Figure 18.15 **Hand tool.**

Skin colors and depth

The different skin colors or phototypes do not all react the same way following their skin's chromatic composition: a Caucasian phototype might not react identically to an Asian or African type.

The color of the skin is the result of quantitative and qualitative elements. Melanin, eumelanin, and beta-carotene in various proportions make the skin aspect.

This is why one will need to juxtapose red, yellow, and blue pigments in variable but reliable and reproducible proportions.

The practitioner's experience will help in choosing the proper pigmented color from the chromatic circle reference: the color wheel (Figure 18.19).

One needs to know that some people have a natural tendency to influence the implanted color: warm or cold. This will result in a chromatic instability.

The depth of the work will be determined by the area of implantation: the quantity of epidermal cells and the thickness of the dermis vary. For example, we have to implant differently in the sole of the foot compared to the eyelid.

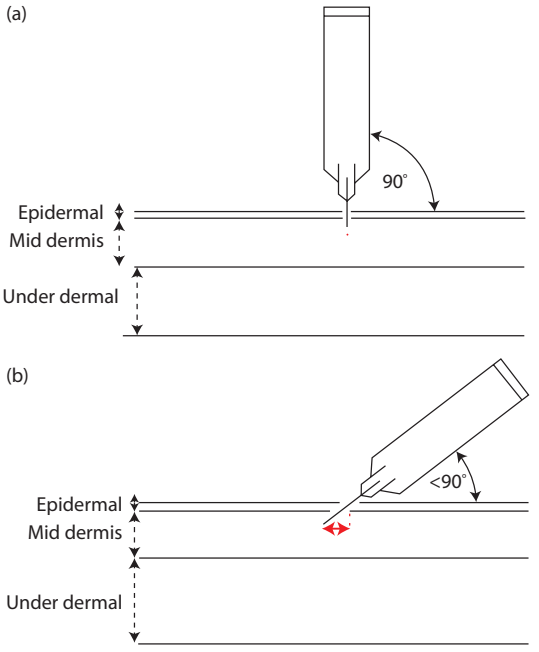

Figure 18.17 **Technical rules. (a) Pigmented aspect is a dot. (b) Pigmented aspect is a line.**

Histology

The pigment must be introduced in the mid-dermis.

Figure 18.16 **Regulator.**

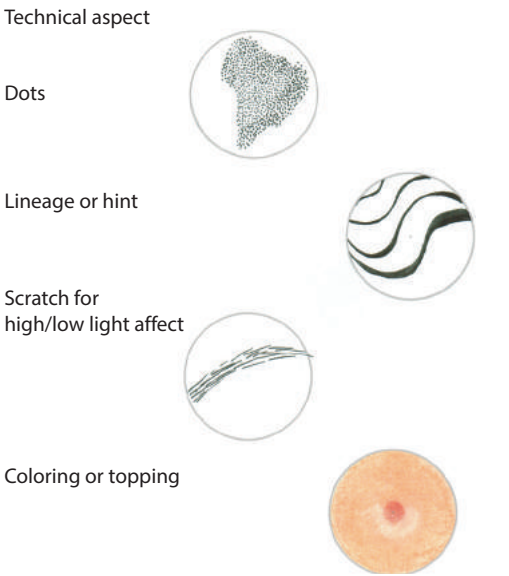

Figure 18.18 **Technical aspect.**

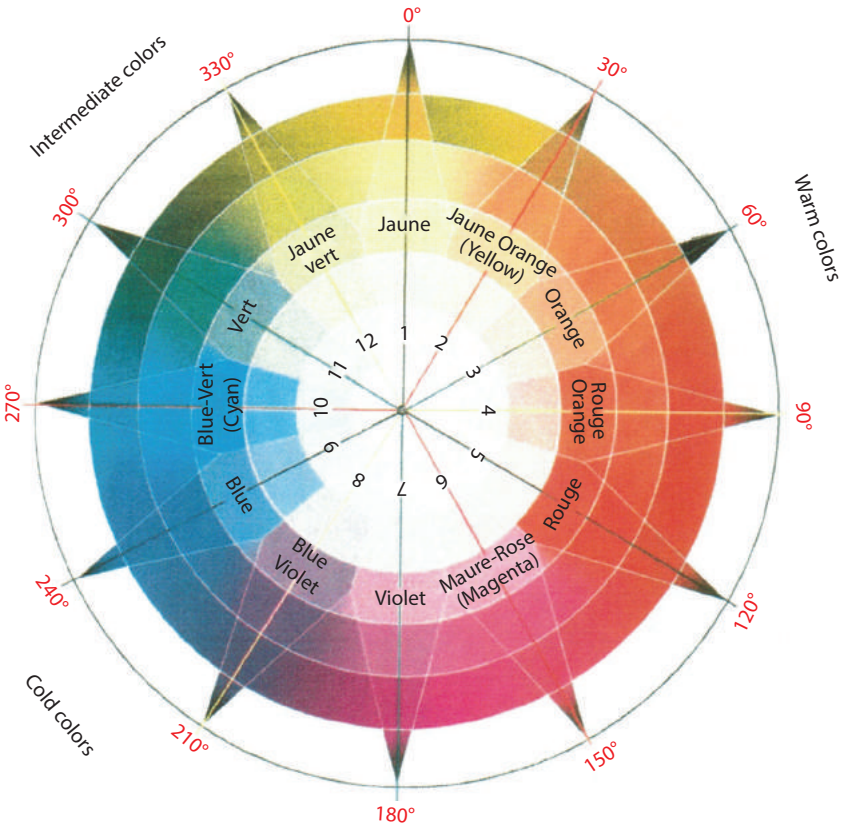

Figure 18.19 **Color wheel is an illustration of the relation between colors.**

A superficial implantation (as done in aesthetic makeup in beauty institutes) is painless but could rapidly fade away and disappear when the epidermis cells change at the next cell renewal.

To start with, when an implant is introduced into the dermis, some will naturally be eliminated in the healing process, and some others will be considered by the body cells as an intrusion. The immune system can then eliminate up to 30% of it. It often occurs between the day 7 and day 21.

Once it has healed, the epidermis is reconstituted "ad integrum" so it appears through transparency under the dermis: it is stored in the papillary dermis near blood vessels (Figure 18.20).

Definition, contraindications, and complications

Dermopigmentation of head hair or micropigmentation of hairy areas, also named trichopigmentation, follows an international process of scalp micropigmentation which is used for:

- Head scars caused by accidents or from transplant donor areas.
- Scars through beards or moustaches.
- Head hair rarefactions, temporary or definitive, dermal pathologies or lichen.
- Alopecia androgenetic capillary rarefactions.

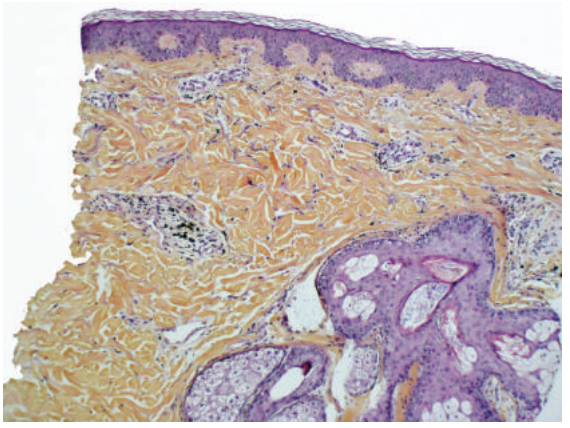

Figure 18.20 **Vertical histological section of the superficial and the mid-dermis showing the pigment implant.**

- Eyebrows.
- Eyelids or lashlids (ciliary border).

Contraindications: If one proceeds following the previous description, contraindications are only relative: kidney failure and hepatic (encephalopathy) and autoimmune disorders.

Pigmentations can only be attained on healthy skin, without progressive diseases and with special precautions for diabetic or arteritic patients or ones with heart valve diseases.

The use of nonallergenic pigments removes the risk of allergies in atopic patients. A test can, however, be performed (in 20 years of practice the author has never come across an allergy following the above procedures).

Complications: When the skin has been broken, one can expect some side effects: inflammation, redness, and bruising.

Rules are the same for dermography, but they will resolve themselves within a few days.

It is possible for the color to change because of a chemical reaction called *oxidoreduction*.

The patient, even aware, might have been exposed to ultraviolet (UV) light. One can try to "mask" or neutralize this change, which demands an excellent command of the color wheel mentioned above.

Another side effect could be a spread of color called the *blotting paper appearance*, with its pigment diffusion in deep dermis or under dermal due to bad operating technique (Figure 18.21).

Extremely rarely a granuloma could appear which will spontaneously disappear within a few weeks.

European Forensic Aspects: A decree dated January 6, 1962, was modified by a decree dated February 19, 2008, which determined the level of skills in the trade according to interventions on the skin. From the article L.312 Code of Public Health: all medical acts that require breaking the skin can only be performed by people from the medical profession or paramedics under a doctor's responsibility.

Figure 18.21 **Blotting paper affect.**

Technical achievements

Head hair scars

Just like donor transplant areas, it is a sunless area that causes the skin to be extremely fair[14,15] (Figure 18.22a and b).

The technique must reproduce, as finely as is necessary, the density and the implantation of the hair in order to fit nto the healthy hair thickness (Figure 18.22b).

Beard and moustache scars

The particularity of this area is its permanent exposure to the sun which gives the scar a whiter aspect (Figure 18.23a and b). The treatment therefore has to be done in two steps:

- The first one concentrates on matching the scar's color with the surrounding skin color as it is usually slightly darker. A "topping" of the same skin color is necessary; the operation might have to be repeated to obtain the same color all around.
- The second step is purely a micropigmentation work: once one has reached the skin color required, the hair can then be micropigmented following the previous technique (Figure 18.24a and b).

Head hair rarefactions, alopecia, and lichen

Micropigmentation can trick the eye by giving a hairy effect enabling us to hide some hairless areas (Figure 18.25a and b).[16,17]

This requires a precise move and fine precision on the depth of the implant.

Two side effects can easily occur:

- The pigment can be diffused in the deep dermis (as mentioned above, the blotting paper effect) following its thinning engendered by a local cortisone treatment, for example, in lichen of the scalp.
- The color can turn due to a chemical reaction (oxidoreduction) from mineral components of the pigment implant.

A thorough study of the phototype is necessary to choose the right color in order to correct or neutralize the area if that risk is likely to happen.

This technique is used for patients who suffer from male pattern baldness or for those who are awaiting a transplant or who are in the process of hair micrografts. It is used on the area pending a transplant or the area that needs redensifying, or simply if it is desired to give the

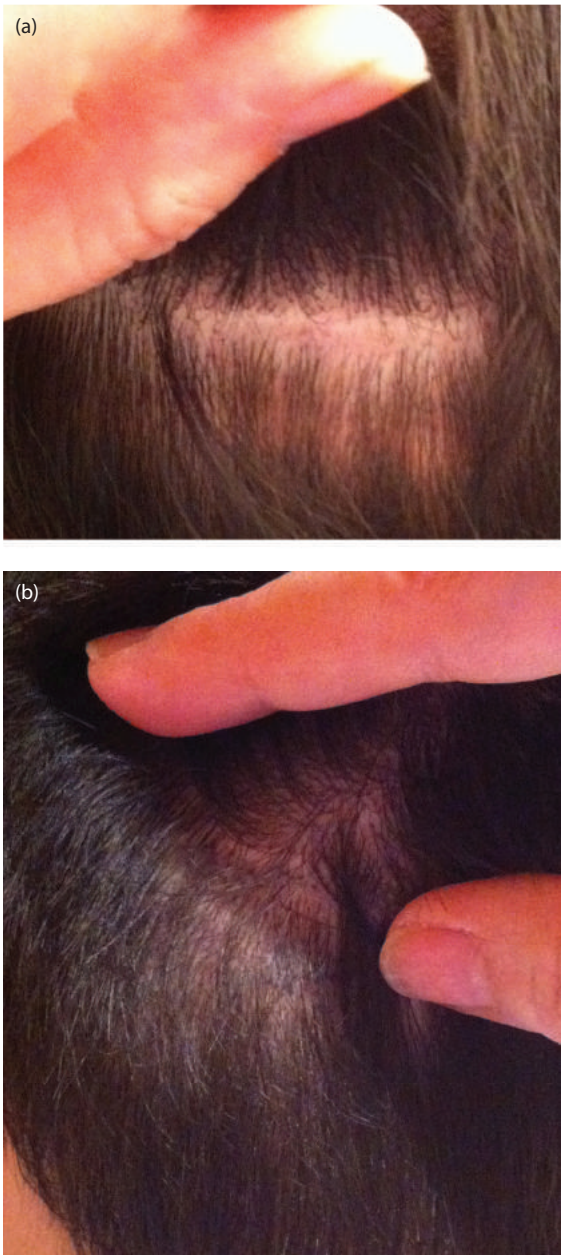

Figure 18.22 **Donor transplant scar (a) before and (b) after pigmentation.**

impression of a shortly shaved head, depending on the actual fashion.

Eyebrows

They frame the face and are essential to facial expression: happiness, sorrow, concentration, relaxation, etc.[18,19]

This explains why its neutral layout is so important so as to keep a natural expression when there is one.

Figure 18.23 **Beard scar (a) before and (b) after pigmentation.**

1. *Dermography can offer:* Reconstruction of the eyebrows can be accomplished. They are organs that also age with the rest of the face. They can get whiter and the layout thinner. Dermography can redesign an eyebrow's layout and proceed to a slight high or low light affect giving its original hairy impression.
2. *Hiding a scar:* Like any other hairy areas, eyebrows can get scarred from burns or accidents. Dermography can therefore hide a scar by using the same technique as used in sunless areas.
3. *Eyebrows reconstruction:* This can be accomplished after a repeated epilation or after medical treatments (chemotherapy, hormonal therapy) (Figure 18.26a and b).

Figure 18.24 **Cicatricial alopecia due to a lichen (a) before and (b) after densification.**

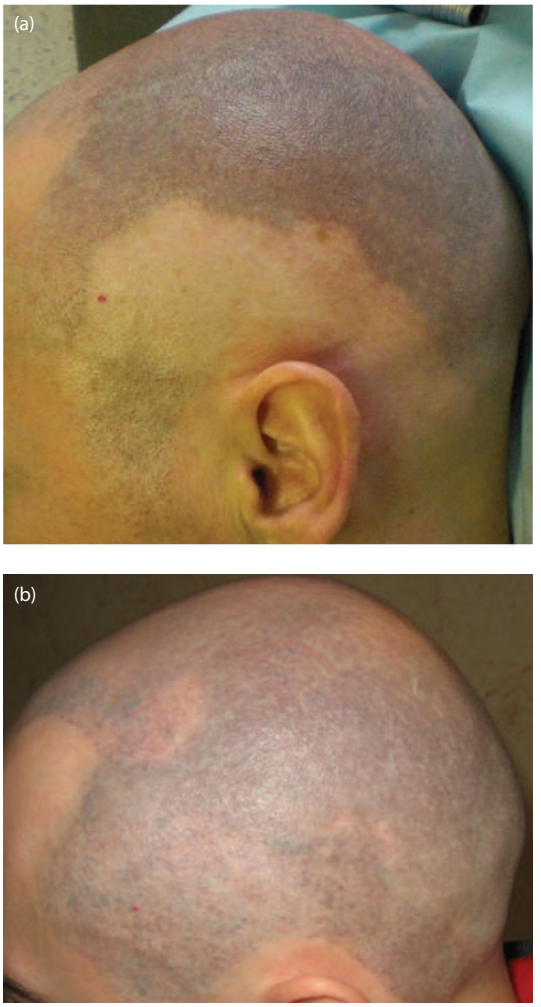

Figure 18.25 **Temporal alopecia areata (a) before and (b) after micropigmentation.**

Eyelashes

The edge of the eyelashes can rarefy due to different factors: one would be chemotherapy. The ciliary area can then be redensified: "type lash liner." The dermopigmentation method uses "close points" (which can vary depending on the density requested).

One can also accomplish a complete makeup-type eyeliner; the method then used is a lineage type.

The rebuild of a ciliary line can also be obtained on a grafted eyelid (Figure 18.27a and b).

Anesthesia

Anesthesia has a fundamental role in dermography. Indeed, the pain will produce an oxidative stress that might cause an oxidoreduction of the pigment and

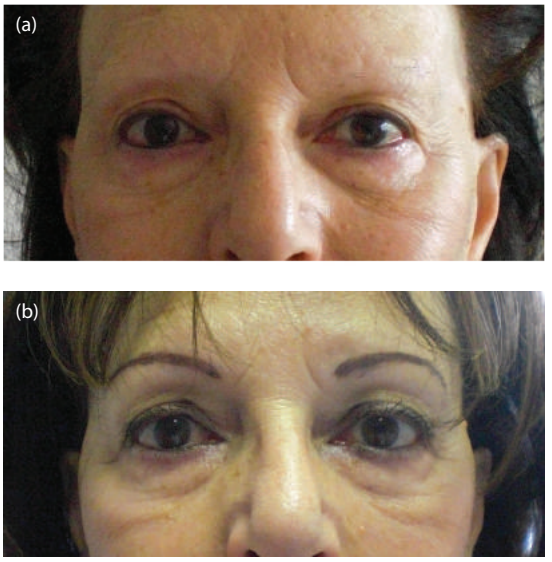

Figure 18.26 **Eyebrow alopecia (a) before and (b) after pigmentation.**

Figure 18.27 **Eyelids (a) before and (b) after pigmentation.**

therefore engender the oxidation of the mineral pigments and produce a color change.

This explains why we use "lidocaine" for skin pigmentation and "xylocaine" by intradermal injections for eyelids and eyebrows.

Conclusion

Dermopigmentation, or dermography or trichopigmentation or micropigmentation, are adapted processes of yesteryear's primitive tattoos.

For the last 20 years, its use in medicine and surgery as well as its research to date, allow its use in dermatological pathological treatments. Before, this was not possible, and its use enables us to improve the appearance and therefore the quality of our patients' lives, which are often extremely affected by their look.

After thousands of areola nipple reconstructions, eyebrows, eyelashes, outlines, and recoloring of the lips after accidents or pathologies, thanks to the technical progress, we now have power tools, needles, and biochemistry pigments which have enabled us to successfully achieve great results in hairy areas. We anticipate more to come in the future.

CONCLUSION

Wigs, hairpieces, and scalp-covering cosmetics are important and often underutilized tools in helping patients with hair loss or alopecia. Dermopigmentation, if well handled, used alone or in combination with hair surgery, becomes a good indication for definitive alopecia or body hair alopecia. Synthetic hair implants should become a useful tool for the treatment of some definitive alopecia if we observe a decrease of the rejection and the complications and an increase of the tolerance.

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19 Hair cosmetology

Claude Bouillon and Michèle Verschoore

CLEANSING HAIR AND SCALP

Shampooing is a basic hygiene measure worldwide, yet performed in various ways from one individual to another or from one place to another. Hair cleaning is more frequent where water is abundant or where it is considered as a symbol of purification, like in Japan and Korea.

The word *shampoo* comes from the Hindi "Champo," meaning to massage, to knead. It still fi s such a traditional way as practiced by hairdressers in China, involving a prolonged massaging with pure shampoo prior to adding water, a procedure called "dry wash" by the Chinese people.

The frequency of shampooing largely increased in parallel to improved housing and living standards. In Europe, it reaches three times weekly on average, and about one out of four among the population, especially younger men (<30 years), shampoo their hair daily. Eighty percent of people in the United States and 90% of those in Japan declare washing their hair twice daily on average. With regard to gender, the shampooing procedure is less frequent among women who view time-consuming hair-drying and management of long hair,

The primary function of shampoo is to cleanse both hair and scalp, which requires this product to be versatile enough to fulfill a variety of demands:

- To remove rapidly and efficiently the soil from hair without damaging the latter when rubbing onto hair and with no irritant effect upon eyes, scalp, and hands.
- To correctly clean with a widely variable amount depending on the user (from few grams to dozens), irrespective of the nature and the amount of soil, the condition and characteristics of hair (sparse or dense, dry or not, short or long, straight or frizzy, etc), different scalp conditions (seborrhea, dandruff), and using tap waters of varying hardness.
- To develop enough foam, since perceived as evidence of cleaning efficiency, a key aspect.

But the expectations of a consumer, more acute for women with regard to longer hair, lie far beyond efficient cleaning and pleasant in-use qualities, aesthetic appearance, liquid, gel, or cream, smooth and abundant foam, and easy rinsing. The shampoo must transform the head of hair, yielding lively and bright hair.

Changing and beautifying hair condition may encompass a variety of aspects according to the user:

- To provide ease of entangling of wet hair
- To enhance wet hair feel
- To ease combing of hair when dried
- To impart volume, body, spring, manageability, and suppleness
- To reduce flyaways
- To bring a silky feel
- Not to reveal drawbacks when frequently used
- To meet specific needs, such as clearing a scalp condition or maintaining a hairstyle

In brief, these items compose a huge diversity of requirements and/or expectations, often conflicting and not easy to reconcile, that make the development of a quality shampoo an intricate achievement. This also explains the wide range of shampoos designed to most appropriately solve the various and varying compromises like a magic wand.

From a consumer viewpoint, in addition to its foaming properties (rapidity to develop, density), the fragrance (fruity, floral, or woody) introduced within a shampoo plays a crucial role in its marketing/consumer acceptance. Both hedonic properties during shampooing and residual fragrance(s) left on a dried head of hair are such key factors that despite its best cleansing and conditioning properties, an inappropriately fragranced shampoo is promised very low commercial attainment.

CLEANSING FUNCTION OF SHAMPOO

Hair soil consists of lipids of the daily gram range, mostly originating from sebum released through follicular outlets[1] and trapped mineral and organic air pollutants, scalp keratin debris, hair dressing deposits, and a significant number of resident and transient members of scalp flora (bacteria and yeasts). Table 19.1 gathers the overall ranges of quantitative key factors involved in or eliminated during the act of shampooing, according to individual daily life routines and specificities (hair length, hair shapes, dandruff, etc.).

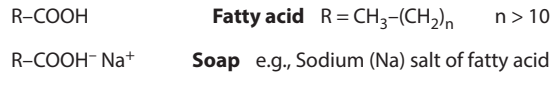
The role of a cleansing or detergent agent is to weaken the adhesive forces that stick the soil to hair and scalp, then transfer it into water medium and disperse it within while avoiding any redeposit onto the hair.[2] This process is performed by surfactants, dual-faceted agents

Table 19.1 Major Elements of Skin and Hair Involved and Eliminated during the Act of Shampooing

Scalp surface (adult)	600–700 cm^2
Hair surface (according to hair length)	0.5–6 m^2
Sebum on scalp and hair (daily amount)	0.5–2 grams
Keratin debris and scales	5–50 milligrams (including squames/dandruff)
Volume of water used, rinsing included	20–50 L
Amount of shampoo used (one to two successive times)	2–30 grams
Total time of shampooing	1–5 minutes
Time to dry (hair dryer)	5–30 minutes, according to length

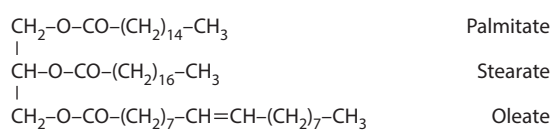
(i.e., endowed with dual affinity). These are composed of a long hydrocarbon chain (10–14 carbon atoms), so-called fatty chain with hydrophobic/lipophilic properties, and a polar hydrophilic head group. The lipophilic part of the surfactant shows high affinity toward lipids and links to the soil, whereas the polar head is water soluble and transfers the soil into water when rinsing.

Soap (Figure 19.1), a salt of fatty acid mixture produced by saponification of plant oils and fats by strong alkaline agents (sodium or potassium hydroxide), was the first detergent used for hair cleansing.[3] To make it soluble in water and avoid acid release, however, soap requires an increase in pH toward an alkaline level, hence possibly altering the hair surface. Moreover, in the presence of hard water, insoluble calcium salts are



Example of soap from natural plant oil/butter:

Cocoa butter: Triglyceride of palmitic acid (26%), stearic acid (34.5%) and oleic acid (34.5%)



Cocoa soap: Mix of sodium palmitate (26%), stearate (34.5%) and oleate (34.5%)

Palmitic and stearic acids are saturated fatty acids while oleic acid has one C=C double bond and therefore falls into unsaturated acid class.

Figure 19.1 **Soaps.**

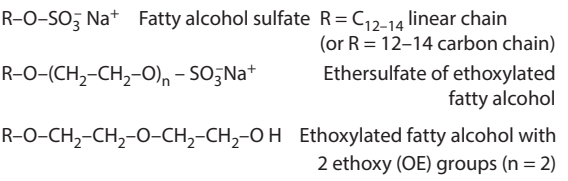


Figure 19.2 **Fatty alcohol sulfates and ethersulfates.**

formed leaving deposits on hair and causing hair to look dull.

These drawbacks have been erased in replacing soaps by other anionic surfactants, the linear fatty alcohol sulfates, or the ethersulfates of ethoxylated fatty alcohols (Figure 19.2) which both offer good foaming, emulsifying, and cleansing powers, and biodegradability as well. The rather poor cosmetic properties of these highly suitable hair cleansing agents have led to them being combined with amphoteric surfactant (such as betaines, for example), the fatty chain of which ends with both anionic and cationic sites (Figure 19.3). Amphoteric surfactants form complexes with anionic surfactants, improve foam tightness and softness, and reduce the tendency of anionics to adsorb onto proteins.

Progress in research and formulation has allowed shampoos that are very mild on the skin and eye to be developed, involving anionic surfactants such as sulfosuccinates, sarcosinates, taurates, glutamates, polyethoxylated fatty acids, or *N*-acylpeptide salts.[4]

FORMULATING SHAMPOO

The development of a cleansing base is the prime goal that needs to be optimized according to the versatile or specific features of the shampoo that are desired. It must be suitable for hair and scalp condition, frequency of use, and hair care or styling routine. The goal is to efficiently and rapidly clean without drying, keeping unaltered normal scalp homeostasis, given that the scalp is more sensitive than the hair to degreasing action. Requirements also entail lubricating hair while removing soil (i.e., replacing soil by conditioning material that enhances hair condition), another challenge.

In-use properties are brought by a variety of additives affording pleasant texture and feel when carrying out the

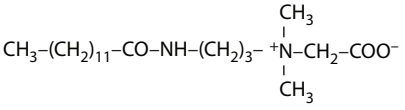


Figure 19.3 **Amphoteric surfactant (cocoamidopropylbetaine). At neutral pH it behaves like an internal salt (ammonium carboxylate).**

cleansing operation. To the detergent/cleansing ingredients which account for 10%–20% of the shampoo product, thickening agents are added to providing controlled flow, easy measuring out in the hollow of the hand, easy spreading, and easy distribution into the hair without altering foam. Some of these enhance foam smoothness and stability, whereas others show critical thresholds to prevent fall in foam and product consistency, notably with hard water. Pearlescents such as ethyleneglycol distearate provide micrometric crystal particles whose size, density, and arrangement lend an opaque, shiny, or creamy appearance.

Choosing the conditioning ingredients and defining their right proportions, however, has become the most tricky step when designing and developing a shampoo. The purpose is to bring to hair ease of untangling, soft touch, gloss, and reduced flyaway. Conditioning agents should help to gain a smoother, even hair shaft with tighter adhesiveness of cuticle scales to minimize friction. A large variety of ingredients, mentioned below in the section dedicated to hair care products, may be introduced into the formula of a shampoo as far as they are compatible with the cleansing base. The contribution of such ingredients in a shampoo product of course does not compare with that in a product fully designed for hair care only or a specific after-shampoo rinse, due to different, hardly reconcilable, if not antonymic, functions to be achieved at the same time within a single operating procedure instead of two, separately performed. This way, however, the selected conditioning ingredients can play a significant role in the aesthetic appearance, condition, and manageability of hair after shampooing.

The initial breakthrough in conditioning shampoos came with the availability of cationic polymers (PC) with high affinity for damaged hair that, unlike dedicated cationic surfactants, are compatible with anionic surfactants used in shampoos. The mechanisms of PC interaction with, and effect upon, the hair shaft are described in the section dealing with hair care. These PCs form soluble complexes with anionic surfactants by adjusting either or both concentrations and possibly adding amphoteric or nonionic surfactant. When diluted with water, the structure of these complexes changes, leading to phase separation and polymer deposit onto hair, a sequence of intricate micelle formation, air/liquid, and liquid/hair substrate interaction processes.[5] Most used cationic polymers are cellulose and guar gum derivatives. These improve hair untangling and combing considerably, while affording a clearly soft feel. They also impart dense, smooth foam. Most dramatic effects of these PCs are obtained upon dry and sun or oxidation damaged hairs. Less efficient on unaltered or slightly damaged hair due to reduced affinity (low ionic character/charges), they may have some build-up effect, and are not easy to rinse off ith frequent shampooing.

A second breakthrough arose from the introduction of silicones of polydimethylsiloxane type (Figure 19.4)

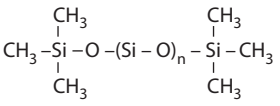


Figure 19.4 **Polydimethylsiloxanes (dimethicones). The viscosity of dimethicones used in conditioning shampoos is 50,000–1,000,000 mm²/s.**

which impart a silky feel to hair and protect the hair surface with a hydrophobic film. However, silicone polymers are insoluble in the aqueous vehicle of shampoos, an aspect that raised a major issue and subsequently delayed their use in such an application. The formulation process had to be devised for homogeneous and stable dispersions in surfactant solutions to be achieved without altering their detergent and foaming properties. Such dispersions could be further stabilized through adding pearlescent agents to thickened solutions of cleansing bases. They gave rise to so-called "2 in 1" shampoos.

A further step forward consisted in combining polydimethylsiloxanes (PDMS) and selected cationic polymers, thereby optimizing beneficial effects. For example, PDMS adsorption onto hair can be strengthened by PC, whereas PC inhibits potential build-up of PDMS with repeated shampooing. On the other hand, PDMS favors an even deposit of PC along the hair shaft. The strong interdependence between PC and PMDS has been particularly accounted for in most performing conditioning shampoos, as well as the use of PDMS derivatives having cationic groups such as amodimethicones (Figure 19.5).[6]

Developing such shampoos requires PDMS technology and industrial processing to be perfectly mastered in addition to a tremendous contribution from research investigations.

TYPES OF SHAMPOO

A variety of shampoos ranging from general use to hair- or scalp-specific conditions are available on the market. They are most often presented in opaque liquid form of varying viscosities, or in cream form for dry, damaged hair. Other forms are gels or clear liquids, with minimal ingredient content for hair care with the exception of some cationic polymer for easier combing of wet hair. The main types are as follows.

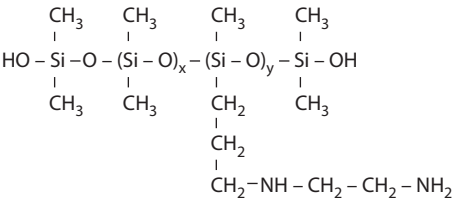


Figure 19.5 **Amodimethicones.**