HAIRDRESSING

HAIRDRESSING refers to the care, treatment and styling of head hair. The fashioning of hair can be considered an aspect of personal grooming, fashion, and cosmetics, although practical considerations also influence some hairstyles. Hairstyles are also influenced by various subcultures.

Factors that define a hairstyle

A hairstyle's aesthetic considerations may be determined by many factors, such as the subject's physical attributes and desired self-image or the stylist's artistic instincts.

Physical factors include natural hair type and growth pattern, face and head shape from various angles, and overall body proportions; medical considerations may also apply. Self-image may be directed toward conforming to mainstream values (military-style crew cuts or current "fad" hairstyles such as the Dido flip), identifying with distinctively-groomed subgroups (e.g., dreadlocks or punk hair), or obeying religious dictates (e.g., Orthodox Jewish payot or the Sikh practice of kesh), though this is highly context-dependent and a "mainstream" look in one setting may be limited to a "subgroup" in another.

Hairstyling may also include adding accessories to the hair to hold it in place, enhance its ornamental appearance, or partially or fully conceal it with coverings such as a kippa, hijab, or turban.bulla

Hairstyle process

Hair dressing may include cuts, weaves, coloring, extensions, perms, permanent relaxers, curling and any other form of styling or texturing.

Length and trimming

Hair cutting or hair trimming is intended to create or maintain a specific shape and form. Its extent may range from merely trimming the uneven ends of the hair to a uniform length to completely shaving the head.

The overall shape of the hairstyle is usually maintained by trimming it at regular intervals. There are ways to trim one's own hair but usually another person is enlisted to perform the process, as it is difficult to maintain symmetry while cutting hair at the back of one's head. Although trimming enhances the hair's appearance by removing damaged or split ends, it does not promote faster growth or remove all damage along the length of the hair.

Stylists often wash a subject's hair first, so that the hair is cut while still damp. Compared to dry hair, wet hair can be easier to manage in a cut/style situation because the added weight and surface tension of the water cause the strands to stretch downward and cling together along the hair's length, holding a line and making it easier for the stylist to create a form.

This may cause certain problems with curly hair, which has a greater degree of unfurling when fully wet; also, different areas of the hair may curl in different degrees or directions. Cutting curly hair while wet may result in unexpected results when dry, depending how the curls coil back up. Lorraine Massey, author of *Curly Girl,* specializes in the care of curly hair types, and has designed a specific method for trimming curly hair to avoid these problems.

Brushing and combing

Brushes and combs are used to organize and detangle hair, encouraging all of the strands to lie in the same direction and removing debris such as lint, dandruff, or hairs that have already shed from their follicles but continue to cling to the other hairs.

There are all manner of detangling tools available in a wide variety of price ranges. Combs come in all shapes and sizes and all manner of materials including plastics, wood and horn. Similarly, brushes also come in all sizes and shapes. There are also a variety of brushes in various paddle shapes. Most benefit from using some form of a wide tooth comb for detangling. Most physicians advise against sharing hair care instruments like combs and clips, to prevent spreading hair conditions like dandruff and head lice.

The historical dictum to brush hair with one hundred strokes every day is somewhat archaic, dating from a time when hair was washed less frequently; the brushstrokes would spread the scalp's natural oils down through the hair, creating a protective effect.

However, this does not apply when the natural oils have been washed off by frequent shampoos. Also, hairbrushes are now usually made with rigid plastic bristles instead of the natural boar's bristles that were once standard; the plastic bristles increase the likelihood of actually injuring the scalp and hair with excessively vigorous brushing.

Drying

Hair dryers speed the drying process of hair by blowing air, which is usually heated, over the wet hair shaft to accelerate the rate of water evaporation.

Excessive heat may increase the rate of shaft-splitting or other damage to the hair. Hair dryer diffusers can be used to widen the stream of air flow so it is weaker but covers a larger area of the hair.

Hair dryers can also be used as a tool to sculpt the hair to a very slight degree. Repeated blowdrying can slowly train hair follicles towards the desired direction. Proper technique involves aiming the dryer such that the air does not blow onto the face or scalp, which can cause burns.

Braiding and "Updos"

Tight or frequent braiding may pull at the hair roots and cause traction alopecia. Rubber bands with metal clasps or tight clips, which bend the hair shaft at extreme angles, can also have the same effect.

If hair is pinned too tightly, or the whole updo slips causing pulling on the hair in the follicle at the hair root are other scenarios that can cause aggravation to the hair follicle and result in headaches. Although many African- Americans use braiding extensions as a form of convenience , it is important NOT to keep the braids up longer than needed to avoid hair breakage or hair loss.

An industry

Hair styling is a major world industry, from the salon itself to products, advertising, and even magazines on the subject.

Hairstyling tools

Styling tools may include Hair irons (including flat, curling and crimping irons), hair dryers, hair rollers. Hair dressing might also include the use of product to add texture, shine, curl, volume or hold to a particular style.

Hairstyling products

Styling products aside from shampoo and conditioner are many and varied. Leave-in conditioner, conditioning treatments, mousse, gels, lotions, waxes, creams, serums, oils, and sprays are used to change the texture or shape of the hair, or to hold it in place in a certain style. Applied properly, most styling products will not damage the hair apart from drying it out; most styling products contain alcohols, which can dissolve oils. Many hair products contain chemicals which can cause build-up, resulting in dull hair or a change in perceived texture.

Wigs

Care of human or other natural hair wigs is similar to care of a normal head of hair in that the wig can be brushed, styled, and kept clean using haircare products.

Synthetic wigs are usually made from a fine fiber that mimics human hair. This fiber can be made in almost any color and hairstyle, and is often glossier than human hair. However, this fiber is sensitive to heat and cannot be styled with flat irons or curling irons.

Human hair wigs can be styled with heat, and they must be brushed only when dry. *Synthetic* wigs should be brushed dry before shampooing to remove tangles, then it should be dipped into a container with water and mild shampoo, then dipped in clear water and moved up and down to remove excess water. The wig must then be air dried naturally into its own hairstyle.[1]

Functional and decorative ornaments

There are many options to adorn and arrange the hair. Hairpins, clasps, barrettes, headbands, ribbons, rubber bands, scrunchies, and combs can be used to achieve a variety of styles. There are also many decorative ornaments that, while they may have clasps to affix them to the hair, are used solely for appearance and do not aid in keeping the hair in place.

Hairstyle as event

The editor of the *New York Times Magazine* describes his pages as reflecting "a place where change is not a threat, where doubt and complexity are more TRUE than certainty, and where most everything non-criminal is tolerated — except a bad haircut."[2]

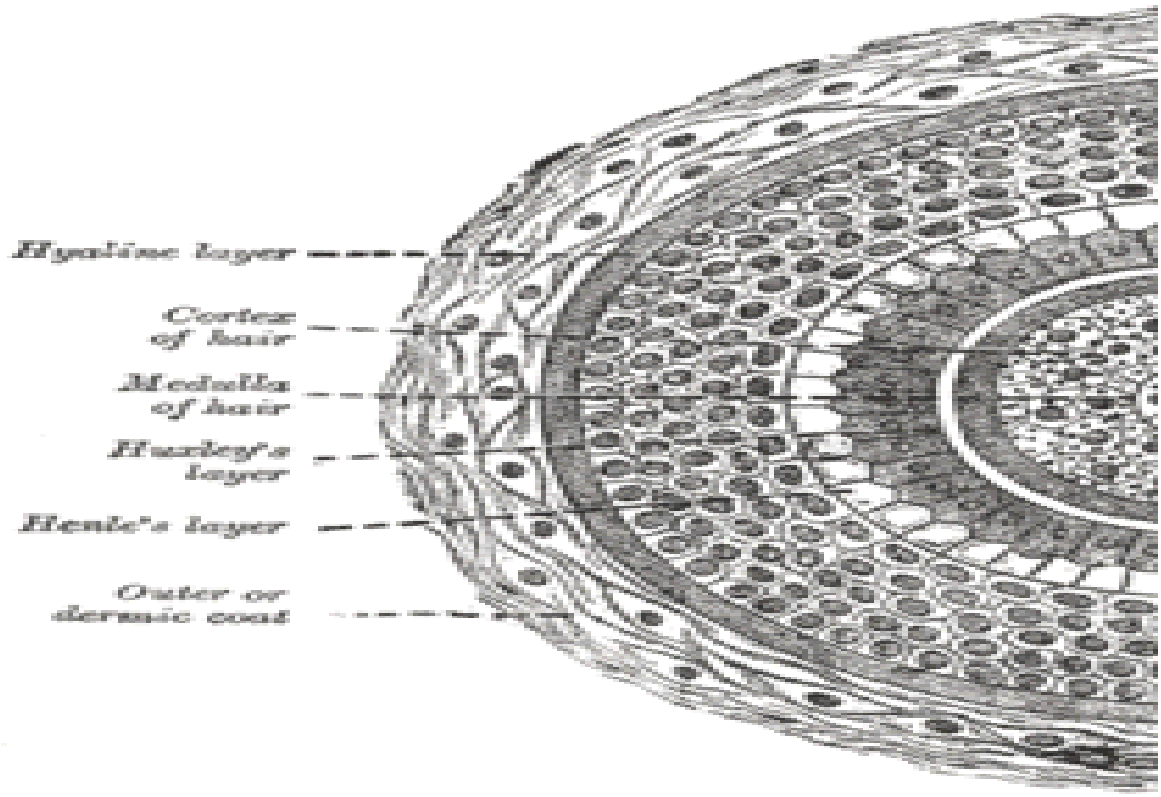
For Shoichi Yokoi, the first haircut in 28 years became his first ordinary contact with another person after living alone for many year

s. Yokoi hid in the forested mountains of Guam after the Imperial Japanese Army surrendered in 1944; and he managed to elude capture until 1972. The mere opportunity to sit in a barber's chair became a documented step in Yokoi's transformation from a reclusive, solitary combatant in a war which lasted for nearly three decades longer than for the rest of the world.[3]

Yokoi's haircut was literally and figuratively life-changing. After 1972, the story of Yokoi's life became a narrative about the process of adapting to worldwide attention and the radically different role of a celebrity.[4]

In Sikh culture, the hair of men is never cut; but some modern Sikhs are abandoning this tradition. The act of cutting hair itself takes on a significance unrelated to the corollary changes in appearance.[5]

Hair



Cross section of a hair

Hair is an outgrowth of filamentous cells, containing keratin, that grows from follicles found in the dermis. The human body, apart from the palms of the hands and soles of the feet, is covered in follicles which produce thick terminal and fine vellus hair. Most common interest in hair is focused on hair growth, hair types and hair care but hair is also an important biomaterial and the hair follicle is a well studied biological organ.

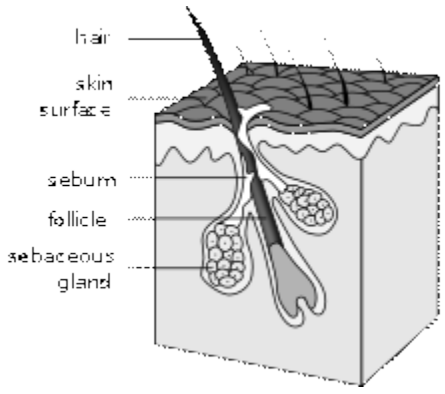
Found exclusively in mammals, hair is one of the defining characteristics of the mammalian class.[1] Although other non-mammals, especially insects, show filamentous outgrowths, these are not considered "hair" in the scientific sense. So-called "hairs" (trichomes) are also found on plants. The projections on arthropods

such as insects and spiders are actually insect bristles, composed of a polysaccharide called chitin. There are varieties of dogs, cats, and mice bred to have little or no visible fur. In some species, hair is absent at certain stages of life. The main component of hair fiber is keratin.

Hair often refers to two distinct structures (1) the part beneath the skin, called the hair follicle or when pulled from the head called the bulb. This organ is located in the dermis and maintains stem cells which not only re-grow the hair after it falls out but also are recruited to regrow skin after a wound[2]; and (2) the shaft, which is considered the part of the hair above the skin surface though it appears first in the epidermis. The hair shaft, in cross-section, can be divided roughly into three zones. Starting from the outside, (1) the cuticle which consists of several layers of flat, thin cells laid out like roof shingles, (2) the cortex which contain the keratin bundles in cell structures that remain roughly rod like and in some cases (3) the medulla, a disorganized and open area at the fibers center[3].

Description

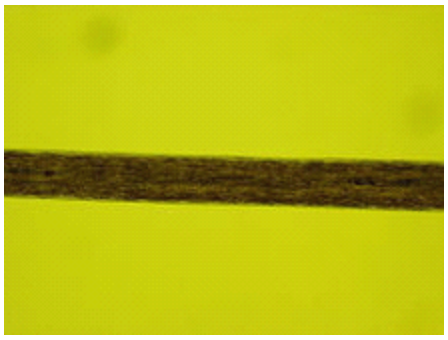
Construction of the root and strand



Hair Follicle Structure

Hair is mainly composed of the protein keratin. Keratin is made of rope-like intermediate filaments. The structure of the filaments provides strength to the hair shaft. Like other proteins, keratin is non-polar and is not miscible in polar substances, like water. For this reason, hair is waterproof.

Hair growth begins under the skin at the root. Each individual strand of hair is housed in a hair follicle. Only the "living" portion of the hair is found in the follicle. The hair that is visible is considered dead and is called terminal hair.[4] The base of the root is called the bulb, which contains the matrix and the papilla.[5] These two structures promote hair growth. Other structures of the hair follicle include the sebaceous gland and the erector pili muscles, which, respectively, produce a natural oil, called sebum, so that the shaft does not dry out, and are responsible for causing goose bumps.[6]



Strand of human hair

Each strand of hair is made up of the medulla, cortex, and cuticle.[7] The medulla is the innermost region of the hair strand and reflects light to give hair its various colors and tones.[4] Finer hairs and naturally blond hairs have a fragmented or nonexistent medulla layer.[8] Like the medulla, the cortex, or middle layer of the hair, contributes to hair color. The cortex contains melanin, which predisposes hair color based on the type of melanin that is present. The presence of eumelanin suggests brown or black hair, while

pheomelanin suggests red hair.[4] Blond hair is the result of having little pigmentation in the hair strand.[4] The cortex also determines the shape of the hair strand. If the cortex is round, the hair is straight and if it is oval-shaped, the hair is wavy or curly.[4] The cuticle coats and protects the hair strand.[9]

Hair pigment

Main article: Human hair color

All natural hair colours are the result of two types of hair pigment. Both these pigments are a type of melanin produced inside the hair follicle: *Phaeomelanin* is responsible for the yellowish-blond to red colors and *Eumelanin* is responsible for the brown to black shades. Gray hair occurs when these melanin molecules are no longer produced, so there is no pigment left to colour the hair naturally.

Human hair growth

Main article: Human hair growth

Human hair grows everywhere on the body except for the palms of the hands, soles of the feet, the lips, and the eyelids, apart from eyelashes. Like skin, hair is an epithelium. Unlike skin, it is stratified, squamous, keratinized epithelium because it is made of multi-layered, flat cells and contains the protein keratin, whose rope-like filaments provide structure and strength to the hair shaft.

Hair follows a specific growth cycle with three distinct and concurrent phases: anagen, catagen, and telogen phases. Each phase has specific characteristics that determine the length of the hair. All three phases occur simultaneously; one strand of hair may be in the anagen phase, while another is in the telogen phase.

The body has different types of hair, including vellus hair and androgenic hair, each with its own type of cellular construction. The

different construction gives the hair unique characteristics, serving specific purposes, mainly warmth and protection.

Purpose

Many animals, and even plants, have fur and tiny hairs that serve different purposes. Animals need fur to keep warm, for camouflage, and, in some cases, to warn or signal other animals with the special markings on their coats. Evolution has proved that these reasons for having hair are not as important to human survival. Humans have developed to have very little hair to help keep warm and communicate with one another compared to other organisms that use their fur for these reasons.

Warmth

Polar bears use their fur for warmth, camouflage while hunting and for protection by hiding cubs in the snow.

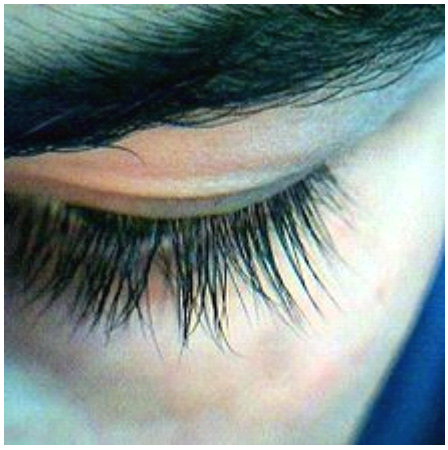
While humans have developed clothing and other means of keeping warm, the hairs found on the head and other parts of the body serve as primary sources of heat and insulation. Hats and coats are still required while doing outdoor activities to prevent frost bite and hypothermia, but the hair on the human body does help to keep the internal temperature regulated. When the body is too cold, the erector pili muscles found attached to hair follicles stand up, causing the hair in these follicles to do the same. These hairs thus form a heat-trapping layer above the epidermis. This is called piloerection, which is a Latin word where 'Pilo' means hair and 'erect' means to

stiffen. This process is more commonly known as having goosebumps [10]. The opposite happens when the body is too warm. The erector muscles make the hair lay flat on the skin which allows heat to leave.

Protection

Human hair may not compete with the painful spines of the porcupine, but much of the hair on the human body is suited to protect it. This natural armor cannot directly protect humans from potential predators, but it does help to keep the sense organs, like the eyes, working properly.

Eyebrows and eyelashes



Eyelashes and eyebrows help to protect the eyes from dust, dirt, and sweat

The eyebrows are situated above the eyelids on the forehead. While they have little significance to the survival of humans, they remain a part of the body's physiological makeup because of the role they play in protecting the eyes from dirt, sweat, and rain, as well as communication [11]. People have developed other means, such as hats, umbrellas, and goggles to serve the purpose of eyebrows more effectively, but the presence of eyebrows may suggest that they were once important to earlier species' survival.[11]

The eyelashes grow at the edges of the eyelid and protect the eye from any dirt that may enter the eye. Eyelashes are to humans what whiskers are to cats; they are used to sense when dirt, dust, or any other potentially harmful object is too close to the eye [12]. The eye reflexively closes as a result of this sensation.

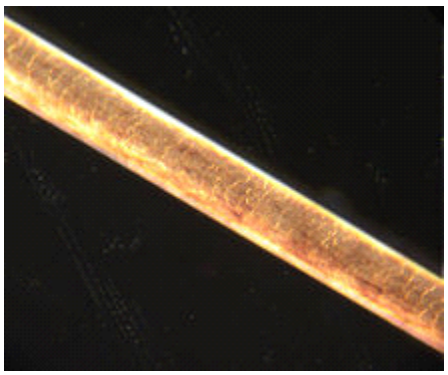
Evolution

See also: Evolution of hair

A 2008 study by scientists from the Medical University of Vienna traced the origins of hair to the common ancestor of mammals, birds and lizards that lived 310 million years ago. The study found chickens, lizards and humans all possessed a similar set of genes that was involved in the production of alpha keratin. In chickens and lizards, the α-keratin produced was found in their claws, but in mammals it was used to produce hair. The scientists involved continued searching for the mechanisms that allowed mammals to use the keratins of animal claws to produce hair. [13][14]

Human "hairlessness"

Human hair is barely visible as it is thinner, shorter and more translucent than the hair of other mammals. Historically, some ideas have been advanced to explain the apparent hairlessness of humans, as compared to other species.



Human hair under 200-times magnification

Most mammals have light skin that is covered by fur, and biologists believe that human ancestors started out this way also. Dark skin probably evolved after humans lost their body fur, because the naked skin was vulnerable to the strong UV radiation as would be experienced in Africa. Therefore, evidence of when human skin darkened has been used to date the loss of human body hair, assuming that the dark skin was needed after the fur was gone.

Dr. Alan R. Rogers, an evolutionary geneticist at the University of Utah, used mutations in the MC1R gene to estimate when human skin darkened. He said humans may have gone through several genetic "clean sweeps" with light-skinned individuals dying off and dark-skinned individuals surviving. He estimates the last of these clean sweeps took place 1.2 million years ago.[15] Therefore, humans, in part, have been hairless at least since that time, as body hair does still remain in human populations.

The soft, fine hair found on many nonhuman mammals is typically called fur.

The savanna hypothesis suggests that nature selected humans for shorter and thinner body hair as part of a set of adaptations to the warm plains of the African savanna (in addition to bipedal locomotion and an upright posture). Some counter this argument by noting that among the most hairless people are Northern Europeans who live in a cold and relatively low sun environment. However, abundant genetic

and archaeological evidence indicates that the hairlessness of those current-day modern humans whose immediate ancestors came to occupy Northern latitudes is attributable to the relatively recent origin of these people in equatorial, sub-Saharan Africa approximately 200,000 years ago, followed by an even more recent departure from Africa that was initiated approximately 60,000 years ago. Hence it is highly likely that the ancestors of Northern Europeans (et al. Northern groups) failed to develop fur due to a) their relatively recent entry into the area, and b) the fact that the high levels of intelligence that had evolved in the human lineage while in Africa enabled them to survive in the cold European climate by way of the practice of wearing animal furs. Hence the development of fur was rendered effectively unnecessary.

Nevertheless, other species likely migrated to Africa by way of a gradual process. This provided them with time to adjust to the intense UV and sunlight by way of other means (such as panting). Hominids, on the other hand, originally possessed fur, but, due to a relatively sudden change in behavior 2.5 million years ago (due to hominid inventiveness/technological innovation) that involved intense hunting during the day, they developed sweat glands that enabled them to perspire. This change necessitated the loss of most body hair in order to facilitate sweat evaporation (i.e. cool the body).

Balding usually occurs at around 30 – 40 years of age. In prehistoric times, most individuals were not as likely to live past 30.[*citation needed*] Hence it wasn't as common a trait. Also, dark pigmentation of the skin could have partially compensated for premature baldness.[*citation needed*] There are other African mammals that have lost fur due to equatorial heat. These include the elephant and the hippopotamus. Thus it is arguable that the Savanna Theory model provides the best explanation for the loss of fur experienced by the human lineage given the available evidence.

Another theory for the thin body hair on humans proposes that Fisherian runaway sexual selection played a role (as well as in the selection of long head hair), (see types of hair and vellus hair), as well as a much smaller role of testosterone in women.

The aquatic ape hypothesis posits that sparsity of hair is an adaptation to an aquatic environment, but the theory has little support among scientists.[16]

Humans are part of a trend toward sparser hair in larger animals. The *density* of human hair follicles on the skin is actually about the average for an animal of equivalent size[17]. It is still not clear why so much of human hair is short, underpigmented vellus hair, rather than terminal hair and the effect of testosterone on the hair follicles in both human and other mammallian species.

Evolutionary variation

Evolutionary biologists suggest that the genus Homo arose in East Africa approximately 2.5 million years ago (Jablonski, 2006). They devised new hunting techniques. (Jablonski, 2006). The higher protein diet led to the evolution of larger body and brain sizes (Jablonski, 2006). Jablonski (2006) postulates that increasing body size, in conjunction with intensified hunting during the day at the equator, gave rise to a greater need to rapidly expel heat. As a result, humans developed the ability to sweat and thus lost body hair to facilitate this process (Jablonski, 2006). Some note that other primates and horses have armpits that sweat like those of humans and so this was not a new evolution, rather a possible preferential selection of perspiration over body hair. However, it can be argued that these two species also pant; a device that compensates for inefficiencies in the evaporation of sweat due to fur. Some counter the argument that dark skin was necessary following loss of fur by suggesting that tanning on exposed skin in primates is also seen and possibly was a retained feature, while hyper-pigmentation as in Africans and Indians, as well as albinism are

later mutations. However, this argument doesn't account for the fact that equatorial UV light is such that the relatively minor tanning that occurs among chimpanzees (who, it should be mentioned, spend most of their time protected from the sun by way of a forest canopy), is insufficient in terms of providing full protection.

In addition, while some individuals affirm the hypothesis concerning loss of hair via the evolution of sweat glands, they assert that the question remains as to why such a large surface area is required for cooling when other animals in these regions have much larger volumes to surface area, yet are still covered in thick fur and are able to cool solely by panting. They cite examples that include monkeys, lions and zebra, (though as previously mentioned, they acknowledge that both zebra and monkeys possess the ability to sweat). However, this assessment fails to account for the fact that the speed at which the human lineage changed in response to higher cognitive ability far outpaced that of other species. Specifically, the fairly sudden invention of stone tools by primitive humans ~2.8 million years ago rapidly transitioned the human lineage away from the simple scavenging of protein from the bone marrow derived from the kills of large African predators (a fairly passive endeavor), towards active hunting that entailed spending relatively long periods of time chasing wild game in the hot equatorial sun. Such a pace of change was unparalleled among other species who, instead, acquired their adaptations to the African heat over considerably longer periods of time during which many of them moved into the equatorial region at a gradual pace. Thus, the significantly greater urgency amongst the members of the human lineage for heat adaptations that could keep up with the huge nutritional benefits that they were accruing from the practice of hunting (leading to an avalanche effect in which increasing protein intake fueled increasing brain size/intelligence) may explain these stark differences.

Texture

Curly hair

Jablonski (2006) agrees that it was evolutionarily advantageous for pre-humans (Homo erectus) to retain the hair on their heads in order to protect the scalp as they walked upright in the intense African (equatorial) UV light (Jablonski, 2006). While some might argue that, by this logic, humans should also express hairy shoulders given that these body parts would putatively be exposed to similar conditions, the protection of the head, the seat of the brain that enabled humanity to become one of the most successful species on the planet (and which is also very vulnerable at birth), was arguably a more urgent issue (axillary hair in the underarms and groin were also retained as signs of sexual maturity). During the gradual process by which Homo erectus transitioned from furry to naked skin, their hair texture putatively changed gradually from straight (the condition of most mammals, including humanity's closest cousins—chimpanzees), to Afro-like or 'kinky' (i.e. tightly coiled). In this sense, during the period in which humans were gradually losing their straight body hair and thereby exposing initially the pale skin underneath their fur to the sun, straight hair would have been an adaptive liability. Hence, tightly coiled or 'kinky' Afro-hair may have evolved to prevent the entry of UV light into the body during the transition towards dark, UV-protected skin.

Alternatively, some intuit that tightly coiled hair that grows into a typical Afro-like formation would have greatly reduced the ability of the head and brain to cool. They reason that although hair density in African peoples is much less than their European counterparts, in the intense sun the effective 'woolly hat' produced would have been a disadvantage. However, anthropologists such as Nina Jablonski make the opposite argument with regards to this hair texture. Specifically, Jablonski's (2006) assertions suggest that the adjective "woolly" in reference to Afro-hair is a misnomer to the extent that it connotes the

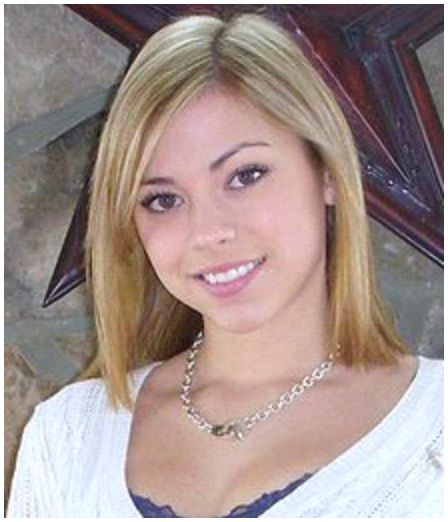
high heat insulation derivable from the true wool of sheep. Instead, the relatively sparse density of Afro-hair, combined with its springy coils actually results in an airy, almost sponge-like effect. This, in turn, Jablonski (2006) argues, actually facilitates an increase in the circulation of cool air onto the scalp. Further, Afro-hair does not respond as easily to moisture and/or sweat as straight hair. Thus it does not stick to the neck and/or scalp when wet. Rather, unless totally drenched, it tends to retain its basic springy puffiness. In this sense, the trait may enhance comfort levels in intense equatorial climates compared to straight hair (which, alternatively, tends to naturally fall over the ears and neck to a degree that provides slightly enhanced comfort levels in cold climates relative to tightly coiled hair).

Further, some interpret the ideas of Charles Darwin as suggesting that some traits, such as hair texture, were too trivial for natural selection to have played a role. They argue that Darwin's explanation was that sexual selection may be responsible for such traits.[18] However, the concept of "triviality" is a human value judgment. It has nothing to do with whether physical traits are/were actually adaptive. In fact, while the sexual selection hypothesis cannot be totally ruled out, the asymmetrical distribution of this trait does not indicate that this was the primary causal factor. Specifically, if hair texture were simply the result of arbitrary human aesthetic preferences, one would expect that the global distribution of the various hair textures would be fairly random. Instead, the distribution of Afro-hair is strongly skewed towards the equator. Further, it is notable that the most pervasive expression of this hair texture can be found in sub-Saharan Africa; a region of the world that abundant genetic and paleo-anthropological evidence suggests was the relatively recent (~200,000 year old) point of origin for modern humanity. In fact, although genetic findings (Tishkoff, 2009) suggest that sub-Saharan Africans are the most genetically diverse continental group on earth, Afro-textured hair (along with a small cluster of other physical features) approaches ubiquity is this region. This points to a strong, long-term selective pressure that, in stark contrast to most other regions of the genomes

of sub-Saharan groups, left little room for genetic variation at the determining loci. Such a pattern is, again, not indicative of the relatively variable trends associated with human sexual aesthetics.

Straight hair

According to the recent single origin hypothesis, anatomically modern humans (Homo sapiens) arose in East Africa approximately 200,000 years ago (Tishkoff, 1996). Then, ~150,000 years later, modern humans began to expand their range to regions outside of (and within) this continent (Tishkoff, 1996). Among those in the group which left the African continent, their skin had developed the ability to manufacture vitamin D (which was essential for bone development) upon exposure to UV light (Jablonski, 2006). However, the UV light of northern regions was too weak to penetrate the highly pigmented skin of the initial migrants in order to provide enough vitamin D for healthy bone development (Jablonski, 2006). Malformed bones in the pelvic area were especially deadly for women because they interfered with the successful delivery of babies; leading to the death of both the mother and the infant during labor. Hence, those with lighter skin survived and had children at higher rates because their skin allowed more UV light for the production of vitamin D (Jablonski, 2006).



Woman with straight blonde hair

In this sense, the evidence with regard to the evolution of straight hair texture seems to support Jablonski's (2006) suggestions that the need for vitamin D triggered the transition from dark to light skin. Specifically, the distribution of this trait suggests that this need may have grown so intense at certain points that Northerners with mutations for straighter hair survived and had children at higher rates. This argument is made based on the principle that straight fibers better facilitate the passage of UV light into the body relative to curly hair. It is substantiated by Iyengar's (1998) findings that UV light can pass through straight human hair roots in a manner similar to the way that light passes through fiber optic tubes (Iyengar, 1998).

Nonetheless, some argue against this stance because straighter hair ends tend to point downward while fiber optics requires that light be transmitted at a high angle to the normal of the inner reflective surface. In light of this, they suggest that only light reflected from the ground could successfully enter the hair follicle and be transmitted down the shaft. Even this process, they argue, is hindered by the curvature at the base of the hair. Therefore, coupled with the amount of skin covered by long head hair, these factors seem to mitigate against the adaptive usefulness of straight hair at Northern latitudes. They further argue that UV light is also poorly reflected from soil and dull surfaces. These ideas can be countered by the fact that during the winter, the time of year in which UV light is most scarce at Northern latitudes, the ground is often covered with white snow. Given that white is the most effective color in terms of facilitating the reflection of ground light, the hypothesis that straight hair could have been adaptively favorable cannot be fully discounted in this regard. In addition, as mentioned in the previous section, straight hair may have also contributed to enhanced comfort levels in the North. This is evident in the extent to which, relative to curly hair, it tends to provide a layer of protection for ears and necks against the cold.

The EDAR Locus

A group of studies have recently shown that genetic patterns at the EDAR locus, a region of the modern human genome that contributes to hair texture variation among most individuals of East Asian descent, support the hypothesis that (East Asian) straight hair likely developed in this branch of the modern human lineage subsequent to the original expression of tightly coiled natural afro-hair (Mou, 2008; Fujimoto, 2008; Fujimoto, 2008b). Specifically, the relevant findings indicate that the EDAR mutation coding for the predominant East Asian 'coarse' or thick, straight hair texture arose within the past ~65,000 years, which is a time frame that covers from the earliest of the 'Out of Africa' migrations up to now.

Removal practices

Though growing hair is an inevitable part of being human, many believe that it is unsightly and should be removed. Hair removal is almost always done for cosmetic reasons.

Depilation is the removal of hair from the surface of the skin. This can be achieved through methods like shaving. Epilation is the removal of the entire hair strand, including the part of the hair that has not yet left the follicle. A popular way to epilate hair is through waxing it.

Shaving

Many razors have multiple blades to ensure a close shave. While shaving will initially leave skin feeling smooth and hair free, stubble will inevitably appear a few hours after hair removal.

Shaving is done with bladed instruments, such as razors. The blade is brought close to the skin and stroked over the hair in the desired area to cut the terminal hairs and leave the skin feeling smooth. Depending on the rate of growth, one can begin to feel the hair growing back within hours of shaving. This is especially evident in men who develop a five o'clock shadow after having shaved their faces. This new growth is called stubble. Stubble typically grows back thicker than the original hair in the area because the very ends of terminal hairs are the thinnest parts of the hair shaft.

Waxing

Waxing involves using a sticky wax and strip of paper or cloth to pull hair from the root. Waxing is the ideal hair removal technique to keep an area hair-free for long periods of time. It can take five to nine weeks for waxed hair to begin to resurface again [19]. Hair in areas that have previously been waxed is also known to grow back finer and thinner, especially compared to hair that has been shaved with a razor [19].

Cutting and trimming

Because the hair on the head is normally longer than other types of body hair, it is cut with scissors, clippers, or a trimmer. People with longer hair will most often use scissors to cut their hair, whereas shorter hair is maintained using a trimmer. Depending on the desired length and overall health of the hair, periods without cutting or trimming the hair can vary.

Many people will confuse what a haircut is versus what a trim is. A haircut is usually performed in order to change one's hairstyle, while a trim helps to keep away split ends and keep the hair well-groomed

and healthy. Cutting hair tends to take off more hair than trimming hair does. When hair is trimmed, only the first few centimeters need to be removed, whereas haircuts can sometimes result in the loss of many inches of hair.

Social role

Portrait of a Woman, Alessandro Allori (1535 - 1607; Uffizi Gallery): a plucked hairline gives a fashionably "noble brow"

Hair has great social significance for human beings. It can grow on most areas of the human body, except on the palms of the hands and the soles of the feet (among other areas), but hair is most noticeable in most people in a small number of areas, which are also the ones that are most commonly trimmed, plucked, or shaved. These include the face, nose, ears, head, eyebrows, eyelashes, legs and armpits, as well as the pubic region. The highly visible differences between male and female body and facial hair are a notable secondary sex characteristic.

Indication of status

Healthy hair indicates health and youth (important in evolutionary biology). Hair colour and texture can be a sign of ethnic ancestry. Facial hair is a sign of puberty in men. White hair is a sign of age or genetics, which can be concealed with hair dye. Male pattern baldness is a sign of age, which can be concealed with a toupee, hats or religious/cultural adornments. Although drugs and medical procedures exist for the treatment of baldness, many balding men simply shave their heads. Hair whorls have been discovered to be associated with brain development.

Hairstyle can be an indicator of group membership. During the English Civil War, the followers of Oliver Cromwell decided to crop their hair close to their head, as an act of defiance to the curls and ringlets of the king's men.[20] This led to the Parliamentary faction being nicknamed Roundheads. Having bobbed hair was popular among the flappers in the 1920s as a sign of rebellion against traditional roles for women. Female art students known as the "cropheads" also adopted the style, notably at the Slade School in London, England. Regional variations in hirsutism cause practices regarding hair on the arms and legs to differ. Some religious groups may follow certain rules regarding hair as part of religious observance. The rules often differ for men and women.

Many hippies, metalheads and Indian sadhus have long hair; many punks wear a hairstyle known as a Mohawk or other spiked and/or dyed hairstyles; skinheads have short-cropped or completely shaved heads; Mullet hairstyles have stereotypically been associated with rednecks; the Deathhawk, a larger, fuller, back-combed version of a Mohawk is popular with goths and deathrock fans; an undercut in which the sides and back of the head are shaved short or bald, and the top hair is allowed to grow long, is common among cybergoths and fans of Industrial and heavy electronic music; hair that is usually

short with a long side fringe — often dyed black or vibrant and contrasting colours — is associated with emo fans.

Heads were shaved in concentration camps, and head-shaving has been used as punishment, especially for women with long hair. The shaven head is common in military haircuts, while Western monks are known for the tonsure. By contrast, among some Indian holy men, the hair is worn extremely long.

The ethnically Manchu Qing Dynasty, beginning in the late 17th century China, ordered all Chinese citizens to adopt Manchurian hairstyles by shaving the front of their head and adopting a queue.

Regular hairdressing in some cultures is considered a sign of wealth or status. The dreadlocks of the Rastafari movement were despised early in the movement's history. In some cultures, having one's hair cut can symbolize a liberation from one's past, usually after a trying time in one's life. Cutting the hair can be a sign of mourning. Yoko Ono famously cut her very long hair after the assassination of her husband John Lennon, saying "John loved my long hair, so I gave it to him".

Tightly coiled hair in its natural state can be worn in an Afro. This hairstyle was once worn among African Americans as a symbol of racial pride. Given that the coiled texture is the natural state of most African Americans' hair, this simple style is now often seen as a sign of self-acceptance and an affirmation that the beauty norms of dominant (northern/European) culture are not absolute.

Flappers in the 1920s cut their traditional long hair into short bob cuts to show their independence and sexual freedom. Hippies in the 1960s allowed their hair to grow long and largely unstyled in order to illustrate their distance from mainstream society and conformity, which at that time favoured short hair in men, and complex hairstyling for women.

The film *Easy Rider* (1969) includes the assumption that the two main characters could have their long hairs forcibly shaved with a rusty razor when jailed, symbolizing the intolerance of some conservative groups toward members of the counterculture.

At the conclusion of the Oz obscenity trials in the UK, the defendants had their heads shaved by the police, causing public outcry. During the appeal trial, they appeared in the dock wearing wigs.

Religious practices

Women's hair may be hidden using headscarves, a common part of the *hijab* in Islam and a symbol of modesty required for certain religious rituals in Orthodox Christianity. Orthodox Judaism endorses the use of wigs, scarves and other headcoverings for women for modesty reasons as in Islam. Hassidic Judaism, on the other hand, discourages the trimming of head hair, and male practitioners typically wear their hair in ringlets (peyos). Sikhs generally keep their hair uncut and men keep it tied in a bun on the head, which is then covered appropriately using a turban.

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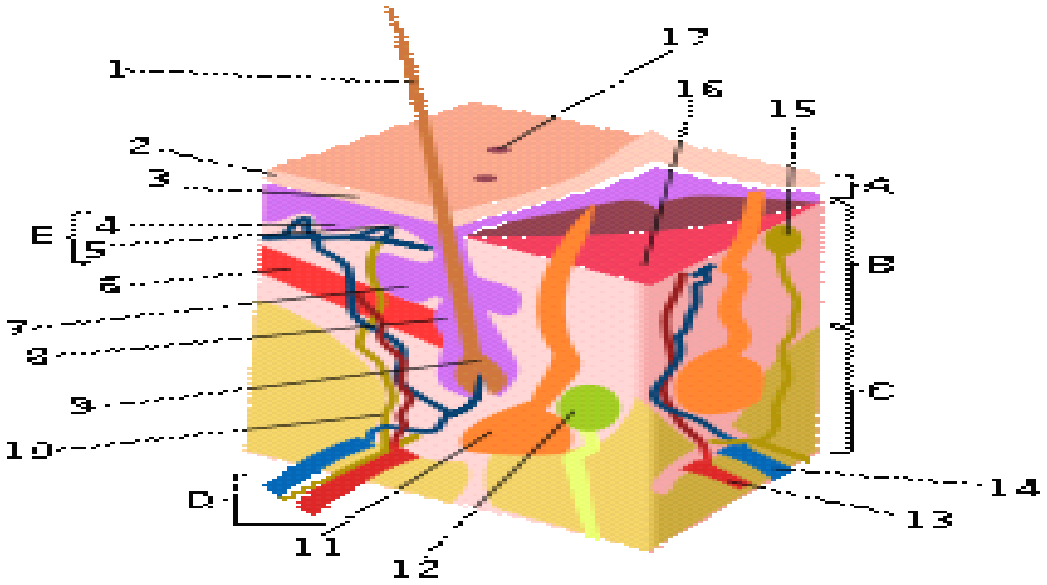
Human skin

Skin



epidermis (A), dermis (B), and subcutis (C), showing a hair follicle (1), sweat gland (11) & sebaceous gland (7)

The **skin** is the outer covering of the body. In humans, it is the largest organ of the integumentary system made up of multiple layers of ectodermal tissue, and guards the underlying muscles, bones, ligaments and internal organs.[1] Human skin is not unlike that of most other mammals except that it is not protected by a pelt and appears hairless though in fact nearly all human skin is covered with hair follicles. There are two general types of skin, hairy and glabrous skin.[2] The adjective **cutaneous** literally means "of the skin" (from Latin *cutis*, skin).

Because it interfaces with the environment, skin plays a key role in protecting (the body) against pathogens[3] and excessive water loss.[4] Its other functions are insulation, temperature regulation, sensation,

synthesis of vitamin D, and the protection of vitamin B folates. Severely damaged skin will try to heal by forming scar tissue. This is often discolored and depigmented.

In humans, skin pigmentation varies among populations, and skin type can range from dry to oily. Such skin variety provides a rich and diverse habit for bacteria which number roughly a 1000 species from 19 phyla.[5][6]

-

Skin components

Skin has mesodermal cells, pigmentation, or melanin, provided by melanocytes, which absorb some of the potentially dangerous ultraviolet radiation (UV) in sunlight. It also contains DNA-repair enzymes that help reverse UV damage, and people who lack the genes for these enzymes suffer high rates of skin cancer. One form predominantly produced by UV light, malignant melanoma, is particularly invasive, causing it to spread quickly, and can often be deadly. Human skin pigmentation varies among populations in a striking manner. This has led to the classification of people(s) on the basis of skin color.[7]

The skin is the largest organ in the human body. For the average adult human, the skin has a surface area of between 1.5-2.0 square metres (16.1-21.5 sq ft.), most of it is between 2–3 mm (0.10 inch) thick. The average square inch (6.5 cm^2) of skin holds 650 sweat glands, 20 blood vessels, 60,000 melanocytes, and more than a thousand nerve endings.

Functions

Skin performs the following functions:

1. Protection: an anatomical barrier from pathogens and damage between the internal and external environment in bodily defense; Langerhans cells in the skin are part of the adaptive immune system.[3][4]
2. Sensation: contains a variety of nerve endings that react to heat and cold, touch, pressure, vibration, and tissue injury; see somatosensory system and haptics.
3. Heat regulation: the skin contains a blood supply far greater than its requirements which allows precise control of energy loss by radiation, convection and conduction. Dilated blood vessels increase perfusion and heatloss, while constricted vessels greatly reduce cutaneous blood flow and conserve heat.
4. Control of evaporation: the skin provides a relatively dry and semi-impermeable barrier to fluid loss.[4] Loss of this function contributes to the massive fluid loss in burns.
5. Aesthetics and communication: others see our skin and can assess our mood, physical state and attractiveness.
6. Storage and synthesis: acts as a storage center for lipids and water, as well as a means of synthesis of vitamin D by action of UV on certain parts of the skin.
7. Excretion: sweat contains urea, however its concentration is 1/130th that of urine, hence excretion by sweating is at most a secondary function to temperature regulation.
8. Absorption: In addition, medicine can be administered through the skin, by ointments or by means of adhesive patch, such as the nicotine patch or iontophoresis. The skin is an important site of transport in many other organisms.
9. Water resistance: The skin acts as a water resistant barrier so essential nutrients aren't washed out of the body.

Hygiene and skin care

skin supports its own ecosystems of microorganisms, including yeasts and bacteria, which cannot be removed by any amount of cleaning. Estimates place the number of individual bacteria on the surface of one square inch (6.5 square cm) of human skin at 50 million, though this figure varies greatly over the average 20 square feet (1.9 m^2) of human skin. Oily surfaces, such as the face, may contain over 500 million bacteria per square inch (6.5 cm^2). Despite these vast quantities, all of the bacteria found on the skin's surface would fit into a volume the size of a pea.[8] In general, the microorganisms keep one another in check and are part of a healthy skin. When the balance is disturbed, there may be an overgrowth and infection, such as when antibiotics kill microbes, resulting in an overgrowth of yeast. The skin is continuous with the inner epithelial lining of the body at the orifices, each of which supports its own complement of microbes.

Proper skin hygiene is important because unclean skin favors the development of pathogenic organisms. The dead cells that continually slough off the epidermis mix with the secretions of the sweat and sebaceous glands and the dust found on the skin form a filthy layer on its surface. If not washed away, the slurry of sweat and sebaceous secretions mixed with dirt and dead skin is decomposed by bacterial flora, producing a foul smell. Functions of the skin are disturbed when it is excessively dirty; it becomes more easily damaged, the release of antibacterial compounds decreases, and dirty skin is more prone to develop infections.[*citation needed*]

Cosmetics should be used carefully on the skin because these may cause allergic reactions. Each season requires suitable clothing in order to facilitate the evaporation of the sweat. Sunlight, water and air play an important role in keeping the skin healthy.

Oily Skin

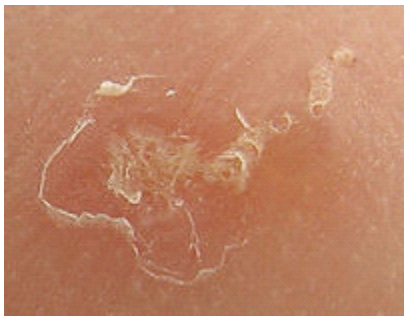
Oily skin is caused by over-active sebaceous glands, that produce a substance called sebum, a naturally healthy skin lubricant.[1] When the skin produces excessive sebum, it becomes heavy and thick in texture. Oily skin is typified by shininess, blemishes and pimples.[1] The oily-skin type is not necessarily bad, since such skin is less prone to wrinkling, or other signs of aging,[1] because the oil helps to keep needed moisture locked into the epidermis (outermost layer of skin).

The negative aspect of the oily-skin type is that oily complexions are especially susceptible to clogged pores, blackheads, and buildup of dead skin cells on the surface of the skin.[1] Oily skin can be sallow and rough in texture and tends to have large, clearly visible pores everywhere, except around the eyes and neck.[1]

The goal of treating oily skin is to remove excess surface sebum without complete removal of skin lipids.[1] Severe degreasing treatment can foster an actual worsening of sebum secretion, which defeats the aim of the cleansing.[1] A method of cleansing oily skin is to cleanse with a natural face cleanser formulated especially for oily skin. The cleansers pH should be 4.5 - 5.5, since the skin's pH value is approximately 5.4. Gel cleansers work best on oily skin.[1] (*see:* surfactant) Oily skin products should contain very little natural oils. They should not contain waxes or other synthetic lipid agents that could aggravate the oily condition of the skin. A toning lotion should also be natural and have a pH of 4.5-5.5 and formulated especially to help balance and hydrate oily skin. Some cleansing products have lower concentrations of hydroxy acids, which remove dead cells from the upper levels of the stratum corneum.[1] Those products should be used on a regular basis to work adequately.

In cases of excessive output of sebum, there have been anecdotal reports of successful control using dietary supplementation of Niacin (Vitamin B3) at a dosage of 500 mg to 1000 mg a day

A typical rash



Skin infected with Scabies

AGING

As skin ages, it becomes thinner and more easily damaged. Intensifying this effect is the decreasing ability of skin to heal itself as a person ages.

Among other things, skin aging is noted by a decrease in volume and elasticity. There are many internal and external causes to skin aging. For example: Aging skin receives less blood flow and lower glandular activity.

Cortisol causes degradation of collagen[9], accelerating skin aging.[10]

Photoaging

Photoaging has two main concerns: an increased risk for skin cancer and the appearance of damaged skin. In younger skin, sun damage will heal faster since the cells in the epidermis have a faster turnover rate, while in the older population the skin becomes thinner and the epidermis turnover rate for cell repair is lower which may result in the dermis layer being damaged.[11]

Disease

For more details on this topic, see skin disease.

Dermatology is the branch of medicine that deals with conditions of the skin.[2]

Two abnormal conditions of skin pigmentation:-

Leucoderma: skin pigmentation is lost(melanin) from smaller or larger patches at different regions of the body:exact cause of this disease is not yet known

Albinism: complete loss of pigmentation of skin all over the body including hair, eyebrows, eye lashes, and even the iris. skin of such person appears pinkish because of the underlying blood capillaries. albinism is a recessive trait caused due to inheritance: an albino couple would get all albino children

Variability in skin tone

Individuals with ancestors from different parts of the world can have highly visible differences in skin pigmentation. Individuals with sub-Saharan African ancestry (black people) tend towards darker skin, while those of Northern European descent (white people) have paler skin. Between these extremes are individuals of Asian, South-East Asian, Native American, Middle Eastern, Polynesian and Melanesian descent.

The skin of black people has more variation in color from one part of the body to another than does the skin of other racial groups, particularly the palms of the hands and soles of the feet. Part of this is the result of the variations in the thickness of the skin on different parts of the body. The thicker the skin, the more layers of cells with melanin in them, and the darker the color.[12] In conclusion, these parts of the body have melanin-producing cells.

Skin types

Skin can be classified based on its reaction to ultraviolet radiation:[13]

Type	Definition	Description
I	Always burns, never tans	Pale, Fair, Freckles
II	Usually burns, sometimes tans	Fair
III	May burn, usually tans	Light Brown
IV	Rarely burns, always tans	Olive brown
V	Moderate constitutional pigmentation	Brown
VI	Marked constitutional pigmentation	Black

Skin flora

Main article: Skin flora

The human skin is a rich environment for microbes.[5][6] Around 1000 species of bacteria from 19 bacterial phyla have been found. Most come from only four phyla: Actinobacteria (51.8%), Firmicutes (24.4%), Proteobacteria (16.5%), and Bacteroidetes (6.3%). Propionibacteria and Staphylococci species were the main species in sebaceous areas. There are three main ecological areas: moist, dry and sebaceous. In moist places on the body Corynebacteria together with Staphylococci dominate. In dry areas, there is a mixture of species but dominated by b-Proteobacteria and Flavobacteriales. Ecologically, sebaceous areas

had greater species richness than moist and dry one. The areas with least similarity between people in species were the spaces between fingers, the spaces between toes, axillae, and umbilical cord stump. Most similarly were beside the nostril, nares (inside the nostril), and on the back.

Reflecting upon the diversity of the human skin researchers on the human skin microbiome have observed: "hairy, moist underarms lie a short distance from smooth dry forearms, but these two niches are likely as ecologically dissimilar as rainforests are to deserts."[5]

The NIH has been launched the Human Microbiome Project to characterize the human microbiota which includes that on the skin and the role of this microbiome in health and disease.[14]

Skin layers

Skin is composed of three primary layers:

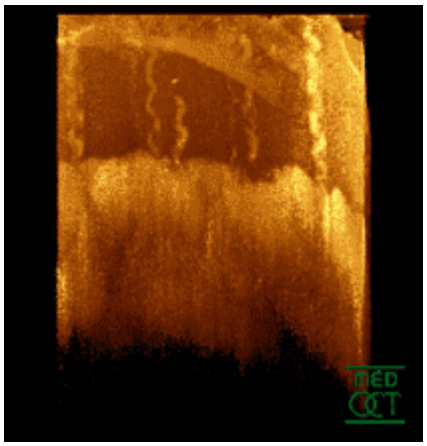
- the *epidermis*, which provides waterproofing and serves as a barrier to infection;
- the *dermis*, which serves as a location for the appendages of skin; and
- the *hypodermis (subcutaneous adipose layer)*.

Epidermis

Epidermis, "epi" coming from the Greek meaning "over" or "upon", is the outermost layer of the skin. It forms the waterproof, protective wrap over the body's surface and is made up of stratified squamous epithelium with an underlying basal lamina.

The epidermis contains no blood vessels, and cells in the deepest layers are nourished by diffusion from blood capillaries extending to the upper layers of the dermis. The main type of cells which make up the epidermis are Merkel cells, keratinocytes, with melanocytes and

Langerhans cells also present. The epidermis can be further subdivided into the following *strata* (beginning with the outermost layer): corneum, lucidum (only in palms of hands and bottoms of feet), granulosum, spinosum, basale. Cells are formed through mitosis at the basale layer. The daughter cells (see cell division) move up the strata changing shape and composition as they die due to isolation from their blood source. The cytoplasm is released and the protein keratin is inserted. They eventually reach the corneum and slough off (desquamation). This process is called *keratinization* and takes place within about 27 days. This keratinized layer of skin is responsible for keeping water in the body and keeping other harmful chemicals and pathogens out, making skin a natural barrier to infection.



[*also see: image rotating (1.1 mb)*]
Optical Coherence Tomography tomogram of fingertip, depicting stratum corneum (~500 µm thick) with stratum disjunctum on top and stratum lucidum (connection to stratum spinosum) in the middle. At the bottom superficial parts of the dermis. Sweatducts are clearly visible.

Components

The epidermis contains no blood vessels, and is nourished by diffusion from the dermis. The main type of cells which make up the epidermis are keratinocytes, melanocytes, Langerhans cells and

Merkels cells. The epidermis helps the skin to regulate body temperature.[*citation needed*]

Layers

Epidermis is divided into several layers where cells are formed through mitosis at the innermost layers. They move up the strata changing shape and composition as they differentiate and become filled with keratin. They eventually reach the top layer called *stratum corneum* and are sloughed off, or desquamated. This process is called *keratinization* and takes place within weeks. The outermost layer of the epidermis consists of 25 to 30 layers of dead cells.

Sublayers

Epidermis is divided into the following 5 sublayers or strata:

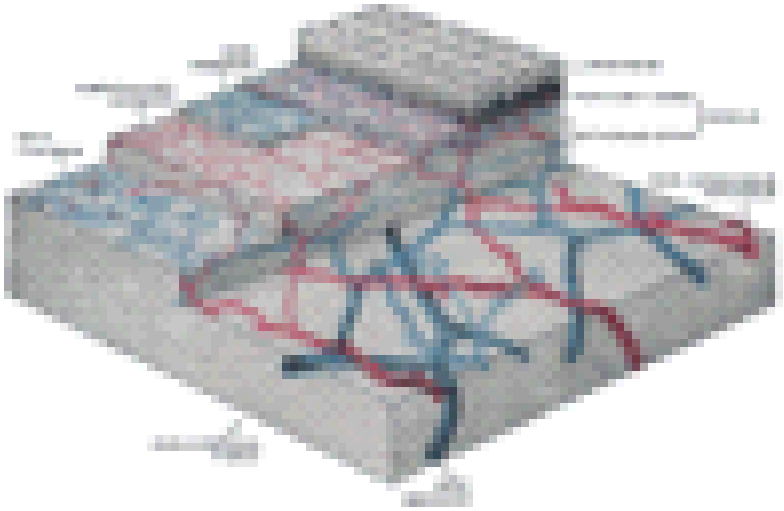
- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum germinativum (also called "stratum basale")

Mnemonics that are good for remembering the layers of the skin (using "stratum basale" instead of "stratum germinativum"):

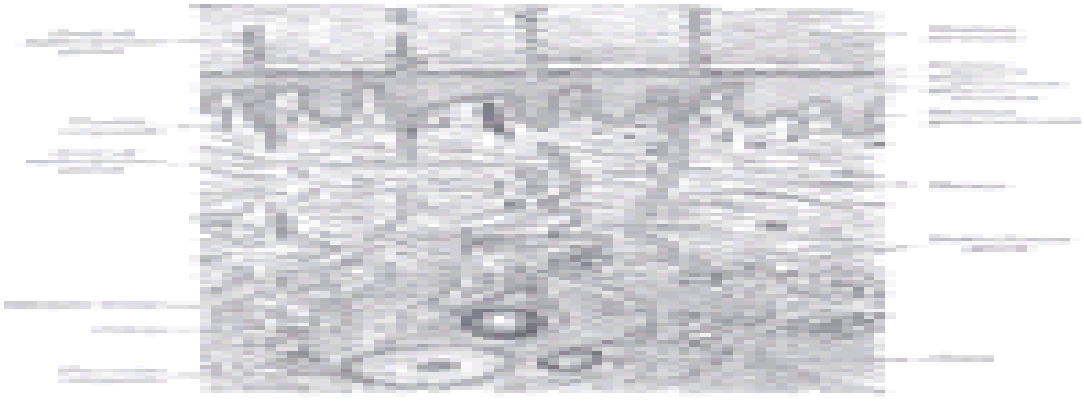
- "**C**an **L**ong **G**et **S**ome **B**urgers" (from superficial to deep)
- "**C**her **L**ikes **G**etting **S**kin **B**otoxed" (from superficial to deep)
- "**B**efore **S**igning, **G**et **L**egal **C**ounsel" (from deep to superficial)

Blood capillaries are found beneath the epidermis, and are linked to an arteriole and a venule. Arterial shunt vessels may bypass the network in ears, the nose and fingertips.

Dermis



The distribution of the bloodvessels in the skin of the sole of the foot. (Corium - TA alternate term for dermis - is labeled at upper right.)



A diagrammatic sectional view of the skin (*click on image to magnify*). (Dermis labeled at center right.)

Gray's	*subject #234 1065*
MeSH	*Dermis*
Dorlands/Elsevier	*Skin*

Dermis

The **dermis** is the layer of skin beneath the epidermis that consists of connective tissue and cushions the body from stress and strain. The dermis is tightly connected to the epidermis by a basement membrane. It also harbors many Mechanoreceptor/nerve endings that provide the sense of touch and heat. It contains the hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels and blood vessels. The blood vessels in the dermis provide nourishment and waste removal from its own cells as well as from the Stratum basale of the epidermis.

The dermis is structurally divided into two areas: a superficial area adjacent to the epidermis, called the *papillary region*, and a deep thicker area known as the *reticular region*.

Papillary region

The papillary region is composed of loose areolar connective tissue. It is named for its fingerlike projections called *papillae*, that extend toward the epidermis. The papillae provide the dermis with a "bumpy" surface that interdigitates with the epidermis, strengthening the connection between the two layers of skin.

In the palms, fingers, soles, and toes, the influence of the papillae projecting into the epidermis forms contours in the skin's surface.

These are called *friction ridges*, because they help the hand or foot to grasp by increasing friction. Friction ridges occur in patterns (*see:* fingerprint) that are genetically and epigenetically determined and are therefore unique to the individual, making it possible to use fingerprints or footprints as a means of identification.

Reticular region

The reticular region lies deep in the papillary region and is usually much thicker. It is composed of dense irregular connective tissue, and receives its name from the dense concentration of collagenous, elastic, and reticular fibers that weave throughout it. These protein fibers give the dermis its properties of strength, extensibility, and elasticity.

Also located within the reticular region are the roots of the hair, sebaceous glands, sweat glands, receptors, nails, and blood vessels.

Tattoo ink is held in the dermis. Stretch marks from pregnancy are also located in the dermis.

Hypodermis

The hypodermis is not part of the skin, and lies below the dermis. Its purpose is to attach the skin to underlying bone and muscle as well as supplying it with blood vessels and nerves. It consists of loose connective tissue and elastin. The main cell types are fibroblasts, macrophages and adipocytes (the hypodermis contains 50% of body fat). Fat serves as padding and insulation for the body.

Microorganisms like *Staphylococcus epidermidis* colonize the skin surface. The density of skin flora depends on region of the skin. The disinfected skin surface gets recolonized from bacteria residing in the deeper areas of the hair follicle, gut and urogenital openings.

Permeability

Human skin permeability is the ability of foreign substances to penetrate and diffuse through the skin. Skin naturally has a low permeability, thus protects the body from particles and foreign toxins by not allowing them to penetrate through the surface. However, technologies in nanomedicine and biology have led to developments in techniques to increase permeability of skin for various applications. The stratum corneum is the outermost layer of skin and is an effective barrier to most inorganic nanosized particles [15] [16]. Nanomedicine researchers are interested in nanoparticles that can penetrate the stratum corneum and settle in the epidermis where cells primarily reproduce. If the nanoparticles are targeted to surround cancer cells, they can be used to map where the cancer is located and deliver therapeutic agents directly to the site.

Nanoparticles

Nanoparticles 40nm in diameter and smaller have been successful in penetrating the skin [17] [18] [19]. Research confirms that nanoparticles larger than 40nm do not penetrate the skin past the stratum corneum [17]. Most particles that do penetrate will diffuse through skin cells, but some will travel down hair follicles and reach the dermis layer.

The permeability of skin relative to different shapes of nanoparticles has also been studied. Research has shown that spherical particles have a better ability to penetrate the skin better than oblong (ellipsoidal) particles because spheres are symmetric in all three spacial dimensions [19]. One study compared the two shapes and recorded data that showed spherical particles located deep in the epidermis and dermis whereas ellipsoidal particles were mainly found in the stratum corneum and epidermal layers [19]. Nanorods are used in experiments because of their unique fluorescent properties but have shown mediocre penetration.

Nanoparticles of different materials have shown skin's permeability limitations. In many experiments, gold nanoparticles 40nm in diameter or smaller are used and have shown to penetrate to the epidermis. Titanium oxide (TiO2), zinc oxide (ZnO), and silver nanoparticles are ineffective in penetrating the skin past the stratum corneum [16] [20]. Cadmium selenide (CdSe) quantum dots have proven to penetrate very effectively when they have certain properties. Because CdSe is toxic to living organisms, the particle must be covered in a surface group. An experiment comparing the permeability of quantum dots coated in polyethylene glycol (PEG), PEG-amine, and carboxylic acid concluded the PEG and PEG-amine surface groups allowed for the greatest penetration of particles. The carboxylic acid coated particles did not penetrate past the stratum corneum .

Increasing permeability

Scientists believed that the skin was an effective barrier to all inorganic particles and alterations to the skin using mechanical stressors causing damage to the skin would be the only way to increase permeability. However, simpler and more effective methods have been developed. For example, ultraviolet radiation (UVR) has been used to slightly damage the surface of skin, causing a time-dependent defect allowing easier penetration of nanoparticles The UVR's high energy causes a restructuring of cells, weakening the boundary between the stratum corneum and the epidermal layer . The damage of the skin is typically measured by the transepidermal water loss (TEWL), though it may take 3-5 days for the TEWL to reach its peak value. When the TEWL reaches its highest value, the maximum density of nanoparticles is able to permeate the skin. Studies confirm that UVR damaged skin significantly increases the permeability [22] [21]. The effects of increased permeability after UVR exposure can lead to an increase in the number of particles that permeate the skin. However, the specific permeability of skin after

UVR exposure relative to particles of different sizes and materials has not been determined [22].

Other skin damaging methods used to increase nanoparticle penetration include tape stripping, skin abrasion, and chemical enhancement. Tape stripping is the process in which tape is applied to skin then lifted to remove the top layer of skin. Skin abrasion is done by shaving the top 5-10 micrometers off the surface of the skin. Chemical enhancement is the process in which chemicals such as polyvinylpyrrolidone (PVP), dimethyl sulfoxide (DMSO), and oleic acid are applied to the surface of the skin to increase permeability [23] [24].

Electroporation is the application of short pulses of electric fields on skin and has proven to increase skin permeability. The pulses are high voltage and on the order of milliseconds when applied. Charged molecules penetrate the skin more frequently than neutral molecules after the skin has been exposed to electric field pulses. Results have shown molecules on the order of 100 micrometers to easily permeate electroporated skin [24].

Applications

A large area of interest in nanomedicine is the transdermal patch because of the possibility of a painless application of therapeutic agents with very few side effects. Transdermal patches have been limited to administer a small number of drugs, such as nicotine, because of the limitations in permeability of the skin. Development of techniques that increase skin permeability has led to more drugs that can be applied via transdermal patches and more options for patients [24].

Increasing the permeability of skin allows nanoparticles to penetrate and target cancer cells. Nanoparticles along with multi-modal imaging techniques have been used as a way to diagnose cancer non-invasively. Skin with high permeability allowed quantum dots with an antibody attached to the surface for active targeting to

successfully penetrate and identify cancerous tumors in mice. Tumor targeting is beneficial because the particles can be excited using fluorescence microscopy and emit light energy and heat that will destroy cancer cells [25].

Importance and Differences of Sunblock and Sunscreen

Although some believe that sunblock and sunscreen are both the same, they are not. Although they have similar properties and are both important in caring of the skin.

Sunblock Sunblock is opaque and is stronger than sunscreen since it is able to block majority of the UVA/UVB rays and radiation from the sun, thus not having to be reapplied several times a day. Titanium Dioxide and Zinc Oxide are two of the important ingredients in sunblock.

Sunscreen Sunscreen is more transparent once applied to the skin and also has the ability to protect against UVA/UVB rays as well. Although the sunscreen's ingredients have the ability to break down at a faster rate once exposed to sunlight, and some of the radiation is able to penetrate to the skin. In order for sunscreen to be more effective you'll have to consistently reapply and use a higher spf.

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