

Integumentary system consists of **skin** and its derivatives (**sweat glands, sebaceous glands**, etc.).

It protects us from pathogens, ultraviolet radiation, dehydration, physical and chemical injury.

Its blood vessels are the site of **vitamin D** production.

It allows us to be aware of our environment in terms of temperature and the sensation of touch.

Its exposure to the external environment coupled with its vascularity provides a site where body heat can radiate away, thus allowing for the control of body temperature.

The skin is divided into 2 big layers: the **epidermis** and the **dermis**.

The epidermis is the superficial covering layer and is composed of **stratified squamous epithelial tissue**.

The dermis is the deep underlying structural layer and is primarily composed of **areolar connective tissue** and **dense irregular connective tissue**.

Deep to the dermis is a layer known as the **hypodermis**. This layer is not considered part of the skin despite its proximity to the dermis. The hypodermis (a.k.a. the **superficial fascia**) is primarily composed of adipose tissue. It provides insulation, energy storage, and attaches the skin to underlying muscles.

The epidermal stratified squamous epithelium consists of many layers of cells and acts as a barrier to pathogen entry and water loss.

The majority of the cells in the epidermis are **keratinocytes**. They are so named b/c of their production of copious amounts of **keratin** (Gk. *Keras* horn) which is the tough, waterproof, bacteria-resistant protein that gives skin its protective properties.

Other cells within the epidermis include the **melanocytes** and the **epidermal dendritic cells**.

Melanocytes produce the pigment **melanin** (Gk. *Melanos* black) which provides protection from the damaging effects of UV radiation. Melanocytes have multiple cellular extensions that snake between and around the keratinocytes. This allows the melanocytes to transfer the melanin to the keratinocytes. The granules of melanin cluster on the apical side of the keratinocytes. This ensures that they are between the sun's rays and the cells' nuclei. This protects the DNA in the nuclei from mutations that UV radiation can cause. Such mutations can potentially lead to skin cancer.

Epidermal dendritic cells are capable of performing **phagocytosis** (the ingestion and destruction of invading pathogens). They also take the remains of the pathogens to the **lymph nodes** and present pathogen fragments to **white blood cells** in order to prompt an immune response.

The epidermis is divided into several named layers (each of which can consist of multiple layers of keratinocytes).

In **thick skin** (found on the ventral surface of the hands and the plantar surface of the feet), there are 5 epidermal layers.

In **thin skin** (found everywhere else), there are 4 epidermal layers.

Thick skin not only has an extra layer but its layers are thicker as well. This is logical since the palms and soles experience much more friction and abrasion than other areas of the skin.

From deepest to most superficial, the 5 layers of thick skin epidermis are: **stratum basale**, **stratum spinosum**, **stratum granulosum**, **stratum lucidum**, and **stratum corneum**.

The stratum basale is the basal-most layer and is just above the basement membrane and the underlying areolar connective tissue. This layer consists of a single row of cells that are constantly performing **mitosis** (dividing to make new cells). The new cells are continually pushed above towards the surface. Additionally, melanocytes are commonly found in the stratum basale.

The stratum spinosum is next and it contains several layers of keratinocytes. The desmosomes mechanically linking the keratinocytes are quite visible in slides of the epidermis and are responsible for the name of this layer. These keratinocytes are still alive and have not yet become filled with keratin. Epidermal dendritic cells are common in this layer.

The stratum granulosum is next and is a thin layer where the **keratinization** of the cells really gets going. The keratinocytes here accumulate granules (hence the name of the layer) of keratin precursors and as a result have a very dark and spotty appearance.

The **stratum lucidum** is superficial to the stratum granulosum but is only found in thick skin. The cells of this thin layer appear somewhat clear (lucidum is from the Latin *lux*, “light”) in the microscope since their nuclei and organelles have greatly diminished in size and number as bundles of keratin come to dominate the cell.

The final superficial layer is the stratum corneum (Gk. *Cornu* horn). It consists of flattened, dead cells filled with keratin. It can be up to 30 cell layers thick in thick skin. Its strength and durability give the skin many of its protective qualities. The apical-most cells of the stratum corneum are constantly flaking off and being replaced by new cells from below.

The dermis underlies the epidermis and consists of 2 major layers: the **papillary dermis** and the **reticular dermis**.

The papillary dermis is the upper $\frac{1}{5}$ of the dermis and primarily consists of areolar connective tissue. It supports the epidermis and contains abundant blood vessels and nerves. Upward projections of the papillary dermis (known as **dermal papillae** (Lat. *papilla* projection) interlock with downward projections of the epidermis to anchor the 2 layers to one another.

The reticular dermis is the lower $\frac{4}{5}$ of the dermis and primarily consists of dense irregular connective tissue. This provides the skin with a great deal of structural integrity and resistance to damage.

The skin includes several structures that are derived from the epidermis. These **skin appendages** include: **sweat glands**, **sebaceous glands**, **hair follicles**, and **hair**.

The skin contains 3 million or so sweat glands. Each is a coiled tube with the secretory portion in the dermis and a duct leading through the epidermis to an opening at the surface. Sweat is almost entirely

water with only a few solutes (NaCl, antibodies, and some wastes). The evaporation of sweat on the skin surface removes heat from the skin and thus cools the body.

Modified sweat glands called **ceruminous glands** are found in the external ear canal lining. Their secretion adds to sebum to yield **cerumen** (a.k.a. earwax) which helps block entry to the ear canal.

Sebaceous glands secrete sebum, an oily bactericidal substance that helps moisturize the skin. They are typically found branching from hair follicles and are absent on the palms and soles.

Hair covers the majority of the human body and is abundant on the surface of the head, axillae, and pubic region. It plays a role in sensation and provides some warmth and protection from UV radiation. Hair consists of a visible **shaft** and a deeper **root**. Hairs are composed of concentric layers of keratinized cells. Surrounding the lower shaft and the root is the hair follicle. It is responsible for the production of the hair itself. Attached to the follicle is a small muscular bundle called an **arrector pili muscle**. It contracts and causes the hair to stand up in response to cold temperature and fright. There is no functional value to this in humans. In furrier mammals, it helps them look larger and can trap an insulating layer of air next to the skin.