Evolution of Skin Pigmentation in Homo sapiens

By: Ana Cuentas

The early genus Homo were hairy individuals that were not able to regulate internal body temperature. It is believed that our skin was covered with dark hair and was lightly skin pigmented. Over time as we became more bipedal and more active, we developed the ability to cool down by evolving the ability to sweat. Thermoregulation was not the only method we used to cool off. Figure 1: The loss of a large amount of body hair also facilitated our body to cool down. As body hair decreased and became thinner, our skin also had more significant amounts of pigmentation.

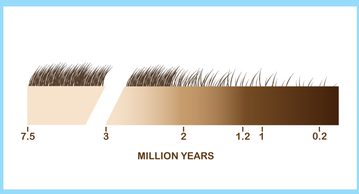

Figure 1

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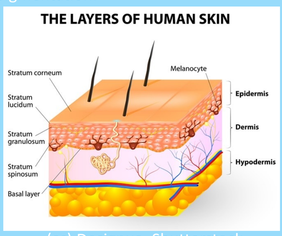

Figure 2

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How is pigmentation produced?

Figure 2: Different wavelengths of light are absorbed and reflected through melanin, a pigment located on top of our skin layer. Melanocytes produce melanosomes which are responsible for the production of melanin. Our genetics is what is responsible for determining the type of melanin that is produced by our body. Melanin is responsible for absorbing the light that the sun gives off, also known as ultraviolet radiation.

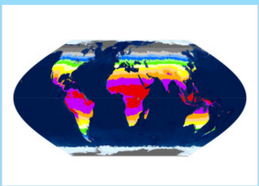

Figure 3

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The map displayed on Figure 3 shows the annual average of Ultraviolet radiation. UV exposure varies in different parts of the world: the hot pink and red areas near the equator with higher UVR. The cooler-toned areas have less UVR. Ultraviolet radiation is higher the closest it is to the equator, whereas Outside tropical regions near the Mediterranean, there is a moderate range of ultraviolet radiation. The north side has the lowest amount of UVR. This is where many individuals moved toward thousands of years ago.

UVC falls to the earth, most of which is absorbed by the atmosphere. However, some UVB (in charge of Vitamin D production) continues to pass through as UVA is presented as visible light. This is responsible for UV radiation. UV radiation is responsible for breaking up the bonds of DNA. Melanin plays a role in protecting the skin by forming supranuclear caps to protect DNA from radiation damage. Many of our ancestors that lived closer to the equator prevented DNA damage through darker skin pigmentation, which increased the amount of melanin. These individuals who best adapted to the hot equatorial sun with darker skin then live longer and reproduce and pass on that trait to their offspring.

Why is UVB and UVR important?

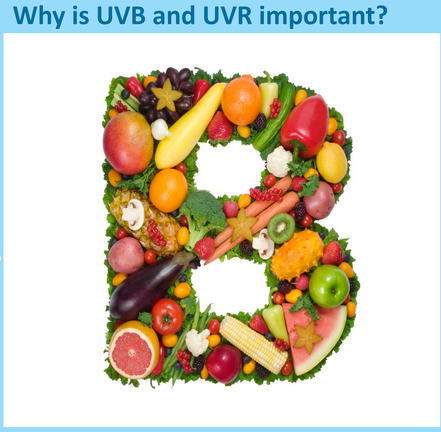

Figure 4

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UVR plays a role in vitamin B, which also plays a role in an individual's fitness. UVR breaks down the B vitamin, also known as folate. This is responsible for DNA production, DNA regulation, and cell division. In the long run, deficiency plays a role in neural tube defects. Folate is a crucial vitamin that can be found in foods. Figure 4: Folate is found in whole grains, greens, and citrus foods. Mothers provide folate to their embryos during development. If there is a lack of folate, the embryo's neural tube will not fuse properly, which is called Spina bifida

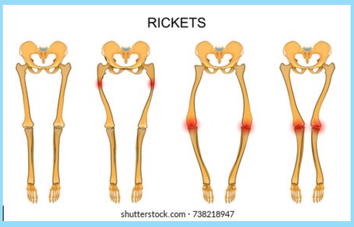

Figure 5

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UVB is in charge of Vitamin D production in the skin. Having too much or too little is crucial to one's health because it plays a role in almost every organ in the human body. If there is little UVB, there is little Vitamin D. Individuals who are lightly pigmented can synthesize vitamin B faster. On the other hand, Individuals with darker skin are not always at an advantage. Although they have a natural like sunscreen, eumelanin to protect them from skin cancer, they cannot synthesize vitamin D due to its protection provided by eumelanin and are at higher risk for health conditions arising from vitamin D deficiency. Vitamin D plays many essential roles. Two of the most important are the absorption of calcium and phosphorus in diets. Figure 5: If not enough is produced, nutritional rickets may arise in children, a disease that causes the weakening of bones. This is often found in darkly pigmented children that cannot produce enough vitamin D. In the long run, the female pelvis becomes deformed and is more likely to cause complications in childbirth, which may result in lower reproductive success.

The primary force for the increase in pigmentation in the skin is the protection it provides for folate metabolism, increasing reproductive success. A selective sweep eliminated variation in the MC1R (melanocortin one receptor) locus. The melanocortin receptor is in charge of the regulation of melanin. It can produce two types of pheomelanin: a reddish yellow undertone pigment often found in lightly pigmented individuals, and eumelanin which is in charge of brown-black pigmentation; the more significant amounts of eumelanin, the more pigmented the skin is.

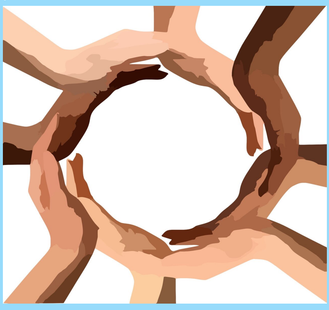

Figure 6

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The "Vitamin D Compromise" includes the loss of pigmentation in the skin that eventually led to Europeans and East Asians. Since dark-skinned pigmented individuals did not have great success in places with less UV., Due to the consequences that arise from vitamin D deficiency in dark skin, the loss of pigment in the skin underwent a strong selection. An example is in Scotland, where there is low UVR. Individuals here are very lightly pigmented. Due to the low amount of UVB synthesizing of vitamin D is not enough; therefore, adding vitamin D rich foods such as seafood (Figure 7) allowed an uptake in Vitamin D. In simpler words, skin pigmentation is mainly based on ultraviolet radiation.

Figure 7

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