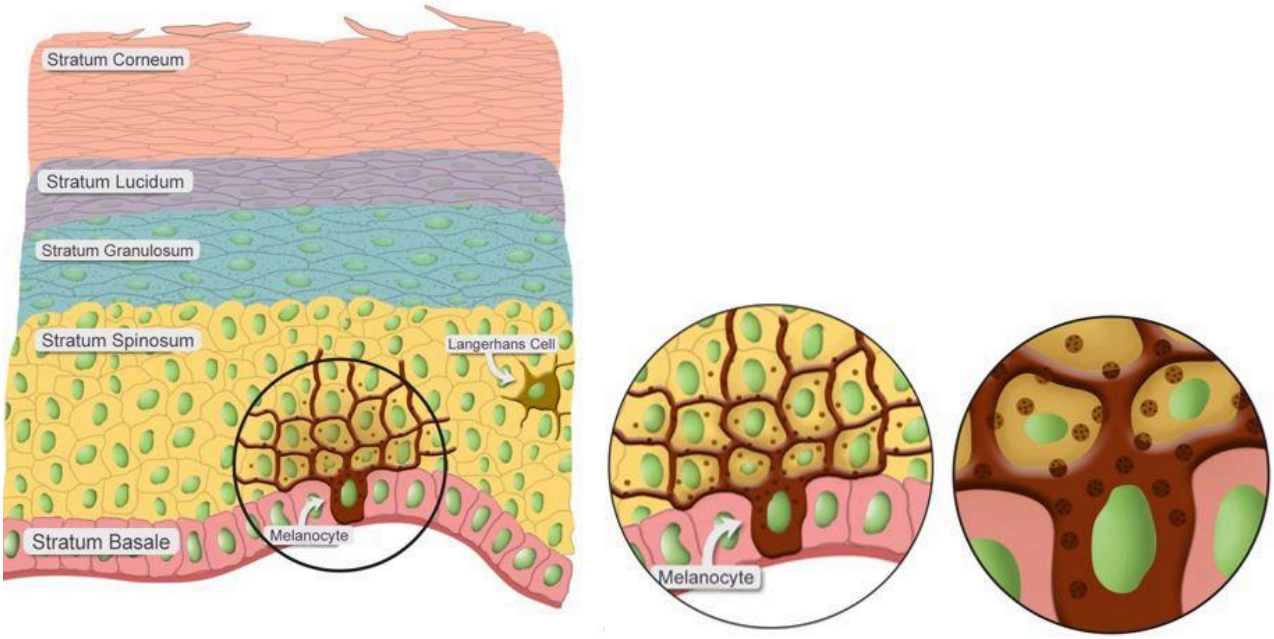
4.1.3

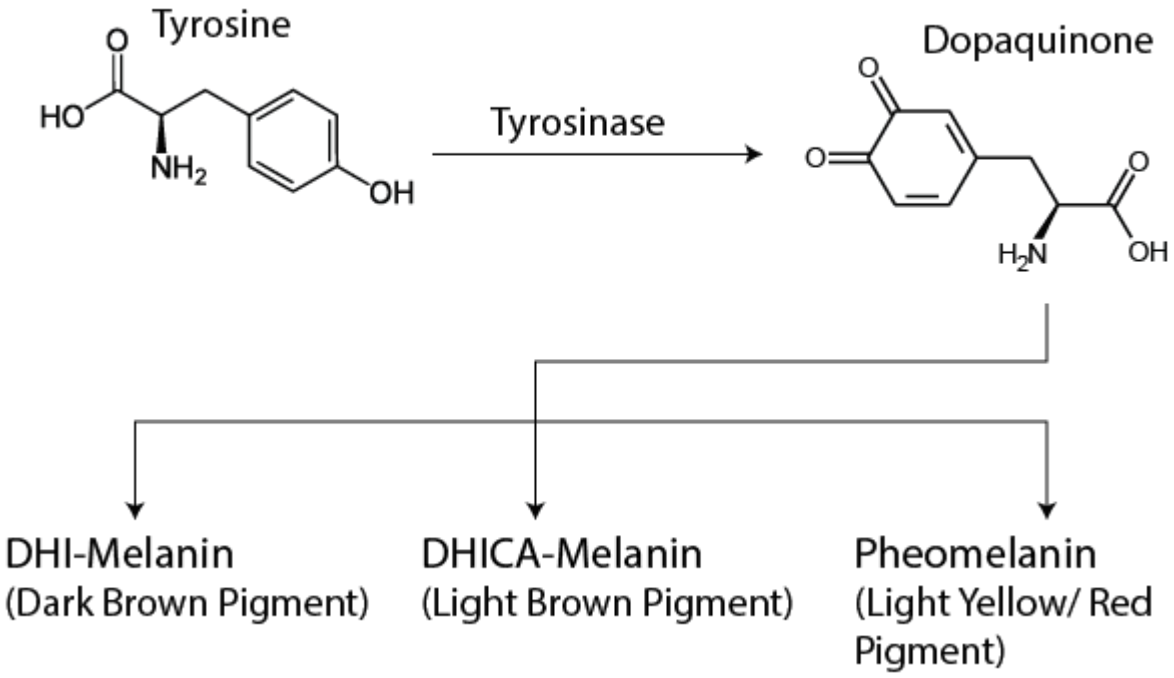
Skin Color



Melanocytes and Melanin. *Image drawn by Tabitha Daughtery at BYU-Idaho Winter 2014*

Human beings come in a rich variety of complexions. If we took everyone in our class and compared skin color we would undoubtedly see a large spectrum of pigmentation. In this section we will discuss the factors that determine skin color.

Melanin: The primary pigment in human skin that is responsible for skin color is **melanin** (from the Greek melas meaning black or dark). Melanin is actually a family of compounds (derived from the amino acid tyrosine) that are produced in specialized cells called **melanocytes.** The most common form of melanin is eumelanin, and has two main subtypes, black and brown. Another form of melanin, pheomelanin, contains the amino acid cysteine and has a pink or red color. Pheomelanin is responsible for the pigmentation seen in people with red hair and also in freckles. The types, amounts, and distribution of these pigments result in the spectrum of skin colors observed in humans.



Conversion of Tyrosine into Pigment. *Image drawn by J. Shaw BYU-Idaho Spring 2016*

As mentioned above, the cells that produce the melanin are the melanocytes. Recall that the melanocytes are located in the stratum basale of the epidermis. Inside the melanocytes the enzyme **tyrosinase** is hard at work converting the amino acid **tyrosine** into the various forms of melanin. Which type of melanin, how much is produced and how it is distributed is determined by our genetics. It is obvious from the many different skin colors observed that the genetics of skin color is very complex and will not be addressed in this class. Once the melanin is produced it is packaged in vesicles known as **melanosomes.** The melanocytes produce long, slender tentacle-like processes that infiltrate the keratinocytes. These processes are then able to transfer the melanosomes to the keratinocytes. Envision the keratinocytes phagocytizing the melanosome rich tips of these processes, thus incorporating the melanosomes into the keratinocytes. It is estimated that one melanocyte serves about 36 keratinocytes. Therefore, even though only the melanocytes can produce melanin, all of the keratinocytes will have melanin in them.

It is also interesting to note that among the different races the number of melanocytes is about the same. Therefore, it is the production of melanin and not the number of melanocytes that differs among these groups. We think that the main function of melanin is to absorb **ultraviolet** (UV) radiation that can induce mutations in the skin cells, resulting in skin cancer. Indeed, people who have higher levels of melanin, darker skin, have much lower incidences of skin cancer. Likewise, exposure to UV radiation increases melanin production as a mechanism to prevent damage. It is not a perfect system however, as the increased melanin production takes time. As a result, oftentimes the damage is already done before the melanin levels increase.

Other factors: In fair skinned people, the observed color of the skin is influenced by the bluish-white connective tissue layer located under the dermis. In addition, blood flowing in the veins of the dermis influences the coloration of those with little melanin. When blood flow increases as we exercise or become embarrassed this becomes even more prominent.

Other pigments from our diets can also influence skin color. For example, carotene is an orange pigment found in plants like carrots, pumpkins and summer squash. Carotene is an important dietary compound as it is a precursor to vitamin A, which plays an important role in vision, proper immune system function, and growth/development. Carotene is concentrated in fat cells in the body and consuming large quantities of carotene-containing foods can result in an

orange tint to the skin. Notice the orange pigmentation in the face of the child in the picture below. Her diet included a lot of carrots and squash.

Carotene Pigmentation. *Image used with permission of Michael Groesbeck Winter 2015*

Certain hormones such as estrogen and melanocyte-stimulating hormones tend to increase during pregnancy. These hormonal changes may cause pregnant women to suffer from splotchy skin (especially on the face and arms) where the production of melanin is greater. This condition is known as **chloasma** or **melasma,** but is more commonly called the "mask of pregnancy". The effects of chloasma usually go away soon after giving birth. Pregnant women also often develop increased pigmentation around the nipples and genitalia as well, and may develop a dark line down the middle of their abdomens known as the linea nigra. This is more common in fair skinned women and usually goes away after delivery.

As was mentioned earlier, skin color can change depending on the amount of blood flowing through it. **Erythema** comes from the Greek root *erythros*, which means red. Erythema is caused by hyperemia (increased blood flow) to the capillaries located in the skin. Sunburn, bug bites, rashes, infections and allergic reactions may cause an inflammatory response in the skin that can lead to erythema. The effects of erythema can also be seen in skin exposed to cold, wind, heat or in the skin of an embarrassed or angry individual. The opposite occurs when blood flow is reduced to the skin. For example, just before someone passes out their face will become white. Both of these conditions are more easily observed in people with fair skin.

Another condition, known as **cyanosis** (from Greek word for blue, *kyanos*), results from a decrease in oxygenation of the blood. Deoxygenated hemoglobin becomes dark red, which when seen through the skin appears blue. Typically, these signs are first observed around the lips or the fingertips. Appearance of cyanosis usually means there is some serious underlying problem that should be addressed immediately.

Bruises are typically something that most people actively avoid. A bruise is caused by the rupturing of capillaries under the skin, which allows blood to escape and seep into the surrounding tissue. Depending on the severity of the initial trauma, nerve endings can become sensitized and the area will be painful. Some bruises are not painful at all. Bruises can change color due to the breakdown of the protein hemoglobin found in red blood cells. As hemoglobin is degraded, different hues such as green, golden-brown and yellow can be seen in the bruised area. Oftentimes the tissue repair will be complete before the bruise disappears.

Disorders of Pigmentation:

Several disorders can result in unusual pigmentation. **Albinism** is a genetic disorder that causes a lack of melanin. Individuals with albinism lack the enzyme tyrosinase that converts tyrosine to the different forms of melanin. Therefore, individuals with this condition cannot produce melanin.

Albinism – Lack of Tyrosinase.

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Vitiligo is another disorder affecting skin pigmentation. Vitiligo is an autoimmune disorder in which the immune system destroys the melanocytes. Sufferers of this disorder typically have patches of skin that lack pigment next to areas with normal pigmentation. As the disease progresses it may eventually spread to the entire body.

Vitiligo on hands.

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For more reading on skin disorders go to Wikipedia and read sections on albinism, vitiligo and birthmarks.