It's all in your colour

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Human skin comes in various shades and hues. It is a different matter that historically this evolutionary endowment has been the center of intense cultural tension. In fact this tension and the extreme controversy that accompanies the issue of skin colour has forced most of the scientific community to shy away from venturing into research on the topic. For more than ten years though, some anthropologists and biologists have been revisiting the delicate issue, to analyse the factors that determine the colour of our skin. It has proved to be an extremely interesting topic; one that is affected by our cultural behaviour and one that in turn decides how we behave socially.

For those who believe in the theory of evolution, it is an accepted fact that human beings evolved from apes. Our deep similarity to them has been a subject of much scientific interest over the years. Yet, one basic difference is the fact that human beings lack the dense covering of hair that apes possess. In fact, most mammals are endowed with significant amounts of hair or fur. Human skin is practically bare in comparison, and the reason for this lies in the story of our evolution.

Once upon a time, human beings looked a lot more like their immediate ancestors, the chimpanzees. In fact, around 3.2 million years ago, human activity closely resembled theirs, which included foraging in the African savanna. However, around 1.6 million years ago, human beings changed rather dramatically. They became bipeds, which allowed them to forage over much larger distances (which meant access to a more varied diet than before). However, the large distances of travelling also meant that their bodies got a lot hotter as they moved about. The increase in body temperature as especially detrimental to the human brain. In order to combat this, they shed a large amount of hair from their bodies and developed an increase in the number of sweat glands in their skin. Once this was accomplished though, they had to deal with another serious problem. Human skin was now completely defenseless against the extensive exposure to sunlight and the consequent effects of Ultra Violet (UV) radiation. It was at this stage that human beings developed the ability to synthesize pigments in their skin, in order to counter the effects of UV rays[1].

Human skin is coloured because it contains the pigment melanin. Melanin, a large organic molecule, is found in our skin, in our hair and in the retina of the eye. During the course of evolution, its molecular structure was modified in order to develop a very active 'trap' that could spread the energy of the absorbed photons in a non-damaging way, turning it into kinetic energy. Moreover, melanin is a scavenger, i.e. a 'sweeper' of free radicals, which is very active in neutralizing the excited molecules that are produced because of the absorption of radiation. Many experimental studies indicate that the increase in ocular pigmentation reduces the risk of the damage caused by the visible radiation[2]. James E. Cleaver[1] of the University of California, San Francisco has shown that people afflicted with the disease xeroderma pigmentosum, in which melanocytes are destroyed, suffer from significantly higher than normal rates of squamous and basal carcinomas. These diseases are usually quite easily treated[1]. Exposure to UV radiation can however, have terrible effects, the most notorious being malignant melanoma. The direct correlation between skin cancer and exposure to UV radiation is what bolstered the theory that human beings developed the ability to synthesize melanin in order to combat skin cancer.

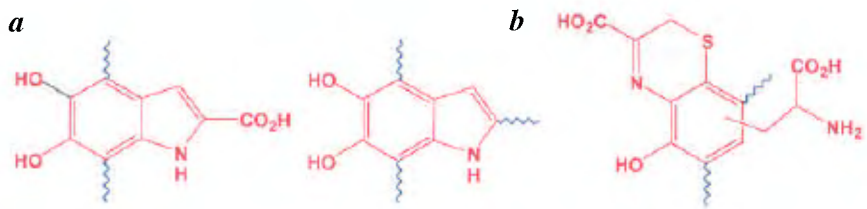

Figure 1. Two types of melanin, eumelanin (***a***) and pheomelanin (***b***). Curly blue lines indicate the sites of attachment to the extended polymer and possibly to proteins. See (http://omlc.ogi.edu/spectra/melanin/)[4] for further details.

Melanocytes are the skin cells that produce pigment, whereas melanosomes are the pigment-containing organelles in these cells. Two types of melanin exist: the cysteine-rich red-yellow form, known as pheomelanin and the less soluble black form, known as eumelanin (Figure 1). Skin colour depends more on the total amount of melanin produced in the body, rather than the ratio of the two types of melanin produced. For the same region of the body, light skinned people have the same number of melanocytes and a different number of melanosomes. Darker people have larger melanosomes than light skinned people do, and these are greater in number and contain more pigment[3].

One of the basic tenets of the theory of evolution is the idea that survival is essentially about successful procreation of one's own species. Skin cancer could have been detrimental to the survival of the human beings, save for one crucial factor. It affects humans later in their lives, and by this time, they have usually completed the act of reproduction. A disease can have a serious impact on the survival of a species only when it affects the capacity to reproduce. This means that skin cancer, though detrimental to human well beings, is not a direct reason for human beings to evolve the ability to synthesize pigments.

In a recent review article in *Nature*[5], Jared Diamond explains how the common generalization about the distribution of differently coloured people is based on latitudinal distribution. Most people assume that darker people live near the equator and fairer people live near the poles, i.e. the farther people move from the equator, the lighter their skin becomes. However, this generalization is a rather sweeping one to make, and there are quite a few exceptions to it. The method by which skin colour has been understood over the years has undergone a significant change. Skin colour was formerly tabulated in descriptive terms, but now it is categorized by skin reflectance spectrophotometry. This has allowed the quantitative tabulation of skin colour of human beings across the globe, according to factors such as the intensity and amount of UV radiation in a given area. As a result, the generalization made above, necessitated a reevaluation.

In 2000, Nina Jablonski and George Chaplin published a paper narrating the story of skin colour in human beings. They discussed how and why human beings developed skin colour. In another article, in the *Scientific American*, titled 'skin deep', they stated how in 1991, Jablonksi came across a paper, which was later identified as a critical find. The paper, published in 1978 by Richard F. Branda and John W. Eaton, elucidated how light skinned people who had been exposed to simulated strong sunlight had abnormally low levels of the essential B vitamin folate in their blood. Subjecting human blood serum to identical conditions also resulted in a 50% loss of its folate content within one hour. Meanwhile, Fiona J. Stanley and Carol Bower were researching birth defects at the University of Western Australia. They showed that low folate levels in mothers resulted in a neural birth defect, called spina bifida, in which the spinal cord of the individual is incompletely covered by the vertebral column. The spinal vertebrae do not close around the spinal cord completely, which results in complications, such as paralysis, and hydrocephalus. Now there are worldwide efforts being made to educate women about the inclusion of folate as an important nutrient in their diets. In addition to preventing such neural tube birth defects in children, folate plays another crucial role in reproduction. It is essential for the synthesis of DNA in dividing cells or anything that requires rapid proliferation, such as spermatogenesis in males. Folate, as it turned out, was the missing piece of the puzzle. Since it was critical to human reproduction, human skin developed a natural shield to preserve it[1].

However, sunlight is not entirely a detrimental agent. In fact, it is an essential factor in the production of vitamin D in human skin. Vitamin D is necessary for calcium metabolism in the human body. This makes it indispensable to the development and maintenance of our skeletal, muscular, and nervous systems. Deficiency of vitamin D in children, results in rickets, and in adults, it causes osteomalacia and osteoporosis. Women always have greater requirements for calcium than men do, since it plays an important role during pregnancy and lactation[6]. The risk of osteoporosis is especially high in postmenopausal women. Ironically, it appears that hypovitaminosis D is very common in some of the most sunny countries in the world – the cause of this problem is the cultural dictate that women be heavily veiled when outside in public[7].

Vitamin D production can be affected by cultural differences between the two sexes. At the same time, it affects the cultural behaviour of males and females. According to Jablonski and Chaplin, sexual dimorphism in skin pigmentation is primarily due to natural selection. Their analysis led to the realization that women across populations, tend to have lighter skin than men. Since women need greater amounts of calcium during pregnancy and lactation, their lighter skin enables greater penetration of UVB radiation and hence, induces the synthesis of more vitamin D[1]. Also, darker pigmentation may have been the object of natural selection in males because of the importance of maintaining optimal levels of folate in order to safeguard sperm production, a process dependent on folate for DNA synthesis[6].

Skin colour is affected both by one's environment and by one's ancestry. The overall effect of heritable factors is quite high, as long as exposure to sunlight is controlled. Skin reflectance is additive. This means that an F_1 hybrid (first generation offspring) of a couple having different skin colour, will inherit a skin colour that is an intermediate of that of the parents[8]. The exceptions to this are mainly Mendelian forms of albinism[3]. In this context, the study of the global distribution of skin colour is extremely interesting. The skin colour of indigenous people is representative of the evolutionary process that their skin has undergone. Thus, the skin colour of the indigenous inhabitants of Africa has had the longest time to adapt because anatomically modern humans first evolved there. As people began to migrate from one place to another, across the oceans and continents, their skin had to adapt to the change in the intensity and the amount of UV radiation to which they were exposed. They also had to adapt to the dietary availability of vitamin D. People who were originally very dark, and later moved to places which received comparatively less sunlight, had to supplement their vitamin D requirements in their diet. For example, there have been instances where dark skinned Indian suffer from low levels of vitamin D in the United Kingdom, where the weather is predominantly cloudy[9]. On the other hand, the problem was reversed for people who were light skinned and did not have adequate protection from UV radiation.

Skin colour is a subject that is always accompanied by deep cultural prejudice. Unlike many other species, human beings are differentiated from each other by the colour of their skin. This variation has been the cause of a lot of discrimination. Yet, it is this genetic and adaptive trait that has taken us this far on the evolutionary chart. Little do most of us realize that had this variation not existed, human beings would never have survived in so many places across the planet. It is one of our most valuable evolutionary traits and although we are taught to conform to certain ideals of skin colour, this is one variation, importance of which we simply cannot afford to undermine.

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