WHAT DO GOLD NANOPARTICLES HAVE TO DO WITH WRINKLY SKIN?

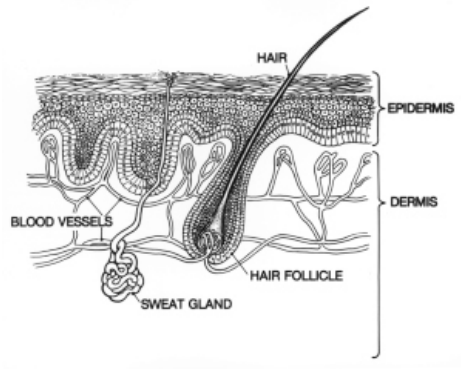
Incorporation of engineered nanomaterials into cosmetic products including sunscreens, makeups, soaps, moisturizers and shampoos is becoming increasingly more commonplace. Manufacturers incorporate nanomaterials into their products to improve product stability, improve the delivery of vitamins and antioxidants and make products more aesthetically appealing.[1] As a result of this increasing use, you may have encountered nanomaterials in your morning routine as you apply soap, lotion, or deodorant, brush your teeth or wash your hair. The Food and Drug Administration (FDA) does not require that cosmetic products be tested for health and environmental impacts before making it into the consumer market, though it is encouraged. Nevertheless, nanotechnology-driven products are on the market and have been for decades.

Brands like Lancome (L'Oreal), Dior and Olay (Procter and Gamble) employ a variety of nanomaterials into their products including niosomes, liposomes and nanoemulsions.[2]Niosomes and liposomes are *amphiphilic*, which means they have both *hydrophobic* ("water-fearing") and *hydrophilic* ("water-loving") parts. This nature is what allows them to carry vitamins and drugs across the skin.[2]

Skin naturally loses some of its elasticity with age.image source

Other products incorporate micro-gold particles into their formulations. For instance, Pond's "Gold Radiance" line boasts that gold promotes cell renewal and glowing skin. The inclusion of gold into consumer products is of particular interest to us in the Center for Sustainable Nanotechnology, and has motivated, in part, our decision to study gold nanoparticle interactions with biological systems. Companies boast that gold improves skin tone and elasticity, provides anti-aging benefits and improves blood circulation. Well, how exactly do gold nanoparticles provide all of these benefits?

That's a great question, but before we proceed, a crash course in skin science might be useful. Skin is composed of three main layers: the epidermis, dermis and hypodermis. The *epidermis* is the outermost skin layer and it mainly comprises dead cells that we continuously shed. There is a constant generation of new cells, with the newest cell found in the deeper layers and the older cells found on the outermost layer. It is the *dermis* that supports the epidermis and contains our hair follicles, oil, sweat glands, muscles, nerves and blood vessels. The dermis also contains connective tissues, mostly made of *collagen* and *elastin*. *Collagen* is a group of proteins that serve as one of the main structural components of skin and connective tissue. It, along with other proteins like keratin and elastin, is responsible for the structural integrity and elasticity of the skin. As we age, collagen and elastin break down and as a result skin loses its elasticity and its ability to retain its shape.



Epidermis and dermis. image source

Over time, the collagen in skin becomes degraded and contributes to the signs of aging (i.e. wrinkles). In addition to time, other things that contribute to the aging process include pollution, eating and sleeping habits, smoking, exercise, UV radiation, and genetics. One process that is known to lead to visible signs of aging, like wrinkles, is the formation of advanced glycation end products (AGEs).[3,4] *AGEs* are the products of a chain of reactions that initially kick off with a reaction between carbohydrates (sugars) and proteins, like collagen.*Carbohydrates* are one of main fuel sources for your body and are found in fruits, vegetables, bread and many other foods. The accumulation of AGEs in the skin causes the skin to lose some of its elasticity.[4]

Collagen molecule from RCSB Protein Data Bank.image source

Understanding how the accumulation of AGEs affects skin elasticity leads us to the role of gold in cosmetics. Gold nanoparticles are able to compete with carbohydrates to bind to amino acids like *lysine* and *arginine*. With gold particles taking up the place where carbohydrates would otherwise bind, the formation of AGEs should therefore be inhibited, and fewer wrinkles should form on the skin.

Nanomaterials are being used in everything from medicine to electronics because of their unique properties. You have just read about one particular application of

nanotechnology in cosmetics, but as we have discussed on the blog before, there is still a great need to understand what kinds of effects these materials will have in the body (during product use) and on the environment (after product disposal). Challenges like this motivate our research here in the CSN and illustrate how our research might be instrumental in the engineering of societally beneficial nanotechnologies.

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