaper that is rubbed over the hair-bearing skin in a circular fashion (13). This mechanically fractures the hair shaft but is also irritating to the skin. This is a method used to remove female leg hair and male facial hair in some countries but is not popular in the United States. The most important use of hair-removing gloves is in a female patient with excessive white vellus hair on the face. It is easy to break off the vellus hairs without the irritation from depilatories or shaving.

Abrasives

A variation on hair-removing gloves is the use of abrasive substances to break and remove the hair. Pumice stone or other abrasives can be rubbed over the skin to remove hair through mechanical friction (13). Again, this is very irritating to skin, and not a popular hair removal technique in the United States. This hair removal method is more commonly found in developing nations.

Threading

Threading is a hair removal technique popular in India that has found a following in the United States, especially for the removal of eyebrow hair and unwanted vellus facial hair that is difficult to pluck. Threading is performed by looping a cotton thread around the neck of the operator and twisting the other end into a loop held in one hand. Then the ends are twisted, and the loop is pulled across the skin. The thread catches the hair and removes some

at the level of the follicle, while some hairs break above the skin surface (8). Threading is an efficient way of plucking the hair that involves minimal trauma if properly done. The success of the hair removal result is highly operator-dependent, but the supplies to perform threading are simple and inexpensive.

Threading is performed by looping a cotton thread around the neck of the operator and twisting the other end into a loop held in one hand.

Depilatories

From the mechanical methods of hair removal, the discussion now turns to chemical hair removal with products known as depilatories. Chemical depilatories function by sufficiently softening the hair shaft above the skin surface so it can be gently wiped away with a soft cloth (Figure 32.6). Presently marketed chemical depilatories are available in pastes, powders, creams, and lotions with formulations specially adapted for use on the legs, groin area, and face. All formulations function by softening the cysteine-rich hair disulfide bonds to the point of dissolution. This is accomplished by combining five different classes of ingredients.



FIGURE 32.6 Male facial hair depilatories are popular among African American men who avoid the disfigurement of pseudofolliculitis barbae from shaving by dissolving the hair shaft at the follicular ostia.

The agents combined to produce a chemical depilatory are detergents, hair shaft swelling agents, adhesives, pH adjusters, and bond-breaking agents (14). Together, they function to prepare the hair for and facilitate removal. Detergents such as sodium lauryl sulfate, laureth-23, or laureth-4 remove protective hair sebum and allow penetration of the bond-breaking agent. Further penetration is accomplished with swelling agents such as urea or thiourea. Adhesives such as paraffin allow the mixture to adhere to the hairs, while adjustment of pH to between 9.0 and 12.5 is important to minimize cutaneous irritation. Lastly, the bond-breaking agent is able to successfully destroy the hair shaft.

Several bond-breaking agents are available: thioglycolic acid, calcium thioglycolate, strontium sulfide, calcium sulfide, sodium hydroxide, and potassium hydroxide. The most popular commercial bond-breaking agents are the thioglycolates because they minimize cutaneous irritation while effectively breaking disulfide bonds; however, they are less effective at dissolving coarse hair such as the male beard. Sulfide bond-breaking agents are faster acting but are more irritating and sometimes produce an undesirable sulfur odor. Sodium hydroxide, also known as lye, is the best bond-breaking agent but is extremely damaging to the skin.

Chemical depilatories are designed to remain in contact with the skin for five to ten minutes, shorter for fine hair and longer for coarse hair. The products are somewhat selective for hair shaft damage because the hair shafts contain more cysteine than the surrounding skin but are still irritating to the skin, especially if the contact is prolonged. The hairs are wiped away once they assume a corkscrew appearance. Under no circumstances should chemical depilatories be applied to abraded or dermatitic skin.

The main advantage of chemical depilatory hair removal is slower regrowth than with shaving, and if used properly, the technique is painless and free of scarring. The major disadvantage is the skin irritancy (8).

The main advantage of chemical depilatory hair removal is slower regrowth than with shaving.

Chemical depilatories are best used for the removal of hair on the legs, including the upper thigh. Darkly pigmented hair seems somewhat more resistant to removal than lighter hair, and coarse hair is more resistant than fine hair. This explains why these products are difficult to use on the male beard. However, a variety of powder depilatories containing barium sulfide are available for the African American male who has difficulty with pseudofolliculitis barbae (15, 16). These powdered products are mixed with water to form a paste and applied to the beard with a wooden applicator for three to seven minutes. The hair and depilatory are then removed with the same applicator, and the skin is rinsed with cool water. This procedure should be performed no more frequently than every other day.

Both allergic and irritant contact dermatitis can occur with the use of chemical depilatories. Allergic contact dermatitis is less common but may be seen due to fragrances, lanolin derivatives, or other cosmetic additives. Irritant contact dermatitis is common, especially in individuals who use the product more than

once weekly or apply it close to mucous membranes. Generally, the product is not appropriate for any patient with dermatologic problems. Most cutaneous problems can be remedied by discontinuing use and applying a topical corticosteroid. Depilatories can also damage fabrics and furniture.

Electrolysis

Electrolysis is a permanent method of hair removal. It is not so commonly performed now that laser hair removal has become a mainstream method, yet it is worth discussing. Dermatologists are well aware of the complications of electrolysis, which include scarring, failure to destroy the germinative follicular cells, and the transmission of viral and bacterial diseases. Yet, electrolysis remains a tremendously popular hair removal technique among women for unwanted hairs on the face, chin, neck, and bikini areas (17). There are three electrolysis techniques: galvanic electrolysis, thermolysis, and the blend.

The first individual to use electrolysis for hair removal was a Missouri ophthalmologist named Dr. Charles E. Michel, who, in 1875, used the technique in the treatment of trichiasis. The technique became well known during the later part of the 19th century. In 1924, the technique of thermolysis was developed by Dr. Henri Bordier of Lyon, France. The combination of electrolysis and thermolysis, known as the blend, was developed by Arthur Hinkel and Henri St. Pierre in 1945, and a patent was granted for the technique in 1948 (18).

All electrolysis techniques involve the insertion of a needle into the follicular ostia down to the follicular germinative cells. The dermal papillae must be destroyed to permanently prevent hair growth. There are several important considerations in determining the effectiveness of electrolysis techniques.

Telogen vs. Anagen

Only hairs that are visible can be removed by electrolysis, and only anagen hairs can be adequately treated. Follicles in the telogen phase, without a visible hair shaft, cannot be treated. If there is a high telogen to anagen ratio, a substantial amount of hair growth will be seen in the treated area. This ratio varies depending on the body area (19).

Many electrologists advise that their clients shave the hair in the area to be treated several days prior and refrain from other temporary hair removal techniques. This ensures that only anagen hair follicles are treated. Prior waxing or plucking of the hairs may delay regrowth, thus decreasing the thoroughness of electrolysis.

Moisture content

The moisture content of the hair follicle is also important in determining the success of electrolysis. The lower part of the hair follicle is better hydrated than the more superficial follicle. Water is necessary for transmitting electrical energy between the needle and dermal papillae. For this reason, the electrolysis needle must be inserted to the depth of the hair follicle.

Depth

The depth of needle insertion is determined by the hair shaft diameter. As is readily demonstrated in Table 32.2, larger-diameter hairs require deeper needle insertion for adequate destruction. Knowledge of follicular depth is necessary to ensure adequate follicular destruction without scarring.

TABLE 32.2: Hair Shaft Diameter and Hair Follicle Depth

Hair Shaft Diameter (inches)	Description of Hair	Hair Follicle Depth (mm)
<0.001	Very fine	<1
0.001–0.002	Fine	1–2
0.002–0.003	Medium	2–3
0.003–0.004	Coarse	3–4
0.004–0.005	Very coarse	4–5
0.005–0.006	Extra coarse	5
>0.006	Super coarse	5

Source: Adapted from Ref. 21.

Intensity and duration

Dermal papillae damage depends both on the intensity and duration, of the current administered. High-intensity energy may be used for a short duration or lower-intensity energy may be used for a longer duration. The decision of how much energy to use depends upon both the technique used by the electrologist and the pain tolerance of the client. As might be expected, pain increases with high-intensity energy. Low-intensity energy, however, is unable to destroy some hairs. In general, coarse hairs require longer treatment than fine hairs (20).

Follicular shape

Electrolysis is much more difficult to perform on individuals with curly, wavy, or kinky hair. This is due to difficulty in placing the needle accurately into the hair follicle.

Only visible hairs can be removed by electrolysis; thus, only anagen hairs can be adequately treated.

Hair removal technique

Electrolysis, thermolysis, and the blend represent the three techniques that can be used to permanently remove unwanted hair (21). Other advertised methods, such as electronic tweezers, do not work.

Electrolysis

This technique is properly known as “galvanic electrolysis” and utilizes direct current (DC), which is passed through a stainless steel needle into sodium chloride and water in the tissue surrounding the hair follicle. DC causes ionization of the salt (NaCl) and water (H₂O) into free sodium (Na⁺), chloride (Cl⁻), hydrogen (H⁺) and hydroxide (OH⁻) ions. These free ions then recombine into sodium hydroxide (NaOH), known as lye, and hydrogen gas (H₂). The caustic sodium hydroxide destroys the hair follicle, while the hydrogen gas escapes into the atmosphere. The amount of sodium hydroxide produced is greater at the base of the hair follicle due to increased moisture content and minimal at the skin surface. Less lye production near the skin surface accompanied by the protective effect of sebum decreases the skin irritancy potential of this technique. The amount of follicular destruction induced is measured in units of lye, defined by Arthur Hinkel as the amount of lye produced when 0.1 mA of current flows for one second (22).

Galvanic electrolysis is the most effective method of producing permanent hair removal but is tedious and slow. This has led to the development of multiple needle techniques.

Thermolysis

Thermolysis, also known as short-wave radio frequency diathermy, differs from galvanic electrolysis in that high-frequency alternating current (AC) is passed down the needle. This current causes vibration of the water molecules around the hair follicle and produces heat, which occurs in the same manner as in a microwave oven (23).

The needle begins to heat at the tip first, and the thermal gradient spreads superficially toward the skin surface. This means that the heat remains longer around the hair follicle than at the skin surface, minimizing discomfort and cutaneous damage. If too much AC is administered, steam is produced, which exits through the follicular ostia, resulting in a burn and possible scarring.

Thermolysis is much faster than galvanic electrolysis but does not destroy the hair follicle as reliably. Additionally, thermolysis does not work well on distorted or curved hair follicles. An extremely rapid method of thermolysis, known as the flash method, was introduced several years ago but unfortunately was plagued by high hair regrowth rates.

Blend

The blend is a combination of both galvanic electrolysis and thermolysis (24). Both direct and high-frequency alternating current are passed down the needle at the same time to produce sodium hydroxide and heat. The hot lye is extremely effective in destroying the dermal papillae, allowing superior results with less regrowth. Furthermore, the tissue damage induced by the thermolysis allows the lye to spread through the hair follicle more rapidly. The blend requires only one-fourth the time of galvanic electrolysis alone.

Needle selection

Needle selection is important to the success of electrolysis. Needles are available in a variety of shapes: straight, tapered, bulbous, and insulated (25) (Figure 32.7). Most electrologists prefer to use a straight needle with a gently rounded tip. Tapered needles (narrower at the tip than the base) are sometimes selected

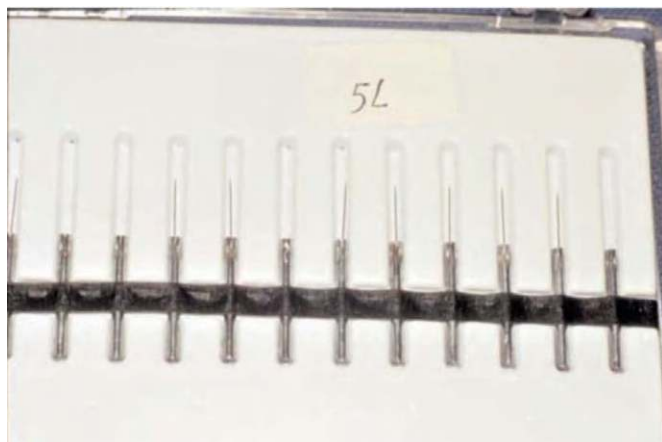


FIGURE 32.7 Single-use electrolysis needles are recommended to prevent the inadvertent transmission of contagious diseases.

for the removal of deep terminal hairs. Electrolysis of these hairs requires more energy, which can be delivered at the tip without exposing the more superficial tissues to excessive damage.

Various sizes are also available because the needle diameter should match the diameter of the hair shaft to be treated. Smaller needles generally get hotter than larger needles. Client pain can be reduced by selecting the largest needle possible.

Stainless steel is the standard material from which needles are made; however, one company markets a gold-plated needle, which is termed “hypoallergenic.” Sometimes the electrologist may use multiple needles at a time to speed the treatment. A computerized electrolysis machine is used to sequentially administer energy to the needles in the proper order and for the specified length of time.

Needle insertion techniques

The needle must be properly inserted into the follicular ostia to ensure destruction of the hair follicle without cutaneous scarring. The most popular technique for needle insertion is known as the forehead technique. The needle holder is held much like a pencil between the thumb and forefinger. The removal forceps are then placed between the needle holder and thumb of the same hand. This allows the free hand to be used for stretching the skin. Skin stretching is important to open the follicular ostia for needle insertion.

The needle is always inserted parallel to the hair shaft, opposite to the direction of hair growth. Hairs may exit the skin at angles varying between 10° and 90°. The needle must be inserted at the same angle as hair growth. If the hair is long and lies on the skin surface, it should be clipped to gain a better appreciation of its exit angle. The needle should also always be inserted below the hair shaft. These steps are necessary to destroy the follicle without scarring the surrounding skin.

It is important that needle is inserted to the proper depth. A general rule is that coarse hairs have deeper follicles than fine hairs. A slight dimpling of the overlying skin and resistance means that the bottom of the follicle has been reached, and the needle should be withdrawn slightly until the dimpling disappears. A proper needle insertion should be painless and bloodless for the client. Shallow needle insertions may result in pain and scarring for the client.

Electrolysis hair removal techniques

Once the hair has been treated, the needle should be withdrawn at exactly the same angle as it was inserted. The forceps held between the thumb and needle holder are now positioned 90° to the hair shaft for epilation. The hair should be grasped firmly and gently slide out of the follicle if the treatment has been properly performed. Resistance in removing the hair means that the hair has been epilated and not treated with electrolysis, thus regrowth may occur.

Electrolysis adverse reactions

Electrolysis must be properly performed to minimize client scarring. Table 32.3 summarizes the pointers that must be followed for successful electrolysis (26). Care must also be taken to perform the procedure under sanitary conditions to prevent the spread of bacterial and viral infection (27).

TABLE 32.3: Method for Electrolysis Scar Prevention

1. The treated hair should be pulled effortlessly from the follicular ostia.
2. The needle size should be the same as the hair diameter.
3. The skin should be dry.
4. The skin should not be blanched following treatment.
5. The current should only flow when the needle has been completely inserted in the follicular ostia to the level of the follicle.
6. The needle should only be removed when the current has stopped.
7. The same follicular ostia should not be re-entered or treated twice.

The real concern regarding electrolysis is the lack of regulation. This lack of licensing means that training and health standards are apt to vary tremendously between salons. Improper techniques can result in permanent scarring, and failure to adequately sterilize equipment can result in the transmission of bacterial and viral infections. If a good operator with superior health standards can be found, electrolysis may be useful in a female with a few unwanted facial hairs on the upper lip or chin. This technique is not suitable for the removal of large hairy areas, such as the male beard because only 25 to 100 hairs can be removed per sitting.

Bleaching

Bleaching is not a method of hair removal but is included in this section because it can make unwanted hair less apparent. Commercial products are available for bleaching hair; however, a home-made bleach can be made by mixing 40 mL of hydrogen peroxide with 7 mL of 20% ammonia. The bleach is left in contact with the hair until the color is removed, about five to ten minutes. This product is irritating to the skin and should not be used around the eyes or mucous membranes.

Hair bleaching is most appropriate in the female patient who notes excess pigmented hair on the arms, upper lip, or jawline. The hair may be pigmented due to Asian, Hispanic, Mediterranean, or Middle Eastern genetic background. Bleaching may be the most acceptable alternative when shaving produces an unacceptable regrowth appearance and the area is too large for waxing.

Hair bleaching is most appropriate in the female patient who notes excess pigmented hair on the arms, upper lip, or jawline.

Laser

Lasers have revolutionized professional hair removal and are in the consumer market as well (28, 29). Laser hair removal is clearly more permanent and more effective than any other method. Many types of lasers and light sources can be used to destroy hair growth, including normal-mode ruby, neodymium:yttrium-aluminum-garnet (Nd:YAG), diodes, and intense pulsed light (IPL) (30, 31, 32, 33).

Even though laser hair removal is considered permanent, the US Food and Drug Administration (FDA) definition of permanent is a stable decrease in the number of terminal hairs for a period longer than one complete hair cycle at a given site. This does not mean that the hair is all gone! This is why it takes several treatments to completely remove the hair, and some hair may regrow, but it is finer and less pigmented. How much hair

reduction occurs depends on the treatment type, the hair location, and the color of the hair. Persons with deeply pigmented hair do the best, but persons with red, blonde, gray, or white hair may not get as much reduction, requiring treatments every three months (34).

Laser hair removal works best in deeply pigmented hair, meaning patients with red, blonde, gray, or white hair achieve as much hair growth reduction.

In order for the hair to be permanently removed, complete destruction only occurs when both the germinative cells in the hair bulb and the stem cells in the hair bulge area are destroyed. This topic is discussed in the hair chapter in more detail. The melanin in the hair serves as the target for the laser energy. This means that selective thermolysis is used to damage the hair growth. The hair melanin functions to absorb energy in the range of 600 to 1100 nm and is known as the chromophore. The energy is then released by melanin as heat. This allows the light energy to penetrate to the bottom of the hair follicle and rapidly heat the water, thus cooking and destroying the hair. Hairs in the telogen resting cycle cannot be treated with laser hair removal, accounting for the multiple treatments needed to achieve a satisfactory result. A variety of laser and light devices can be used for permanent hair removal, as long as they follow the concept of selective thermolysis.

Summary

The hair removal techniques discussed here should be used in combination with wet shaving, discussed in chapter 31, to assist the patient concerned about hirsutism. Every hair removal technique has pluses and minuses that should be evaluated in light of the needs of the patient and the risk versus benefit ratio (35). In the case of laser hair removal, the cost and the suitability of the hair for selective photolysis should also be considered (36). These hair removal techniques should be combined with medical treatment, where appropriate, in the hirsute patient.

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HAIR AND PHOTOPROTECTION

Photoprotection, as it pertains to hair, is not a common topic addressed by the dermatologist. After all, hair is nonliving, and as such, requires no protection from UV radiation because carcinogenesis of the hair shaft itself is not possible. If hair proteins are altered by sun exposure, damaged hair can be removed and replaced by new growth. Thus, at first glance, the whole issue of photoprotection for the hair might seem irrelevant. However, patients frequently consult the dermatologist for advice on hair growth and appearance problems. Hair photoprotection is an important part of maintaining the cosmetic value of the hair shaft. This chapter will focus on the chemical effects of UV radiation on the hair shaft, hair photoaging, intrinsic hair UV photoprotective mechanisms, and the use of hair sunscreens. The entire science of hair and photoprotection is currently in its infancy and an area of focused research within the hair care product and salon industries.

Hair and UV radiation

Much of the understanding regarding hair and how it interacts with UV radiation has come from the textile industry. Natural fibers, such as wool, cotton, silk, and rayon, discolor when exposed to sunlight. Although fabrics tend to take on a light brown/yellow color, a process known as photoyellowing (1, 2). The same chemical process of photoyellowing can also occur in natural unprocessed human hair. Human hair contains two pigments, eumelanin and pheomelanin, accounting for the brown and red hues seen in hair, respectively. A third melanin pigment, known as oxymelanin, is found in unprocessed human hair that has been exposed to sunlight. Oxymelanin is an oxidative photodegradation product. Although the presence of this photodegraded melanin decreases the cosmetic value of the hair, it also chemically affects hair dye and permanent wave solution interaction with the hair shaft. Most importantly, the amount of oxymelanin present equates with the degree of hair shaft photoaging.

Oxymelanin is a photodegradation pigment that accounts for photoyellowing in hair.

UV radiation also damages the hair lipids. It is for this reason that photodamaged hair is dull and dry. Intact hair lipids are required to coat the hair shaft, imparting shine and manageability. Manageability is the ease with which the hair shaft can be styled. Hair that is devoid of intact lipids is subject to static electricity, fractures easily with combing friction, and appears frizzy.

Hair photoaging and endogenous protection

To understand hair photoaging, it is necessary to understand how UV radiation interacts with the proteins of the hair shaft. Hair is a complex, nonliving structure with an outer cuticle that provides a hard protective barrier for the inner cortex. The cortex is composed of fibrillar proteins, which are responsible for the

mechanical strength of the hair shaft. Melanin pigments are contained in the cortex, embedded in an amorphous protein matrix. Sometimes the hair shaft may contain a medulla, but the function of this inner structure is largely unknown and is found less frequently in mature hair shafts. Sunlight damages the strength of the hair shaft by increasing the scission of the cystine disulfide bonds. The hair disulfide bonds prevent the hair shaft from fracturing with minimal trauma. Thus, the primary photoaging effect of sunlight on hair is physical weakening of the shaft.

The protein structure of the hair is damaged by UV radiation.

The second major effect of sunlight on the hair shaft is oxymelanin production, as previously mentioned. Although oxymelanin leads to pigment dilution and lightening of hair color, it is the pigments within the hair shaft that provide the only source of endogenous photoprotection. The natural pigments actually prevent disulfide bond disruption, preserving the strength of the hair shaft, even though a hair color change occurs. In other words, chemical alterations in the hair pigment function to protect the protein structural backbone of the hair. Hair contains the original pigment sunscreen, which is an area of rapid technical development in the commercial skin sunscreen industry.

The third major effect of sunlight on hair is bleaching, or lightening, of the hair color (3). Brunette hair tends to develop reddish hues due to photo-oxidation of melanin pigments, whereas blonde hair develops photoyellowing. The yellow discoloration is due to photodegradation of cystine, tyrosine, and tryptophan residues within the blonde hair shaft (4). Furthermore, hair treated with permanent or semipermanent hair dyes may also shift color when exposed to UV radiation (5).

Topical hair photoprotection

Until recently, the main approach to topical exogenous hair photoprotection was no different from skin photoprotection. UVB and UVA sunscreens were added to formulations designed for hair use, such as instant conditioners, styling gels, and hair sprays. The main problem with this topical approach to hair photoprotection was the failure to create an even film protecting the entire surface area of every hair on the head. This is virtually impossible because the collective surface area of the hair on a human head is huge. Another challenge is creating a sunscreen formulation that will adhere to the hair cuticle. Furthermore, coating each and every hair shaft with an equal thickness of sunscreen without making the hair appear limp or greasy is a cosmetic challenge no hair care product has yet overcome.

A photoprotection rating system has been proposed for hair care products known as an HPF or hair protection factor (6). This is similar to the concept of the sun protection factor (SPF), or skin protection factor, except that tensile strength assessments of the hair shaft are used for grading instead of sunburn assessment. HPF ratings follow a logarithmic scale from 2 to 15. At present,

this system is not being used. Hair care products are true cosmetics and are not included in the sunscreen monograph. This dilemma led cosmetic researchers to question whether photoprotection could be imparted to the hair shaft through another means, perhaps through the internal structure of the hair shaft.

Intrinsic hair photoprotection

An analysis of the internal structure of the hair shaft led to some interesting insights into possible mechanisms of photoprotection. The natural color of the hair shaft results from a combination of visible light absorption and light scattering abilities of the pigment granules distributed within the cortex. Exposure of the hair to sunlight leads to lightening of the hair color, known as bleaching, and ultimately damage to the fiber itself, as previously discussed. The pigment lightening is obvious when looking at a woman with long brown hair. The distal hair tips have a reddish hue, while the proximal hair shafts have a brown hue. This loss of pigment and the resultant amino acid changes appear to predispose the hair shaft to more accelerated photoaging. This led the cosmetics industry to question whether alterations in hair color could be used to enhance intrinsic hair photoprotection.

Industry hair researchers have demonstrated that unpigmented hair is much more susceptible to UV-induced damage than pigmented hair, meaning that the color granules are providing some protection from oxidative damage. Hair protein degradation is induced by light wavelengths from 254 to 400 nm (7). Chemically, these changes are thought to be due to ultraviolet light-induced oxidation of the sulfur molecules within the hair shaft (8). Oxidation of the amide carbon of polypeptide chains also occurs, producing carbonyl groups in the hair shaft (9). This is explained by the fact that the rate of cystine disulfide bond breakage due to environmental exposure is greater for unpigmented than pigmented hair. Thus, white hair and advanced gray hair are more susceptible to the damaging effects of UV radiation than youthful pigmented hair. Even though it has been traditionally held that hair dyes are damaging to the hair shaft, the photoprotective effects of replacing hair shaft pigments may offset some of this damage.

Pigmented hair is much less susceptible to UV photodamage than unpigmented hair.

Methods of enhancing intrinsic photoprotection

If natural pigments within the hair shaft provide photoprotection, it may be possible to preserve the hair's cosmetic value with synthetic pigments deposited on the cuticle and within the cortex via hair dyes. There are two types of hair dyes that can artificially increase the hair shaft pigments: semipermanent and permanent hair dyes.

Semipermanent hair dyes are composed of a combination of dyes, such as nitro phenylenediamines, nitro aminophenols, and aminoanthraquinones. These dyes are left on the hair for 25 minutes and used in combination to arrive at the final desired color. As might be imagined, there is damage that occurs to the hair fibers upon dyeing. However, because the hair is exposed to longer periods of UV radiation, the initial damaging effect

of the dyeing procedure is outweighed by the antioxidant effect of the color deposited on and in the hair shaft. Thus, white hair that is undyed exhibits more mechanical strength damage from UV radiation than semipermanently dyed hair after four days of exposure. This means the darker the hair dye color, the more photoprotection provided. The semipermanent hair colors are a mixture of dyes designed to create the desired final color. Usually, a mixture of reds and blues is used to create brown. It is interesting to note that the red pigments produce better photoprotection than the blue pigments. This is probably due to the red dyes absorbing the more energetic part of the UV spectrum than the blue dyes.

This same effect was also observed with permanent hair dyes. Permanent hair dyes penetrate more deeply into the hair shaft, creating color because of an oxidation/reduction reaction. They, too, act as photoprotectants; however, the permanent hair dyes are more damaging due to the hydrogen peroxide and ammonia used to allow the chemicals to penetrate the hair shaft. It is somewhat paradoxical that the more alkaline dyes, which produce more cuticular and structural hair shaft damage, provide better photoprotection. This is due to the ability of permanent hair dyes to act as passive photofilters by reducing hair fiber protein damage through incident light attenuation. The dye molecule absorbs light energy, which promotes it to a more excited state, followed by a return to the ground state via radiative and nonradiative pathways. This is the mechanism by which hair dyes can function as antioxidants to prevent hair from weakening through disulfide bond dissolution (Figure 33.1).

Brown permanent hair dyes provide excellent photoprotection.

Sunscreen-containing hair care products

There are a variety of hair care products, in addition to hair dyes, which can provide some hair photoprotection. These include shampoos, instant conditioners, deep conditioners, and hair-styling products. Some of the higher-priced prestige shampoos are incorporating sunscreens into their formulations designed for dyed hair. As mentioned previously, because UVA radiation alters the color of dyed hair, these shampoos are marketed as products that extend the life of the hair dye. They may prevent dyed blonde hair and dyed brunette hair from developing red hues or brassy overtones. Certainly, the delivery of photoprotection from a shampoo is challenging because the surfactant must be completely rinsed from the hair prior to styling.

A better approach to hair photoprotection is through the use of conditioners. Some of the newer conditioners based on silicones, such as dimethicone, can indeed deposit a thin film of both conditioner and sunscreen on the hair shaft. Although it is likely that the film will not evenly coat each hair shaft, sunscreens have better substantivity when applied in this manner. Instant conditioners that are applied immediately following shampooing and rinsed prior to towel drying are not as effective as deep conditioners that remain on the hair for 15 to 30 minutes. The longer the conditioner remains on the hair shaft, the more likely the added sunscreen ingredient will adhere to the hair. Thus, the contact time of the conditioner with the hair will determine the degree of photoprotection obtained, to some extent.



FIGURE 33.1 (A) Dyed brunette hair is more photoresistant than gray hair because the dye within the hair shaft is able to absorb UV radiation, preventing hair protein damage. (B) Dyed blonde hair is more susceptible to photodamage than dyed brunette hair.

Styling products that are applied following drying of the hair are probably the most effective in terms of delivering photoprotection. These include blow-drying conditioners, styling gels, and hair sprays. Blow-drying conditioners are massaged through the hair when wet, just prior to drying, to act as a protectant against heat damage. If they are massaged thoroughly through the hair, they may provide excellent photoprotection. Styling gels that may be applied to only certain areas of the hair, such as the hair shaft roots or tips, may not provide much protection due to limited contact. This is also the case with hair sprays that are applied as a thin film to a finished hairstyle.

Sunscreen-containing hair sprays and conditioning sprays can reduce hair UV damage.

The degree of photoprotection offered by hair care products is minimal at best. A more thorough, thicker application will result in better photoprotection, but this is difficult given the massive surface area of a head of hair (10). Many currently available sunscreen actives are not substantive to hair, meaning that they do not stick or adhere to the hair well, preventing sunscreen deposition and facilitating removal. A better approach to hair photoprotection may be the use of clothing, such as a hat, scarf, or umbrella. Much research and development remains to be done in the realm of hair photoprotection.

Summary

New insights into semipermanent and permanent dyes as a means of hair photoprotection are intriguing. Many of the female patients who present to the dermatologist for suggestions regarding hair growth are mature with gray hair. The temptation is to bleach the hair, thus removing any remaining pigment granules to produce hair color lightening. Hair that is gray or bleached

possesses fewer pigment granules than brown hair and is thus more susceptible to photoaging (11). Darker hair colors are more resistant to photodegradation. Thus, it may be beneficial to mature women who enjoy the outdoors to dye their hair a darker color to prevent hair shaft weakening from UVA exposure (12). Currently, hair dye is the best sunscreen available. Sunscreen-containing shampoos and conditioners offer limited photoprotection at best (13).

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ALOPECIA AND COSMETIC CONSIDERATIONS

The practicing dermatologist frequently encounters patients who express concerns regarding hair loss. Generally, patients state their usually thick, shiny, and manageable hair has become thin and difficult to style. If this is the dermatologist's first consultation with the patient, verifying the degree of hair loss is difficult. It is estimated that an individual must lose approximately 50% of their hair before an unacquainted observer can examine the scalp and note a reduction in the hair shaft number. In the hair cosmetic industry, the number of hairs required for hair fullness is listed in [Table 34.1](#). Notice that the lighter the hair color, the greater the number of hairs that are required for visually thick hair.

Red hair requires fewer shafts than blond hair to appear full because red hair shafts have the thickest diameter, whereas blond hair shafts are the thinnest. This is of interest because more blond and brown-haired patients seem to present for hair loss issues than those with black or red hair, in ZDD's practice. Nevertheless, hair loss is a complex dermatologic problem mediated by internal and external factors. It may be difficult for the dermatologist to know where to begin when assisting the distressed patient who is complaining of hair loss. An algorithm must be in mind when the patient requests help to efficiently and logically address the problem. This chapter describes an approach to the patient with diffuse, nonscarring hair loss, which can be addressed medically and cosmetically. Scarring causes of hair loss are beyond the scope of this book and unfortunately must be addressed using hair prostheses, discussed in a prior chapter (1).

Evaluation of external vs. internal hair loss causation

It is of utmost importance to begin an evaluation of the hair loss patient by differentiating internal versus external factors. Generally, internal causes of hair loss result in shedding of the complete hair shaft, including the bulb. If the bulb is elongated, the hair has been shed during the anagen phase, indicating anagen effluvium. On the other hand, if the bulb is club-shaped, the hair has been shed during the telogen phase, indicating telogen effluvium.

Patient hair loss must be evaluated for external and internal causes.

External causes of hair loss resulting from grooming practices or cosmetic chemical hair treatments weaken the hair shaft so that breakage occurs. These broken hair shafts do not contain

TABLE 34.1: Number of Hairs by Hair Color for Hair Fullness

Blond: 140,000 hairs
Brown: 110,000 hairs
Black: 108,000 hairs
Red: 90,000 hairs

the bulb. However, abnormally formed hair shafts, found sporadically or in association with genodermatoses (trichoschisis, trichorrhexis invaginata, pili torti, monilethrix, and trichorrhexis nodosa) can also result in decreased hair shaft strength and subsequent breakage. Examination of several plucked hairs under the microscope is necessary to ensure normal hair structure.

Hair loss can be easily distinguished from hair breakage by performing 10 hair pulls over various areas of the scalp. The hair pull is performed by grasping the hair shaft close to the scalp with the fingers and firmly pulling over the length of the shaft. Removed hairs are examined for the presence and formation of the bulb. If more than six hairs are removed per pull, excessive hair loss is present. This procedure also provides an opportunity to ascertain that no localized areas of total hair loss are present, allowing elimination of tinea capitis, alopecia areata, and so on as the cause.

Evaluating the magnitude of hair loss

Hair pulls in the office can be misleading, especially if the patient has shampooed prior to being examined and has removed the loose or broken hairs. It may prove difficult to get an accurate estimate of the magnitude of the hair loss from the patient because most are not aware that a normal individual may lose approximately 100 to 125 hairs per day. If grooming of the hair is infrequent, shampooing may cause a loss of up to 200 hairs.

Normal hair loss is around 100 to 125 hairs per day.

Information on the magnitude of the loss can best be obtained by having the patient collect all hair lost for four consecutive days and place each day's loss in separate envelopes, noting days on which shampooing was performed. The hair should be brushed or combed over the sink and the hair collected from the sink and also from the brush or comb. Hairs should also be removed from the drain following shampooing. The dermatologist can examine each day's loss, noting both the amount and the presence or absence of the hair bulb.

Internal causes of hair loss

Once it has been determined that the hair loss indeed exceeds 100 hairs per day and that normally formed hairs are being shed diffusely from a nonscarred scalp with an intact bulb, anagen effluvium and telogen effluvium must be considered. Anagen effluvium is generally due to systemically administered medications, such as chemotherapy agents, which act as toxins and disrupt the growing hair follicle. Telogen effluvium, on the other hand, is due to an increased number of hair follicles prematurely exiting the anagen phase or hair cycle synchronization (2). Premature anagen exit can be due to medications, such as coumarin or heparin, whereas hair cycle synchronization occurs during pregnancy and with oral contraceptive use.

TABLE 34.2: Internal Causes of Diffuse, Nonscarring Alopecia

1. *Hormonal causes*: Postpartum, oral contraceptives, menopause, hormone supplementation
2. *Physical stress*: Surgery, illness, anemia, rapid weight change
3. *Emotional stress*: Psychiatric illness, death of family member
4. *Endocrinopathy*: Hypothyroidism, hyperthyroidism, hypoparathyroidism, hyperparathyroidism
5. *Oral medications*
 - a. *Blood-thinning agents*: Heparin, coumarin
 - b. *Retinoids*: High-dose vitamin A, isotretinoin, etretinate
 - c. *Antihypertensive agents*: Propranolol, captopril
 - d. *Miscellaneous*: Quinacrine, allopurinol, lithium carbonate, thiouracil compounds

The causes of diffuse, nonscarring telogen hair loss to be considered are summarized in Table 34.2. Most of these considerations can be eliminated by a review of systems and some basic laboratory work. Anemia, thyroid abnormalities, and many illnesses can be evaluated by obtaining a complete blood count with differential, thyroid panel, and chemistry panel to include liver function studies. If deemed clinically necessary, an antinuclear antibody can also be obtained to rule out any collagen vascular diseases. A complete history can determine the nature of any severe physical or emotional stress and document the ingestion of prescription or over-the-counter medications or vitamin supplements.

Physical or emotional stress

Surgeries, febrile illnesses, and severe emotional stresses must be evaluated by the dermatologist for the past six months. In many cases, a three-month delay is present between the actual event and the patient's onset of hair loss. Furthermore, there may be another three-month delay prior to the return of noticeable hair regrowth. Thus, the total hair loss and regrowth cycle can last six months or possibly longer. Patients should be educated as to when a reasonable regrowth can be expected.

Diet considerations

Hair loss due to rapid weight loss is not uncommon. Many times, patients embark on franchised diet programs administered under the direction of a physician with prescribed meals and dietary supplements. Sometimes patients are told that vitamin supplements purchased as part of the weight loss program are necessary to prevent hair loss associated with dieting. From a dermatologist's standpoint, however, the vitamins cannot prevent hair loss associated with rapid, significant weight loss.

Hormonal considerations

Hormonal causes of hair loss deserve special attention in the female patient. Many women do not realize that hair loss can present postpartum or following discontinuation of oral contraceptives. It is important to remind the female patient that hair loss may be delayed by three months following a hormonal status change, and another three to six months may be required for regrowth to be fully appreciated.

Menopausal women with decreased ovarian estrogen production may also experience diffuse hair thinning, generally more prominent over the top of the head with bitemporal recession. A thin strip of hair at the anterior hairline is usually spared. A follicle-stimulating hormone (FSH) level can be obtained to document the onset of menopause, although menopausal hair thinning may be present even though FSH levels are not low. Estrogen

replacement can prevent further loss but has not been shown to promote regrowth. Other treatments, such as topical minoxidil, may be indicated.

Lastly, it is important to rule out any hormonal abnormalities in the female patient. Inquiring as to the regularity of menses and the presence of infertility problems can uncover ovarian hormonal failure or the presence of excess endogenous androgens. Questions should also be directed concerning whether the patient is ingesting oral steroids with androgenic effects. If necessary, hormone levels such as free testosterone and dehydroepiandrosterone sulfate (DHEA-S) can be drawn, and an endocrinologic evaluation initiated (3). A more detailed discussion of hormonally induced hair loss is beyond the scope of this book (4, 5).

External causes of hair loss

Shed hairs without a hair bulb are considered broken hairs. Hair breakage is generally due to external factors; however, abnormalities in hair shaft formation must be eliminated. Table 34.3 contains the technical terms used to describe hair shaft abnormalities and a definition of the term (6). Trichoschisis, trichorrhexis invaginata, pili torti, and monilethrix are all abnormalities intrinsic to the hair shaft (7). Trichoptilosis and trichonodosis may be due to cosmetic manipulation of the hair. Trichorrhexis nodosa may be due to intrinsic abnormalities or cosmetic manipulation. All of these conditions predispose the hair to breakage, which can become magnified by extensive grooming, chemical waving procedures, or permanent dyeing.

The hair shaft should be examined under the microscope in the alopecia patient to evaluate intrinsic malformations in the hair shaft and abnormalities due to cosmetic procedures.

TABLE 34.3: Structural Hair Shaft Abnormalities

Intrinsic abnormalities

1. *Trichoschisis*: A clean, transverse fracture across the hair shaft through both cuticle and cortex. Congenital forms seen in trichothiodystrophy characterized by hair with an abnormally low sulfur content.
2. *Trichorrhexis invaginata*: A nodular expansion of the hair shaft in which a ball-in-socket joint is formed; also known as bamboo hair. Congenital forms are seen in Netherton's syndrome.
3. *Pili torti*: A flattened hair shaft that is twisted through 180° on its own axis.
4. *Monilethrix*: Elliptical nodal swellings along the hair shaft with intervening, tapering constrictions that are nonmedullated.

Extrinsic abnormalities

1. *Trichoptilosis*: A longitudinal splitting or fraying of the distal end of the hair shaft, also known as split ends.
2. *Trichonodosis*: Knotting of the hair shaft.

Intrinsic or extrinsic abnormalities

1. *Trichorrhexis nodosa*: Small, beaded swellings associated with a loss of the cuticle. Congenital forms seen in argininosuccinic aciduria and Menkes disease but may also be due to cosmetic hair shaft manipulation.

Gross hair shaft evaluation

Once it has been determined that the primary cause of hair loss is breakage, the patient's scalp hair should be grossly examined to assess the state of the hair shafts. An overall impression should be formed:

1. Does the hair have shine?
2. Does the hair feel soft?
3. Does the hair lay in an orderly fashion?
4. Is there an evidence of hairstyling aid being used?
5. Does the hair color appear natural and match the patient's eyebrows, eyelashes, and body hair?
6. Is the hair curly or straight?
7. How long is the hair and when was it last cut?

Hair shine

Hair possessing an intact cuticle with closely overlapping cuticular scales is shiny, healthy hair. It is the smoothness of the overlapping scales that promotes light reflection, interpreted by the eye as shine. Normal grooming processes such as combing and brushing result in loss of cuticular scales, which is more pronounced at the distal hair shaft (8). This process is known as "weathering" and is accelerated by overly aggressive grooming and chemical processing (9, 10) (Figure 34.1).

Hair softness

Hair softness, also due to an intact cuticle, creates a smooth hair shaft surface. Permanently waved or dyed hair must have a disrupted cuticle to allow penetration of the waving lotion or dye. Thus, chemically processed hair never feels as soft as virgin hair, even though hair conditioners attempt to temporarily smooth the disrupted cuticle. Harsh-feeling hair is evidence of cuticular damage.

Hair frizziness

Hair that has been chemically processed is also prone to static electricity. This allows the hair to appear frizzy and unruly, especially at the distal hair shafts. Generally, chemicals applied to the hair penetrate better at the distal hair shaft due to less cuticular scale. A well-educated cosmetologist is aware of this fact, especially when processing long hair, and will apply the chemicals to the scalp first and then dilute the product prior to applying the solutions to the distal hair shafts. Overprocessed hair appears frizzy and is severely weakened.

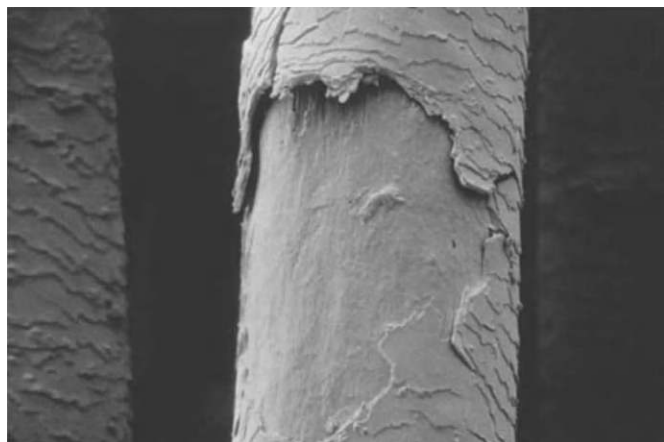


FIGURE 34.1 Weathered hair is characterized by cuticle loss.

Use of styling aids

It is important not to be misled when evaluating hair shine, softness, and frizziness using hairstyling aids such as hair spray, mousse, and styling gels. These products usually contain a polymer that forms a thin film over the hair shafts, imparting shine and stiffness. Combing the hair will remove the polymer film, which will appear as tiny white flakes throughout the hair, but the true state of the hair shafts can be better appreciated.

Use of hair coloring

Unfortunately, some patients who dye their hair will not openly admit that they use hair coloring. Furthermore, many patients do not know what kind of dye has been applied to the hair and whether any bleaching has occurred. This means that the dermatologist must rely on his or her powers of observation.

Hair color should be compared with eyelashes, eyebrows, or other body hair. (It is possible to dye the eyelashes and eyebrows.) If the scalp hair color is lighter than the hair of other body parts, bleaching has occurred. If regrowth is present at the scalp, a permanent hair color has been used. If the color appears to gradually vary from the proximal hair shaft to the distal hair shaft with the presence of some grayish hairs, a semipermanent hair color has been used. If the hair has a yellowish cast, a metallic hair color has been used. These guidelines can be used to initiate conversation when obtaining a patient history.

Degree of curl

The degree of curl the hair possesses should also be evaluated because tightly curled hair is more prone to breakage. It should also be determined whether the curl is natural or due to permanent waving. Hair that has been chemically waved appears straight at the scalp and curlier at the ends. Hair that is naturally curly will have an even curl throughout the length of the hair shaft. If the hair has been chemically waved, the type of permanent wave and length of processing should be obtained either from the patient or from the salon. These factors cannot be determined by visual examination.

Hair length

Lastly, it is important to note the length of the hair and ask the patient when it was last cut. Longer hair is subject to more weathering, and so an increased breakage is expected. Patients also evaluate hair loss by the amount of hair in the brush or sink; longer hair shafts will create a larger lump than shorter hair shafts, even though the same number of hairs has been lost. Thus, patients with longer hair tend to overestimate their actual loss. Hair that has been cut frequently shows less evidence of damage than infrequently cut hair. If the damaged hair shaft ends have been removed prior to visiting the dermatologist, the full extent of hair damage may not be appreciated; however, chemical processing damages the whole hair shaft and the evidence of damage will reappear shortly.

Microscopic examination of a hair shaft

The gross findings should be confirmed by a microscopic examination of a shed hair shaft. The cuticular scales should be examined to note if weathering is present. The decrease or absence of scales can confirm the gross observation that the hair is dull, harsh, and frizzy. If the cuticular scales are greatly decreased at the distal hair shaft, trichoptilosis results from exposure of the soft medulla. If trichonodosis is observed, hair twisting or teasing may be the cause of the knots, predisposing the hair to breakage. If trichorrhexis nodosa is present and not part of a genodermatosis, this suggests an extensive cuticular loss.

Cosmetic techniques for minimizing the hair loss

Hair grooming includes cleansing, drying, combing, brushing, and styling of the hair. Although any manipulation of the hair shaft can cause breakage, loss can be minimized by recommending proper grooming practices to the patient.

Proper grooming practices can minimize hair loss.

Hair cleansing

Cleansing the hair should be done only when the hair has dirt or excess sebum. If sebum production is minimal and the patient has a sedentary lifestyle, daily washing is not necessary for good hygiene. Patients should select a shampoo appropriate for their hair type: normal, oily, dry, fine, damaged, or chemically treated. These labels usually appear on the outside of the shampoo bottle. If the patient with normal to minimal sebum production insists on daily shampooing, a dry hair shampoo with less detergent action should be recommended. Aggressive removal of sebum results in hair that tangles readily, appears dull, and attracts static electricity.

Hair conditioning

An instant conditioner or a cream rinse can be valuable in minimizing hair loss by detangling the hair, especially long hair (11). Patients who have excess sebum production may prefer a cream rinse over a conditioner. All formulations of instant conditioners are good at detangling hair by smoothing the cuticle and reducing friction. However, if the hair has been severely damaged and the cuticular scales are sparse with the presence of trichoptilosis, only a protein-containing conditioner can penetrate the hair shaft and temporarily mend split ends. This is due to the substantivity of protein conditioners for hair keratin.

Hair drying

It is best if the hair is allowed to dry without externally applied heat; however, many patients wish to speed up the drying process or style their hair while drying. Heat-damaged hair from improper dryer use appears frizzy and curly at the ends. It may also develop an abnormality known as “bubble hair” (12) (Figure 34.2). Any tension applied to the burned hair shaft will cause the hair to break in tiny fragments, some of which can be crushed between the fingers. Heat damage can be avoided by using the lowest heat setting and holding the nozzle at least 6 inches from the scalp. A specially designed vented blow-drying brush should be used to prevent high temperatures along the brush.

Hair combing and brushing

Hair shafts are subject to fracture most when they are wet due to increased elasticity. It is much easier to stretch a wet hair shaft to the breaking point than a dry one. Therefore, hair should be initially detangled with the fingers and slightly dried prior to detangling with a wide-toothed comb. Brushes should not be used for detangling. Combing and brushing should be kept to a minimum. The idea that 100 brush strokes a day are beneficial to the hair is mistaken. Combs should be selected for their smooth, widely spaced teeth so that they glide freely through the hair. Brushes should have widely spaced bristles with rounded tips for the same reasons. Whether the bristles are synthetic or natural is less important than the spacing of the bristles.

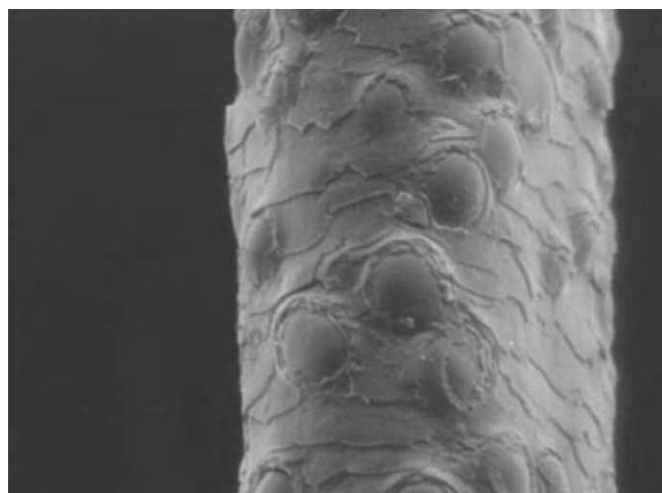


FIGURE 34.2 Bubble hair forms when the hair is rapidly heated and the water within the hair shaft turns to highly energetic steam and exits the hair shaft, creating a bubble.

Hair shafts are most subject to fracture when wet due to increased elasticity and stretching of the hair beyond the breaking point.

Hairstyling

Hairstyles should be loose to minimize breakage and not require excessive hairpins or combs. All hair pins should be rubber coated with smooth edges so that the hair is not broken as the clasp is closed. Unfortunately, the clasp must hold the hair tightly, or it will not remain in place. Rubber bands should not be used in the hair as they are difficult to remove.

There are several common presentations of patients who are experiencing hair breakage due to hairstyling. The first is the patient who wears her or his hair in a ponytail or braid and claims decreased hair growth. Examination of the hair shows hair shafts fractured at the same distance from the scalp. This is due to repeated breakage where the hair clasp is placed. A second presentation is the patient who wears braids on the scalp, also known as cornrows, and notes thinning at the front hairline. In this instance, the hair is broken due to maximum tension at the front hairline; traction alopecia may also be present. The third presentation is the patient who has had hair extensions glued or woven into their natural hair. The weight of the extensions can cause hair breakage and traction alopecia. It may be necessary to question the patients on hairstyling practices because they may wear their hair differently on the day they visit the dermatologist.

A summary table of hairstyling practices that can be shared with patients is presented as Table 34.4.

Hair appliances

Burning of the hair and subsequent breakage can also be caused by heated hair appliances: curling irons, crimping irons, straightening irons, and heated curlers. Most patients prefer to use these appliances at their hottest setting because this produces the tightest, longest-lasting curl but also induces hair damage to the greatest extent. This burning is minimized if a lower heat setting is chosen. Hair that is burned with a heated appliance appears

TABLE 34.4: Hairstyling Tips for Alopecia Patients

1. Cut hair frequently to remove hair damaged by grooming, environmental exposure, shampooing, chemical processing, etc.
2. Handle the hair as little as possible. Hair is healthiest when not manipulated.
3. Do not pull, yank, or stretch wet hair. Wet hair is more elastic than dry hair and can be easily stretched to the breaking point.
4. Comb hair gently with a wide-toothed comb with smooth teeth that easily glide over the hair.
5. Brush hair as little as possible, selecting a brush with smooth, ball-tipped, coarse, bendable bristles.
6. Remember that less is more when it comes to hair grooming.

frizzy at the ends. Table 34.5 summarizes the effect of heat on the hair shaft.

Permanent hair coloring

Darkening the natural hair color is less damaging than lightening the natural hair color because the original eumelanins and pheomelanins are not removed. Any lightening of the hair color requires the use of bleaching to remove the existing pigments. In general, the more bleaching is required to achieve the final hair color, the weaker the hair shaft at the end of the chemical process. Many patients erroneously think that if the bleached blonde hair is redyed to its darker original color, it will be healthier. This is not true. Any further dyeing only contributes to additional weakening of the hair shaft.

Permanent waving of hair

Permanent waving of the hair is more damaging than dyeing because the protein structure of the hair shaft is actually degraded and reconstructed in a new form. Damage can be minimized, however, by wrapping the hair loosely around larger curlers. This results in a looser, shorter-lasting curl, but breakage is minimized (Figure 34.3).

The processing time can also be shortened, which decreases the degree of bond breaking. The processing time is checked by performing a “test curl.” The test curl is a rod, usually selected at the nape of the neck, where the hair is periodically unwound to determine if the desired amount of curl has been achieved. Not all cosmetologists use a test curl, but it is highly recommended. It is also recommended that the test curl not be placed at the nape of the neck, but rather at the front hairline. Traditionally, the nape of the neck is chosen because hair here is more difficult to permanently wave than in any other area of the scalp. If the appropriate amount of curl is present at the nape, then the rest of the scalp will also be curled. However, hair at the front hairline

TABLE 34.5: Damaging Effects of Heat on Hair

1. Heat denatures the keratin protein structure of the hair shaft.
2. The water in the hair shaft allows the hair to function as an elastic material. Heat turns this water to steam.
3. The highly energetic steam escapes from the hair shaft, physically removing the cuticular scale.
4. The removed cuticular scale exposes the underlying cortex, which has less structural strength than the cuticle.
5. Hair that is heat-damaged easily fractures and appears frizzy at the ends.
6. Heat-damaged hair is known as bubble hair and cannot be repaired.



FIGURE 34.3 A proper technique for wrapping hair around mandrels for a permanent waving procedure.

curls more readily and may be overprocessed by the time the nape has curled. This accounts for patients noting more breakage at the anterior hairline.

Many patients both permanently dye and wave their hair. Although the damage produced by these procedures is additive, it can be minimized by allowing 10 days between procedures and permanently waving the hair first, followed by dyeing the hair.

Camouflage techniques for female pattern hair loss

Female pattern hair loss affects susceptible women beginning at puberty, with noticeable thinning present by age 40. These women present with hair loss over the entire scalp, but the thinning is most prominent over the frontoparietal areas, with sparing of a thin fringe along the anterior hair line. This pattern was first illustrated by Ludwig (13). Camouflaging hair loss over the top of the scalp presents a greater challenge than that over the sides of the scalp. Cosmetic methods of camouflaging female androgenetic alopecia should be combined with appropriate medical treatments (14). Only cosmetic approaches for androgenetic alopecia are discussed: hairstyling, hairstyling products, hair permanent waving, hair coloring agents, hairpieces, and hair additions. Camouflaging ideas are presented in Table 34.6 in a summary table that can be shared with patients.

TABLE 34.6: Scalp Camouflage Tips for the Alopecia Patient

1. Curling the hair allows less hair to cover more scalp.
2. Crayons can be rubbed on the scalp to minimize the color contrast between the lighter balding scalp and darker hair.
3. Wool fibers in the form of a powder or spray will adhere to remaining hair shafts to thicken the appearance of the hair and camouflage the underlying scalp temporarily.
4. Avoid pulling the hair with braids or ponytails tightly to the scalp.
5. Use hair spray to style hair over areas of hair thinning.
6. Avoid a distinct part that exposes areas of hair thinning. Select a hairstyle that does not require a distinct part.
7. Use leave-in hair conditioners that are applied to towel-dried hair and not rinsed to apply a film over remaining hair physically thickening the hair shaft temporarily until the next shampoo.

Hairstyling

Careful hairstyle selection can minimize the appearance of female-pattern hair loss. Because the hair is thinned predominantly on the top of the head, styling techniques should be aimed at adding volume and fullness in this area. The perception of thick hair is based on the distance that the hair stands away from the scalp, but hairstyling and styling products can create the illusion of fullness.

Two styling techniques are valuable for creating the illusion of hair volume: curling and back combing. Curled hair does not lay as close to the scalp as straight hair, and therefore appears fuller. Temporary curls can be created by heat styling with a blow-dryer and a round brush, setting wet hair on rollers, wrapping hair around heated rollers or a curling rod, and forming pin curls close to the scalp. Tighter curls will yield more hair fullness.

Back combing involves combing the hair in the opposite direction from which it would normally lay on the scalp. In most women, the hair pattern is such that the hair on the top of the scalp lays forward. Combing the hair backward from the front of the head to the crown lifts the hair, creating the illusion of volume. The hair will not stay in this unnatural position for long; therefore, styling aids are necessary for the hair to hold this shape.

Teasing is another technique that was used to create volume, which was popular in the 1960s “beehive” hairstyles. Teasing involves combing the hair from the distal to proximal hair shaft using a fine-toothed comb or teasing brush to create tangles between the hair shafts. These tangles, or “rats,” as they are known, allow the hair to stand away from the scalp. Teasing, however, can result in the disruption of the hair shaft cuticle and accelerate hair breakage. It is important to avoid hair breakage in areas where the hair is already thinned.

Hairstyling products

Hairstyling products can aid in creating the illusion of fullness by allowing the hair to stand away from the scalp. Available styling products include styling gels, sculpturing gels, mousses, and hair sprays. Styling gels, sculpturing gels, and mousses are generally applied to towel-dried hair, whereas hair sprays are used to improve the hold of a finished hairstyle. Sculpturing gels provide a stiffer hold than styling gels, which provide a better hold than mousses.

A small amount of gel or mousse is massaged into the base of the hair shafts, and then the hair is dried with a blow-dryer while combing the hair away from the scalp. This will increase the ability of the hair to stand away from the scalp, creating the illusion of volume. The styling products lose their hold once the hair is combed or gets wet, so reapplication is necessary each time the hair is styled.

Hair spray can be used to keep the final hairstyle in place. For example, after backcombing the hair, it can be liberally sprayed to allow the hair to fall backward instead of forward on the forehead.

Permanent waving

Permanent waving of the hair increases the apparent hair volume, allowing less amount of hair to cover more area of the scalp due to increased curl. Thus, a permanent wave in the frontoparietal area can nicely camouflage the female pattern hair loss. However, chemical curling damages the hair shaft by decreasing its strength, degrading its structure, and causing protein loss. This damage can be minimized if the permanent wave is performed with care.

TABLE 34.7: Hair Dyeing Tips for the Alopecia Patient

1. Dye hair as infrequently as possible. All hair dyes are damaging to the hair shaft.
2. Dye hair within your natural color group, perhaps selecting shades that are no more than two shades lighter or two shades darker. This will minimize hair shaft damage.
3. Dye hair darker rather than lighter, if possible. Bleaching is more damaging to the hair shaft.
4. Avoid highlighting hair or selectively bleaching certain hair strands. This promotes hair breakage in the highlighted hair strands.
5. Always permanently wave or straighten hair first and wait two weeks, at least, before undergoing a hair dye procedure. If possible, avoid permanent waving or straightening.
6. Do not wash hair for at least 4–5 days after hair dyeing.
7. Use a shampoo for chemically processed hair to extend the life of the hair dye.
8. Protect dyed hair from UV exposure because the UV will undesirably lighten the hair color.

Hair shaft damage can be decreased by wrapping the hair loosely around larger curling rods, resulting in a looser curl that is shorter lasting but also less likely to fracture the hair shaft. Another method of decreasing hair shaft damage is to shorten the processing time, which decreases the degree of bond breaking. It is also advisable to allow as much time as possible between permanent waving procedures.

Dyeing

Hair color lightening can be an effective camouflage technique for female pattern hair loss because it blends very well with a fair scalp. Of all the hair coloring types available, only permanent hair dyes can achieve color lightening, but permanent hair dyes can also cause the most damage to the hair shaft. A summary table of hair dyeing tips that can be shared with patients is presented in Table 34.7.

Hairpieces

A valuable hairpiece for the female with androgenetic alopecia is a hair thickener, which sits on top of the head, to provide additional hair in the frontoparietal region. The hair is wefted to a mesh through which the patient can pull her own hair to both anchor the hairpiece and provide a natural appearance. This type of hairpiece costs between \$30 and \$100, depending on whether it is constructed of synthetic or natural human hair.

Hair additions

Hair additions can nicely camouflage frontoparietal thinning but must be used cautiously as the weight of the hair addition can result in traction alopecia, only augmenting hair loss. Hair additions can be expensive, depending on the time required to complete the hairstyle, and are not appropriate for all patients.

Camouflage techniques for male pattern hair loss

The same basic camouflage techniques described previously for female pattern hair loss also apply to male pattern hair loss. However, male pattern hair loss does not spare a thin strip of hair at the anterior hairline (15). This makes re-creation of a natural-appearing anterior hairline more challenging.

Cosmetic techniques for damaged hair

Unfortunately, cosmetically damaged hair cannot be repaired by the body. However, cosmetic remedies may allow the hair to assume an acceptable appearance until new growth occurs. [Table 34.8](#) lists cosmetic suggestions for the common hair problems.

The initial step in advising a patient on cosmetic remedies for hair problems is to ensure that he or she is using the appropriate shampoo. Patients with light-colored hair may note a greenish discoloration following swimming in a pool with copper-contaminated water from copper-containing algicides or copper pipes (16). Low water pH, chlorinated water, and copper contamination all must be present for the hair discoloration to occur. This problem is most pronounced in individuals with bleached hair because the copper is readily absorbed due to the increased content of cysteic acid and other anionic sulfonate groups (17). The use of special shampoos (Clairol, Metalux) or 2% penicillamine shampoos has been reported to be effective in removing the abnormal color (18). Green hair may also be

seen after using copper-contaminated tap water (19) and some tar-based shampoos. Special shampoos can aid in removing the undesirable hue.

Shampoo selection is also important for chemically treated hair, which is dry and more subject to static electricity and tangling than healthy hair. Patients can achieve an improved feel and manageability if a conditioning shampoo is selected. Patients with fine, chemically treated hair, however, may find that a conditioning shampoo works well for about one to two weeks and then leaves the hair limp and without the ability to hold a curl. This is due to excess conditioner on the hair shaft, which is inadequately removed by the mild shampoo. Shampooing with a deep cleaning detergent shampoo once weekly will prevent conditioner buildup. Patients should be encouraged to allow their hair to begin drying prior to combing because wet hair is more elastic and more subject to fracture.

It is recommended that patients with chemically treated hair use an instant conditioner following shampooing. The optimal instant conditioner should contain hydrolyzed animal protein. For severely damaged hair, a deep conditioner is recommended

TABLE 34.8: Cosmetic Suggestions for Common Hair Problems

Problem	Possible Cosmetic Cause	Possible Cosmetic Solution
Hair texture		
Fine, limp hair	Overconditioning	Use instant oily hair conditioner.
Coarse, unmanageable hair	Underconditioning	Use deep conditioner.
Fine, frizzy hair	Underconditioning	Use instant conditioner for dry hair.
Hair contour		
Too curly	Underconditioning	Use instant conditioner for dry hair.
Too straight	Overconditioning	Use instant conditioner for oily hair.
Hair color		
Early graying, less than 15%	Normal process	Vegetable or synthetic semipermanent dye or stain
Yellow-gray hair tones	Gradual loss of eumelanin pigments	Temporary rinse applied following shampooing
Hair grow out	New undyed hair growth	Touch up dye to roots, not entire hair shaft.
Undesirable permanent dye hair color	Dyeing of previously chemically treated hair	Use semipermanent dye to tone undesirable shade until grown out.
Green hair	Copper in swimming pool water	Wear a swim cap, treat pool water, use special shampoo
Hair thinning		
Total scalp	Numerous medical problems	Wig
Top of scalp	Male or female pattern baldness	Partial hair piece, spot permanent wave; use of styling gels, sculpturing gels, or mousse
Decreased length	Slower growth rate, hair breakage	Remove damaged hair to halt inevitable breakage
Hair breakage		
Trichoptilosis	Loss of cuticle on distal hair shaft	Cut damaged hair or use an instant conditioner containing hydrolyzed animal protein for temporary repair.
Trichoclasia	Styling trauma	Avoid tight hair clasps and use ball-tipped styling combs and brushes.
General shaft fragility	Overprocessed hair	Use semipermanent instead of permanent hair dyes; use short permanent wave processing time.
Hair appearance		
Dull	Cuticle irregularities	Use styling glaze or leave-in conditioner.
Lack of body	Fine hair texture	Hair permanent wave, styling gel, or sculpturing gel to increase hold.
Hair texture		
Dry, rough	Overshampooing, permanent wave process time to long	Deep conditioner, shorten permanent wave processing time, do not repeat permanent wave for 3 months
Greasy, slick	Overconditioning or inadequate shampooing	Avoid conditioning shampoos and deep or oily hair conditioners

every two weeks, although too frequent application will render the hair limp. Patients who have a permanent wave will note that heavy conditioners tend to relax the curl, which may or may not be desirable.

Damaged chemically treated hair should be subjected to as little physical stress as possible. Permanent waving alone decreases hair strength by 15%. Styling, including combing and brushing, should be kept to a minimum. Tight hair clasps and hairstyles that pull on the hair shaft should be avoided. Patients should be encouraged not to sleep with brush-type plastic rollers in their hair. Curling irons that clamp the hair to the heated rod should be avoided. In other words, anything that might result in hair breakage should be minimized because chemically treated hair is more likely to demonstrate trichoptilosis and trichoclasia. Recommended styling procedures include the use of a round, ball-tipped brush to curl the hair while blow-drying and heated rollers.

Permanent waving decreases hair strength by at least 15%.

Shine, or gloss, can be restored to chemically damaged hair with a hair glaze or leave-in conditioner. Additional shine and hold can be achieved with a styling gel for minimal hold or a sculpting gel for maximal hold. These products work best when applied sparingly to damp hair and massaged throughout the hair prior to styling.

Many patients undergo another chemical process to improve the appearance of damaged hair. For example, a patient who notes that her permanently dyed hair does not hold a curl may undergo a "conditioning" permanent wave. The end result is more hair damage and further problems. Patients are better advised to opt for an attractive wig, which may cost no more than a permanent wave, until new hair growth occurs.

Cosmetic techniques for medical hair conditions

Numerous inherited medical hair conditions (trichorrhexis nodosa, trichorrhexis invaginata, pili annulati, etc.) exhibit a variety of hair shaft defects. The end result of all these conditions is a fragile hair shaft lacking shine or growing slowly. Defective hair shafts should not undergo permanent dyeing or waving procedures. The end result will be cosmetically poor, and the hair shaft will fracture more readily. However, temporary or semipermanent hair dyes may be used; these coat or minimally penetrate the hair shaft without causing severe internal shaft damage.

Hair manipulation, including shampooing, combing, brushing, and curling, should be minimized. Patients generally do best with a short, straight hairstyle. Infrequent shampooing with a conditioning shampoo, followed by an instant conditioner, decreases breakage and increases manageability.

If the quality of the scalp hair is poor, patients may wish to investigate the possibility of wearing a hairpiece.

Summary

Alopecia is a physically and emotionally disabling condition for many patients. The dermatologist may find it challenging to assist patients with hair loss because of the relatively little knowledge that is available in medical textbooks on the subject and the lack of exposure to hair care issues during residency. This chapter has distilled the medical and cosmetic treatment of alopecia down to each basic step. Familiarity and personal customization of these guidelines can make assisting patients with hair issues rewarding and productive.

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SEBORRHEIC DERMATITIS

Seborrheic dermatitis, which is considered a severe case of symptomatic dandruff, is one of the most challenging conditions for the dermatologist to treat because it is a chronic relapsing disease. Although the exact etiology is known to be the overgrowth of fungal organisms such as *Malassezia globosa* and *M. restricta*, the reason for some exhibiting the inflammatory condition and others not is unknown. Proper treatment requires both prescription agents and proper shampoo selection to prevent recurrence. The biggest challenge is recurrence because these organisms are normal flora on the scalp but can reproduce rapidly in the absence of an intact immune system, using sebum as food for growth. The sebum is broken down into free fatty acids that cause scalp irritation and the signs and symptoms of seborrheic dermatitis. Seborrheic dermatitis is frequently seen in immunosuppressed persons and elderly individuals, especially after myocardial infarction, stroke, and the onset of Parkinson's disease. It is interesting to note that the signs and symptoms of seborrheic dermatitis can be elicited by applying oleic acid, a free fatty acid, to the scalp of susceptible individuals in the absence of fungal organisms. This means that scalp hygiene is key to the prevention of seborrheic dermatitis.

The signs and symptoms of seborrheic dermatitis can be reproduced by placing oleic acid on the scalps of susceptible individuals.

Shampoo selection for seborrheic dermatitis

The treatment for seborrheic dermatitis may include a variety of prescription antifungals, such as ketoconazole, either orally for five days accompanied by sweating to allow the ketoconazole to reach the skin surface via eccrine secretions or topically. Many other topical antifungals, such as clotrimazole, terbinafine, and ciclopirox, may also be prescribed. Usually, topical corticosteroids are added to reduce the inflammation induced by the *Malassezia* produced free fatty acids. It is interesting to note that topical corticosteroids alone will alleviate the symptoms of seborrheic dermatitis without an antifungal. However, the symptoms will rapidly return without the use of something to decrease the *Malassezia* population (1). This is where shampoos become important in aiding treatment and preventing recurrence (2).

Shampoos are important in aiding the treatment and prevention of seborrheic dermatitis.

Seborrheic dermatitis cannot be adequately controlled without proper shampoo selection (3). Effective shampoo ingredients include sulfur, tar, selenium sulfide, zinc pyrithione, and salicylic acid. Sulfur shampoos have fallen out of favor because they

can stain light colored hair yellow, but sulfur pomades are still used in persons with kinky hair, both on the hair and scalp, to control fungal growth because shampoo frequency is weekly or biweekly. Sulfur is a potent antifungal and will maintain scalp hygiene without the need to shampoo, but scalp scale will accumulate because the physical removal of the dander with scrubbing is absent. For this reason, the accumulation of scalp scale in African American individuals cannot be used as a definitive marker for seborrheic dermatitis, although the two observations are many times related.

Tar shampoos are some of the most effective cleansers for seborrheic dermatitis. This is because tar is a naturally occurring anti-inflammatory agent. By definition, anti-inflammatory agents decrease the white blood cell population in a given skin area. Inflammation in the skin always occurs for a reason, but the dermatologist may not be able to determine the cause. Many skin conditions are treated with anti-inflammatory agents nonspecifically without understanding the etiology. Psoriasis and seborrheic dermatitis are excellent examples. Anti-inflammatories can only control symptoms and not produce a cure. Although reducing the cutaneous white blood cell population with tar in seborrheic dermatitis produces remission of the scaling and itching associated with the condition, it is also a carcinogen for the same reason. The carcinogenicity of tar has been a source of controversy discussed on some consumer websites. Tar is a carcinogen, but purified tar with the creosote removed is less carcinogenic. The newer dandruff shampoos use purified tar because it does not stain fabric washcloths, has a more pleasant odor, and offers a better safety profile. Interestingly, it is also less effective in treating seborrheic dermatitis.

Small particle zinc pyrithione dandruff shampoos can decrease fungal colonization on the scalp.

Selenium sulfide and zinc pyrithione are two ingredients with similar effects on the scalp. They also function as antifungal and anti-inflammatory agents. Zinc pyrithione is felt to be a better anti-inflammatory than selenium sulfide due to the known benefits of zinc on the skin. An antifungal can only be effective, however, if it is present on the scalp. The newer dandruff shampoo formulations use smaller particle size zinc pyrithione allowing more particles to be present in the bottle with the same percentage of the active ingredient. It is only the particle edge that touches the scalp that is effective in preventing fungal growth, so the smaller particle formulations are more effective. Also, the formulations that leave behind the small zinc pyrithione particles in the follicular ostia are more effective. Because this is the most sebum-rich area of the scalp, the follicular ostia contain more *Malassezia* organisms, representing the ideal target site for zinc pyrithione deposition.

Finally, salicylic acid is useful in seborrheic dermatitis to remove scalp scale and functions as an anti-inflammatory because it is of the salicylate family. Salicylic acid shampoos are most efficacious

in patients who have seborrhiasis (sebopsoriasis), an overlap condition of seborrheic dermatitis and psoriasis. Another discussion of shampoos for this purpose is found in the chapter on psoriasis.

Even though most dermatologists focus on the active agent in the shampoo, the workhorse of the shampoo is really the detergent. The detergents are what remove the sebum nutrient source for the *Malassezia* and physically break apart the skin. The detergents are applied with vigorous rubbing and massaging, which further removes the skin scale. Shampooing is both a chemical and a physical process that prevents the recurrence of seborrheic dermatitis, and this cannot be overlooked. Most dandruff shampoos contain excellent foaming agents and strong surfactants. The foaming allows the detergent to be effectively spread over the hair and scalp for more thorough sebum removal, up to a point. Although consumers associate abundant foam with good cleansing, foaming agents can be added in any quantity desired by the formulator. Clean hair foams better than dirty hair, so patients should not use this as a criterion for efficacious shampoo selection.

Many seborrheic dermatitis patients apply shampoo to the hair only and do not clean the scalp adequately.

Seborrheic dermatitis is a condition of the scalp and not the hair. Many patients with this disease are focused on hair beautification, apply shampoo only to the hair, and do not clean the scalp adequately. Remind patients that shampoo is primarily to clean the scalp and not the hair. Proper shampoo technique should be to apply a half-dollar-sized dab of shampoo to the palm and rub into the scalp thoroughly. Leave the shampoo on the scalp while washing the rest of the body. This increases contact time between the active ingredient in the shampoo, such as tar or zinc pyrithione, and the scalp, thereby increasing efficacy (4). The shampoo can then be worked through the hair and rinsed immediately. Gently scrubbing with a scalp brush or the fingernails is necessary to remove the scalp scale and clean every portion of the scalp. The frequency of shampooing is determined by the scalp sebum production. An oily scalp may require daily shampooing, whereas a dry scalp may only require twice-weekly shampooing. One of the biggest contributing factors to seborrheic dermatitis is poor scalp hygiene.

Conditioners for seborrheic dermatitis

Conditioning the hair is very important in the seborrheic dermatitis patient. Most dandruff shampoos do not do a good job of beautifying the hair. They attempt to remove sebum thoroughly from the scalp but overdry the hair. This leaves the hair dry, brittle, rough, frizzy, difficult to style, dull, and susceptible to humidity and static electricity. All of these problems can be overcome by proper conditioning.

Treatment conditioners containing zinc pyrithione are available for dandruff. The conditioner leaves behind zinc pyrithione in the follicular ostia in greater concentration than the zinc pyrithione-containing dandruff shampoo. This may be helpful in preventing the growth of *Malassezia*, but many women do like the feel of their hair after using this type of conditioner. These products are well accepted by men with shorter hair, however. Women using dandruff shampoos should definitely be encouraged to use

conditioner. Conditioners do not worsen seborrheic dermatitis because they do not increase *Malassezia* growth and do not interfere with prescription medications.

Conditioners do not worsen seborrheic dermatitis.

Instant conditioners are the best way to overcome the reduced aesthetics of dandruff shampoos. Dandruff shampoos tend to overcleanse the hair, and the conditioner can restore hair shine. Instant conditioners are applied immediately following shampooing and rinsed before leaving the shower and towel drying the hair. The instant conditioner should be rubbed generously onto every hair shaft by pulling the fingers through the hair multiple times from proximal to distal end. If possible, the conditioner should be left in contact with the hair for three to five minutes, perhaps in shaving in the shower. It should be rinsed with cool water, which leaves more conditioner residue behind to beautify the hair.

Rinsing an instant conditioner with cool water can increase the amount of dimethicone left on the hair to improve appearance in patients using dandruff shampoos.

The two best conditioning agents for persons with seborrheic dermatitis are dimethicone and the polyquaternium compounds. Both coat the hair shaft and smooth the cuticle, which increases hair shine. They also provide a protective coating over the hair to minimize the effects of humidity and static electricity. The conditioner can protect the hair from heat damage due to the use of hair dryers, curling irons, hot curlers, crimping irons, or heated hair straightening devices. Conditioners can reduce combing friction, decrease hair breakage, and improve the softness of the hair. Instant conditioners can be combined with leave-in conditioners applied after towel drying the hair to increase hair beautification. There are no special leave-in conditioners for seborrheic dermatitis patients, and a thorough discussion of this topic can be found in the chapter on hair conditioners.

Grooming practices

Grooming practices are important to increase the success of treatment in seborrheic dermatitis patients. Combing and brushing gently can help to dislodge skin scale, but aggressive scalp manipulation should be avoided. The most important activity to avoid in seborrheic dermatitis patients is scalp scratching. Unfortunately, pruritus is the most bothersome symptom of seborrheic dermatitis and may be the main reason for which the patient seeks treatment. Scalp scratching must be stopped immediately to prevent hair damage. It is impossible to scratch only the scalp; the hair is scratched at the same time. In only 45 minutes, the entire cuticle can be removed from a hair shaft. Once the cuticle is removed, it cannot be restored, and the hair devoid of the cuticle will readily fracture and break. This is why many seborrheic dermatitis patients complain of poor hair growth. The hair is growing fine because seborrheic dermatitis does not generally affect the hair shaft, but the hair is damaged cosmetically by scalp scratching, giving the impression of poor hair growth.

Topical prescription corticosteroids to alleviate itching are probably the best solution to poor hair quality in seborrheic dermatitis patients. This will work better than any high priced hair procedure or concoction to beautify the hair. It may seem too simple, but the key to great-looking hair in the seborrheic dermatitis patient is itch control.

The key to great-looking hair in the seborrheic dermatitis patient is alleviating pruritus.

OTC treatments

A variety of over-the-counter (OTC) scalp treatments, based on salicylic acid and hydrocortisone, are available for seborrheic dermatitis. These treatments may not be sufficient for alleviating pruritus but may be used in the maintenance phase of the disease. Salicylic acid can remove some of the skin scale but is probably more effective in patients with a psoriasis/seborrheic dermatitis overlap condition where the skin scale does not slough from the scalp properly. Once it has been well treated, 1% hydrocortisone solutions can aid in the control of itching.

OTC seborrheic dermatitis treatments contain salicylic acid and hydrocortisone.

Seborrheic dermatitis is a challenging condition to treat, but the judicious selection of shampoos and conditioners can prolong remission and increase hair beauty. Both are important to the patient, and the dermatologist who will understand the hair care market and offer patients better advice.

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Dermatologists are preoccupied most with improving scalp psoriasis to alleviate itching and reduce scaling. Although these are important goals, patients with scalp psoriasis are also concerned with the health and appearance of their hair. Most patients will not have beautiful hair until the psoriasis has been treated, but providing advice on hair beautification during the early phase of treatment can be helpful in building a strong physician–patient relationship and encouraging compliance. This chapter discusses the psoriasis patient and hair care practices.

Shampoos

Various shampoos are available to meet the needs of the scalp psoriasis patient. These shampoos are considered over-the-counter (OTC) drugs and list an active agent on the label, which is the distinct packaging attribute of all OTC drugs. The limitations of OTC drugs are that they can only contain one active agent, and this agent must be selected from a list of approved active agents in a monograph that is set forth by the government. There is no psoriasis scalp monograph, so all the active agents for psoriasis shampoos are taken from the dandruff shampoo monograph. This monograph has limited ingredients for selection, which is why most shampoos for psoriasis are basically dandruff shampoos, even though the etiology of psoriasis is much different from that of seborrheic dermatitis.

Psoriasis shampoos are basically dandruff shampoos, even though psoriasis and seborrheic dermatitis have different etiologies.

Psoriasis treatment shampoos usually contain a very strong detergent to deliver the active agent to the scalp and remove as much sebum as possible. Although this is important in improving scalp psoriasis, this type of shampoo does not beautify the hair. Thus, psoriasis shampoo selection is a balance between optimizing scalp treatment while not damaging the hair. Sodium laureth sulfate or sodium lauryl sulfate are the two main cleansers in the shampoos. A new trend is to eliminate the sulfates from shampoos because they are considered “unnatural” ingredients. Sulfates are the most important synthetic detergents in all body and hair cleansers today, and eliminating them for replacement by another detergent is really immaterial because cleansers remain in contact with the skin for a brief period of time before removal and are not ingested.

In addition to detergents, psoriasis shampoos may contain sulfur, tar, botanicals, salicylic acid, zinc pyrithione, and selenium sulfide (1, 2). Sulfur is an antifungal and antibacterial. Some dermatologists believe that bacteria-induced inflammation may worsen psoriasis, which may point to the value of sulfur shampoos. Furthermore, many patients have psoriasis that overlaps with seborrheic dermatitis and may find the antifungal properties important, but for the most part, sulfur is not a good ingredient in shampoos. It stains light-colored hair and is damaging to

the hair shaft. Tar can similarly stain light-colored hair if it has not been purified to remove the creosote. However, creosote is one of the most potent anti-inflammatory agents in the complex naturally occurring mixture known as tar. Creosote is also carcinogenic. Botanical anti-inflammatory concoctions blending green tea, lavender, chamomile, tea tree oil, and oatmeal extract are also on the market. It is unlikely that these ingredients have much effect separate from their detergent vehicle in improving scalp psoriasis.

Salicylic acid is the most useful shampoo ingredient for scalp psoriasis.

In ZDD’s opinion, salicylic acid is the most helpful ingredient in scalp psoriasis (3). It is an oil-soluble substance that can mix with scalp sebum to cause the thick, collected scalp corneocytes to exfoliate. Unless the scalp scale is removed, prescription topical treatments do not physically touch the scalp and cannot provide improvement. It is the chemical effect of the detergents on the scalp scale and the physical effect of scrubbing that provide most of the improvement, which are augmented by the exfoliating effect of the salicylic acid. Salicylic acid can also function as a mild anti-inflammatory, but the brief contact of the salicylic acid with the scalp may minimize this effect. Unfortunately, salicylic acid is not a hair-friendly chemical. It can remove scalp skin scale and also hair cuticular scale. This means that a conditioner must be used following shampooing to smooth the cuticle and restore the softness and luster of the hair.

Zinc pyrithione and selenium sulfide are the last two ingredients that can be used in scalp psoriasis. Selenium sulfide is not used as much because it is an orange ingredient that is fairly expensive and difficult to formulate. Its efficacy is similar to zinc pyrithione, but zinc pyrithione is a better anti-inflammatory agent. New grinding technology has allowed very small zinc pyrithione particles to be produced that can deposit in the follicular ostia. This technology may be worthwhile in psoriasis because this delivery may provide longer-lasting anti-inflammatory effects. Zinc pyrithione is also antifungal and provides benefits for patients with seborrhiasis (sebopsoriasis), an overlap between seborrheic dermatitis and psoriasis.

Rotating shampoos in the psoriasis patient is very important because use of one shampoo may create cosmetic scalp and hair issues.

Rotating shampoos in the psoriasis patient is very important because use of one shampoo may create cosmetic scalp issues. Many psoriasis patients wish to shampoo daily to optimize scale removal, which can create dry hair issues. A possible shampoo

TABLE 36.1: Sample Shampoo Regimens for Patients with Scalp Psoriasis

(A) Sample Scalp Psoriasis Daily Shampoo Regimen	
Monday	Salicylic acid shampoo
Tuesday	Conditioning shampoo
Wednesday	Zinc pyrithione shampoo
Thursday	Conditioning shampoo
Friday	Salicylic acid shampoo
Saturday	Conditioning shampoo
Sunday	Conditioning shampoo
(B) Sample Scalp Psoriasis Thrice-Weekly Shampoo Regimen	
Monday	Salicylic acid shampoo
Tuesday	No shampoo
Wednesday	Conditioning shampoo
Thursday	No shampoo
Friday	Zinc pyrithione shampoo
Saturday	No shampoo
Sunday	No shampoo
(C) Sample Scalp Psoriasis Twice-Weekly Shampoo Regimen	
Monday	Salicylic acid shampoo
Tuesday	No shampoo
Wednesday	No shampoo
Thursday	Conditioning shampoo
Friday	No shampoo
Saturday	No shampoo
Sunday	No shampoo

regimen to maximize scalp and hair appearance might be as listed in Table 36.1. Patients with drier hair and less scalp scale may wish to shampoo twice or thrice weekly, and possible regimens are also presented in Table 36.1. Using a hair conditioner is very important in all regimens to maintain the cosmetic beauty of hair, the next topic of discussion.

Conditioners

Conditioners are very important for psoriasis patients to beautify the hair while minimizing the presence of disease. Some of the newer zinc pyrithione dandruff hair conditioners are worthwhile in the psoriasis patient because these instant conditioners applied after shampooing can leave behind additional zinc pyrithione in the follicular ostia to decrease inflammation and the colonization of the scalp by *Malassezia* species. This type of conditioner should be used once or twice weekly. A standard instant conditioner that is applied immediately following shampooing should be used the rest of the time. Instant conditioners can leave behind dimethicone during the rinse phase to minimize the damaging effect of the psoriasis shampoo surfactant. The instant conditioner will provide more hair benefits if left on the hair for a longer period of time in the bath. A possible recommendation might be to have the patient shampoo first in the shower and rinse, then apply the instant conditioner. The conditioner should be left on while bathing the rest of the body or shaving, and then rinsed just before leaving the shower. This allows more time for the conditioner to coat the hair shaft and smooth the cuticle. Instant conditioner can also be rubbed into the scalp to soften the psoriatic scale and rinsed.

Leave-in conditioners can function as a scalp moisturizer to lubricate skin scale and reduce scalp itching.

Once the instant hair conditioner is rinsed, the hair is towel dried, and a leave-in conditioner that is not removed is applied. These creams provide additional dimethicone to further smooth the cuticle. The cream should be massaged through the hair and lightly rubbed into the scalp. The leave-in conditioner can function as a scalp moisturizer to lubricate scalp scales and reduce scalp itching. Once the hair has dried, further conditioning can be provided with a dimethicone-containing hair serum. These are clear liquids, also known as products to control hair frizz, further smooth the cuticle. The hair serum should be applied daily to keep the hair moisturized, but can also be applied to the scalp as a moisturizer. Skin moisturizers are frequently used by psoriasis patients to make the skin feel smoother and softer, and can also be used to lubricate the scalp in the form of hair serums.

Grooming practices

Patients with scalp psoriasis are very self-conscious of their hair and sometimes have elaborate grooming practices that can be detrimental to disease treatment. Aggressive combing and brushing are sometimes used on a daily basis to decrease the amount of scalp scale. Psoriasis patients sometimes mistakenly think they can brush out all the scalp disease. Because psoriasis exhibits the Koebner phenomenon, where trauma to the scalp increases the inflammation and resultant scaling, combing and brushing of the scalp are not recommended. The hair should be gently groomed, and the scalp manipulated as little as possible. Psoriasis patients may also wish to permanently dye, wave, or straighten their hair with chemicals that can also be damaging to the scalp. One way to minimize inflammation is to pretreat the scalp with a clobetasol solution or gel on the night prior to and after the chemical hair procedure. This can aid in reducing the inflammation and thus prevent a flare of psoriasis. In general, advise psoriasis patients to minimize manipulation of the scalp (4).

Aggressive combing and brushing should be avoided to decrease scalp trauma, which may worsen scalp psoriasis.

OTC treatments

OTC treatments for scalp psoriasis are available in plenty to alleviate scaling and itching (5). Again, because only one active agent can be present, most psoriasis scalp solutions have either hydrocortisone or salicylic acid. The prescription formulations at higher concentrations utilizing fluorinated corticosteroids are more effective, but understanding the OTC market is important to the dermatologist. OTC salicylic acid solutions can be formulated with up to 2% salicylic acid, which should be applied directly to the scalp and not to the hair. OTC topical corticosteroid solutions can contain up to 1% hydrocortisone, which is only effective in the thinnest of plaques. The best efficacy is achieved by using 2% salicylic

acid in the morning and 1% hydrocortisone in the evening for patients with limited funds or those who are in the maintenance phase of treatment.

Summary

This chapter evaluated the use of OTC drugs and hair care products in patients with psoriasis. It is important for the dermatologist to skillfully transition the patient from prescription products to OTC treatments as the disease improves. Treatment can be supplemented by the careful selection of shampoos and hair conditioners to optimize scalp psoriasis treatment.

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Hair ages differently than other body structures because it is one of the few nonliving tissues that is constantly renewed, the only other similar structure being the nails. Hair care becomes important as aging progresses because damage to the hair is irreversible, and the average hairs on a mature head are three years old. This means that the effect of any cosmetic procedure gone awry will be present for a long time. Changes that occur as the follicle matures, partly from oxidative stress, include a decrease in the rapidity of hair growth, a reduction in the diameter of the hair shaft, and a failure to pigment the hair shaft (1). All of these observations are consistent with a loss of follicle vigor. Because hair growth requires high-energy output, this decreased vigor is consistent with the slowing of other body activities with age, but the senescence of the hair shaft is particularly visible. Gray hair is the first sign of maturity noticed by both men and women (2).

This chapter addresses methods of maintaining the hair in a state of health. Much of the information regarding hair behavior is obtained from the textile literature, especially the processing and dyeing of wool fabrics. Human hair experiences most of the same phenomena exhibited by wool, and extrapolations can be made with accuracy. Healthy hair is full, shiny, soft, and manageable. It resists static electricity, maintains the desired hairstyle, and bounces with movement. Because hair is nonliving, hair care becomes very important, especially with maturity. This chapter presents nine concepts that are important when considering the unique needs of aging hair.

Healthy hair is natural hair

Many mature women are dissatisfied with the appearance of their hair and seek cosmetic alterations, such as hair dyeing or permanent waving. These procedures work well on hair that grows quickly because the hair that is damaged by the chemical process is removed and not reprocessed repeatedly. This is not the case with aging hair that has a slower growth rate (3). Hair manipulations of all types should be kept to a minimum and as much time as possible be allowed between chemical processing. The hair should be protected when outdoors at all times by wearing a hat or scarf. Sun, wind, and humidity are the enemies of aging hair. It may be difficult to convince the mature woman that the less she does to her hair, the better! It is just too simple to believe.

Sun, wind, and humidity are the enemies of aging hair.

Trim hair frequently

Many mature patients are hesitant to cut their hair because the hair growth rate slows down with age, decreasing the maximal achievable length. If the hair shafts have been damaged by too much manipulation and chemical processing, no special shampoo or pricey conditioner can restore hair beauty. For these patients,

the overall hair appearance can be improved by removing 1 to 2 inches from the distal hair shafts every other month, depending on the rate of hair growth. This trims away split ends, formed when the missing cuticle exposes the softer internal cortex, and creates fresh hair ends that are less frizzy, more likely to maintain a curl, and less subject to static electricity. Trimming also eliminates the irregularity of broken hairs and creates the illusion of fuller, healthier hair. Frequent haircuts are recommended to improve hair appearance.

Treat underlying scalp conditions

The health of the hair is directly related to the health of the scalp. Many mature patients have postmenopausal itchy scalp, seborrheic dermatitis, or scalp folliculitis. When assessing the hair of a mature patient, do not forget to assess the scalp. Any pruritic scalp disease will cause hair problems. It is possible to remove all the cuticular scale from a hair shaft with only 45 minutes of continuous scratching with the fingernails. Most patients will not scratch their scalp continuously for 45 minutes, but the hair shaft effects of scratching are additive. Forty-five minutes can easily be accumulated if the patient scratches 5 minutes a day for 9 days. For this reason, it is important to treat scalp itching and any other scalp conditions noted on physical examination.

Aging hair and heat exposure

It is common for mature individuals to apply external heat to speed hair drying and prevent chilling of the body. Although the blow-dryer is an excellent way to rewarm a wet head, the heat can permanently damage the protein structure of the hair. Once the water has evaporated from the outside of the hair shaft, over-drying of the hair can occur where the water within the shaft turns to steam and exits the hair shaft, creating a loss of cuticular scale, known as “bubble hair” (Figure 34.2 in Chapter 34 is a scanning electron micrograph demonstrating the bubbles created by the energetic steam). Unfortunately, the condition is permanent, and bubble hair results in a weakening of the mature hair shaft and eventual breakage. For this reason, aging hair should be dried until very slightly damp but not completely dry to avoid bubble hair. The dermatologist can easily detect the presence of hair shaft damage, such as bubble hair, by grasping the hair 1 inch from the end with one hand and pulling on the hair ends with the other. If the hairs break, hair damage from bubble hair or other causes may be present.

Aging hair and chemical processing

Chemical processing becomes an important part of grooming in aging hair. Gray hair is dyed to bring back a more youthful color and permanently waved to make the hair appear thicker and fuller. Both procedures damage aging hair, but most mature women are resistant to giving up chemical processing. For many, the hairdresser is a weekly social outing that is an enjoyable part of retirement. Chemical processing

can be continued with maturity as long as the hairdresser realizes that the aging hair will process more quickly than youthful hair. This is because aging hair is smaller in diameter, allowing easier penetration of the chemicals, and the slower growth rate means that the same hair is reprocessed repeatedly. Hair that is already chemically processed is processed more rapidly with each subsequent chemical exposure due to the already damaged cuticle.

Overprocessing of aging hair by leaving the permanent wave solution or the hair bleach on the hair too long is the most common problem I see in my office. It is easy to avoid if the beautician is aware of the issues. When the processing time is completed, the beautician must attend to the patient immediately, rather than allowing another 10 to 15 minutes to pass while she attends to other customers. Unfortunately, there is no way to undo the damage caused by overprocessing. This means that the mature patient must pick a beautician who is careful in her technique and experienced in treating aging hair.

Overprocessing of aging hair leads to hair breakage and poor manageability.

Shampoos for aging hair

Many mature patients who present to the dermatologist have already severely damaged their hair, and permanent restoration is not possible. Yet, it is important to counsel the patient on how to optimize hair appearance until new growth occurs. One method of minimizing hair damage is to select a shampoo designed to remove sebum and simultaneously beautify the hair, known as a conditioning shampoo. Conditioning shampoos, also known as 2-in-1 shampoos, perform two separate functions based on the difference in the shampoo-to-water ratio during the washing and rinsing phases. During the washing phase, the shampoo is applied to damp hair and massaged into the scalp. In this phase, the shampoo quantity is high, and the water quantity is low, resulting in detergent cleansing primarily of the scalp but also the hair. Following completion of the cleansing phase, the shampoo is rinsed from the hair, progressively reducing the amount of shampoo and increasing the amount of water. During this rinse phase, a thin layer of conditioner is left behind to coat each hair shaft, thus minimizing damage.

Conditioners for aging hair

Conditioners are very important in aging hair to preserve the architecture of the cuticle and make the hair soft and shiny. Because the rapidity of hair growth slows down with age, the hair is cut less frequently. This means that mature patients must take better care of their hair, and the damage resulting from any unsuccessful cosmetic manipulation will be longer lasting. Conditioners place a coating over the hair shaft that can be protective against the heat damage from blow-dryers and heated hairstyling appliances. Conditioners also reduce hair grooming friction, thereby minimizing hair breakage. Mature patients should first condition with an instant conditioner that is applied in the shower immediately following shampooing. The conditioner is then rinsed with cool water, and the hair is towel dried. When the hair is mildly damp, a quarter-sized amount of leave-in cream

conditioner containing dimethicone should be dispensed into the hand and stroked through the hair in an attempt to cover every hair shaft. More should be applied to the distal hair shaft and less to the proximal hair shaft. The hair should then be allowed to air dry to minimize heat damage. When the hair is almost dry, a hair serum should be applied with two to four squirts into the palm and again rubbed gently through the hair. The stepwise application of these conditioners will protect the hair and enhance its ability to shine. The conditioner will also improve the ability of the hair to hold a style.

Styling products for aging hair

Once the hair has been shampooed, conditioned, and dried, it is ready for styling. Hairstyling is best done when the hair is almost dry. Whatever the hair configuration, the instant the hair shaft goes from wet to dry, it will determine the final shape of the hair. For this reason, it is best to style almost dry hair. The hair should be handled gently because wet hair is more prone to breakage than dry hair. Another layer of hair serum containing dimethicone should be applied at this point. A hair conditioning spray containing sunscreen, most commonly benzophenone, can also be applied to minimize UV damage to the hair (Figure 37.1). The hair can then be finger styled or styled with a curling iron or hot rollers set on low to avoid heat damage. Finally, once styled, the hair can be sprayed with a flexible-hold pump hair spray.



FIGURE 37.1 An example of a hair conditioning spray for dyed hair containing photoprotection.

Aging hair should be manipulated as little as possible to prevent hair breakage from hair styling.

Hair styles for aging Hair

The hairstyle selected for aging hair should be simple and require little hair manipulation. Combing and brushing frequently fracture the fine hair shafts characteristic of aging hair (Figure 37.2). Combs should be wide-toothed and brushing should be avoided if possible (Figure 37.3). The hair should only be styled when dry and handled minimally when wet because wet hair is more susceptible to hair breakage. Elaborate hairstyles requiring teasing, pulling, clasps, barrettes, rubber bands, and the like are not recommended because hair breakage will be increased. Hairstyles that can only be achieved with permanent waving or frequent hair-setting are also not advised. Simple is again the most important consideration when selecting a hairstyle to optimize the appearance of aging hair.



FIGURE 37.2 A wide-toothed, smooth bristle brush is less likely to fracture weak aging hair shafts.

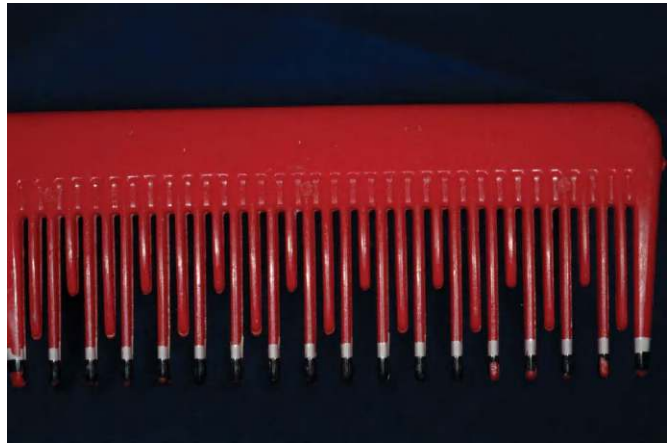


FIGURE 37.3 Combs with broadly spaced teeth will style hair while minimizing hair shaft cuticle damage.

Summary

It is important for the dermatologist to understand the needs of aging hair (4). Mature men and women want to look their best at any age, and hair is an important part of appearance. Although aging hair is not as forgiving as youthful hair, it can be carefully groomed and styled to optimize appearance. It is most important not to undergo risky procedures that might end up in a disastrous cosmetic result because scalp hair growth slows with age, and it is not as easy to cut away the unattractive hair in anticipation of regrowth.

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38

DAMAGED HAIR ISSUES

One of the most common problems the dermatologist faces is the patient who is experiencing hair loss, which can result from either medical or cosmetic causes. No matter what the cause of the hair loss, premature hair breakage is an important contributing factor. Hair is protein, and anything that weakens the protein structure will cause the hair to fracture with minimal trauma. Patients are usually seeking medical help to determine how to strengthen their hair, and sometimes resort to body-building permanent waves, hair-strengthening hair dyes, or expensive hair conditioners with caviar. The truth is that once the nonliving hair is damaged, it cannot be permanently repaired. Furthermore, any additional cosmetic manipulations will result in more problems. The best and simplest answer for the patient who wishes to restore hair beauty is to cut the hair off and allow new hair to grow, avoiding the cosmetic mistakes of the past. This is excellent advice, but usually not well received by the patient.

This chapter discusses ten easy tips to be shared with patients in search of elusive, great-looking hair. Providing these ideas will help the patient minimize problems and perhaps allow them to feel that their problems were seriously addressed by the physician. These tips are summarized in [Table 38.1](#) and can be easily placed in a handout for patient distribution.

Hair manipulation

Manipulate the hair as little as possible ([Figure 38.1](#)).



FIGURE 38.1 Thinning hair that has been manipulated too much will break and appear even thinner.

TABLE 38.1: Care Instructions for Damaged Hair

1. Manipulate the hair as little as possible.
2. Select a wide-toothed comb with Teflon-coated tips.
3. Select a vented ball-tipped styling brush.
4. Do not comb hair when it is wet.
5. Allow hair to air dry, avoiding heated drying appliances.
6. Avoid scratching the hair and scalp.
7. Select a conditioning shampoo.
8. Apply an instant conditioner after each shampooing.
9. Consider use of a deep conditioner once weekly.
10. Cut away damaged hair shafts.

There is a misconception among hairstylists that the more you do to the hair, the healthier it becomes. This is not true. There is no such thing as a “body restoring permanent wave” or a “strengthening hair dye.” The more you dye or perm the hair, the weaker it becomes. The more you comb, brush, curl, twist, clip, tease, braid, etc. the hair, the more damage it incurs. This damage is permanent because the hair is nonliving. Basically, any manipulation of the hair shaft results in the possibility of cuticular damage, which is known in the hair care industry as “weathering.” Weathering is visible even on the healthiest head of hair as a tightly overlapped intact cuticle on the newly grown proximal hair shaft, with a disrupted, sometimes absent cuticle on the older distal hair shaft. Weathering is basically the sum of chemical and physical environmental insults on the hair shaft, which can be minimized through reduced manipulation.

Hair comb selection

Select a wide-toothed comb with Teflon-coated tips ([Figure 38.2](#)).



FIGURE 38.2 A wide-toothed comb should be used, especially when detangling the hair after shampooing to minimize hair shaft breakage.

One of the most common insults the hair receives on a daily basis is grooming. This grooming is usually done with a comb. Thus, it is important to select a comb that decreases hair breakage by minimizing the friction between the hair and the teeth of the comb (1). For this reason, a comb should have broadly spaced smooth teeth, preferably Teflon-coated, to reduce combing friction. A comb that tends to grab the hair shafts as they pass through the tangled hair increases hair shaft fracture, usually at the point where the cuticular scale is most disrupted or completely absent (2).

Combing friction is also maximal when the hair shafts are tangled. Unfortunately, the most common reason for combing the hair is to remove tangles. This means that the hair should be protected from situations that might cause hair tangles, such as wind, unconscious hair twisting, or teasing. The most effective way to reduce hair combing friction, besides proper comb selection, is the application of a conditioner.

Hairstyling

Select a vented ball-tipped styling brush (Figure 38.3).

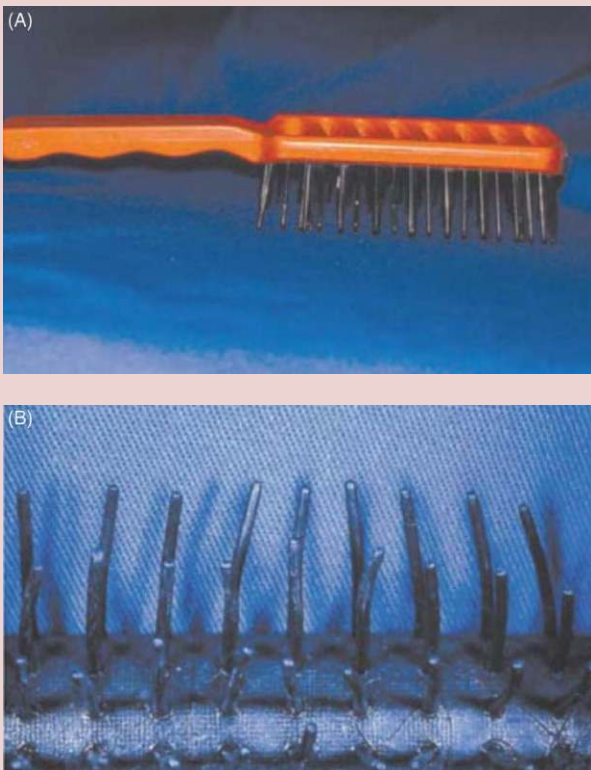


FIGURE 38.3 (A) A vented ball-tipped blow-drying brush is demonstrated, which minimizes hair breakage from grooming. (B) A brush without ball tips is demonstrated, representing a poor-grooming brush choice.

The second-most commonly used grooming implement is a brush, and it too requires careful selection. The main goal again is to reduce friction between the brush and the hair shafts (3).

Natural bristle brushes or brushes with a dense arrangement of bristles have recently become popular because they fit quite nicely with the current “back to nature” trend and the use of botanicals in the hair care industry. However, these brushes maximize hair breakage. A better option is to select a brush design known as a blow-drying brush for general grooming needs. These brushes possess vents or openings on the brush head to prevent heat from building up between the hair and the brush head. The widely spaced bristles are also plastic and ball-tipped to minimize friction. If drawing the brush across the palm of the hand causes discomfort, the brush is not recommended for use on the hair.

Hair grooming

Do not comb hair when wet (Figure 38.4).



FIGURE 38.4 Freshly shampooed hair is tangled and fragile, creating a situation conducive to hair shaft fracture.

Hair is much more likely to fracture when wet than dry. For this reason, it is advisable to gently detangle hair following shampooing from the distal ends to the proximal ends with the fingers, not attempting combing or brushing until the hair is almost dry. Many persons feel that the hair must be styled wet to attain the desired style. This is only partially true. Hair will set in the position in which it is placed the instant that the last water molecule evaporates from the hair shaft. This means that the hair is optimally styled just before it is completely dry. Thus, it is best to finger-detangle the hair wet and then allow it to almost dry prior to styling to prevent hair breakage.

Hair drying

Allow hair to air dry, avoiding heated drying appliances (Figure 38.5).

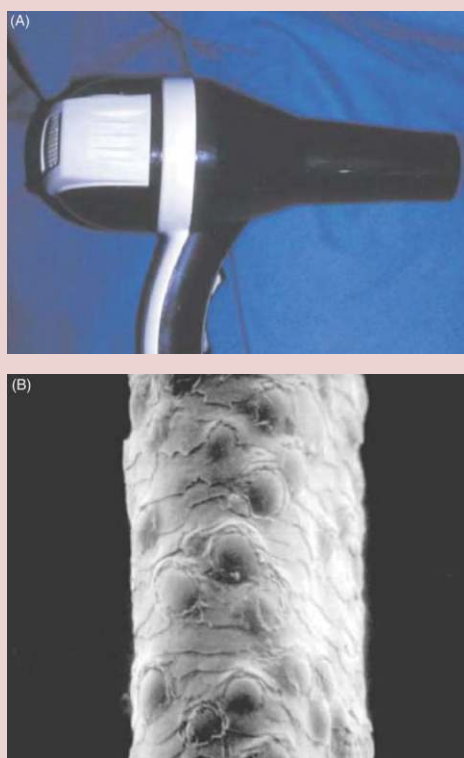


FIGURE 38.5 (A) Blow drying the hair can lead to heat damage and a condition known as bubble hair. (B) An electron micrograph of bubble hair illustrating the bubbles or lumps in the hair shaft created by escaping steam.

Many people prefer to speed the drying process by applying heat to the hair shaft to speed up the evaporation of water. This can be done with a handheld blow-dryer or a hooded professional salon dryer. Heat is also used to style the hair shafts in the form of heated rollers or a curling iron. Unfortunately, any type of heat that is applied to the hair shafts can permanently damage the protein structure of the hair.

It is important to distinguish between the water that resides on the outside of the hair shaft when the hair is wet and the water that resides inside the hair shaft to act as a plasticizer. Hair dryers attempt to speed evaporation of the water on the outside of the hair shaft, and heating styling appliances attempt to rearrange the water deformable bonds within the hair shaft. Remember that water is the plasticizer of all the keratin-based structures of the body, including the skin, hair, and nails. When the hair is rapidly exposed to high temperatures, the water within the shaft turns to steam and exits the hair shaft, creating a loss of cuticular scale and a condition known as “bubble hair.” Under scanning electron microscopy, it is actually possible to see the bubbles created by the energetic steam. Unfortunately, the condition is permanent, and bubble hair results in a weakening of the hair shaft that contributes to breakage.

The dermatologist should be aware that many patients who present with hair loss may be experiencing hair breakage due to

bubble hair. Although it is not possible to see bubble hair under a light microscope, it is possible to have the patient collect four days’ worth of hair loss by placing each day’s loss in a separate bag. The dermatologist can examine these bags to determine the ratio of broken hairs without the hair bulb to shed telogen hairs containing the hair bulb. If the number of broken hairs exceeds 20%, the patient is experiencing hair breakage. At this point, the dermatologist should inquire as to the use of heated hair drying and styling appliances and make some recommendations. However, most patients will not discontinue the use of heat.

Even though all forms of heat are damaging to the hair shaft, it is possible to minimize damage by altering the abrupt manner in which the hair contacts heat. Bubble hair is more likely to occur if the hair shaft at room temperature is suddenly exposed to high heat. If the hair exposure to the heat is gradual, the damaging effect is not as great. Thus, a gradual temperature increase is recommended. This means that hair dryers can be safely used if the nozzle blowing out hot air is held at least 12 inches from the hair, allowing the air to cool prior to touching the hair shaft. Hair dryers also should be started on low heat to initially warm the hair prior to drying at higher temperatures.

Heated hair rollers and curling irons can be used safely if allowed to cool prior to application to the hair. These thermostatically controlled devices tend to slightly overheat, which can induce bubble hair immediately on hair contact. Heated styling devices should be unplugged for 1 to 2 minutes prior to placing them in contact with the hair. If possible, the styling devices should be operated on a low, rather than high, temperature setting. If the device does not have multiple temperature settings, the temperature of the metal or plastic that contacts the hair can be lowered by placing it in a damp towel. Many patients prefer to use styling heated devices at a high temperature setting because the high temperature results in the rearrangement of more water-deformable bonds and a tighter, longer-lasting curl. Hair that has been heat damaged appears wavy and friable to the human eye.

Scalp scratching

Avoid scratching the hair and scalp (Figure 38.6).



FIGURE 38.6 Scratching of the scalp can lead to increased hair breakage, only magnifying the hair loss characteristic of a scarring alopecia.

It is not usual for patients with seborrheic dermatitis to present with the complaint of hair loss. Medically, it is difficult to reconcile how a fungal infection of the skin of the scalp could alter hair growth from the hair follicles located deep within the dermis and in the superficial subcutaneous tissue. The answer to hair loss in the seborrheic dermatitis patient lies in having the patient collect all hairs lost while shampooing or grooming over a 24-hour period in a bag. Examination of these hairs will reveal absence of the cuticle and hair shaft fracture. Remarkably, it is possible to remove the entire cuticle from the hair shaft with 1 hour of vigorous scratching. Most patients will not scratch their scalp continuously for 1 hour, but the effects of scratching are additive to the hair shaft. One hour can easily be achieved if the patient scratches 10 minutes a day for 6 days. Usually, patients intend to scratch only the itching present on the scalp, but it is impossible to scratch the scalp without scratching the hair shafts, as well.

Thus, the solution to hair loss in the seborrheic dermatitis patient is to treat the underlying disease. Many times, it is necessary to treat patients complaining of hair loss aggressively for scalp pruritus in addition to a standard hair loss workup. Fingernail damage to the hair shaft will result in dull, unmanageable, broken hair that performs poorly. Stopping hair shaft damage from scalp itching is key to solving the cause of hair loss in some patients.

Shampoo selection

Select a conditioning shampoo (Figure 38.7).



FIGURE 38.7 Use of a conditioning shampoo can minimize hair shaft damage due to shampoo detergents.

Unfortunately, many patients who present to the dermatologist have already severely damaged their hair, and therefore, a permanent restoration is not possible. Yet, it is important to counsel the patient on how to optimize the appearance of their damaged hair until new growth occurs, and the damaging cosmetic procedure has been discontinued. One such method of minimizing hair damage is to select a conditioning shampoo. There is no doubt that sebum is the optimal hair conditioner, and all synthetic conditioners are poor substitutes; however, patients do not like the greasy, flat appearance sebum imparts to the hair shaft. This led to the introduction of shampoos designed to remove sebum from the hair. Remember that the original intention of shampoo was to remove sebum, skin scale, environmental dirt, and apocrine and eccrine secretions from the scalp. Patients forget that shampoo is to cleanse the scalp and not the hair when they are in the shower.

The need to improve the hair while cleansing the scalp has led to the development of conditioning shampoos. The main ingredient in this technology is silicone, a light-weight, clear oil that can coat the hair shaft and smooth the disrupted cuticular scale. This technology was pioneered as part of the Pantene line of shampoos (Procter & Gamble, Cincinnati, Ohio), still manufactured today. These shampoos were originally known as 2-in-1 shampoos because they both cleansed the scalp and conditioned the hair. They are available for all types of hair, including dry, normal, oily, and chemically treated. Silicone is instrumental in these formulas because it can coat the hair shaft without leaving the greasy appearance of sebum. Silicone also significantly reduces the friction of combing and brushing, minimizing hair breakage. Thus, patients with hair loss or chemically damaged hair may benefit from the use of a silicone-containing conditioning shampoo.

Conditioner selection

Apply an instant conditioner after each shampooing (Figure 38.8).



FIGURE 38.8 An instant conditioner is important to prevent tangles from developing among the hair shafts, predisposing the hair shaft to breakage.

Silicone technology has also been applied to instant conditioners. Instant conditioners are products applied immediately following shampooing in the bath or shower. They are left on the scalp for

a short period of time and then thoroughly rinsed from the hair, hence the name “instant” conditioner. Because these products do not contain a surfactant designed to remove oils from the scalp, they can focus on augmenting the effect of a previously applied conditioning shampoo. Instant hair conditioners usually incorporate cyclomethicone, dimethicone, or amodimethicone as their active agent, in addition to quaternary ammonium compounds. Amodimethicone is a cyclic silicone that appears to have more substantivity for hair keratin. This means that it sticks to the cuticle better and resists water rinsing, thus providing longer-lasting conditioning. Quaternary ammonium compounds, also known as quats, are excellent at decreasing static electricity, which produces unmanageable frizzy hair.

Although these important ingredients function to smooth the loosened cuticular scale and increase hair shine, they also reduce friction. By doing so, it is easier to detangle freshly washed hair, thus reducing hair breakage during the hair drying process. Hair conditioners also decrease the grooming friction between the comb and brush and the hair fibers. Hair conditioners also provide a protective coating over the hair shaft that can protect from heat damage and the effects of UV radiation.

In short, one of the best recommendations the dermatologist can provide to the patient who experiences hair loss is to use an instant conditioner following shampooing. Use of this product will prolong hair longevity, regardless of the underlying cause of hair loss. No fabrics are sold without a fabric finish, which improves with wear and imparts shine to the fabric. It is actually the removal of the fabric finish that changes a soft cotton t-shirt into a stiff faded rag with repeated visits to the wash machine. These same changes occur with hair. Restoring the softness of fabric by using a fabric softener in the wash machine or dryer is analogous to applying an instant conditioner to the hair.

Deep conditioners

Consider use of a deep conditioner once weekly (Figure 38.9).



FIGURE 38.9 Deep conditioners are especially important in chemically straightening African American hair to prevent hair shaft breakage.

Occasionally, it is necessary to impart more conditioning benefits to the hair fiber than an instant conditioner can deliver. This is especially the case in hair that has undergone chemical processing, such as permanent dyeing, bleaching, permanent waving, or chemical straightening. These procedures all intentionally disrupt the cuticular scale to reach the cortex and medulla of the hair shaft to induce a change in color or configuration. Once the cuticle has been disrupted with chemical processing, it can never be fully restored. Thus, there is a tradeoff for the patient between the cosmetic value of chemically treating the hair shaft and its reduced ability to function optimally. Some of the damage can be minimized by using what is known as a deep conditioner.

Deep conditioners are applied to hair for 20 to 30 minutes outside the bath or shower. They can be used both at home and in a salon. There are basically two types of deep conditioners: oil treatments and protein packs. Oil treatments are usually used for kinky hair that has been straightened. The process of lye straightening hair results in decreased hair water content, which reduces the hair shaft elasticity and predisposes to hair breakage. Applying a heavy oil to the hair shaft is much like moisturizing the skin in that it attempts to both smooth the cuticle and prevent further water loss from the hair shaft. In general, oil treatments are not used for straight hair because the heavy oil leaves the hair limp and difficult to style.

Protein packs represent a second type of deep conditioner and can be used for all hair types. These conditioners are formulated as creams or lotions and are a variation on the instant conditioner, except that they remain on the hair longer prior to rinsing. Protein packs may contain silicones and quaternary ammonium compounds, as previously discussed, but they also contain some form of hydrolyzed protein. Usually, collagen from animal sources is used, but any hydrolyzed protein will do. The protein can diffuse into the hair shaft through the cuticular defects created by the chemical treatment. The protein can impart some strength to the hair shaft and also smooth the cuticular scale more thoroughly than an instant conditioner.

For patients who have chemically processed hair, I recommend a deep conditioner once every one to two weeks in addition to an instant conditioner after shampooing.

Hair trimming

Cut away damaged hair shafts (Figure 38.10).



FIGURE 38.10 (Continued)



FIGURE 38.10 (Continued) (A) Broken irregular hair shafts must be cut away to restore the hair to a presentable appearance because the hair is nonliving. (B) Patients with thinning hair may be tempted to reduce the frequency of hair trimming. Hair trimming should be performed on an approximately six-week basis to keep the hair looking full and healthy.

Many patients who are losing their hair are reluctant to cut their hair. They feel they should hang onto all their hair in case no more grows. Unfortunately, hair that has been damaged by too much chemical processing and too little conditioner application cannot be restored. For these patients, the overall appearance of the hair can be improved simply by removing 1 to 2 inches from the distal hair shafts. This trims away the split ends and creates new hair ends that are less frizzy, more likely to maintain a curl, and less subject to static electricity. Trimming also eliminates the irregularity of broken hairs that creates a thin appearance. In short, removal of the damaged hair can create the illusion of fuller, healthier hair. Of course, the newly exposed ends must receive proper care, or they too will develop an unattractive cosmetic appearance with time.

Summary

Even though hair is a nonliving substance, proper care can allow it to resist breakage that contributes to hair loss. Much of the product development regarding hair care has been the adaptation of textile processing techniques to the human hair fiber. When hair is thought of as a fabric, it is easy to understand how proper handling of the hair fiber and limited exposure to damaging chemicals and environmental variables can influence its cosmetic performance. This section has presented some ideas for the dermatologist to use when assisting patients concerned about medical or cosmetic hair loss.

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Section IV

Nails

Introduction

The nails are interesting structures. Perhaps they are vestiges of claws used by animals for eating and self-protection. Maybe they are necessary for protection of the highly innervated tissues of the fingertips. Perhaps nails are there for nothing more than cosmetic adornment! Certainly, there are a myriad of products to improve the appearance of the nails, from something as simple as a nail clipper to something as complex as a polymerized acrylic prosthesis placed on the nail for elongation. It is said that nails can tell a lot about an individual. Grease-stained fingernails indicate work as an auto mechanic, whereas yellowed fingernails may indicate excessive cigarette smoking. Clean, well-trimmed fingernails may indicate physical health and excellent hygiene, whereas misshapen fingernails may indicate an underlying dermatologic disease. Nails can be a clue to a lung or renal disease that may be lurking inside the body yet undiagnosed, except by the skillful eye of the dermatologist! There is no doubt that nails tell an unspoken story about the life of a person.

Given this preoccupation with nails, the cosmetic industry has found a ripe opportunity. There are products designed to bleach

discolored nails and moisturize brittle nails. There are nail polishes to coordinate nail color with clothing, moods, or fashion trends. Some nail prostheses are designed to be worn only for one day or for months at a time in short, medium, long, and excessively long lengths. The prostheses have become an art form for many, with elaborate painting, jewels, or sculptures stuck to the natural nail plate. These manipulations are not only performed on the fingernails but also on the toenails, creating 20 little canvases for artistic expression.

In addition to the cosmetic intrigue, nails also have specific grooming and hygiene needs. It is said that outside of the mouth, the skin beneath the nails is one of the dirtiest areas on the human body. Indeed, many diseases are passed from the hands to the mouth, eyes, or nose by the fingernails. This means that nail hygiene can assume paramount importance in both sexes and in persons of all ages. There are specific needs for nails in children and also in nail disease, including nail dystrophy and nail psoriasis. This section of the book covers all these areas and provides a compendium of nail cosmetics for nail health and disease.



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A PROBLEM-ORIENTED APPROACH TO FINGERNAIL ISSUES

Nail problems are perplexing for the dermatologist and in many ways more challenging than skin problems because the nails are nonliving (Figure 39.1). The renewal time for the stratum corneum is a mere two weeks, but it takes three to six months to grow a new fingernail and 6 to 12 months to grow a new toenail. This means the time between treatment and visible results is prolonged, creating problems with unrealistic patient expectations. Nevertheless, the nails are an important appearance attribute nonverbally communicating our sex, personal care habits, occupation, hobbies, and habits. Although the nails function primarily to protect the tender fingertip and facilitate manipulation of small items, modern society assigns paramount importance to the appearance of nails as a manner of determining social status. Persons who perform manual labor cannot maintain long nails, whereas individuals who work in managerial positions use longer nail length as one method of indicating occupational success. Women spend both time and money pursuing long, brightly colored prosthetic fingernails and toenails as nonverbal body art to display social standing.

Nail adornment is an interesting topic because it allows expression of subtle personality characteristics. Is red nail polish an indication of an extrovert, whereas clear nail polish an indication of an introvert? Are damaged nails from biting an indication of a nervous, timid personality? This reasoning further extends into the concern over nail disease. Do the yellow/green thickened nails of a fungal infection indicate a contagious condition? Are the pitted nails characteristic of psoriasis socially associated with ill health? Certainly, the hands and nails are the second area of visual contact when meeting a new individual after the face. There can be no doubt that nails say a great deal about who we are and what we aspire to be.

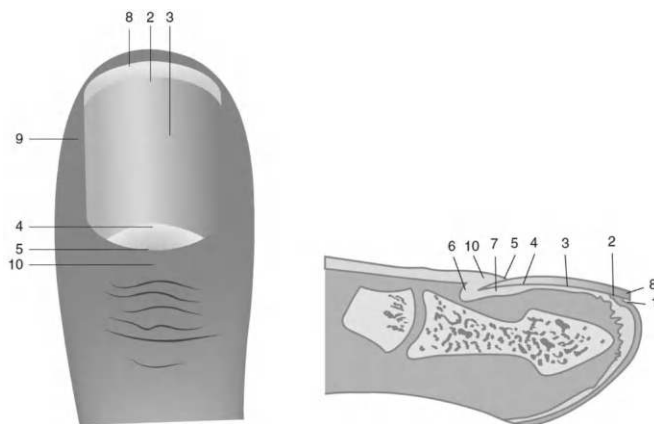


FIGURE 39.1 Normal anatomy of the nail: (A) top view; (B) sagittal section. 1, distal groove; 2, hyponychium; 3, nail bed; 4, distal border of lunula; 5, cuticle; 6, proximal matrix; 7, distal matrix; 8, free edge; 9, lateral nail fold; 10, proximal nail fold. (Source: From Richert B, Di Chiachio N, Haneke E. *Nail Surgery*. Informa Healthcare, 2010, with permission).

This chapter takes a problem-oriented approach to nail cosmetic problems and issues of nail disease. It begins by dividing nail issues into those pertinent to the fingernails, toenails, and unique issues in children. Common patient cosmetic problems are presented with a discussion of the issues and products that may cause and improve the condition. Because most cosmetic problems require that the damaged nail grow until replaced by new normal growth, identifying the problem and suggesting solutions is paramount. Nail disease, on the other hand, can be challenging to treat; yet, cosmetic interventions may provide a temporary solution until a new nail appears. This chapter links nail cosmetics and nail cosmetic procedures to the problems they create and camouflage (Table 39.1).

Nail discoloration

Nail discoloration is a common cosmetic concern (Table 39.2) (1–4). The normal nail plate is transparent, allowing the nail bed to be visualized as pink through the proximal nail plate, with the air interface allowing the nail to appear white at the distal free edge. With advancing age and the onset of nail disease, the nail plate becomes less transparent and more translucent, making the nail bed appear paler and giving the impression of reduced blood flow. The aging nail may also be yellowed, either from a poorly formed nail plate or staining from environmental substances, such as nicotine, foodstuffs, cleaning fluids, and pigmented cosmetics (Figure 39.2). Nail growth also slows down, increasing the renewal time for the nail plate and the opportunity for nail staining. The easiest camouflage for nail discoloration is the use of nail polish, which is also the most common nail cosmetic for adornment. Discolored nails can also be treated by bleaching.

Nail polish

Nail polish, also known as nail enamel, is a pigmented coating applied to the nail plate. It was introduced in the 1920s when lacquer technology was developed in the automobile industry to replace slow-drying oil-based paints. The basis of nail polish is nitrocellulose created by reacting cellulose fiber, from cotton linters or wood pulp, with nitric acid. Boiled nitrocellulose is dissolved in organic solvents, which evaporate, leaving a hard, glossy film known as a lacquer (5). In 1930, Charles Revson developed the idea of adding pigments to the clear lacquer to form an opaque, colored nail polish and founded the cosmetic company, Revlon, in 1932.

Nail polish can be used to camouflage nail discoloration.

Nail polish consists of pigments suspended in a volatile solvent to which film-formers have been added (Figure 39.3). The ingredients are listed in Table 39.3 (6). Nitrocellulose is the most commonly employed primary film-forming agent in nail lacquer because it produces a shiny, tough film that sticks well to the nail plate. The film is oxygen permeable, which is felt to be important

TABLE 39.1: Nail Cosmetics

Nail Cosmetic	Main Ingredients	Function	Adverse Reactions
Nail polish	Nitrocellulose, toluene-sulfonamide resin, plasticizers, solvents, and colorants	Adds color and shine to nail plates	Allergic contact dermatitis to toluene-sulfonamide resin, nail plate staining
Nail hardener	Formaldehyde, acetates, acrylics, or other resins	Increases nail strength and prevent breakage	Allergic contact dermatitis to formaldehyde
Nail enamel remover	Acetone, alcohol, ethyl acetate, or butyl acetate	Removes nail polish	Irritant contact dermatitis
Cuticle remover	Sodium or potassium hydroxide	Destroys keratin that forms excess cuticular tissue on nail plate	Irritant contact dermatitis
Nail bleach	Hydrogen peroxide	Removes nail plate stains	Irritant contact dermatitis
Nail polish drier	Vegetable oils, alcohols, or silicone derivatives	Speeds drying time of nail polish	Practically none
Nail buffing cream	Pumice, talc, or kaolin	Smooths ridges in nails	Practically none
Nail moisturizer	Occlusives, humectants, and lactic acid	Increases water content of nails	Practically none

TABLE 39.2: Nail Discoloration Causes

1. Aging nail plate with poor keratin production
2. Nicotine staining from cigarette smoking
3. Handling fruits (peaches, oranges, tomatoes, strawberries) and vegetables (yellow squash, beets, pumpkin) with carotenoids that are colored yellow, orange, or red
4. Nail polish staining from red and orange nail polish
5. Solvent contact, such as turpentine, glutaraldehyde, formaldehyde, etc.
6. Poor internal health (respiratory disease, cancer chemotherapy, heart disease)
7. Contact with pigmented products, such as hair dye, self-tanning preparations, facial foundations, etc.
8. Yellow nail syndrome
9. Onychomycosis

to nail plate health. This is the advantage of using nail polish to camouflage nail discoloration instead of artificial nail prostheses, which are oxygen impermeable. Thus, nail polish places an inert protective coating on the nail plate that does not produce damage.

Toluene-sulfonamide-formaldehyde resin found in many nail polishes is a common allergen.



FIGURE 39.2 Discolored nail plate.

A secondary film-forming resin must be added, however, to make the nail polish film flexible; otherwise it would crack with movement of the nail plate. The main resin used to enhance the nitrocellulose film was toluene-sulfonamide-formaldehyde. This resin is allergenic and found on the standard dermatology patch test tray. Nail polishes labeled “hypoallergenic,” meaning reduced allergy, should not use this resin. The resin has been eliminated in some hypoallergenic nail enamels and replaced with a polyester resin or cellulose acetate butyrate, but sensitivity is still possible and the enamel is less resistant to wear, meaning it is readily removed from the nail plate with friction (7).

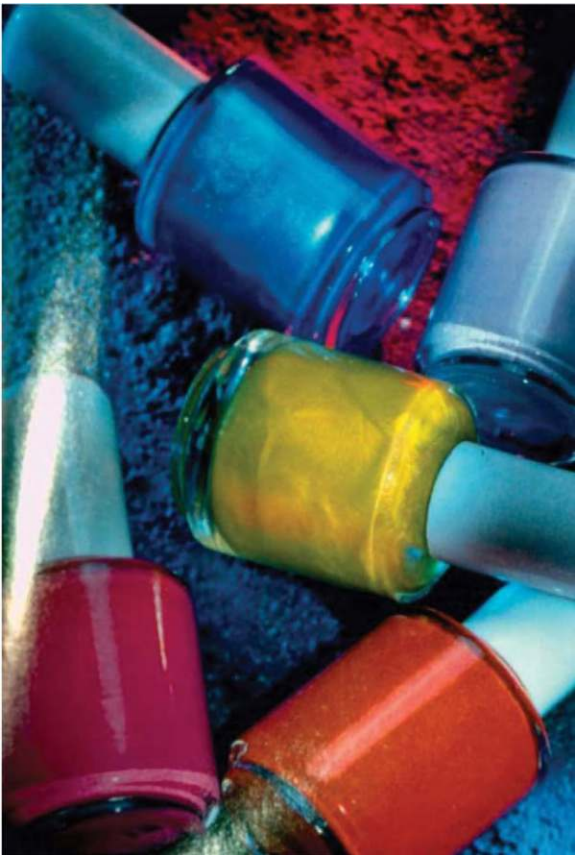


FIGURE 39.3 Nail polish is available in a myriad of modern colors.

TABLE 39.3: Nail Polish Ingredients

1. Primary film-former (nitrocellulose, methacrylate polymers, vinyl polymers)
2. Secondary film-forming resin (formaldehyde, p-toluene sulfonamide, polyamide, acrylate, alkyl and vinyl resins)
3. Plasticizers (dibutyl phthalate, dioctyl phthalate, tricresyl phosphate, camphor)
4. Solvents and diluents (acetates, ketones, toluene, xylene, alcohols)
5. Colorants (organic D&C pigments, inorganic pigments)
6. Specialty fillers (guanine fish scale or titanium dioxide-coated mica flakes or bismuth oxychloride for iridescence)
7. Suspending agents

Nail lacquers also contain other ingredients, such as plasticizers like dibutyl phthalate and dioctyl phthalate, which function to keep the product soft and pliable in the bottle. It should be mentioned that the phthalates have recently come under criticism for their possible estrogenic side effects. Some states are considering legislation to remove this family of ingredients, which is also used for preservative purposes, from the market.

All the ingredients discussed are then dissolved in a solvent, such as N-butyl acetate and ethyl acetate, leaving a colored film on the nail plate. Toluene and isopropyl alcohol may be added to act as diluents to keep the lacquer thin and lower its cost. To this vehicle, various coloring agents and specialty fillers can be added to determine the final cosmetic appearance of the nail polish. Coloring agents, such as organic colors, can be selected from a Food and Drug Administration (FDA) approved list of certified colors. Inorganic colors and pigments may also be used, but must conform to low heavy-metal content standards (8). These colors can be suspended within the lacquer with suspending agents, such as stearalkonium hectorite, to produce colors ranging from white to pink to purple to brown to orange to blue to green.

Specialty fillers, such as guanine fish scale, bismuth oxychloride, or titanium dioxide-coated mica, can be added to give a frosted appearance due to enhanced light reflection. Chopped aluminum, silver, and gold can be added for a metallic shine. Several types of specialty nail polishes have been developed to create unique nail appearances. These nail polish varieties are presented below.

1. Photochromic nail polish

Photochromic nail polish is based on the photodarkening that occurs with glasses that automatically darken with sun exposure. The nail polish similarly darkens from white to a pinkish color with sun exposure. UV breaks the carbon-oxygen spiro bond, allowing the nail polish to exhibit color when the absorption spectrum shifts to a lower energy state in the visible range.

2. Thermochromic nail polish

Thermochromic nail polish changes color when exposed to heat or cold based on the temperature of the fingertip and air. When the temperature is below the solvent melting point, hydrogen donation between molecules occurs, leading to rearrangement and the production of color. When the solvent melts with increasing temperature, the molecular interaction stops and the colorless state reappears.

3. Magnetic nail polish

Magnetic nail polish contains magnetic particles, such as nickel, cobalt, or iron oxide, that align themselves when a magnet is placed over the wet nail polish to create interesting designs.

4. Crackle nail polish

Painting the nails with regular nail polish and then painting the crackle layer on top creates cracks as the nail polish dries unevenly due to the presence of ethyl alcohol in the crackle layer. A top coat is then applied of clear nail polish to prevent chipping.

For optimal nail discoloration camouflaging, the nail polish should be opaque and properly applied. The technique for nail polish application is discussed next.

Nail polish camouflaging technique

Nail polish does not damage the nail plate, but nail polish remover dehydrates the nail plate.

Nail polish must be properly applied to camouflage the underlying discolored nail plate. Proper application ensures the longevity of the camouflage. This is important because it is not the nail polish that damages the nail plate, but rather the nail polish remover. Proper application requires three layers of nail polish: a base coat, pigmented nail enamel, and a top coat (Table 39.4). The base coat ensures good adhesion to the nail plate and prevents polish chipping. It contains no pigment, less primary film-former, more secondary film-forming resin, and is of a lower viscosity because a thinner film is desirable. The second layer is the actual pigmented nail enamel. The top coat, or third layer, provides gloss and resistance to chipping. It contains increased amounts of primary film former, more plasticizer, and less secondary film-forming resin. Some top coats may contain sunscreen to prevent the nail lacquer color from being damaged but do not contain pigment. Finally, a nail polish drier, consisting of vegetable oils, alcohols, and silicone derivatives may be brushed or sprayed over the completed nails to induce rapid hardening of the enamel by drawing off the nail polish solvent.

These three consecutive coats increase the ability of the nail polish to stay on the nail plate, a characteristic known as nail lacquer “wear.” The wear of the nail polish is determined by the film hardness, water resistance, adhesion to the nail, and ability to resist abrasion. Because it is the nail polish remover that damages the nail plate, it is desirable for the nail polish to remain on the nail plate as long as possible.

A newer nail color application technique to improve the wear of nail color is known as gel nails. Here, a long-lasting colored polymer film is placed over the nail that is chip-resistant, strong, long-wearing, and shiny; however, it must be applied and removed professionally. The polymer, which is actually plexiglass, is applied by dipping the nail into a container filled with spherical poly methacrylate powder with particles ranging from 20–60 micrometers. Moisture trapped within the powder initiates the

TABLE 39.4: Nail Polish Application Technique

1. *Base coat*: Clear polish designed to seal the nail plate with a thin coat of film-former
2. *Nail enamel*: Pigmented polish producing an opaque film to camouflage the underlying discolored nail plate
3. *Top coat*: Thin clear polish containing sunscreen to prevent polish color fading, add high shine, and prevent removal of nail enamel
4. *Nail polish drier*: Liquid that speeds up the drying of the nail polish by encouraging evaporation of the solvent



FIGURE 39.4 Removal of old gel nail material.



FIGURE 39.5 Removal of softened polymer.

polymerization or sometimes benzoyl peroxide is used as an initiator. The coating can contain any color and glitter or other materials to create elaborate nail appearances.

The technique is pictorially presented with [Figure 39.4](#) showing the removal of old gel nail material. Here, an acetone-soaked cotton ball is placed over the nail and wrapped in aluminum foil to soften the old nail polymer. This is very drying to the fingertip skin and the natural nail plate. The softened polymer is removed with a drill ([Figure 39.5](#)), which can also create a rough nail surface and nail thinning. Roughening the nail is important to increase the surface area of the nail, so the new polymer has more adhesion, but it can also damage the cuticle. [Figure 39.6](#) shows nails that have been dipped in the copper-colored glittery powder with a liquid initiator being applied on top to create the nail film. The dipping is usually repeated three times to create a thicker, more chip-resistant film. Finally, a drill is used to remove unwanted polymer and to shine the nail surface ([Figure 39.7](#)). The versatility of gel nails is presented in [Figure 39.8](#).

Nail polish staining

Nail polish containing D&C Red Nos. 6, 7, 34, or 5 Lake can temporarily stain the nail plate yellow.

It is important to remember that nail polish can also stain the nail plate ([Figure 39.9](#)). The nail staining occurs when the polish pigment is dissolved rather than suspended. It is most common with deep-red nail polishes containing D&C Red Nos. 6, 7, 34, or 5 Lake ([9](#)). The nail plate will be stained yellow after 7 days



FIGURE 39.6 Liquid initiator applied to create the nail film.



FIGURE 39.7 Removal of unwanted polymer.

of continuous wear, but the stain will fade without treatment in approximately 14 days once the enamel has been removed. Scrapping of the nail plate with a scalpel blade can be used to confirm that only the nail surface has been stained, an important distinction in nail pigmentation abnormalities (10).

French manicure camouflage

A camouflage technique known as the French manicure, which artistically utilizes various colors of nail polish to simulate the normal nail plate, can be a remedy for nail discoloration (Figure 39.10). First, the nail is painted with a white, opaque base coat to cover the discoloration. A light pink enamel is added to the entire nail plate to simulate the nail bed. Finally, a white enamel is applied to the distal nail tip, simulating the nail free edge. A clear top coat is applied last to prevent color fading and minimize enamel chipping (Figure 39.11). French manicures can be performed professionally by a manicurist or at home with pre-packaged kits available at mass merchandisers.

Nail bleach

It is possible to bleach superficial stains out of the nail plate. For example, food and nicotine stains can be removed with the high-volume peroxide found in nail bleach. However, irritant contact dermatitis can occur (11). A safer alternative to nail bleach is nail filling. This technique is discussed next and can also be used to treat ridged nails.

Nail ridging

Nail ridging can be minimized with a nail file or nail buffing creams.



FIGURE 39.8 (A–C) Versatility of gel nails.

Another common nail problem, seen primarily in persons 40 years of age and older, is nail ridging. Longitudinal nail ridging is common because the nail bed ages and can be likened to gray hairs on the head. The ridge represents a group of nail matrix cells that are no longer producing a quality smooth nail plate, much like a gray hair produced by an aging follicle that no longer manufactures pigment. Typically, the ridge is permanent because more ridges appear with advancing age (12). Fortunately, the ridge is only on top of the nail plate and can be removed by sanding or buffing the nail plate along with any nail plate discoloration that may be present.



FIGURE 39.9 Nail plate staining can occur with deep-red nail polish.



FIGURE 39.10 White and pink nail polishes are used to simulate a healthy natural nail plate.

The nail plate is best sanded with a series of three nail files (Table 39.5). The first nail file is coarse and should sand the nail ridge until smooth. This is best determined by rubbing the treated nail with the finger pad of the same nail from the opposite hand. Once the nail is smooth, it is then filed with a finer file to increase smoothness, and finally filed to achieve a high shine. Usually, the three files are sold together for under \$5 in mass merchandisers and labeled as cleaning, conditioning, and shining files. Each time the nails are cut, the filing sequence must be repeated because new nail growth will contain the longitudinal ridge (Figure 39.12).

If the patient does not wish to perform the filing at home, this sequential filing routine can be included as part of a regular manicure. The technique can be used by both men and women to minimize longitudinal ridges, remove nail plate discoloration, and restore a more youthful appearance to the nail plate.

An alternative to nail filing is the use of a nail buffing cream to smooth nail plate ridges. Nail buffing creams contain finely ground pumice, talc, kaolin, or precipitated chalk as abrasives. Waxes are also added to increase the nail shine (13).

A variant of nail ridging is the habit tic deformity. In this condition, the nail is characterized by horizontal ridges, instead of longitudinal ridges, down the nail center. It results from a repeated picking trauma to the nail and is most common when the thumbnail is manipulated by the first fingernail of the same hand. In most patients, it is a subconscious behavior in individuals who like to keep their hands moving. It is a difficult habit to break. Some success can be achieved by offering another object for manipulation, such as a smooth stone, a strand of beads, a piece of cloth, or a compressible ball. The patient can select a comforting object to manipulate in their pocket instead of nail picking. The ridges can be smoothed once the nail picking stops using the same sequential filing technique described for the longitudinal ridges.

Nail splitting

Nails split due to loss of nail plasticity from lack of water.



FIGURE 39.11 A French manicure is an effective way to camouflage discolored, unattractive nails. (A) Colored enamels are artistically applied to the nail plate. (B) The finished appearance of the decorated nails.

TABLE 39.5: Nail Filing Technique for Nail Ridging

1. *Cleaning file*: Coarse file to grind the nail plate leaving a rough surface
2. *Conditioning file*: Finer file to remove nail dust
3. *Shining file*: Smooth file to add high shine to the nail plate

In addition to nail ridging, the nails may also split for many reasons, but primarily due to loss of nail plasticity. Water is the plasticizer of the nail plate, allowing it to bend and rebound with trauma. Because the hands grasp, type, write, dig, scratch, squeeze, and so on, the nails are subject to more trauma than any other nonliving portion of the body. It is no wonder, then, that the nails split. The best method to prevent nail splitting, also known as onychorrhexis, is to preserve the water content of the nail plate. No one knows exactly how much water should be in the nail plate because underhydration results in the cracking of the keratin and overhydration results in the softening of the nail keratin, both of which result in a nail plate less resistant to trauma. The best sources available state that the normal nail contains about 16% water, becoming soft with saturation at 30%. The water content of nail keratin is proportional to relative humidity, being 7% at 20% relative humidity and 30% at 100% relative humidity (14).

There are several techniques of addressing nail splitting issues, sometimes also termed brittle nails, in patients (15–17). The obvious explanation is that the nails should be protected from trauma of all types, but this is not practical advice. Table 39.6 lists some of the cosmetic methods for helping patients minimize nail plate splitting and fracture (18).

Due to the nonliving nature of the nail plate, once the water is lost, it can never be fully replaced. Thus, patients with nail splitting should be advised to prevent nail dehydration at all costs (19, 20). Handwashing is the obvious cause of nail plate dehydration, lending credence to the concept that the nails should not be washed unless dirty, focusing the cleansing on the hands only. Another cause of nail plate dehydration is the use of waterless hand sanitizers, which are usually based on alcohols. The vehicle efficiently removes water from the nail plate to a greater degree than traditional soap and water. For this reason, hand sanitizers should be avoided to prevent nail splitting.

Nails are also dehydrated by the use of cleaning fluids that contain ammonia, bleach, and strong detergents (21). Contact with

**FIGURE 39.12** Demonstration of the filing technique to smooth out nail ridges.**TABLE 39.6: Methods to Minimize Nail Plate Splitting and Fracture**

1. Minimize water loss from the nail plate.
 - a. Wash hands, not nails, if not soiled.
 - b. Avoid waterless hand sanitizers.
 - c. Eliminate antibacterial soaps and cleansers.
 - d. Wear gloves when using cleaning solvents, hair dyes, and hair permanent wave solutions.
2. Apply nail moisturizers to trap and bind water within the nail plate.
 - a. Use nail moisturizer with petrolatum to trap water and glycerin to attract water to the nail plate.
 - b. Increase the water-binding sites on nail keratin with urea or lactic acid.
3. Increase oral biotin intake.
4. Apply a fibered nail polish.
5. Apply a nail hardener but use with caution.

these substances may be necessary, but gloves should be worn to protect the nails from dehydration. It is worthwhile reminding the patient that only one contact with strong surfactants is necessary for dehydration to occur. Thus, consistency in hand protection is important.

Nail moisturizers temporarily increase nail plate hydration by increasing water binding sites on nail keratin.

Nail moisturizers may temporarily increase nail plate hydration to prevent splitting. The products are usually creams or lotions containing occlusives, such as petrolatum, mineral oil, and lanolin (15). Humectants such as glycerin, propylene glycol, and proteins may also be added. Alpha-hydroxy acids, lactic acid, and urea are active ingredients used to increase the water-binding capacity of the nail plate. A well-formulated nail moisturizer should contain substances from all the aforementioned groups to maximally treat the dehydrated nail plate.

A possible solution to nail splitting is oral supplementation with biotin (22). Various commercial products are available in tablet form. Biotin was originally used by veterinarians to prevent hoof splitting in racehorses and then adapted to humans. It is possible that biotin deficiency may occur in the elderly, where biotin transport across the gastrointestinal mucosa may be decreased. Furthermore, the highest concentration of biotin is found in egg whites, and elderly individuals typically limit their egg consumption due to elevated cholesterol issues. For this reason, it may be worthwhile for the physician to consider a biotin supplement (250 mg per day) in persons with brittle, splitting nails (22). There is no evidence that topical biotin added to nail moisturizers has a similar beneficial effect. There is also no evidence that topical gelatin, calcium, iron, botanical extracts, biological extracts, and so on are effective in treating brittle nails (23).

Nail cosmetics can also be used to prevent nail splitting. Nail polishes, as previously discussed, can increase the thickness of the nail plate, thereby improving the ability of the nail to resist trauma. Because nail polish forms a flexible film, it can bend as the nail is deformed, increasing resistance to fracture. The nail polish can add further strength to the nail by containing 1% nylon or rayon fibers. These polishes, termed fibered nail polishes, add further flexibility to the nail plate. They can be used

as an alternative top coat for persons with extremely brittle nails. Nail polish may actually prevent nail plate dehydration by preventing detergent contact with the nail plate, acting as a protectant, and decreasing nail water vapor loss from 1.6 to 0.4 mg/cm²/hour (24).

The main active ingredient in nail hardeners is the allergen formaldehyde.

Finally, products known as nail hardeners are available (Figure 39.13). The main active ingredient in nail hardeners is formaldehyde, originally used in concentrations greater than 10% resulting in onycholysis, subungual hyperkeratosis, reversible subungual hemorrhage, and bluish discoloration of the nail plate (25–27). Formaldehyde is also a cause of allergic contact dermatitis (28, 29). Recognition of this problem led to regulation prohibiting formaldehyde in concentrations greater than 5% in nail hardener preparations manufactured for interstate sale, as mandated by the U.S. FDA. Free formaldehyde in concentrations of 1%–2% is still used, but acetates, toluene, nitrocellulose, and acrylic and polyamide resins, substances found in the nail polishes previously discussed, are now used to structurally reinforce the nail plate.

Once the nail plate has split, there is little that can be done except to address the issues listed in Table 39.6 and wait for a new nail plate to grow. Sometimes the nail will split into the nail bed, causing pain and bleeding. This can be aided with a nail repair technique called the tea bag repair.



FIGURE 39.13 An example of a commercially available nail-strengthening product.

Repairing split nails

A split nail can be repaired with a tea bag until new growth occurs.

A technique that can be safely recommended to patients to repair a painful split nail is the tea bag repair. This method can be used to repair a broken nail where the break occurs proximal to the nail free edge, resulting in the removal of the nail from the nail bed. This type of broken nail is painful and a site of injury for infection. Although the medical solution to this problem is new nail growth, a cosmetic repair can be helpful in alleviating pain and preventing infection. This technique utilizes a tea bag and clear nail polish and can be performed at home by the patient. The tea bag is cut, and the tea leaves emptied to obtain the surrounding fiber paper. A small piece of fiber paper is cut to fit over the nail break and an additional 2 mm around the break. The broken nail is pushed back into place and covered with a layer of clear nail polish. The fibered paper is placed on the break and embedded in the clear nail polish, followed by two to three extra coats. This technique reinforces the break with fibered paper held in place by nail polish as a semipermanent band-aid until healing can occur.

This repair can be repeated as often as necessary as the nail grows. It uses commonly found materials costing little. Most patients who experience this type of painful broken nail wear their nails too long. The easiest suggestion to remedy recurrent broken nails is to cut the nail such that the free edge cannot be visualized over the fingertip as viewed from the palm of the hand. Although the patient may not take kindly to the suggestion that they wear shorter nails, this is the only clinically reproducible method for reducing broken nails of this type.

Nail peeling

Cutting the nail plate with sharp scissors perpendicularly to the nail plate can prevent nail peeling.

Nail peeling, also known as onychoschizia, is lamellar splitting of the nail. The keratin peels from the nail tip in layers, weakening the nail and catching on clothing. This condition is most commonly due to poor nail manicuring techniques. If the nail is not cut sharply perpendicular to the nail plate, nail peeling can occur. The steps in performing a nail manicure to prevent nail peeling are reviewed.

The main goal of a manicure is proper trimming of the nails to maintain a strong, healthy nail plate. The nail should be rounded at the tip for aesthetics, but the corners should be left square to maximize strength. Too sharp an arc extending from the lateral to medial nail margin will weaken the nail structurally, resulting in nail plate fracture. Ideally, the nail plate should not be cut but filed frequently with an orange stick to avoid cracking the nail plate through shearing forces generated by scissors or clippers. However, most patients groom their nails infrequently, necessitating cutting. Cutting should be done with a pair of curved nail clippers because scissors may not cut the nail plate squarely (Figure 39.14). An angle on the distal nail



FIGURE 39.14 Properly designed nail cutters to minimize nail peeling.

plate predisposes to nail peeling. Any remaining sharp edges should be filed with a diamond dust file (30). Under no circumstances should the cuticle be removed or traumatized, as this may precipitate the formation of paronychia, onychomycosis, or onychodystrophy.

Nail peeling can also be minimized with nail polish. Once the nail is properly cut, a thin coat of clear nail polish is placed at the distal free edge and underneath the free edge. This placement protects the nail tip from the trauma that results in nail splitting. However, it should be mentioned that the removal of nail polish may also contribute to onychoschizia (31). Nail polish removers are liquids designed to strip nail polish from the nail plate. They may contain solvents such as acetone, alcohol, ethyl acetate, or butyl acetate. These solvents break down the nail polish film but also dehydrate the nail plate, contributing to brittle nails and nail peeling. Conditioning nail enamel removers are available, containing fatty materials such as cetyl alcohol, cetyl palmitate, lanolin, castor oil, or other synthetic oils. It is thought that these oily substances act as occlusive nail moisturizers, retarding water evaporation, but they cannot totally prevent nail plate dehydration if used frequently. Thus, nail polish should be properly applied, as discussed in the section on nail splitting.

Onycholysis

The most common cosmetic cause of onycholysis is nail prostheses.

Onycholysis is the removal of the nail plate from the nail bed, usually due to trauma. Onycholysis can also be seen in nail fungal infection, a condition known as onychomycosis. However this discussion will focus on onycholysis related to the use of cosmetic nail products.

The most common cause of onycholysis is the use of artificial nails, also known as nail prostheses. Onycholysis occurs because the bond between the artificial nail and the natural nail plate is stronger than the adhesion between the natural nail and nail bed (Figure 39.15). Thus, minor trauma rips the nail from the nail bed, an injury that cannot be repaired until new nail growth occurs.



FIGURE 39.15 Onycholysis between the natural nail bed and the nail prosthesis.

Onycholysis can also occur due to sensitivity to the methacrylate polymer (32, 33).

In addition to onycholysis, many patients are appalled at the broken, thinned, yellowed appearance of their nails following sculpture removal. This is due to interference with the nail's normal vapor exchange, nail plate trauma during the removal process, and damage to the underlying nail bed (6). Although nail prostheses are extremely popular among women of all ages, they present an opportunity for the onset of nail disease. This section examines nail prostheses and their relevant dermatologic issues.

Preformed nail prostheses

The original artificial nail was a preformed piece of plastic that was glued over the natural nail plate with a methacrylate-based adhesive (34) (Figure 39.16). These nails are still popular today and available in a variety of styles: precolored, uncolored, pre-cut, and uncut. Preformed nails come in press-on, pregled forms and in forms requiring glue application, but the nails usually pop off before onycholysis can occur with trauma. The nails also come in a variety of sizes and shapes to match the patient's natural nail plate (35). Even with the variety available, most patients do not find a suitable preformed nail, accounting



FIGURE 39.16 Press-on nails are the simplest at-home application of nail prostheses.

for the increasing popularity of custom-made nail prostheses discussed next.

Custom nail prostheses

Sculptured nails are custom-made nail prostheses created on a template attached to the natural nail plate.

Custom-made nail prostheses are known as sculptured nails, an increasingly popular method of obtaining long, hard nails. The word “sculptured” is used because the custom-made artificial nail is sculpted on a template attached to the natural nail plate. The sculpted nail fits perfectly and, if well done, can be difficult to differentiate from a natural nail. These sculptured nails are the most common cosmetic cause of onycholysis in women who present to the dermatologist.

The application technique is summarized in [Table 39.7](#) ([Figure 39.17](#)). The entire process takes 2 hours to create a set of 10 fingernails. Originally, methyl methacrylate was the monomer used to fashion the nail, but its use has been discontinued due to its sensitizing potential. Currently, liquid ethyl or isobutyl methacrylate is utilized as the monomer and mixed with powdered polymethyl methacrylate polymer. The product is allowed to polymerize in the presence of a benzoyl peroxide accelerator, and a formable acrylic is made, which hardens in seven to nine minutes (36). Usually, hydroquinone, monomethyl ether of hydroquinone, or pyrogallol is added to slow down polymerization (37). The acrylic is then shaped to the length and fingernail style desired by the patient. The bond formed between the acrylic and the natural nail plate is extremely strong because the nail plate is chemically and sometimes physically etched with a drill to increase the surface area over which polymerization can occur. It is for this reason that trauma usually separates the natural nail plate from the nail bed.

Many patients are not aware that the finished nail sculptures require more care than natural fingernails. With continued wear of the sculpture, the acrylic loosens from the natural nail, especially around the edges. These loose edges

TABLE 39.7: Sculptured Nail Prosthesis Technique

1. All nail polish and oils are removed from the nail.
2. The nail is roughened with a coarse emery board, pumice stone, or grinding drill to create an optimal surface for sculpted nail adhesion.
3. An antifungal, antibacterial liquid, such as decolorized iodine, is applied to the entire nail plate to minimize onychomycosis and paronychia.
4. The loose edges of the cuticle are either trimmed, removed, or pushed back depending on the operator.
5. A flexible template is fit beneath the natural nail plate, upon which the elongated, sculpted nail will be built.
6. The acrylic is mixed and applied with a paintbrush to cover the entire natural nail plate and extended onto the template to the desired nail length. A clear acrylic is used over the natural nail plate attached to the nail bed so that the natural pink color shows through. A white acrylic is used from the nail plate's free edge distally.
7. The nail prosthesis is sanded to a high shine.
8. Nail polish, jewels, decals, decorative metal strips, and air-brushed designs may be added, depending on the fashion tastes of the patient.

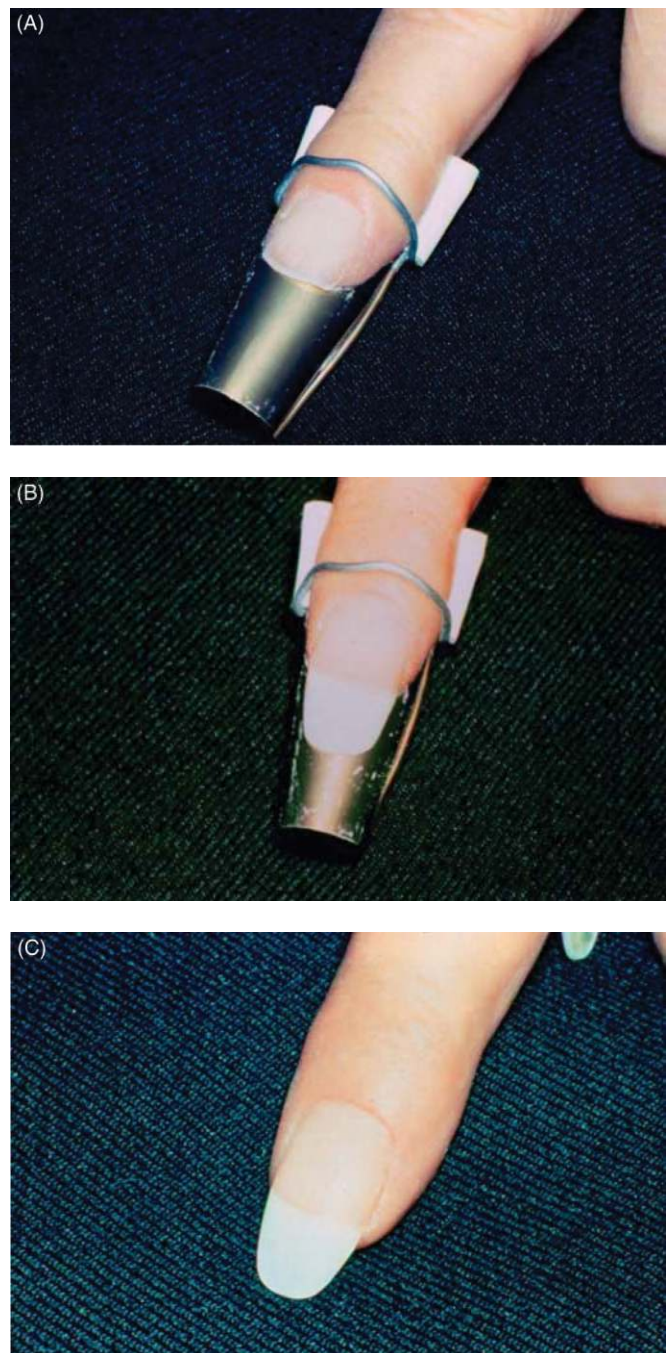


FIGURE 39.17 (A) A form is placed beneath the natural slide over which the nail prostheses will be formed. (B) The polymerized acrylate is formed over the natural nail plate and the form to create the illusion of nail length. (C) The finished appearance of the nail sculpture.

must be clipped, and new acrylic should be applied approximately every three weeks to prevent development of an environment for infection. The sculpture grows out with the natural nail plate, and more polymer material must be added proximally, depending on the nail growth rate. This procedure is known as “filling.” Failure to undergo filling every 2 to 3 weeks will result in the creation of a lever arm that predisposes to traumatic onycholysis or damage to the natural

nail plate. If necessary, the sculptured nails can be removed by soaking in acetone.

Damage to the natural nail plate still occurs with nail sculpture use, even if the patient is conscientious. After two to four months of wear, the natural nail plate becomes yellowed, dry, and thin. Most operators prefer to allow the patient's natural nail to grow and act as a support for the sculpture. However, the nails become thin, bendable, and weak. For this reason, it is not advisable to wear sculptured nails for more than three months consecutively, with a month's rest between applications.

Nail sculptures with preformed tips

Preformed tips allow the creation of excessively long nails that can increase the chance for onycholysis.

A less time-consuming and less expensive method to make custom nail prostheses is to combine custom-made nail sculptures with preformed artificial tips (Figure 39.18). This involves



FIGURE 39.18 (A) Roughening the surface of the nail plate with a file to increase the surface for the nail prosthesis to attach. (B) Application of an antifungal solution to the natural nail plate to prevent infection. (C) Methacrylate-based glue is used to stick the artificial nail to the natural nail plate. (D) Trimming of the artificial nail plate with scissors to the desired length. (E) Mixing of the powdered polymethyl methacrylate with the liquid isobutyl methacrylate to create a formable acrylic to fill the distance between the natural nail plate and the proximal nail fold. (F) A drill is used to smooth the natural nail plate in the prosthesis. (G) The finished appearance of a nail prosthesis. (Continued)



FIGURE 39.18 (Continued)

applying the liquid acrylic to the natural nail and embedding a preformed nail tip at the distal end. This method is used for patients who wish to have extremely long nails or nails embedded with numerous jewels. The possibility of developing traumatic onycholysis is enhanced with this variation due to the extreme length of the nails.

Photo-Induced onycholysis

Photo-induced onycholysis can occur when patients on photosensitizing oral medications use photobonded sculptured nails.

A variation on nail sculptures, known as photobonded nails, can precipitate photo-induced onycholysis. This nail technique utilizes a UV-cured acrylic sculpted on the natural nail. The nail is exposed to a magnesium light for one to two minutes. This technique is similar to restorative dental bonding; however, a patient on photosensitizing oral medications, such as tetracycline or doxycycline, may experience photo-onycholysis (38) (Figure 39.19). When the onycholysis does not involve the distal nail plate and nail sculptures are present, the physician should inquire as to the use of photobonded nails. In addition to photo-onycholysis, nails may also get allergic contact dermatitis.



FIGURE 39.19 Photo-induced onycholysis.

Allergic contact dermatitis

Nail polish allergy may be observed not only in the fingers, but also around the eyes.

Patients with proximal nail fold erythema and edema, fingertip tenderness and swelling, or eyelid dermatitis should be evaluated for allergic contact dermatitis to nail products (39). The most common cause of allergic contact dermatitis of this type is nail polish allergy. The North American Contact Dermatitis Group determined that 4% of positive patch tests were due to toluene sulfonamide-formaldehyde resin used in nail polish, as discussed previously. Patients who are allergic to the toluene sulfonamide-formaldehyde resin should consider using hypoallergenic nail polish containing the alternative polyester resins, which are less allergenic (40). Even though the allergic reaction is most commonly due to wet nail enamel, Tosti et al. found that 11 out of 59 patients who patch tested positive to wet polish, also reacted to the dried enamel (41). Allergic reactions can be severe, necessitating time lost from work (42).

Patch testing to verify allergy to toluene sulfonamide/formaldehyde resin can be performed using the standard patch test tray or the patient's bottle of nail polish. Nail polish can be tested "as is," but should be allowed to thoroughly dry, as the volatile solvent can cause an irritant reaction if not allowed to evaporate rapidly. The toluene sulfonamide/formaldehyde resin can also be tested alone in 10% petrolatum (43). Patients who are allergic to this resin should select hypoallergenic nail polishes (44).

The second most common cause of nail area allergic contact dermatitis is allergy to the methacrylates, which are used to glue artificial nails and create sculptured nail prostheses. Even though methyl methacrylate is no longer used, isobutyl, ethyl and tetrahydrofurfuryl methacrylate are still strong sensitizers (45, 46). It is important to remember the polymerized, cured acrylic is not sensitizing, only the liquid methacrylate monomer (47). Therefore, a careful nail operator who avoids skin contact with the uncured acrylic can avoid sensitizing the patient. Patch testing should be performed in suspected sensitized individuals with methyl methacrylate monomer, 10% in olive oil, and methacrylate acid esters, 1% and 5% in olive oil and petrolatum (48).

Cuticle problems

A large proportion of cosmetic nail issues arise from the removal or trimming of the cuticle.

Cuticle problems are varied and can range from paronychia infection to irritant contact dermatitis. Most cuticle problems arise from the removal of the tissue because it is considered cosmetically unattractive. Perhaps the true reason the cuticle is removed is to aid the nail artist in more easily painting the fingernails or applying nail prostheses. The cuticle can be removed chemically or physically. Chemical cuticle removers are formulated as liquids or creams and contain an alkaline substance to digest the keratin (49). They may contain sodium or potassium hydroxide, a common cause of irritant contact dermatitis, in a 2%–5% concentration with propylene glycol or glycerin added as a humectant. Milder preparations can be made with trisodium phosphate or tetrasodium pyrophosphate, but they are also less effective.

A cuticle remover variant is the cuticle softener. These are quaternary ammonium compounds in a 3%–5% concentration, sometimes combined with urea, designed to soften the cuticular protein and facilitate mechanical removal. Mechanical removal consists of either trimming the softened cuticle or pushing the cuticle back with a plastic or wood stick. Aggressive physical removal of the cuticle can damage the nail matrix cells, resulting in nail dystrophy, which can be temporary or permanent based on the severity of the injury.

Both chemical and physical cuticle removal results in breaking the watertight seal the cuticle provides between the proximal nail fold and the nail plate. Removal of the cuticle creates a potential space for water and other liquids to reside. Because it is difficult to dry this area, water accompanied by body warmth creates an environment for the growth of bacteria and yeast. Usually, the yeast colonization occurs first, setting the stage for subsequent bacterial infection and a paronychia. If the cuticle has been removed, isopropyl alcohol (rubbing alcohol) or acetic acid (vinegar) can aid in the evaporation of the water, preventing paronychia formation. Treatment with a medium-potency topical corticosteroid combined with a topical antifungal can aid in the resolution of a paronychia. However, if the lesion is purulent, an oral antibiotic may be necessary.

The solution has to allow the cuticle to remain in place to prevent a paronychia because it performs an important anatomic function. The physician may wish to establish a relationship with a nail technician who is willing to groom the nails without removing the cuticle. This is especially important in the patient who experiences recurrent or chronic paronychia.

Ingrown fingernails

Proper nail grooming can minimize the recurrence of ingrown nails.

Another frequently encountered medical nail problem is an ingrown fingernail. Ingrown fingernails are most commonly due to improper fingernail cutting. Most people with ingrown

fingernails either bite their nails or cut their fingernails too short. Most people like to cut their fingernails in a gentle arc, with the longest part of the nail in the center of the finger. This grooming method causes trouble at the sides of the fingernail, where improper cutting can leave nail fragments that may ingrow.

The best way to cut fingernails is straight across with no curve. This leaves the sides longer, making the nail too long to ingrow. If the nail should ingrow, then wrapping a piece of Teflon dental tape beneath the ingrown nail and lifting it out to the skin surface may be effective. Regular dental floss can also be used, but the Teflon is less likely to break and is smoother at the edges, preventing skin trauma. The dental tape is then covered by an adhesive dressing, which can be replaced as necessary.

Summary

An understanding of common nail problems and their treatment through medical and cosmetic techniques is important to the physician. Nail cosmetics can both cause disease and provide valuable camouflaging benefits. It has been said that nails are an indicator of social status, age, sex, and general health. Perhaps nail cosmetics are popular because they can conceal the underlying truth. The physician should never be hesitant to remove nail polish or an artificial nail in the office to adequately diagnose disease. For this reason, it is worthwhile to invest in a bottle of acetone-containing nail polish remover for in-office use. Nail polish remover can be placed on a cotton ball and stroked over the nail to remove polish, or poured into a crucible to soak off an artificial nail. It is important never to miss a diagnosis because of failure to visualize the natural nail plate.

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UNDERSTANDING AND TREATING BRITTLE NAILS

There is one condition that is more challenging to treat than bul-
lous pemphigoid or granuloma annulare, and it is simply known
as “brittle nails.” Most dermatologists have had this experience:
the patient who has been treated for a major skin condition dur-
ing an office visit asks as a quick end-of-visit aside for advice on
her brittle nails. Although at first glance, brittle nails may appear
to be a simple problem, treatment for this common condition is
perplexing. It may even be argued that the brittle state is a variant
of normal change associated with aging and should not even be
considered a problem worthy of treatment. Nevertheless, a few
ideas on why brittle nails occur and how to effectively minimize
the problem are worthwhile.

This chapter examines the physiology behind brittle nails and
presents suggestions on how to prevent the condition (1). Nail
problems are particularly challenging to treat because the non-
living nail cannot be healed and can only be replaced by new
growth. This new growth occurs slowly, requiring six months or
longer for a new fingernail to be produced. Treating nail problems
never results in immediate gratification and requires faith on the
part of the patient, who eventually heeds the dermatologic advice
for a positive outcome.

Nail physiology

Brittle nails are the equivalent of xerotic eczema. Water is the
plasticizer of both the nails and the skin. Dehydrated nails
become brittle and fractured, whereas dehydrated skin cracks
and flakes, exposing the underlying nerve endings to the environ-
ment and precipitating itching. Although topical corticosteroid
anti-inflammatories accompanied by moisturizers are the main-
stay of eczema treatment, only moisturizers can be used in the
treatment of brittle nails. A barrier composed of corneocytes and
intercellular lipids maintains the water content of the skin at 30%.
Healing of the skin usually occurs within two weeks, which is the
turnover time for the stratum corneum. Simply put, the nails do
not heal.

At 30% water content, the nails are overhydrated and soft,
which is different from the skin. The optimal water content for
the nails is 16%, but this varies with ambient humidity. Under
conditions of 20% relative humidity, the water content of the
nails drops to 7%. Proper hydration is key because water allows
the nails to bend without fracturing (2). Problems arise when the
water is lost, because it is not possible to permanently replace
the water. Nail soaking results in enhanced water loss, not
rehydration.

The water content of a proper nail is 16%.

Preventing brittle nails

The best treatment for brittle nails is prevention of damage to the
newly growing nail plate. Nails become dehydrated with expo-
sure to surfactants and solvents (3). When the hands are washed,

so are the nails. One piece of advice for patients is to wash their
hands but avoid placing surfactant on the nails unless they
require cleansing. Hand sanitizers, which are replacing hand-
washing, are very damaging to the nail plate. The exposure of the
nail to alcohol is particularly dehydrating. All soaps and house-
hold cleansers cause nail water loss, making glove protection of
the nails essential.

Dehydration from nail exposure to surfactants and sol-
vents is the most common cause of brittle nails.

Strengthening brittle nails

Many cosmetic techniques are available to strengthen nails
because this is a profitable market. The common products are nail
hardeners that contain formaldehyde. Formaldehyde works to
harden nails by cross-linking the keratin protein. Although this
cross-linking makes the keratin harder, it can also paradoxically
make the nails more brittle. Thus, nail hardeners are not recom-
mended for strengthening brittle nails.

Perhaps the best way to strengthen brittle nails rests with nail
polish. Nail polish places a protective film over the nail plate that
thickens the nail. The flexible nail polish polymer, which may be
toluene sulfonamide resin or polyester, also increases nail flex-
ibility and acts as a barrier to nail water contact. Problems arise,
however, when the nail polish must be removed. Both acetone-
containing and acetone-free nail polish removers dehydrate
the nail plate. Thus, nail polish can be used in the treatment of
brittle nails but should be removed as infrequently as possible
(Figure 40.1).

Some also advocate the use of nail prostheses in brittle nail
treatment. Although it is true that artificial nails can protect the
underlying nail plate, removal of the prostheses is always trau-
matic to the nail. With prolonged wearing, oxygen transport is
decreased and the nail weakens. Although prostheses can be
worn for a limited time, continued use for the treatment of brittle
nails is not recommended.

Nail polish may be helpful in placing a polymer coating
over brittle nails to increase flexibility.

Diet and brittle nails

Some also believe that brittle nails can be improved through
dietary modification. Nails are pure protein, so adequate protein
intake is necessary for healthy nails. Many strict vegetarians find
their nails to be one of the first places to show the effects of incom-
plete protein ingestion. Biotin has also been implicated as neces-
sary for healthy nails. Egg whites are the richest source of biotin,
and many individuals do not consume eggs. Nutritionists also



FIGURE 40.1 (A, B) Nail growth and nail-strengthening products that are primarily nail polishes, but contain other ingredients to support their marketing claims.

believe that biotin absorption across the small intestine decreases with advancing age. This is the rationale for providing biotin supplementation as part of nail health in mature individuals.

The use of biotin in human nails was adapted from the veterinary use of biotin in racehorses. If the hoof of a racehorse splits, it ends the career of the animal. Veterinarians supplement horse diets with biotin, believing that it prevents hoof cracking. Whether biotin is useful in humans to prevent nail splitting has not been proven in large double-blind placebo-controlled studies.

Adequate protein intake is necessary for good nail plate formation, which may not be present in strict vegetarian diets.

Nail moisturization

Perhaps the best way to treat dehydrated brittle nails is with a moisturizer. Two ingredients have the greatest efficacy: urea and lactic acid. Both urea and lactic acid are classified as humectants because they increase the water-holding capacity of the nail. This occurs from the digestion of nail keratin, which opens water-binding sites and enhances hydration. The

hydration is only temporary, however, requiring continued moisturizer application.

The urea concentration should be between 5% and 20%, and 20–40% urea digests too much of the nail keratin and softens the nails. Remember that 40% urea is used to avulse toenails. The lactic acid concentration should be between 5% and 10%. Twice-daily application of the urea or lactic acid preparation is sufficient because too frequent application will damage the nail plate. More frequent use of nonmedicated moisturizers rich in glycerin and petrolatum can be used each time the hands are washed.

Urea and lactic acid are humectants that increase nail hydration by opening water-binding sites on nail keratin.

Summary

Brittle nails are indeed a perplexing problem. The basic concepts surrounding brittle nails are summarized in Table 40.1. Prevention is as important as treatment for brittle nails. This chapter has presented the nail physiology accounting for brittle nails and ideas for prevention. Prevention is perhaps the best

TABLE 40.1: Brittle Nails Summary

Nails require hydration for flexibility.
Too much or too little nail water causes problems.
Nail polish and nail prostheses provide only temporary nail strength improvement.
Biotin may be a useful dietary supplement.
Any change in nail treatment will take 3–6 months to see results.
Avoid nail exposure to triclosan, solvents, and household cleaners.
Wear gloves.
Apply urea or lactic acid to increase water-binding sites on nail keratin.

treatment, but other options were also discussed. It is hoped that this chapter has demystified brittle nails and offered insight for the next patient challenge.

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Cosmetics can be of use in nail disease to provide camouflaging or to restore a damaged nail plate to functionality. Anyone who has had a nail torn or ripped can identify with the pain associated with nail damage. Many persons with nail disease experience this same type of discomfort until the nail can be repaired. Because nails are nonliving, nail repair can take three to six months depending on the rate of growth; however, in the case of nail disease, no improvement may be expected for longer. The cosmetic solutions for nail problems are summarized in [Table 41.1](#).

Psoriatic nails

One of the most common nail diseases seen by the dermatologist is nail psoriasis, characterized from minor nail pitting to dramatic nail plate disintegration. The severity of nail disease in nail psoriasis is quite variable. Minor nail pitting results in the irregularity of the nail plate. This can be easily corrected by applying a thin layer of nail sculpture polymer over the nail plate in a procedure known as “shellacking.” The term comes from the shellac shiny finish placed over wood to seal the porous material and provide a waterproof protective covering. Shellacking provides the same benefits to psoriatic nails. Just like in the nail prostheses previously discussed in [Chapter 39](#), liquid ethyl or isobutyl methacrylate is used as the monomer and mixed with powdered polymethyl methacrylate polymer. The shellac is allowed to polymerize in the presence of a benzoyl peroxide accelerator, and a formable acrylic is made that hardens in seven to nine minutes (1).

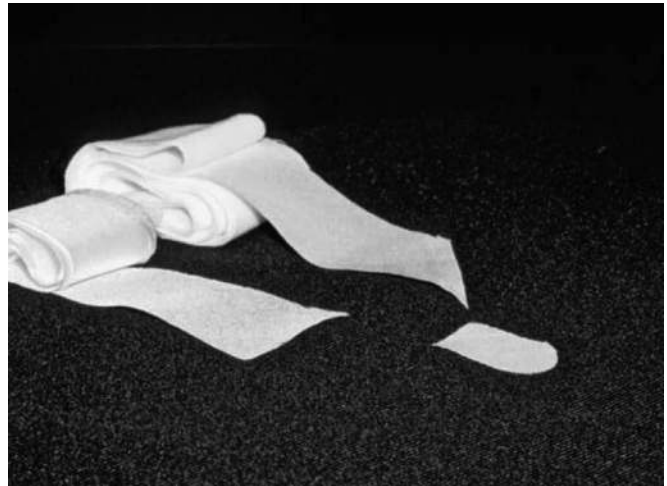


FIGURE 41.1 A silk or linen cloth is used to create a cloth wrap for damaged nails.

The acrylic is then painted over the fingernail in a thin coating and not used to elongate the fingernail. The acrylic can be pigmented with any color desired to camouflage the underlying nail to create a smooth, shiny, fashionable nail appearance for persons with mild nail psoriasis. The coating also strengthens the nail and prevents further pits from occurring due to reduced nail trauma.

For persons with more severe nail psoriasis involving breakdown of the entire nail plate, cloth wraps can be used to strengthen and create a nail plate for adornment. A simple nail acrylic will not be able to create a smooth surface, and the nail will not be strong enough to resist flaking and cracking. Cloth wraps provide reinforcement across the entire nail plate but are most appropriate for female patients ([Figure 41.1](#)). A cloth wrap is created by placing a layer of acrylic over the nail plate, as described previously. Before the acrylic dries, a piece of silk or linen material is placed in the acrylic, sized to fit the nail. Once this dries in place, another layer of acrylic is placed on top to imbed the cloth between the two acrylic layers ([Figure 41.2](#)). The nail can then be painted to camouflage the cloth. This technique is very effective in severely dystrophic female psoriatic nails.

Shellac or cloth wraps can be used to camouflage the nail pitting characteristic of psoriasis.

Mycotic nails

Mycotic nails combine nail thickening, subungual debris, and nail discoloration. The nail thickening and subungual debris can be minimized by proper pedicuring. The nails should be soaked for at least 30 minutes in a pan of warm water with a few drops

TABLE 41.1: Cosmetic Techniques for Damaged Nails

Damage	Possible Cosmetic Cause	Possible Cosmetic Solution
Nail color		
Yellowish stain	Nail polish containing D & C Reds No. 6, 7, 34, 5 Lake	Discontinue nail polish
Poor nail color	Numerous medical conditions	French manicure technique
Nail Structure		
Onychoschizia lamellina	Nail plate dehydration	Application of lactic acid- or urea-containing cream
Mild median canal dystrophy	Trauma	Sculptured nail with linen wrap
Uneven nail surface contour	Trauma to nail matrix	Artificial or sculpture nails
Nail fragility	Numerous medical conditions, idiopathic	Fiber nail polish
Nail thinning	Nail sculptures worn too long	Remove nail sculptures
Nail dystrophy	Numerous medical conditions, idiopathic	Sculptured nails
Broken nail	Trauma	“Tea bag repair” technique



FIGURE 41.2 The finished appearance of a nail cloth wrap.

of liquid dishwashing detergent. The soaking will soften the dystrophic nail plate and subungual debris. The nail can be trimmed with a double-action nail cutter, and the subungual debris can be removed with a nail spatula. Certainly, oral antifungal therapy should be considered, but a nail prosthesis can be used temporarily. One of the easiest ways to camouflage the abnormal mycotic nail bed is to employ a French manicure, which is appropriate for both male and female patients. A French manicure uses several colored nail enamels to simulate the natural appearance of unpainted nails. Initially, the nail is painted with an unpigmented, opaque base coat to cover the discoloration. A light pink enamel is then added to the entire nail plate, followed by white enamel to the tip, simulating the nail free edge. Finally, a clear top coat is applied to prevent enamel chipping. French manicures can be performed professionally by a manicurist or with kits available for home use. This type of artistic re-creation of a normal nail plate is effective following a pedicure in patients with mycotic nails (Figure 41.3).

A French manicure can restore a discolored mycotic nail to a more normal appearance in male and female patients.



FIGURE 41.3 The finished appearance of a French manicure.

Nail dystrophy

Nail dystrophy is an inherited or acquired nail condition involving all 20 nails or selective fingernails and toenails. The cause of the condition is poorly understood, but nail dystrophy can be a presenting finding of several dermatologic conditions that are beyond the scope of this text. One method that can be used to camouflage dystrophic nails is known as “photobonding.” Photobonded nails are a variation on cured acrylic sculptured nails, which was discussed in Chapter 39. Photobonding refers to light curing of the acrylic instead of chemical curing. More recently, photobonded nails are referred to as “gel nails” because the acrylic is a clear gel squeezed out of a tube and allowed to dry under a magnesium light for one to two minutes. This same type of photobonding is used in dentistry to seal children’s teeth protecting them from decay. However, photo-onycholysis and paresthesias have been reported as a result of this procedure (2). In summary, photobonding is an excellent solution for male or female nail dystrophy resulting in a smooth nail plate with a restored nail shape.

Photobonding can smooth the surface and restore shape to dystrophic nails.

Median canal dystrophy and habit-tic deformity

Median canal dystrophy and habit-tic deformity may result in nail plate damage (3, 4). External trauma, including nail-biting, occupational damage, and exposure to harsh chemicals or solvents may also be problematic (5). Nail-biting and habit-tic picking are difficult to treat in the unmotivated patient; however, nail enamel can act as a deterrent to manipulation because picking damages the enamel, which is time-consuming to apply.

Nail deformity can also be repaired so that the nail does not catch on clothing or interfere with the use of the hands. A temporary, effective, inexpensive solution, known as the “tea bag repair” requires a tea bag and fiber clear nail polish; this is discussed in Chapter 39. The broken edges of the nail are reapproximated, and the entire nail is painted with fiber clear nail polish. A piece of tea bag paper or other fiber paper is then cut and shaped to fit over the nail surface and embedded in the wet polish. Several more nail polish coats are subsequently applied. This repair covers the rough, broken nail edge and provides strength. The repair can be removed with fingernail polish remover and reapplied as the repair wears. If a more professional solution is desired, the cloth wraps discussed under nail psoriasis can also be used.

A tea bag can temporarily assist patients with median canal dystrophy where the nail edges are not easily approximated.

Summary

Nail surface contour abnormalities result from a variety of medical conditions and may be temporary or permanent. Temporary abnormalities may be seen after the treatment of a paronychia or

hand dermatitis, involving the proximal nail fold, or longer lasting, as in psoriasis. For patients who are bothered by poor nail appearance, only sculptured nails can offer a solution. The use of sculptured nails in these patients requires a skilled operator and a motivated patient. Poorly applied or poorly maintained nail sculptures could result in worsening of the nail abnormality. The physician should personally visit a number of nail sculpting salons and select an operator for patient referral who upholds the highest standards of hygiene. It is also important that the artist work with the physician and accept suggestions for nail grooming. In these patients, the cuticle should never be removed, and meticulous care must be taken to avoid contact of liquid acrylic with the skin. If a suitable salon cannot be found in the community, patients should not undergo cosmetic nail reconstruction.

Patient safety and the cosmetic results are only as good as the skill and intellect of the nail artist.

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CHILDREN AND NAIL COSMETIC ISSUES

Soft nails

The nail plate of children is not as thick or as well keratinized as an adult nail plate. Because the nails are soft, they are easily torn. Traditional nail clippers do not work well on children's nails for this reason. The nail plate cannot be easily broken because it tends to bend. It is better to cut the nails of children with scissors; however, this may be impractical in children who refuse to sit still. Sometimes it is best to simply tear the soft nail plate with the fingers.

Many parents are concerned that the nails of their child become floppy when they grow long. This is normal. It is inadvisable to paint the fingernails with nail polish to strengthen them. Most young children put their fingernails in their mouth and may ingest the nail polish, which is not recommended.

Soft nails are normal in a child and do not require treatment.

Nails and finger sucking

Continuous wetting of the nail plate from finger sucking can cause unusual nail deformities that may be concerning to parents. The overhydrated nail plate may be very soft and dissolve, but will regrow because the nail matrix remains intact. Further, the overhydrated nail plate may appear an opaque white color. This results from nail keratin hydration but is reversible once the nail plate returns to its normal state of hydration.

Many parents are concerned about thumb or finger sucking because of dentition and speech problems. Sometimes the child will discard the behavior with maturity, but other children hang onto the habit. The most effective way to break the habit is by painting a thin nail lacquer containing capsaicin on the nail of the digit favored for sucking. The capsaicin is released from the lacquer into the mouth with moisture and creates an unpleasant taste without damaging the mouth. This type of aversion therapy seems to be effective in most children because thumb or finger sucking is a subconscious habit.

Thumb or finger sucking may be a subconscious habit that can be broken with a taste-aversive nail lacquer.



FIGURE 42.1 Examples of nail files that can be used to groom nails. The recommended orange stick nail file is shown in the middle.

Nail trimming

Nail trimming can be a big challenge for parents of an active toddler. Several ideas for nail trimming were presented earlier, such as simply tearing the soft nail plate. If this is not possible, the parent can carefully bite the nail away without hurting the child in a playful game, followed by filing the nail plate with a soft orange stick (Figure 42.1). Scissors could scare the child and make nail-cutting difficult while awake. The parent could consider cutting the nails carefully with scissors while the child is sleeping or purchasing a nail clipper specifically designed for children. The arc of an adult nail clipper is too large to trim small nails. Remember, however, that soft nails cannot be broken with a nail clipper.

The nails of a young child could be trimmed while sleeping.

Summary

Nail cosmetics should be largely avoided in children. Children grow fingernails very rapidly, so most problems resolve without the need for treatment. The best advice you can give to worried parents is that the nails will normalize as the child matures.

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TOENAILS AND COSMETIC ISSUES

Toenails are most important for protection of the tender tissues at the tip of the toes, yet most women prize them for their cosmetic value rather than their physiologic purpose. Toenails grow slower than fingernails, with progressive slowing in growth with advancing age. Regrowth of a new great toenail can take six months to one year, requiring patience on the part of the dermatologist and patient while addressing toenail problems. This chapter examines cosmetic issues associated with the toenail and presents cosmetic remedies for consideration.

Toenail dystrophy

Toenail dystrophy can take the form of nail thickening, nail ridging, or onycholysis. Many times, all the findings are observed simultaneously. The most common cause of nail thickening is trauma, followed by fungal infection, which is discussed in the next section. Trauma to the toenail that is transmitted to the nail matrix results in the thickening of the nail plate and sometimes horizontal ridging if the trauma is severe. This trauma usually occurs due to the tip of the toenail receiving a vertical head-on impact from the toe box of the shoe. This trauma can be due to wearing shoes that are too short or the foot moving forward in the shoe during walking, running, or other athletic activity. Patients with a narrow heel and wide-toe spread encounter more problems because the heel of the shoe is too large when a shoe is purchased to accommodate the width of the foot across the base of the toes. The toenail thickening can be remedied by placing a piece of adhesive foam in the shape of the heel of the shoe. This takes up the extra space and holds the foot in place. These shoe inserts can be purchased at most shoe stores. Alternatively, tie shoes tend to hold the foot in place better than slip-on shoes; thus, shoe selection may also help.

Certain athletic activities also predispose to toenail thickening. These include tennis, where the toe is dragged across the ground during serving, and sports that involve kicking a ball, such as football and soccer. Basketball players also experience toenail thickening when the toe is banged against the toe box with rapid pivoting during blocking and shooting. A solution to toenail thickening in these sports is taken from ballet pointe shoes. Lamb's wool is placed in the tip of the toe shoe to prevent the toenail from digging into the shoe and to prevent toenail injury. Similarly, lamb's wool can be placed in the athletic shoe to prevent toenail thickening. Lamb's wool is preferred over cotton or other textiles because it is stiff, yet soft, and does not pack down in the shoe with wearing.

If the toenail injury is severe, horizontal grooves may also appear in the toenail. It is very difficult to camouflage these grooves with nail polish. The best solution to improving the appearance of thickened, grooved nails is to file the nail with a sequential file. A sequential file has sandpaper of different textures. The coarse file is used first to smooth out the grooves and thin the nail. The remaining finishing files use finer and finer grades of sandpaper to progressively shine the nail by smoothing the surface. Filing can improve nail smoothness but also increase nail transparency by removing the opaque, poor-quality nail

keratin. Once the nail has been filed smooth, nail polish can be applied to achieve a better cosmetic result.

Although toenail trauma of the type previously discussed is usually seen in the great toenails, it can also be seen in other toenails for different reasons. For example, in persons with an athlete's toe, where the second toe is longer than the great toe, thickening and ridging will be preferentially seen in this digit. In addition, in persons with a wide foot or a little toe that rolls laterally with walking, the little toenail will also thicken. The little toenail is the second most common toenail to thicken. Usually, the thickening is due to the little toe being squeezed out in shoes, especially in shoes with a pointed toe and a high heel. The foot moves forward in the heel, and the little toenail is tightly pressed against the toe box. The remedy for this situation is to recommend avoidance of heels and a square toe box with ample room for the little toe. Many patients select their footwear based on fashion. This may not be the best approach. The shoes should be purchased that fit the foot. The foot should not be deformed to fit the shoe! This is how toenail problems arise. The dermatologists have no true effective treatment for shoe-induced toenail trauma, except to recommend that the patient select better-fitting shoes.

Severe injury to the toenail can result in onycholysis, which is the lifting of the nail plate from the nail bed. This is especially painful on the toenails because the nail plate continues to be traumatized with walking and other activities. Once the nail plate has been lifted, it cannot reattach, much to the patient's dismay. The nail bed immediately keratinizes when the toenail is lifted, so there is no tissue available for reattachment. The best solution is to cut the torn toenail away, but this is not always possible as the toenail may be irregularly attached. The best solution, in a patient who is not methacrylate allergic, is to drip some methacrylate-based superglue beneath the nail plate, pressing and holding the nail plate against the nail bed until the glue has polymerized. This will prevent the nail from ripping further and also reduce pain. It will not help with appearance because the nail will have an air interface and appear white. Nail polish can be used to camouflage the onycholysis if the patient desires.

The most common cause of toenail dystrophy is ill-fitting shoes.

Grooming thickened toenails and cracked heels

Many mature patients present to the dermatologist with thickened toenails and cracked heels. Cracked heels are a very common debilitating problem in mature adults. Although seemingly innocuous, cracked heels can become a major medical issue in diabetics where the crack can extend into viable skin and provide an entry for infection. The pain of cracked heels can also interfere

with ambulation. Further, thickened toenails can wound adjacent toes and also cause ambulation problems. An instruction sheet to assist with thickened toenails and cracked heels is a helpful clinical aid due to frequent questions about this problem. An example handout to address these issues is below.

This procedure is performed in the evening just before going to bed.

1. Fill up a plastic dishpan with about 2 inches of lukewarm water to completely submerge your feet.
2. Add two drops of hand dishwashing liquid.
3. Swirl the solution a few times with your hand.
4. Put a towel close by for drying your feet.
5. Place the dishpan on the floor, and put your feet in the dishpan for 15 minutes.
6. After 15 minutes, take your right foot out of the dishpan and set it on your left leg. Leave your left foot in the dishpan for continued soaking.
7. Use your fingernails to scrape away the dead skin on the heel of your right foot. Do **not** use scissors or other sharp files or grinders. Only scrape away what can be easily removed. Put your right foot back in the dishpan.
8. Take your left foot out of the dishpan and set it on your right leg. Leave your right foot in the dishpan for continued soaking.
9. Use your fingernails to scrape away the dead skin on the heel of your left foot. Do **not** use scissors or other sharp files or grinders. Only scrape away what can be easily removed. Put your left foot back in the dishpan.
10. Repeat scraping the dead skin from your right and left heels until no more skin can be easily removed with your fingernails. Usually, 2–3 repetitions are sufficient, depending on the amount of dead skin.
11. Use scissors or toenail clippers to trim your softened nails on the right and left feet.
12. Apply petroleum jelly to your feet and place your feet in thin socks.
13. Retire for the evening and sleep in the socks.
14. Remove the socks in the morning and go about your regular daily grooming.
15. Repeat the soaking procedure nightly until the cracked calloused skin has been removed.
16. Repeat the procedure as often as necessary to prevent the calloused skin from returning.

This technique relies on the fact that hydrated keratin is more ductile and softer, making it much easier to cut with scissors or toenail clippers. The lukewarm water penetrates into the nail plate better when the dishwashing detergent is added. The surfactant aids in water penetration by removing any oily debris from the surface and slightly denaturing the keratin protein, thus opening water-binding sites. This allows extra hydration to occur, which softens the keratin and decreases the cutting force. This is important to prevent the nail from cracking.

Fungal infection

Nail fungus is the most common medical cause of nail dystrophy. The best treatment is oral medication to incorporate an antifungal barrier into the nail plate and prevent further infection spreading from the distal free edge of the nail plate to the proximal nail plate. Terbinafine is most commonly used for this

purpose, but the mycotic nail plate must grow out for a normal nail plate to be present. This can take about three to six months or longer, depending on the percentage of the nail plate involved. Some patients may request a cosmetic solution to nail improvement while waiting for the oral antifungal to take effect. Sequential nail filing, as described above for nail dystrophy, may be used to thin the nail plate, which can then be painted with nail polish to camouflage the infection. More deeply pigmented nail polishes, such as burgundy, brown, or black, provide the best camouflage. Alternatively, nail prostheses can be applied to the mycotic nail, a topic discussed later in this chapter under cosmetic issues.

Patients may also be bothered by the smell and appearance of the subungual debris beneath the mycotic nail. This debris can be more easily removed after soaking the foot and nail in water with a benzalkonium chloride-containing surfactant. Benzalkonium chloride is found in all deodorant liquid soaps, such as Dial hand soap. Advise the patient to add a generous amount of the benzalkonium chloride-containing surfactant to some warm water until it foams. Soak the foot every evening in the basin for 30 minutes, and use a nail file to gently remove any loosened nail debris. The odor is in part due to bacterial colonization of the potential space between the nail plate and the nail bed. The benzalkonium chloride will kill the bacteria, thereby reducing odor. This is the same effect benzalkonium chloride has in deodorant soaps to reduce axillary odor. Manual debridement is also important to remove the keratin food source for organisms growing beneath the nail plate. Finally, clear vinegar can be dropped beneath the nail plate to remove any remaining water and lower the pH beneath the nail to inhibit organism growth. The judicious use of this at-home self-administered pedicure can aid in the treatment of onychomycosis.

A 30-minute soak of mycotic toenails in the benzalkonium chloride-containing surfactant can reduce nail odor.

Ingrown toenails

Ingrown toenails are another complex dermatologic problem with poor treatment options. One of the most important considerations is to analyze why the ingrown toenail occurred, and then take steps to prevent recurrence. Typically, the great toenail ingrowth occurs due to trauma, ill-fitting shoes, improper nail grooming, or cutting the toenails too short. It is important to identify the cause of the ingrown nail to allow healing to occur and prevent recurrence. Educating the patient on proper nail cutting is very helpful. Most people like to cut their toenails in a gentle arc with the longest part of the nail in the center of the toe, similar to the technique used for fingernail cutting. This grooming method causes trouble on the toenails, but not on the fingernails, because the feet are forced into rigid shoes that compress the toenail against the skin.

The best way to cut the toenails when they frequently grow inward and cause pain, sometimes accompanied by infection, is to cut the sides of the nail longer than the center. This arc is opposite to the arc created by the toe pad. When the nail is shorter in the center and pressure is applied to the nail, the corners of the nail move out instead of moving in toward the skin. This alternation in nail mechanics prevents the nail from growing inward. It

is also more difficult for the sides of the nail to grow inward when they are longer.

Once the nail has ingrown, the best way to encourage the nail to grow properly is to place a small ball of cotton under the nail that is entering the skin. The cotton will elevate the nail and allow it to grow beyond the surrounding edematous tissue. It is easiest for the dermatologist to insert the cotton in small amounts with a toothless Adson–Brown forceps, pushing as far under the nail as possible with minimal pain. If the cotton becomes dislodged, it can be replaced by the patient, who can participate in the process in the office.

Once the nail begins to grow out, the cotton ball can be replaced with Teflon dental tape. The dental tape is placed beneath the nail to continue to lift the nail above the surrounding tissue to prevent a recurrence of the ingrown nail.

Ingrown toenails can be prevented by properly cutting the toenails longer at the edges than at the center.

Cosmetic issues

The use of nail polish in camouflaging toenail issues has already been covered in the preceding discussion, but the use of toenail prostheses is increasing at a rapid rate (Figure 43.1). Because toenails come in sizes and shapes that are more varied than fingernails, custom-made sculptured nails are popular. The sculptured toenail is made in a fashion similar to sculptured fingernails, as detailed in Table 43.1 (1). It is recommended that patients take their own toenail grooming instruments to the nail salon to prevent infection. Toenail instruments may be contaminated with fungi because persons with onychomycosis frequently go to nail salons because they cannot cut their toenails by themselves. This increases the chance of contracting onychomycosis.

The toenail sculptures must be groomed every three weeks, depending on the nail growth, or onycholysis may occur. The loosened polymer must be replaced by a new one to cover the proximal new nail. Allergic contact dermatitis may also occur in methacrylate-sensitive patients even though methyl methacrylate is no longer used; isobutyl, ethyl, and tetrahydrofurfuryl methacrylate are still strong sensitizers (2, 3). But it should be



FIGURE 43.1 An example of toenail prostheses.

TABLE 43.1: Toenail Nail Sculpture Prostheses

1. The nail is roughened with a coarse emery board, pumice stone, or grinding drill to create an optimal surface for sculpted nail adhesion.
2. An antifungal, antibacterial liquid, such as decolorized iodine, is applied to the entire nail plate to minimize onychomycosis and paronychia.
3. The loose edges of the cuticle are typically trimmed, removed, or pushed back depending on the operator. The patient with toenail disease should request that this step is not performed.
4. A flexible template is fit beneath the natural toenail plate, upon which the elongated sculpted nail will be built.
5. The liquid methacrylate monomer is mixed with the powdered polymethyl methacrylate polymer in the presence of benzoyl peroxide as an accelerator to yield a formable polymer that is placed using a paintbrush to cover the entire natural nail plate. A clear acrylic is used over the natural nail plate attached to the nail bed so that the natural pink color shows through. A white acrylic is used from the nail plate's free edge distally.
6. The final sculpture is sanded to a high shine.
7. An air-brushed design or stencil may be placed over the toenail, depending on the client's wishes.

emphasized that the polymerized, cured acrylic is not sensitizing, only the liquid monomer (4). Therefore, a careful operator who avoids skin contact with the uncured acrylic can avoid sensitizing the patient. Patch testing should be performed in suspected sensitized individuals with methyl methacrylate monomer, 10% in olive oil, and methacrylate acid esters, 1% and 5% in olive oil and petrolatum (5).

Toenail prostheses may be used to camouflage unattractive toenails until new growth occurs.

Summary

Toenails are both functionally and cosmetically important. Thickening, ridging, nail odor, and onycholysis are conditions that cannot be treated by traditional prescription medications. Cosmetic solutions are all that can be recommended until a new toenail grows to replace the damaged nail plate. Because patients want to be empowered to care for their own bodies, the dermatologist must recommend something, or the patient will feel that the medical visit was incomplete. This chapter has presented some practical ideas for the treatment of common toenail maladies.

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CONCLUSION

Summary

Cosmetics and skin care products can be used as adjuvants to traditional dermatologic care. Healthy skin is characterized by an intact skin barrier, which must be maintained after disease resolution. Moisturizers and cleansers can improve therapeutic outcomes in a wide range of dermatoses, from eczema to atopic dermatitis to psoriasis to seborrheic dermatitis to acne. Further, the skin is impacted by the use of ancillary cosmetic treatments of the nails and hair. It is impossible to treat the entire dermatologic patient without understanding the basic care issues created by the use of over-the-counter (OTC) products. This book has provided the basic information needed to create a dermatologic armamentarium that expands traditional therapeutic considerations.

Skin, hair, and nail care information can only be incorporated into a patient's office visit by creating an organized format for their inclusion. The final topic in this closing summary is an outline of how to approach patients requiring assistance in this realm.

It is always important to be objective when making product recommendations. Do not only consider products that are sold in the office. There are excellent formulations sold through dermatologists, mass merchandisers, spa facilities, and boutique outlets. All must be considered, and familiarity can only be obtained through personal experience. The wider the knowledge base of the dermatologist, the more valuable the recommendation becomes.

Understand the purchasing habits of your patient

The first step in making skin care recommendations is to determine the patient preferred purchase point, which directly determines the cost. Skin care manufacturers intentionally produce products to reach consumers through a variety of markets. Some skin care products are sold exclusively in mass merchandisers, such as grocery stores, drug stores, and discount stores. Skin care products sold through these vendors generally range in price from \$2 to \$15, although recently some companies are pushing the envelope, marketing high price point products in the \$30 range. Other skin care products are sold exclusively through cosmetic counters in department stores. Even within the department store market, there are products designed for lower-price point department stores and for higher-price point department stores. Lower-price point department stores market cosmetics sell for \$10 to \$50 as compared to higher price point department store cosmetics that sell for \$40 to \$200. The most expensive skin care products are sold through boutiques, spas, and medical offices. These products range from \$50 to \$400 and possibly higher. The envelope on expensive cosmetics is expanding upward and newer pricier technologies are reaching the marketplace. Interestingly enough, some of these exclusive products are manufactured by the same companies that produce items under a different label for sale in mass merchandisers. Generally, boutique products have more attractive, elaborate packaging accompanied by a greater color selection, more expensive fragrances, and innovative specialty additives. Remember that excellent products can be purchased inexpensively!

Another popular route for product purchase is at household parties and individuals who sell door-to-door in their

neighborhood. Some of these products are sold through distributors who do not maintain product stock personally, but rather turn their orders into a central distribution center that fulfills and mails the orders. Another model for personal sales requires the salesperson to maintain their own stock and deliver orders personally. This difference is important because the independent salespersons may not take care to maintain fresh stock and may not store the products under optimal conditions. These products generally are in the \$4 to \$100 range.

Finally, private label skin care products can be manufactured on a contract basis, generally through small manufacturers. Products can be customized to the needs of the business or simply a standard formulation with a customized label. The price variation in this market is tremendous. It is worthwhile noting that skin care products that are both sold and manufactured in the same state do not need to follow any Food and Drug Administration (FDA) monographs that may apply. All products manufactured and sold between states fall under the FDA jurisdiction, keeping in mind that cosmetics and skin care products are unregulated. Products under FDA regulation are the OTC drugs including sunscreens, antiperspirants, sunscreen-containing moisturizers, acne treatments, and any product that lists an active ingredient. It is important to carefully evaluate these products because smaller cosmetic manufacturers do not have the capital or facilities to undertake product testing.

Identify the patient's unique skin needs

The second step is to understand the specific skin needs of the patient. Begin by determining the patient's skin type: very oily, oily, combination, normal, dry, very dry, etc. Skin care products must be carefully chosen with the skin type in mind. Interestingly, many patients do not know their skin type or have been erroneously assigned a skin type by a salesperson at a cosmetic counter or after reading a book. It is quite straightforward to determine the skin type of a patient based on sebum production. The skin type can be most easily assigned by asking the patient about the amount of sebum production on their nose at various time points throughout the day following morning washing.

Sebum production can be assessed by having the patient run their finger down the nose several hours following washing. If the patient has flaking skin on the nose all day and no sebum from morning until 5 PM, they have very dry skin. If the patient has no flaking and no sebum on their nose at 5 PM, they have dry skin. If the patient has minimal sebum on the nose at 5 PM, they have normal skin. If the patient has sebum on the nose at noon, they have oily skin. Finally, if the patient has sebum on the nose one hour following morning washing, they have very oily skin.

The most common skin type found in mature men and women is combination skin. This is understandable given the large sebaceous glands on the central forehead, nose, medial cheeks, and central chin. Combination skin can be assessed by comparing the amount of sebum present on the nose at 5 PM with the amount present on the cheeks. If there is more sebum present on the nose than on the cheeks, the patient has combination skin. Combination skin can be more challenging, since there are differing needs for different facial areas. It may be necessary to use a different cleanser and moisturizer on the central face and another formulation on the lateral face. Thus, the skin could be classified

as dry on the lateral face, if no sebum is present at 5 PM, and oily on the nose, if sebum product is present at noon. Any combination of the skin types identified above can be present.

This is a simplistic, but accurate and effective approach to identifying skin type, but there are many other labels on skin care products besides the designation dry, normal, and oily. In fact, there is a current move away from classifying products by skin type and moving toward a problem-oriented approach. For example, products for oily skin may be labeled as appropriate for “acne-prone” skin. Further, products for dry skin may be labeled as developed for “sensitive” skin. This can create confusion in the mind of the patient as to which products to choose. Thus, dermatologist education is important to provide accurate patient recommendations.

Take a product use history

Once the patient purchasing habits and skin needs have been identified, it is necessary to take a product use history. This means asking what products the patient is currently using including facial cleansers, facial moisturizers, body cleansers, and body moisturizers. In addition, cosmeceuticals and skin treatment products (exfoliants, astringents, antiaging serums, home use devices, shaving products, etc.) should also be discussed. Many times the patient has concocted a skin care regimen based on visits to three dermatologists, six cosmetic counters, and four day spas. This leads to skin care product overload. The problems that the patient is experiencing may be due to skin barrier damage from an overzealous approach to skin care. The dermatologist's first goal is to examine the products and arrive at a logical, beneficial skin care regimen.

In any skin care regimen, there are certain common factors such as cleanser, moisturizer, and sunscreen. These products do not need to be duplicated. Examine the patient's regimen eliminating duplications in product use. Look at the ingredients in each product and select the one that you believe will provide the most benefit with the least problems. For example, a glycolic acid cleanser can cause barrier damage when used in combination with an exfoliant, while the benefits of brief skin contact with the glycolic acid cleanser are minimal. The glycolic acid cleanser should be eliminated in favor of a bland moisturizer that will prevent the development of self-induced sensitive skin. Similarly, the sunscreen can also be evaluated. Select the sunscreen that offers the highest sun protection factor (SPF). While SPF is an indicator of UVB photoprotection, the sunscreens with an SPF of 30+ cannot achieve this SPF rating without some UVA photoprotection. Until the new sunscreen monograph is released with a UVA rating system, SPF can be used indirectly to assess UVA photoprotection. Since UVA radiation is most important in protection against skin cancer and premature photoaging, this is a valuable patient service.

Do not forget to ask patients about their use of devices to include hand-held microdermabraders, rotary or sonicating skin brushes, red light devices, blue light acne treatment devices, home lasers, and hand-held hair removal devices. You may discover some interesting combinations that could be creating skin disease or creating problems with your medical therapy. Exfoliation is the quickest way to make the skin smoother and induce a small amount of edema, minimizing fine lines on the face. Problems arise when patients adopt an aggressive attitude and damage the skin barrier. Several years ago we did a study where computer chips were placed in a face brush to measure the amount of time

research subjects used the device for cleansing. Detailed instructions and a demonstration were provided indicating the brush was to be used for 5 minutes twice daily for 2 weeks. As might be expected, some brushes were returned with only 10 minutes total use while others recorded 8 hours of use. Be sure to ask the subject how long they are using the device and for how much time.

Perhaps the hardest area to evaluate is moisturizer use. If one really used all of the “beneficial” ingredients in the cosmeceutical marketplace, it would take 8 hours to complete the applications. It is very hard to counsel patients as to which moisturizer is the best. Of course, a sunscreen-containing moisturizer should be used in the morning and a moisturizer without sunscreen should be applied in the evening. Other than that, there are very few absolute recommendations. Nevertheless, patients are looking for instructions that are more detailed. This is difficult given the rapid change in the cosmeceutical marketplace.

The best approach is to look for ingredients in the moisturizer that maintain skin barrier hydration by creating an optimal environment for barrier repair. These ingredients include petrolatum, dimethicone, and glycerin. They represent the workhorse moisturizing ingredients in any formulation. Petrolatum is the premier ingredient for reducing transepidermal water loss, which becomes more aesthetically pleasing when mixed with dimethicone to reduce stickiness. Glycerin, as a humectant, helps the water-holding capacity of the skin. However, these are not new or uncommon ingredients. There is nothing much novel that can be said about this type of a moisturizer from a marketing standpoint. This explains the need to find unusual substances to add to a basic formulation to provide a distinguishing characteristic in a crowded marketplace. It is hoped that this book has clarified some of these issues.

Evaluate skin care needs in light of the presence of dermatologic disease

Most patients who seek dermatologic care have skin disease of one sort or another accompanied by the inevitable photoaging. Skin care products can be used to supplement the prescription treatment of most skin disorders. If proper skin care products are not used, disease recurrence and a short remission time are certain. The dermatologist who strives for excellence in patient care not only tries to treat the disease, but goes beyond to consider the prevention aspects of treatment. If a patient has seborrheic dermatitis, a shampoo that reduces scalp sebum and possesses antifungal properties, such as those formulations containing zinc pyrithione in a strong surfactant base, should be advised once the dermatitis component has resolved. If the patient has psoriasis, an excellent moisturizer should be recommended to prevent barrier damage and initiate new psoriatic plaques due to the Koebner phenomenon. It is this type of thinking that combines the prescription realm with the OTC realm to yield superior therapeutic results.

Develop an algorithmic approach to skin care for the patient

In order to easily combine prescription and OTC products into one treatment plan, it is necessary to develop an algorithmic approach. An algorithmic approach means that a mental checklist has already been imprinted on the brain that can easily be recalled when a patient presents. Each of the chapters in this book

has been aimed at providing the material for developing these personal algorithms. Formulations and their effects on the skin, hair, and nails have been discussed. Review of these previously read chapters with this idea in mind may help you personalize your algorithms.

Update personal and patient database, as needed

Now that you have obtained an understanding of the patient's product use and formulated your recommendation, make a record in the chart. Just like the necessity of documenting the past medical history and the review of systems findings, you must also document your skin care profile. Update this information with each patient encounter. This will allow the most thorough

integration of skin, hair, and nail care products into your dermatologic armamentarium.

This text has attempted to take a serious look at the integration of skin care products, cosmetics, hair adornments, and nail cosmetics in the practice of dermatology, thus expanding the realm of disease treatment beyond the diagnosis and treatment into the maintenance phase of healthy skin, hair, and nails. The impact of OTC products on the structures of the external body cannot be ignored. Major developments are taking place at an accelerating pace in this area requiring vigilance on the part of the dermatologist to remain up-to-date. It is our hope that you have enjoyed reading this book and will use it as a foundation for future learning. Perhaps you can sense our enthusiasm and will no longer look at this area with bewilderment, but will accept the challenge!

Egredere et sanare.



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