Evolution of the human skin

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This review looks briefly at the evolution of human skin. Our skin is unique, employing a very different design and construction compared to that of all other mammals, including our closest primate 'relatives'. The differences between between human skin and that of any other creature, primate or otherwise, are so large that no viable 'just-so' story has yet been proposed to account for this.

The origin of body coverings, specifically scales, feathers, skin, and hair, has stymied evolutionists since Darwin. Most mammals, birds, and reptiles are readily recognized by their hairs, feathers, and scales, respectively. However, the lack of fossil intermediate forms between scales and hairs and substantial differences in their morphogenesis and protein composition have fuelled the controversy pertaining to their potential common ancestry for decades.[1]

Skin, one of the most visible parts of the human body, covers us from head to toe. It is our largest organ and, in many ways, a very unique one. It is also considerably complex, as skin diagrams effectively illustrate (see figures 1 and 2). Skin in general (not just that of humans) has many functions, including sensing of danger, protection from pathogens, regulation of internal temperature, maintaining fluid balance, regulating pH, and presenting visual sexual displays.[2]

For humans and the higher primates, it has a further important function, namely that of bonding between individuals. Research has documented that, without being touched and cuddled by their mothers, both human and chimp babies become very apathetic and fail to progress emotionally.[3]

According to Gallo's observation, "human skin has many functions that are in common with other animals but also is unique to our species."[2] This causes a problem for research on the development of skin-related pharmaceuticals. Animals can provide useful models in the first stages of such drug development, but human and animal skin are so different that the results have often been hard to translate to humans, leading to many clinical trial failures. Since cultured human skin tissue, also used on burns victims, has become available, it can be used to perform safety and efficacy studies of cosmetics, drugs, and medical devices, so animal skin models are no longer used to anywhere near the same extent to generate valuable data. Real human skin models will always yield better and more reliable results that are easy to translate into clinical trials.[4]

Human skin evolution?

Evolutionists concede that "Since human skin is very different from that of all other known mammals, its evolution has very likely been unique." But aside from speculative 'just-so' stories, no evidence exists for this skin evolution.[5] The evolutionary origin of the hair on skin is also unknown.[6]

The principal point of "The uniqueness of human skin is that it has lost its hair cover but has remained, nonetheless, hairy; the only hair it has lost are the vibrissae" (the long hairs used on the body of virtually all mammals for sensory input). The hairs over most of the human body surface are very fine and exist at a density so low that human skin *appears* to be naked.[7,5]

The claim that humans evolved from a fur-covered ape-like ancestor and then lost their thick hair presents an evolutionary problem.[8] Those accepting this belief do so without empirical evidence. Jablonski writes:

> "Explanations for the evolution of human hairlessness have been many, varied, and often highly creative. The most cogent explanations are based on the importance of a functionally naked skin in maintaining body temperature in hot environments."[9]

A related theory of why humans supposedly lost their fur hair was proposed by Wheeler, who argued that

> "… the lower direct solar radiation fluxes incident upon a bipedal mammal made possible the reduction of body hair, and explains the absence of this characteristic among savannah quadrupeds. The major thermoregulatory advantages conferred by bipedality, to an animal extremely sensitive to hyperthermia, could also account for the initial evolution of this unusual form of locomotion."[10]

Another somewhat different theory of why humans lost their body hair is that "human hairlessness evolved late in human evolution as a result of the adoption of clothing and the need to reduce the load of external parasites."[11]

The existence of many different theories is a result of the fact that the loss of body hair is not explained by direct empirical evidence, allowing speculation to flourish. Nonetheless, gradual loss of hair is assumed in the artists' drawings showing the evolution of ape-like creatures into modern man. Images of early *Homo* are usually shown to be very hairy. The earlier in evolution they were claimed to exist, the more hair that was depicted on their bodies. Not only why the hair in our putative ancestors was lost is unknown, but the origin of hair is also unknown:

> "The phylogenetic origin of hair is conjectural. A protothrix hypothesis proposed by Elias and Bodner suggests that hairs may be modifications of hairlike bristles that emerge from certain sensory pits in the skin of lizards."[6]

Human skin

All animal life has a protective covering, but the contrast between the skin of all animals and that of humans puts human skin in a class by itself. The number of human sebaceous glands per unit area is much larger than in all other primates, and the individual glands in humans are much larger than those in chimps, for example. On the downside, but still demonstrating uniqueness, only humans suffer from the sebaceous gland problem known as acne vulgaris, the dread of adolescents worldwide.[12]

Another difference is that while "skin pigmentation is a human adaptation to exposure to the hazards of sunlight, cutaneous pigmentation in many other mammals has little relevance to sunlight."[13] In apes, the fur itself shields against sunlight; shave a chimpanzee, and the skin underneath is 'white'. This is ironic in light of the common racist belief that dark-skinned people are 'closer to the ape' than others. Even many evolutionists now concede that this notion has been greatly boosted by the iconic evolutionary images of human evolution, most of which show skin colour progressively lightening as the image progresses from ape to human.[14]

Yet another

> "… distinctive particularity of human skin is a blood supply greatly in excess of that needed for its metabolism. The human cutaneous blood-vascular supply performs major functions in the control of body temperature and blood pressure. In no other animal is skin so abundantly vascularized, not even in the great apes [Gorilla, Chimpanzee, Orangutan, Bonobo]. Actually, the vascularity of the skin of most non-human primates is essentially similar to that of other furred mammals."[15]

Evolutionary expectations unmet

On the basis of evolution, one might expect human skin to be most similar to that of our supposedly closest relative, the chimp, and then the rest of the apes, and to monkeys. Ironically, though, human skin is more similar to pig skin than to any of these.[16] Comparisons reveal "that from a skin structure perspective pigs [not chimps] are the closest to humans, even though here there are some noticeable differences."[5] The similarity of human skin and pig skin includes its anatomical, physiological, biochemical, and immunological properties.[17] Debeer *et al.* found that antibodies displayed *equivalent immunoreactivity* to healthy human skin as to healthy porcine skin.

Furthermore, pig skin shares similar epidermal/dermal thickness ratios to human skin, plus similar hair follicle and

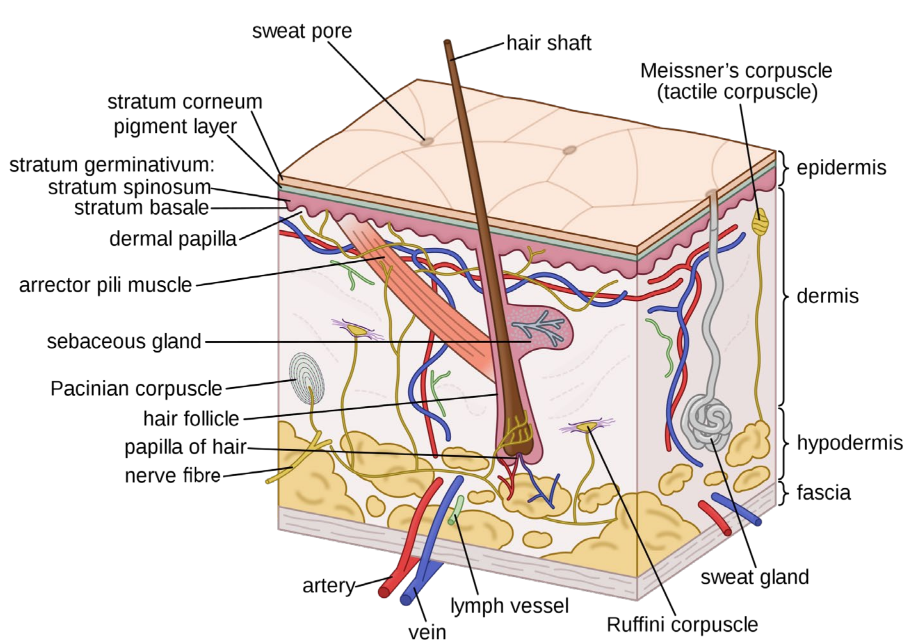

Figure 1. Human skin showing the three layers and the gland system

blood vessel patterns, biochemistry, dermal collagen, and elastin content.

Pig and human skin also display similar physical responses to growth factors.[18] For research on skin reactions, such as reactions to cosmetics, pig skin is often preferred if human samples are unavailable.[19]

Anatomy of the skin

The three main skin layers of humans are the outer layer, the avascularized (i.e. without blood vessels) *epidermis*, the middle layer, *the dermis*, and the bottom layer, *the subcutaneous fat,* or *hypodermis* (see figure 1). The outer layer is the main skin barrier which gives skin its colour and contains specially designed immune cells. Cells called keratinocytes divide at the lowest levels of the epidermis. These new cells gradually push to the top layer where they are weathered by normal living activities. The cells in the top dead layer, the *stratum corneum*, eventually break away from the epidermis and fall off, making room for the newer cells growing below.

The average adult requires about a month for new cells to move from the bottom to the top layer. Consequently, in a month a completely new epidermis is produced. The healthy adult has 75,000 skin cells per cm^2 and every hour sheds over 2,500 of these, meaning we each shed some 200 million skin cells hourly.[20] These become the main component of house dust.

Human skin thickness varies, depending on age and the location on the body. The skin under and around the eyelids is the thinnest (0.5 mm thick) and thus is one of the first areas to show signs of aging as wrinkles. Conversely, the thickest skin on the body is on the palms of the hands and the soles of the feet (4 mm thick).[21] The skin thins with age, beginning at age 35.

On average the human epidermis is much thicker than that of furred mammals, and has a conspicuous, well-structured second layer.[6] The second layer is constituted mostly of keratinocytes connected by collagen and elastin fibres (see figure 2). All mammals are covered with hair, which in non-human mammals provides a significant level of protection. Human skin, by contrast, must be much thicker on average, and the outside layer, the stratum corneum, is highly keratinized to aid its role in protection.

The dermis is divided into a papillary layer (*pars papillaris*) and a reticular layer (*pars reticularis* in figure 2). It contains glands that manufacture a mixture of water and chemicals, collectively called *sweat*. The mixture travels through small tubes and exits from the small pores located on over 99% of the human body (see figures 1 and 2). Evaporation of sweat cools the body. Sweat glands also excrete small amounts of urea, a byproduct of protein metabolism.

Another set of glands located in the dermis are the sebaceous glands whose secretions keep the skin soft, smooth, and waterproof. Human sebum is a "complex mixture of lipids [which] acts to reduce water loss from the surface of the skin and executes a thermoregulatory function. In addition, sebum has anti-microbial activity and is a source of antioxidants, including vitamin E."[22]

In addition, the human dermal layer contains a complex somatosensory system that perceives touch, pressure, temperature, pain and proprioception (the position of parts of the body). The receptors include tactile or Meissner's corpuscles and Pacinian corpuscles. These tactile mechanoreceptors are found in the glabrous (hairless) skin of primates, including fingertips. Meissner's corpuscles were found in higher densities in macaques and humans compared with bonobos and our closest ancestor, the chimpanzees.[23] Bulbous or Ruffini corpuscles are spindle-shaped receptors sensitive to skin stretch. They contribute to precision finger movement and are more common in humans. Their larger number in humans is one factor that accounts for the superior human skills, such as penmanship and the ability to play musical instruments such as the guitar and piano.[24]

The inner of the three layers is the fatty sub-dermal layer, the *hypodermis*, which is the main insulation component that helps regulate the body's requirement for a 'goldilocks' temperature. Our body needs to maintain a 'not too hot and not too cold, but just right' temperature, which for adults is between 36.1°C (97°F) and 37.2°C (99°F). The fat also serves as padding to help protect the bones and muscles from bumps and falls. This layer also contains the connective tissue that attaches the skin to the muscles and bones. Of interest is the fact that humans and pigs have firmly attached skins compared to most other small to medium-size mammals where the attachment is much looser.

Thermoregulation

The human skin was designed to be a major means of thermoregulation. Critical to this function is firstly the skin's active vasodilation control. This allows higher levels of blood flow to the skin surface as required to cool the blood by dilating the small blood vessels. Crucial for this is also the large skin surface area, which is about 18,000 cm^2 (19 sq. ft) for adult men and 16,000 cm^2 (17 sq. ft) for adult women. It allows the heat to be dissipated quickly. Vasoconstriction is used to *reduce* the blood flow to the skin surface to preserve body heat. Adult human skin has about 18 km (11 miles) of blood vessels to achieve these goals. Other temperature regulation systems include sweating. Humans have from 1.5 to 4 million *eccrine* sweat glands, unique to humans both in terms of number and location over the entire body. The *apocrine* sweat glands are located mostly in the axilla, anogenital region, areola and nipple of the female breast, and the external auditory canal.[25] The eccrine secretions are highly hypotonic, containing fewer dissolved particles such as sodium chloride and other electrolytes compared to normal cells and blood. Because of their higher relative water content, they are very effective in cooling.

To cool the body, adult human skin can release as much as 500 ml of water per day at rest in a cool environment, and up to10 litres per day during exercise in the heat.[26]

According to evolutionists, thermal regulation via sweating "was a key innovation in human evolution that allowed maintenance of homeostasis (including constant brain temperature) during sustained physical activity in hot environments."[27] Furthermore, effective "Dissipation of heat is the function that most conspicuously distinguishes human skin from that of all other animals."[28] Of note is that abundant sweating to cool the body "is particular to man: other primates sweat much less".[29]

Another difference between humans and non-human primates is that humans have a comparatively large "number of nerve endings around each hair follicle, regardless of size and location."[30] This sensory information helps to trigger the production of heat, for example, by mechanisms including shivering (special muscle contractions that produce heat). Other mechanisms that help to optimize the balance between thermoregulation and cardiovascular strain in humans include a largely naked skin, upright posture, and bipedal locomotion, which results in a smaller area exposed to solar radiation, and more air flow to help cool the body skin. These, coupled with active vasodilation in response to heat load and, consequently, increased skin blood flow near the skin surface, combine to give humans a uniquely effective cooling system. Last, as already noted, humans have a large skin surface area compared to almost all primates except a few of the great apes.[31]

Evolution

One major evolutionary scenario is that "hairs, feathers, and scales of extant species are homologous structures inherited, with modification, from their shared reptilian ancestor's skin appendages".[1] And the human hair/skin system is believed to have evolved from the last common ancestor of the human and chimp lineage. The problem is that both ideas lack fossil evidence.

The common reason evolutionists provide to explain the lack of fossil evidence to bridge the chasm between scales and skin is that soft tissue is usually not preserved in the fossil record. However, some keratinous structures, including claws, beaks, and hair, are better preserved in the fossil record under certain conditions than soft tissue.[32] The hair on a fossil mammal discovered in Spain was dated at 125 million years old, and is considered the oldest example of preserved mammalian hair structures.[33] Because hair preserves better in the fossil record than skin, enough relevant fossil evidence exists to warrant a review by one research team of the idea that hair evolved from scales. They concluded that "The fossil record lacks any evidence of intermediate forms (hence, of homology) between scales and hairs."[33]

Further, this justification for the lack of evolutionary evidence ignores the fact that thousands of so-called 'living

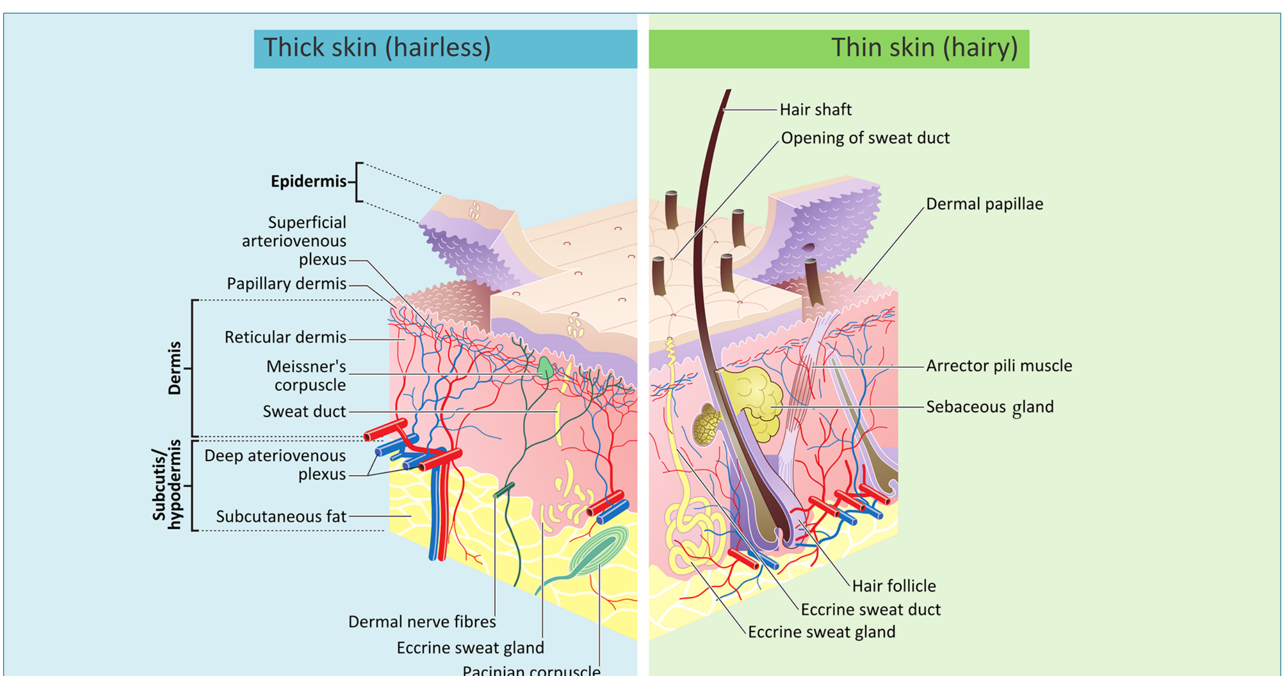

Figure 2. Comparisons of smooth and hairy skin

fossils' exist that are believed to be anatomically very little changed from their claimed multiple-millions-of-years-old designs.[34] At least some of these 'living fossils' would be expected to display evidence of a less-evolved skin organ—if it ever existed—that would bridge these two very different integumentary systems. But none of them do so.

Professor Jablonski, the leading researcher on the evolution of the human hair-skin system, concluded:

> "Reconstruction of the evolution of human [hair/] skin relies on evidence provided by comparative anatomy and physiology, as well as study of the evolution of the genes and gene complexes that determine the function and pigmentation of skin. Using basic principles of historical morphology, one can reconstruct the major steps in the evolution of human skin by utilizing a well-established phylogeny to examine historical transformations of structure and function (Jablonski & Chaplin 2000). This method leads to the reconstruction of the probable appearance of the skin in the last common ancestor of the human and chimpanzee lineages as being lightly pigmented and covered with dark hair, like most catarrhine primates today (Jablonski & Chaplin 2000)."[9]

The problem with this claim is that by their nature, such 'reconstructions' are not based on any direct evidence, but on the assumption that there really was such a 'last common ancestor' of humans and chimps. Circularity is inevitable.

Evolutionists admit that the gap between human skin and that of primates is enormous, writing that "The evolution of mostly naked skin in the human lineage heralded major changes in the biological and social functions of skin."[35] These changes include the enhanced barrier of the thick epidermis for naked skin lacking a protective fur covering "to repel water, resist abrasion, and combat harmful microbes and ectoparasites. Naked skin also changed the nature of human social interactions, both at a distance and at close quarters …".[35] Evolutionists lack specifics, however, confessing that "many of the details of exactly what happened when are not yet known."[35]

One theorized result of hair loss was that raising hackles became no longer possible, meaning that the animal could no longer cause hair on the back of its neck to stick straight up to convey aggression or other strong emotions.[36] Consequently, displays of fear, anger, aggression, and excitement required enhanced facial expressions:

> "With the loss of most body hair, grooming became more focused on scalp hair and the face, and huddling for thermoregulation probably became more important. Erogenous zones and increased sensitivity of facial skin promoted infant-mother and pair bonding. Naked integument almost certainly became a canvas for social expression early in the history of *Homo sapiens*, if not earlier, and the communication functions of temporarily and permanently decorated skin have only increased over the millennia. As visually oriented primates, humans attend closely to the appearance of skin and make assessments of age, health, and group membership based on it."[35]

Evolutionists concede that skin is "generally not preserved in the fossil record and so details of its evolution can be gained only from comparative anatomical and physiological evidence."[37] Nonetheless, "continued study of the evolution of human skin and skin color is important, not only to our realization of a more complete picture of human evolution, but also it is important because the skin is involved in so many aspects of human well-being."[38]

Conclusion

A chasm exists between the integumentary system of humans and its potential evolutionary precursors. A significant difference would have had to exist between modern human skin and the commonly assumed animal-human skin of the alleged common ancestor of humans and chimpanzees. No valid empirical evidence exists to bridge this gap. As Montagna admits,

> "In searching for evolutionary clues to learn more about such disparate organs as the skin of humans and non-human primates, one is repeatedly forced to grasp at straws. But if one is willing to temper fancy with what facts are at hand, the results make for an amusing, if not entirely convincing, revealing story."[5]

Such a story is convincing only if one is already fully convinced of human evolution. The origin of hair itself is a topic that would require a separate paper, but suffice it to say that

> "Hair origin from synapsid scales is speculative and requires extensive modifications of the morphogenetic process transforming lens-shaped dermis of scales into small dermal papillae in hair. Hair evolution from glands is hypothetical but is supported from studies on the signaling control of hair vs glandular morphogenesis."[39]

As Montagna admits, "Neither this nor the other essays in this volume is[sic] free [of] speculation and assumption. But this is the best that can be done in the absence of hard facts."[40] He says: "This situation has not changed—very little has been added to our knowledge of the comparative cutaneous biology of primate skin during the last five years."[5] And also, "Since human skin is very different from that of all other known mammals, its evolution has very likely been unique."[5]

No evidence for the evolution of skin, and the hair that covers it, exists; rather the clear evidence of its functional complexity and superb design, and the inherent implausibility of all evolutionary scenarios to date, are strongly consistent with an *ex nihilo* creation.

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