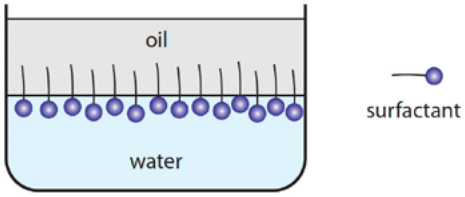
Chapter 12: Essay

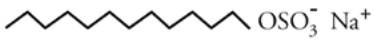
Hair and Skin Care

Through our modern lifestyles, we have become accustomed to chemical-based products that clean and protect our hair and skin. These include soaps, shampoos, conditioners, moisturizers, sunscreens, and many other products formulated to help us maintain a healthy look.

The essential ingredients of all these hair and skin products are part of a broad class of compounds called *surfactants*, which is short for "surface-active agents." All surfactant molecules are polar on one end and nonpolar on the other. Because of their nonpolar ends, they resist dissolving in water and instead cling to water's *surface*, where their nonpolar ends stick out of the water. Pour some oil onto the surfactant-containing water and the nonpolar tails will cling into the oil's surface. In this way, surfactants bind together the surfaces of water and a nonpolar material.

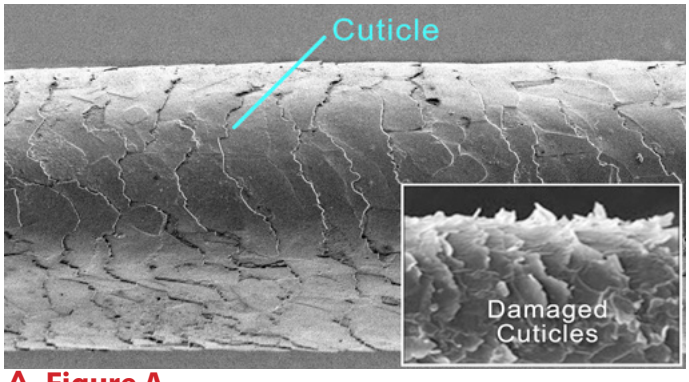


With a little agitation, the surfactant's surface-seeking behavior causes the formation of high-surface-area suds. With such an increased surface area, significant amounts of the oil are able to mix with the water, forming a single phase known as an *emulsion*. So, surfactants don't help nonpolar materials to "dissolve in water." Instead, they just help these two materials to become mixed.



Sodium lauryl sulfate

The prototypical shampoo surfactant is the detergent sodium lauryl sulfate. A big advantage of detergents is that in hard water, they don't form scum (see Section 7.5). For a shampoo, this is particularly important because, otherwise, the scum would adhere to the hair. Rinsing hair first allows the removal of polar materials, such as salts, dirt, or any loose debris. Wetted hair also swells, and this opens the hair cuticles, which are scale-like structures lining the outside of the hair (**Figure A**).



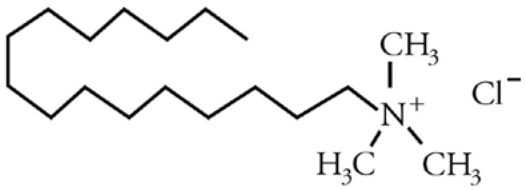
Λ Figure A

One thousand times magnification of a human hair shows a series of folds on the surface known as *cuticles*. These cuticles can open and shut depending upon the conditions. For damaged hair, these cuticles have been splintered.

The main action of the detergent is to remove *sebum*, a skin oil that migrates up the hair and into the cuticles, making one's hair "greasy". Shampoo formulas vary in their cleansing strength. Those formulated for "oily" hair are generally stronger than those formulated for "normal" hair.

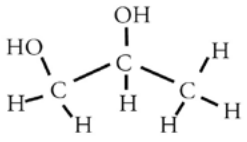
Following the shampoo, many people apply a hair conditioner, which helps to make the hair feel soft and helps to minimize frizz due to the buildup of static charge. Notably, the polar end of a shampoo's surfactant is a negatively charged ion. Such a surfactant is called an *anionic* surfactant. The polar end of a hair conditioner's surfactant, however, is a positively charged ion. Such a surfactant is called a *cationic* surfactant. Shampoos and conditioners are generally not combined into a single formula because the attraction these oppositely charged surfactants have for each other would defeat their functions. Products that are "all-in-one" have the cationic surfactants microencapsulated.

The prototypical hair conditioning surfactant is cetyl trimethyl ammonium chloride, also known as cetrimonium chloride. Its positive charge helps it to bind with the hair so that much of it remains on the hair even after rinsing. The result is hair that feels smoother and is easier to manage. Laundry fabric softeners work by the same principle.

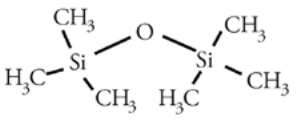


Cetyl trimethyl ammonium chloride

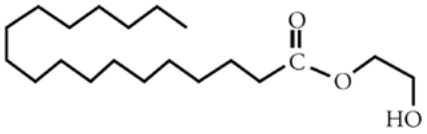
The trick to having comfortably moist skin is to maintain the moisture already found within the skin. The deeper parts of your skin are up to 80 percent water. Because skin has so much more water compared to the surrounding air, the general movement of moisture is from the skin outward. Skin oils help the outer layers of skin to retain much of this moisture. Your skin, however, will begin to feel dry when there is an increase in the rate at which your skin's moisture evaporates. This happens when the air is very dry or when your skin oils are removed by strong soaps or detergents. Rather than splashing water on your dry skin, a more practical solution is to coat your skin with a moisture- protecting nonpolar material that can enhance or mimic the action of skin oils. Commonly used materials include compounds such as propylene glycol, glycerin, and dimethicone. The best way to apply these compounds to the skin is with an emulsion made using nonionic surfactants, such as polyethylene glycol stearate, also known as PEG-100. Nonionic surfactants are used for moisturizers because they tend to be less irritating and less likely to remove skin oils.



Propylene glycol



Dimethicone

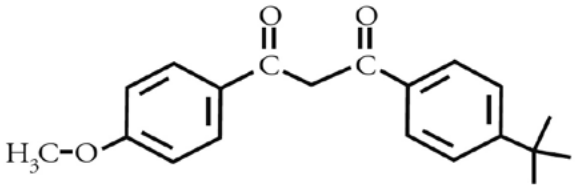


Polyethylene glycol stearate

Add UV-absorbing compounds to a skin moisturizer and you have sunblock lotion. Making a sunblock lotion water resistant, however, is problematic. Upon exposure to water, the surfactants within the lotion help to remove the lotion. Manufacturers generally recommend that you reapply the lotion after swimming. Lotions that minimize the use of surfactants have increased water resistance, but they tend to be oily or greasy. For these reasons, many water-resistant formulas include compounds that polymerize into a nonpolar, water-resistant film that helps to hold the sunscreen agent on the skin when wet.

A special consideration for sunscreens is the portion of the UV spectrum they are able to block. Nearly all sunscreens effectively block the region from 290 to 320 nm, known as UV-B. The traditional Sun Protection Factor (SPF) rating system indicates the effectiveness of a sunscreen lotion in blocking UV-B, which causes sunburn. Scientists, however, are finding that the range from 320 to 400 nm, known as UV-A, is more responsible for skin wrinkling as well as skin cancer. Sunscreens blocking both UV-A and UV-B are labeled "Broad Spectrum."

The most widely used UV-A blockers, avobenzone, is easily formulated into a lotion, but it quickly loses potency if not properly formulated with stabilizers. There is also the more stable UV-A blocker mexoryl SX. Two other UV-A blockers approved by the FDA are titanium dioxide and zinc oxide, both opaque minerals that are impractical to apply over large body-surface areas.



Avobenzone

The lists of approved UV-B and UV-A sunscreens in countries such as Australia and Canada, and in European nations are much longer than in the U.S. These countries treat sunscreens as cosmetics, while the United States treats them as drugs, which are subject to more rigorous regulations.

Another way to help skin maintain a youthful look is to apply alpha- hydroxy acids, such as glycolic acid. These compounds serve as exfoliants, which means they help in the removal of dead outer skin. This stimulates the skin to generate new cells that help to hide thin-line wrinkles.

Discussed here are only the main chemicals used to formulate hair- and skin-care products. As any casual look at an ingredients list tells you, many other chemicals serve other purposes.

Looking to the immediate future, there are some areas where skin care may soon make some significant advances. As we grow older, our skin wrinkles, because it has lost much of its elasticity. One of the reasons for this loss of elasticity is the formation of chemical bonds, called cross- links, between adjacent strands of collagen, which is the fundamental fiber skin cells create to form skin. The search is now underway to find agents that effectively inhibit and even reverse these collagen crosslinks.

CONCEPT **CHECK**

What do shampoos, hair conditioners, moisturizers, and sunscreen lotions all have in common?

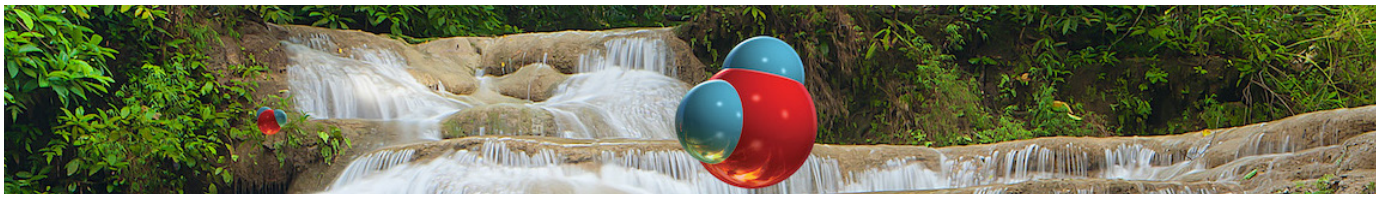
CHECK YOUR ANSWER They all contain surfactants, which are molecules that have both polar and nonpolar ends and permit the formation of emulsions

Think and Discuss

1. In an effort to speed up the drug approval process, the U.S. FDA created a special "fast-track" system for agents that show unusual promise or for agents that have been shown to be generally safe after years of use in other countries. Why are there so few sunscreen agents currently within this fast-track system? Should sunscreen agents continue to be classified as drugs?

2. If a collagen cross-linking agent is determined to be safe by the FDA, should this agent be available only by prescription, or should it be made available to consumers over the counter? If this agent noticeably helped to reduce skin wrinkling, how popular might it be? Assuming you were in your 50's, how much would you be willing to pay for a year's supply?

3. What criteria do you use in deciding what shampoo to buy? List the following in order of importance: the price, the brand name, the ingredients named on the front label, those listed on the back label, the fragrance, commercial advertisements, recommendation from a friend, and your experience with the shampoo.



Author Responses to Think and Discuss

1. Why are so few sunscreen agents currently within the FDA fast track system? There are likely several reasons, such as bureaucratic inertia or preference given to medicines. This would make a good research project for a team of students. Should sunscreen agents be classified as drugs even if that slows down the approval process?

2. If a collagen cross-linking agent is found to be safe, then the FDA might be tempted to initially regulate its formulation and distribution to assure quality control. Clinically shown to eliminate wrinkles? This would be the makings of a new billion-dollar industry.

3. Answers will vary, but remember: Brand is the hook that frees the mind from having to think much when shopping.