

*Theoretical lectures
of
Organs Histology*

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The skin

The skin is the heaviest organ, about 16% of the total body weight. It is composed of two layers:

A. Epidermis

B. Dermis

A deeper superficial fascial layer, the **hypodermis**, lies under the skin. This layer, which is not considered part of the skin, consists of loose connective tissue that binds skin loosely to the subjacent tissue.

The skin contains several epidermal derivatives (sweat glands, hair follicles, sebaceous glands, nails, and the mammary glands). The skin along with its derivatives is called the **integument**.

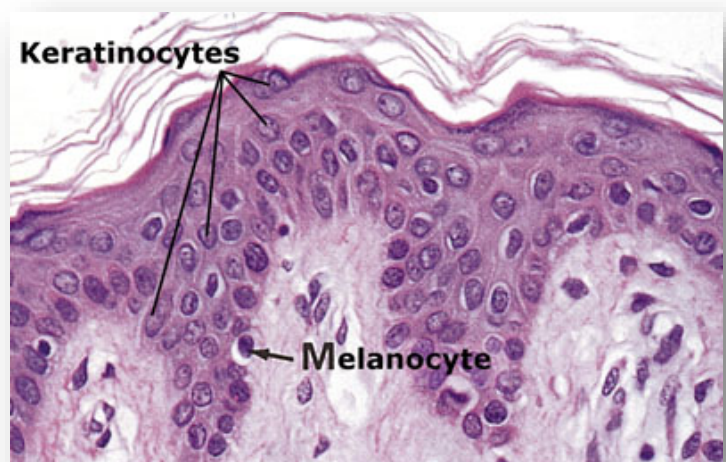
Function

- The skin protects the body against injury, desiccation, and infection.
- Regulates body temperature.
- Absorbs ultraviolet (UV) radiation, which is necessary for synthesis of vitamin D.
- Contains receptors for touch, temperature, and pain stimuli from the external environment.
- Skin acts as an excretory organ via sebaceous, sweat, and apocrine glands.

A) Epidermis

The epidermis is the superficial layer of the skin. It is classified as stratified squamous keratinized epithelium. The epidermis is composed predominantly of:

- A. keratinocytes** are arranged in **five** strata (basale, spinosum, granulosum, lucidum and corneum).



B. Nonkeratinocytes

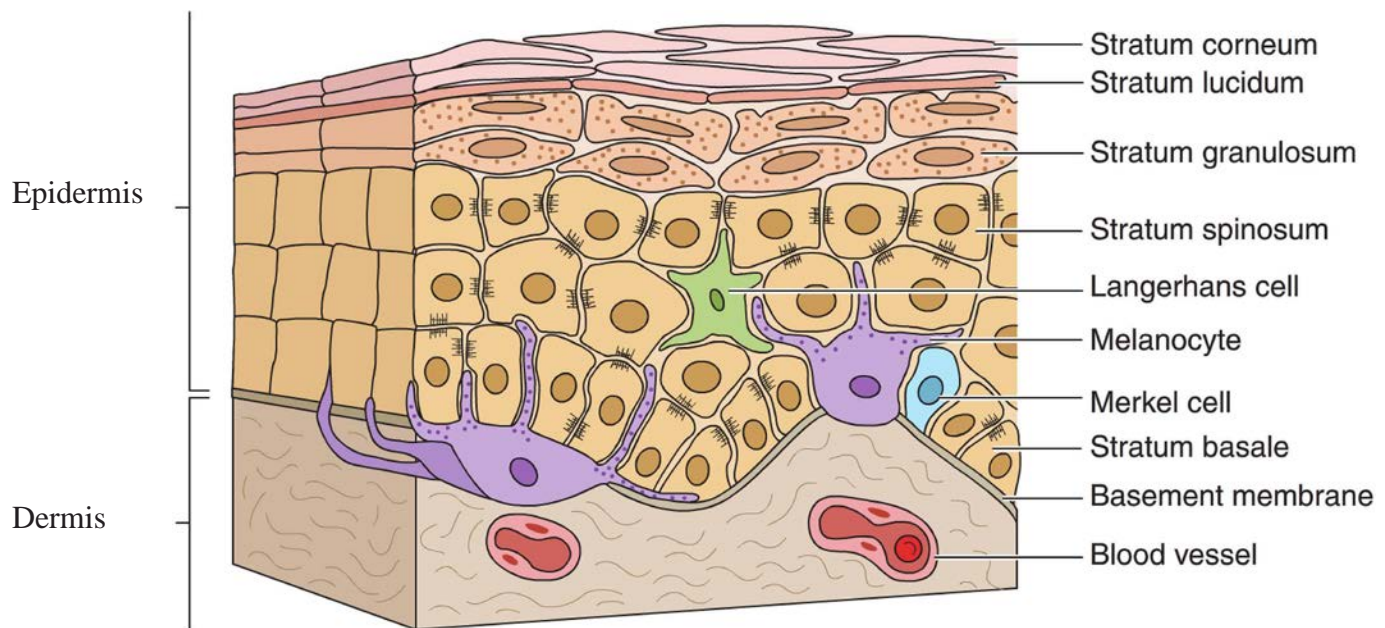
- melanocytes
- Langerhans cells
- Merkel cells.

The epidermis is constantly being regenerated. Regeneration, which occurs approximately every **30 days**, is carried out by the mitotic activity of keratinocytes, which normally divide at night.

Layers of the epidermis

1. **The stratum basale** (stratum germinativum) is the deepest layer of the epidermis and is composed mostly of keratinocytes that are cuboidal to columnar in shape. These mitotically active cells are attached directly to the basal lamina of the basement membrane by hemidesmosomes and to each other by desmosomes. These cells manufacture and house keratins 5 and 14. The stratum basale also contains melanocytes and Merkel cells.
2. **The stratum spinosum** consists of a few layers of polyhedral **keratinocytes** (prickle cells). Keratinocytes and their nuclei become larger and flatter a characteristic of squamous cells. This layer also contains **Langerhans cells**. Keratinocytes in the deeper aspects of the stratum spinosum are also mitotically active. The **malpighian layer** consists of the **stratum spinosum** and **stratum basale**. Nearly all of the mitotic activity in the epidermis occurs in this region, and cell division occurs at night.
3. **The stratum granulosum** is the most superficial layer of the epidermis, in which it comprises three to five layers of flattened keratinocytes that contain even more and bigger accumulations of keratohyalin granules, thick bundles of keratin filaments (tonofibrils), and membrane coating granules.
4. **The stratum lucidum** is a clear, homogeneous layer just superficial to the stratum granulosum; it is often difficult to distinguish in histological sections. It is found only in **palmar** and **plantar** skin. This layer consists of keratinocytes that have neither nuclei nor organelles, but contain an abundance of tonofibrils embedded in keratohyalin, frequently referred to as eleidin.

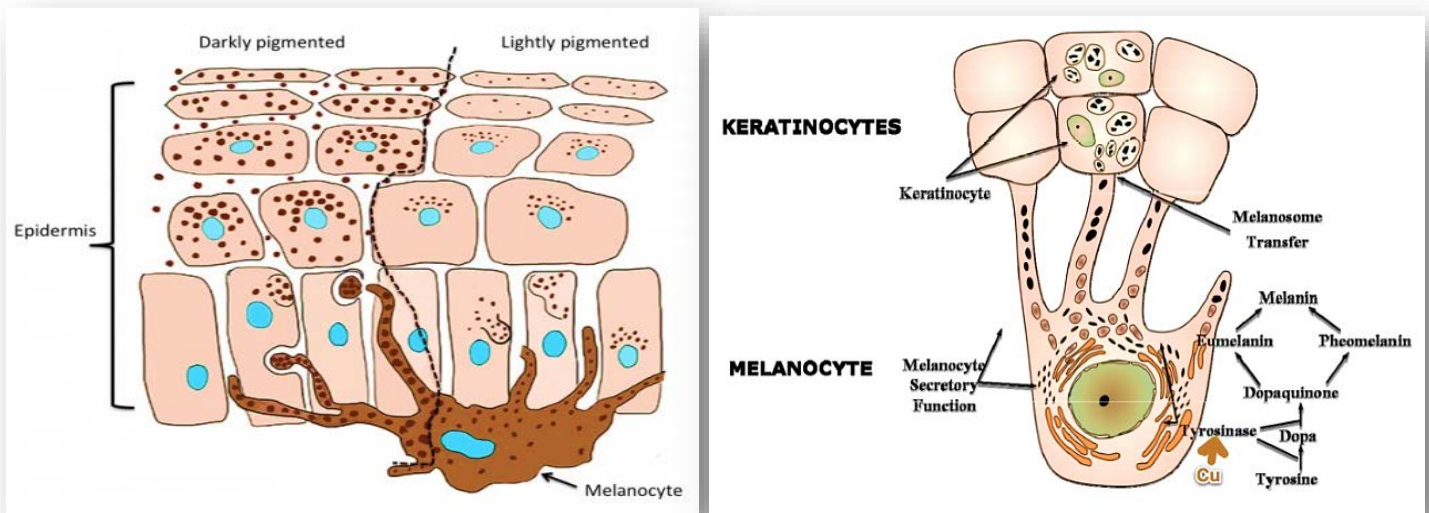
5. The **stratum corneum** is the most superficial layer of the epidermis. It may consist of as many as 15 to 20 layers of flattened, nonnucleated dead "cells" filled with keratohyalin keratin complex. These nonviable scale-like structures are called **squames** (or horny cells), and have the shape of a 14-sided polygon.



Non keratinocytes in the epidermis

1) Melanocytes

Melanocytes are present in the **stratum basale** and originate as **melanoblasts** from neural crest. Once melanoblasts reach the epidermis, they become **premelanocytes**, enter the stratum basale, and form hemidesmosomes with the basal lamina, but do not form adhesive junctions with the keratinocytes. Once premelanocytes bind stem cell factor, they may remain premelanocytes or may differentiate into melanocytes, which extend finger-like processes, known as **dendrites** that occupy some of the extracellular spaces among the cells of the stratum spinosum. The dendrites of a single melanocyte contact a number of stratum spinosum cells, and this group of cells is known as an **epidermal-melanin unit**. Melanocytes synthesize a dark brown pigment, melanin in oval-shaped organelles known as **melanosomes**. Melanosomes contain tyrosinase, which catalyzes the conversion of tyrosine to dihydroxyphenylalanine (DOPA) to melanin. They transfer melanin to neighboring keratinocytes via cell processes that contain melanosomes.



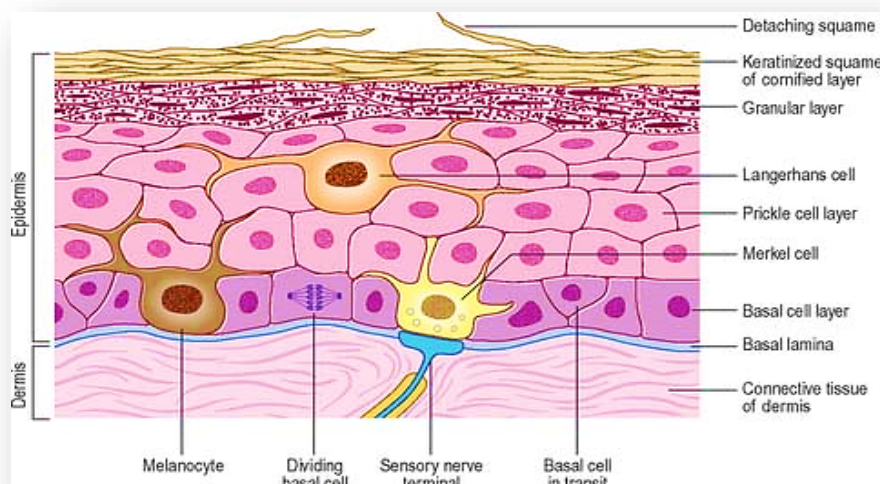
2) Langerhans cells

Langerhans cells are **dendritic cells** (so named because of their long processes) that originate in the bone marrow, travel in the bloodstream, exiting in the dermis and migrating into the epidermis. They are independent cell making no adhesive junctions to keratinocytes. Langerhans cells are located primarily in the **stratum spinosum**. These cells function as antigen-presenting cells in immune responses to contact antigens (contact allergies).

3) Merkel cells

Merkel cells are present in small numbers in the **stratum basale**, near areas of well vascularized, richly innervated connective tissue. They possess desmosomes and keratin filaments, suggesting an epithelial origin. Their pale cytoplasm contains small, dense-cored granules that are similar in appearance to those in some cells of the diffuse neuroendocrine system (DNES) and are presumed to house neurosecretions.

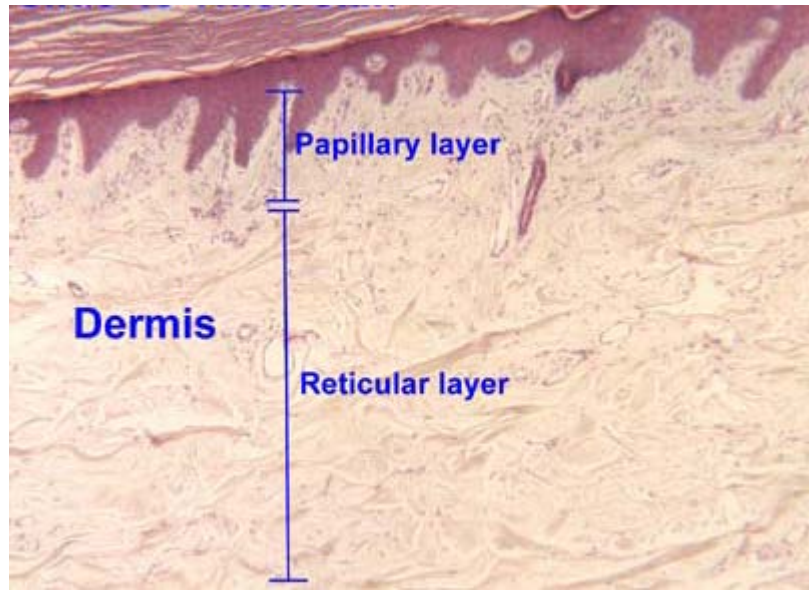
They receive afferent nerve terminals and are believed to function as **sensory mechanoreceptors**. They appear to be more abundant in areas of acute sensory perception, as at the tips of fingers.



B) Dermis

The dermis is the layer of the skin underlying the epidermis and is composed of **dense irregular connective tissue** that contains many type **I collagen fibers** and networks of thick **elastic fibers**. Although it is divided into a superficial **papillary layer** and a deeper, more extensive **reticular layer**, no distinct boundary exists between these layers.

Located at various levels in the dermis are the appendages of skin. These include the two types of **sweat glands** (eccrine and apocrine), **sebaceous glands**, **hair follicles**, and **nails**.



Glands in the skin

1) Sweat glands

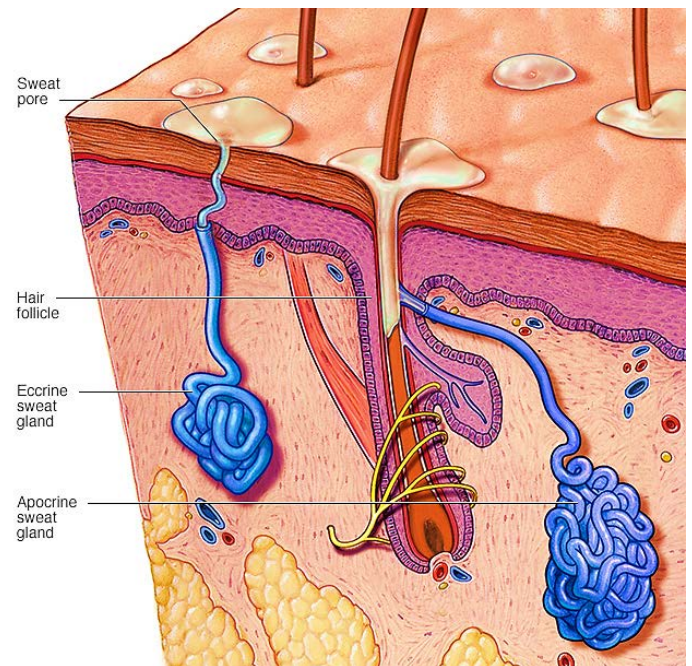
a) Eccrine sweat glands: the 3 to 4 million eccrine sweat glands are simple coiled tubular glands consisting of a secretory unit and a single duct. These glands are present in skin throughout most of the body but not in the **lips** and certain regions of the **external genitalia**. Eccrine sweat glands function in:

- controlling body temperature
- conserving electrolytes
- excreting urea and lactic acid. The secretory unit of eccrine sweat glands is approximately 0.4 mm in diameter, and is embedded in the dermis.

b) Apocrine sweat glands: include the large, specialized sweat glands, approximately 3 mm in diameter, located in various areas of the body (e.g., axilla, areola of the nipple, perianal region), and the ceruminous (wax) glands of the external auditory canal.

These glands do not begin to function until puberty and are responsive to hormonal influences.

Their large **coiled secretory units** are located in the dermis and hypodermis. These glands empty their viscous, odorless secretions into hair follicles at a location superficial to the entry of sebaceous gland ducts. Bacteria act on these secretions to produce odors that are somewhat specific to each individual.



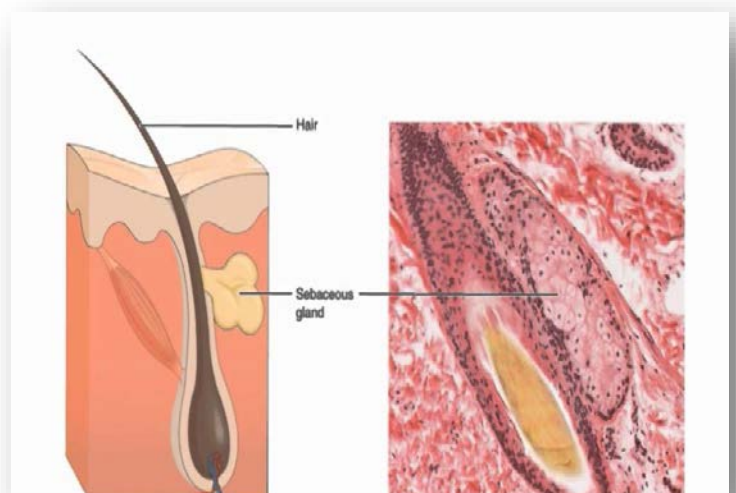
2) Sebaceous glands

Sebaceous glands are **branched acinar glands** that exhibit a lobular appearance. Clustered acini of one sebaceous gland empty into a single short duct.

- The duct empties into the neck of a hair follicle.
- Sebaceous glands are embedded in the dermis over most of the body's surface but are absent from the **palms and soles**. They are most abundant on the **face, forehead, and scalp**. These **Holocrine glands** release sebum (composed of an oily secretion and degenerating epithelial cells). As sebum continues to be produced, the cell undergoes apoptosis and/or necrosis; thus, the cellular debris becomes a component of the secretory product.

- **Sebum has a number of functions, such as:**

- 1-Maintaining the skin's barrier to aqueous fluids.
- 2-Guarding skin from oxidative stress.
- 3-Shielding skin from microorganisms.
- 4-Maintaining the suppleness of skin and the luster of hair.



Hair

Hairs are one of the characteristics of mammals and are keratinized, thin, thread-like structures that extend for various lengths above the surface of the epidermis. Hair in mammals functions in **thermal protection**, and in some instances as **camouflage**, and as **sensory organ**, whereas in humans its function is more of a tactile sensory organ because when a hair shaft is disturbed, it transduces that sensory information to the nervous system.

There are **three types** of human hairs:

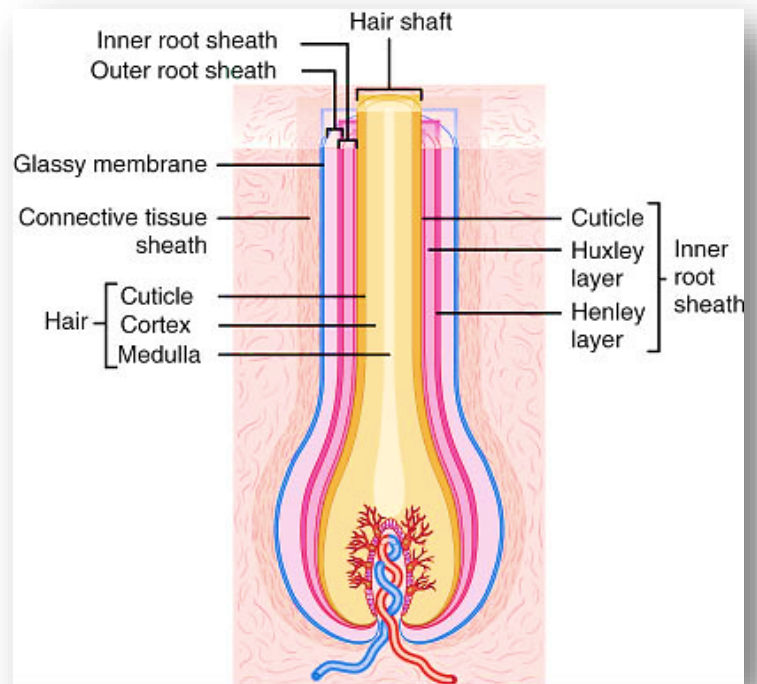
1. **Lanugo** is an exceptionally fine, somewhat longish hair that covers almost the entire fetus and falls out shortly after birth.
2. **Vellus hairs** are present throughout the individual's life. They are almost invisible, but when viewed in sunlight at an angle, for instance, on a person's eyelids (on the skin of the eyelids, not the eyelashes), they are evident as short, very fine, soft, and pale structures. Most of the human body is covered by vellus hairs.
3. **Terminal hairs** are the coarse, long, highly keratinized, dark hairs that one associates with the word "hair." These are present on the head, eyebrows, eyelashes, pubic hairs, etc. Most of the primate body is covered by terminal hair.

Hair follicle

A hair follicle is an invagination of the epidermis, extending deep into the dermis. The hair shaft is a long, slender filament in the center of the follicle that extends above the surface of the epidermis. It consists of an inner **medulla**, **cortex**, and **cuticle** of the hair. At its deep end, it is continuous with the hair root. The cuticle of the hair is surrounded by the internal root sheath.

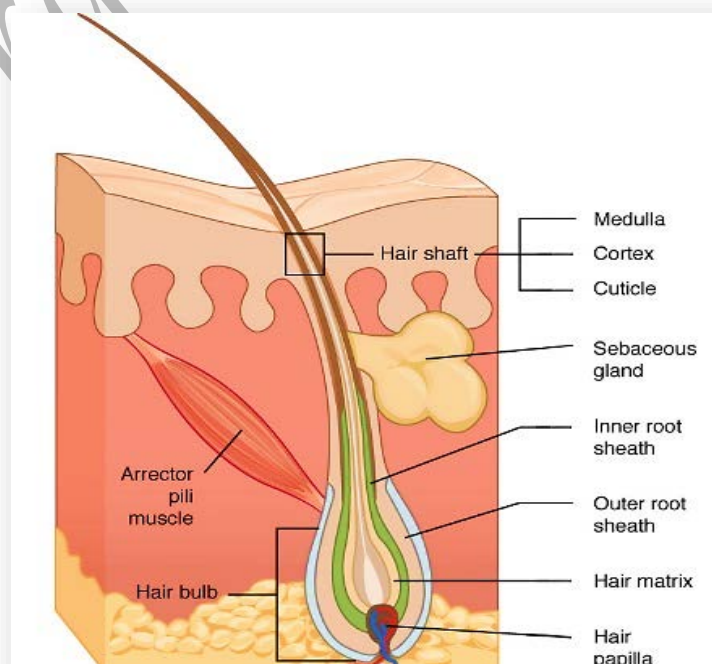
The **hair root** is the terminal expanded region of the hair follicle, located deep within the dermis where the hair is rooted. The hair root is deeply indented by a dermal papilla, which contains a capillary network necessary for sustaining the follicle. The hair root is separated from the dermal papilla by a basement membrane, and the two together constitute the hair bulb. The hair root contains **keratinocytes** that function as stem cells for hair shaft regeneration. Interestingly, these stem cells are present even in **bald individuals**, but the

signaling molecules that induce them to form new hair are absent. The average human head has approximately **150,000 hairs**, which grow at a rate of **2 mm** per day. On a daily basis, approximately **50 to 100** hairs are lost from the head. Hairs in some regions of the body last longer than others. Hair on the **head** stays in place for as long as **seven years**, whereas hairs in the **armpit** fall out in less than **half a year**.



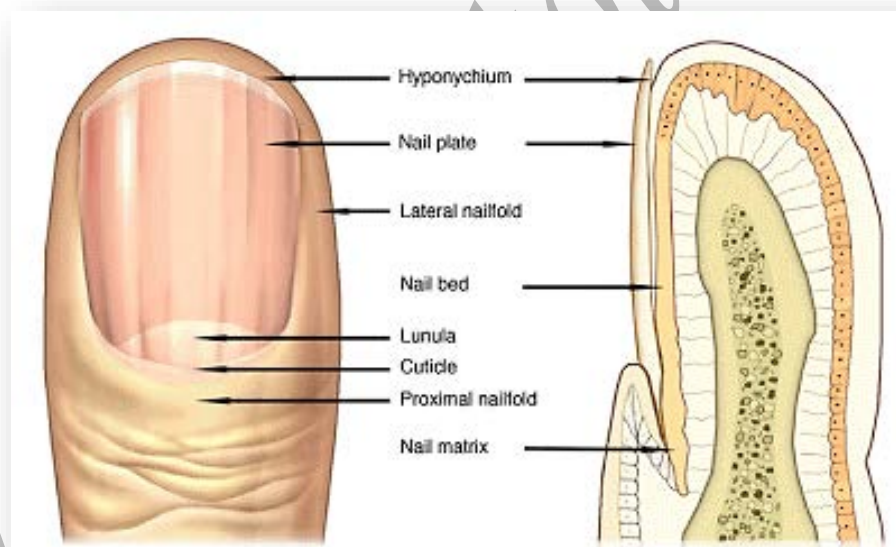
Arrector pili muscle

The arrector pili muscle attaches at an oblique angle to the dermal sheath surrounding a hair follicle. It extends superficially to underlie sebaceous glands, passing through the reticular layer of the dermis and inserting into the papillary layer of the dermis. The contraction of this smooth muscle elevates the hair and is responsible for formation of goose bumps, caused by depressions of the skin where the muscle attaches to the papillary layer of the dermis.



Nails

Nails are located on the distal phalanx of each finger and toe. Nails are hard keratinized plates that rest on the **nail bed** composed of the epidermis and underlying dermis of the skin. At the proximal end, each is covered by a fold of epidermis, called the **cuticle** or **eponychium**, which corresponds to the stratum corneum. The cuticle overlies the crescent-shaped whitish **lunula**. At the distal (free) edge, each is underlain by the **hyponychium**, which is also composed of stratum corneum. Nails grow as the result of mitoses of cells in the **matrix** of the nail root. Fingernails grow no more than **0.5 mm per week**, and toenails grow a bit slower; interestingly, growth is faster in the summer than in any other time of the year.



Thick and thin skin

Thick and thin skin are distinguished on the basis of the thickness of the epidermis.

1) Thick skin

- Thick skin has an epidermis that is **400 to 600 μm** thick.
- It is characterized by a prominent stratum corneum, a well-developed stratum granulosum, and often a distinct stratum lucidum.

- It lines the palms of the hands and the soles of the feet.
- Thick skin lacks hair follicles, sebaceous glands, and arrector pili muscles.

2) Thin skin

- Thin skin has an epidermis that is **75 to 150 μm** thick.
- It has a less prominent stratum corneum than thick skin and generally lacks a stratum granulosum and stratum lucidum, although it contains individual cells that are similar to the cells of these layers.
- Thin skin covers most of the body and contains hair follicles, sebaceous glands, and arrector pili muscles.

