

CHAPTER TWO

THE INTEGUMENTARY SYSTEM

Skin or **integument**, is the body's largest organ. In adults, it covers an area of 1.5 to 2.0 m² and accounts for about 15% of the body weight. This system forms the boundary between the body and the external environment, thereby separating us from the external environment while allowing us to interact with it.

FUNCTIONS OF THE SKIN

The skin is much more than a container for the body. It has a variety of important functions that go well beyond appearance. Major functions of the integumentary system include:

- ✗ **Protection:** the skin provides protection against abrasion and ultraviolet light. It also prevents the entry of microorganisms and prevents dehydration by reducing water loss from the body.
- ✗ **Sensation:** the skin is our most extensive sense organ. It is equipped with a variety of nerve endings that react to heat, cold, touch, texture, pressure, vibration, and tissue injury. These sensory receptors are especially abundant on the face, palms, fingers, soles, nipples, and genitals. There are relatively few on the back and in skin overlying joints such as the knees and elbows.
- ✗ **Temperature regulation:** body temperature is regulated by controlling blood flow through the skin and the activity of sweat glands. In response to chilling, the skin helps to retain heat. The dermis has nerve endings called **thermo receptors** that transmit signals to the brain, and the brain sends signals back to the dermal blood vessels.
 - ◆ **Vasoconstriction**, or narrowing of these blood vessels, reduces the flow of blood close to the skin surface and thus reduces heat loss.
 - ◆ **Vasodilation** or widening of the dermal blood vessels increases cutaneous blood flow and increases heat loss when one is overheated. If this is not enough to restore normal temperature, the brain also triggers sweating.
- ✗ **Vitamin D production:** when exposed to ultraviolet light, the skin produces a molecule that can be transformed into vitamin D, which is needed for bone development and maintenance. The liver and kidneys complete the process.
- ✗ **Water retention:** the skin is important as a barrier to water. It prevents the body from absorbing excess water when you are swimming or bathing, but even more importantly, it prevents the body from losing excess water.
- ✗ **Excretion:** small amounts of waste products are lost through the skin and in gland secretions.

The integumentary system consists of the **skin** and **its derivatives**— **hair, nails, and cutaneous glands**. It consists of **three layers**:

(1) **Epidermis**: which is a stratified squamous epithelium and the top layer of the epidermis is composed of dead cells containing keratin, the horny protein that also makes up hair and nails.

(2) **Dermis**: this is a deeper connective tissue layer.

- ❖ Below the skin is another connective tissue layer, the **hypodermis**, which is not part of the skin but is customarily studied in conjunction with it.
- ❖ If the hypodermis is the foundation on which the house rests, the dermis forms most of the house, and the epidermis is its roof.

EPIDERMIS

The **epidermis** is a keratinized stratified squamous epithelium. That is, its surface consists of dead cells packed with keratin. Like other epithelia, the epidermis lacks blood vessels and depends on the diffusion of nutrients from the underlying connective tissue. It has sparse nerve endings for touch and pain, but most sensations of the skin are due to nerve endings in the dermis.

CELLS OF THE EPIDERMIS

The epidermis is composed of **five types** of cells:

- ✘ **Stem cells** are undifferentiated cells that undergo mitosis and give rise to the keratinocytes. They are found only in the deepest layer of the epidermis, called the *stratum basale*.
- ✘ **Keratinocytes** are the great majority of epidermal cells. They are named for their role in synthesizing keratin.
- ✘ **Melanocytes** also occur only in the *stratum basale*, amid the stem cells and deepest keratinocytes. They synthesize the brown to black pigment *melanin*.
 - ✚ People of all races have about equal numbers of melanocytes. Differences in skin color result from differences in the rate of melanin synthesis and how clumped or spread-out the melanin is.
 - ✚ In light skin, the melanin is less abundant and is relatively clumped near the keratinocyte nucleus, imparting less color to the cells.
- ✘ **Tactile (Merkel) cells**, relatively few in number, are receptors for the sense of touch. They, too, are found in the basal layer of the epidermis and are associated with an underlying dermal nerve fiber. The tactile cell and its nerve fiber are collectively called a *tactile (Merkel) disc*.
- ✘ **Dendritic (Langerhans) cells** are found in two layers of the epidermis called the *stratum spinosum* and *stratum granulosum*. They are macrophages that originate in the bone marrow but migrate to the epidermis and epithelia of the oral cavity, esophagus, and vagina. The epidermis has as many as 800 dendritic cells per square millimeter. They “stand guard” against toxins, microbes, and other pathogens that penetrate into the skin. When they detect such invaders, they alert the immune system so the body can defend itself.

🌿 *LAYERS OF THE EPIDERMIS*

The epidermis consists of four to five layers of cells (five in thick skin). This description progresses from deep to superficial and from the youngest to the oldest keratinocytes.

◆ **STRATUM BASALE** consists:

- Mainly of a *single layer of cuboidal* to low *columnar* stem cells and **keratinocytes** resting on the basement membrane
- **Melanocytes** and **tactile cells** also found in scattered form. As stem cells of the stratum basale undergo mitosis, they give rise to keratinocytes that migrate toward the skin surface and replace lost epidermal cells.

◆ **STRATUM SPINOSUM** consists of several layers of **keratinocytes**; in most skin, this is the thickest stratum, but in thick skin it is usually exceeded by the *stratum corneum*.

- The deepest cells of the stratum spinosum retain the capability of mitosis, but as they are pushed farther upward, they cease dividing. Instead, they produce more and more keratin filaments, which cause the cells to flatten.
- Therefore, the higher up you look in the stratum spinosum, the flatter the cells appear.
- Dendritic cells are also found throughout the stratum spinosum, but are not usually visible in tissue sections.

◆ **STRATUM GRANULOSUM** consists of three to five layers of flat **keratinocytes**—more in thick skin than in thin skin— and some **dendritic cells**.

- The keratinocytes of this layer contain coarse, dark-staining *keratohyalin granules* that give the layer its name.

◆ **STRATUM LUCIDUM** is a thin translucent zone superficial to the **stratum granulosum**, seen only in thick skin.

- The keratinocytes are densely packed with *eleidin*, an intermediate product in the production of keratin.
- The cells have no nuclei or other organelles. Because organelles are absent and eleidin does not stain well, this zone has a pale, featureless appearance with indistinct cell boundaries.

◆ **STRATUM CORNEUM** is the outermost layer consists of up to 30 layers of dead, scaly, keratinized cells that form a durable water-resistant surface layer. It gives protection to skin from abrasion and penetration. It also renders the body relatively insensitive to biological, chemical, and physical attacks

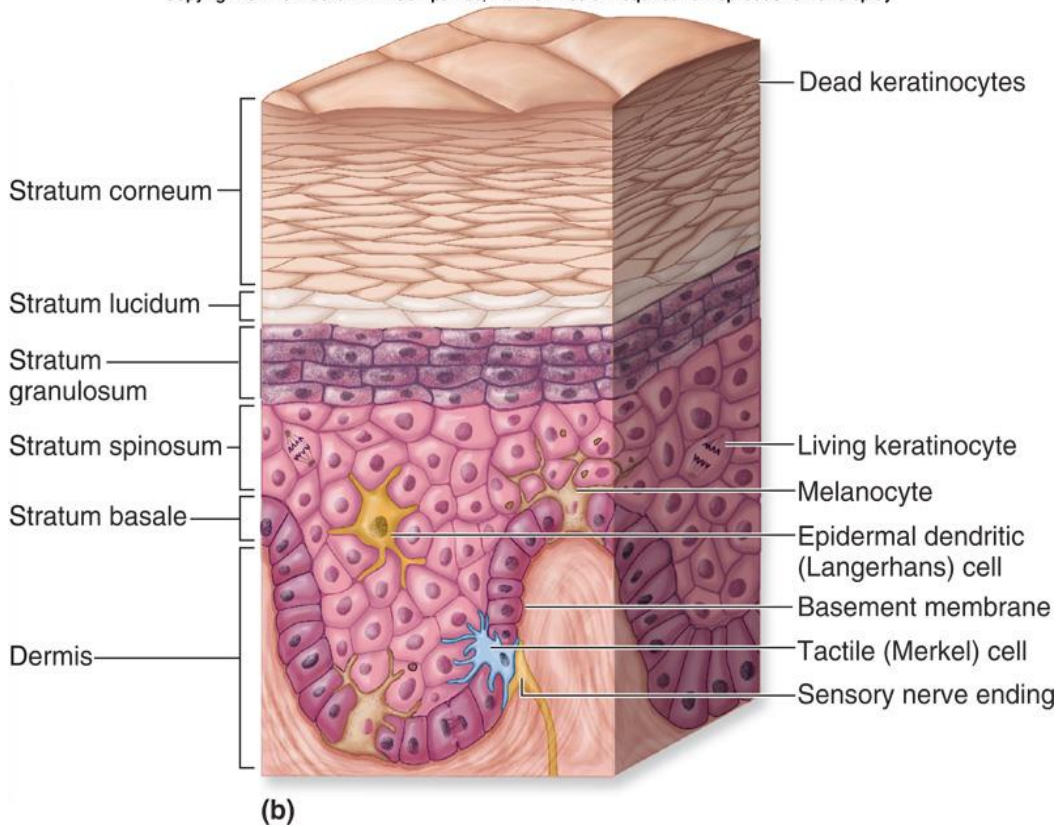


Figure 1: Layers of the epidermis

DERMIS

- ✚ Beneath the epidermis is a connective tissue layer, the **dermis**. It ranges from 0.2 mm thick in the eyelids to about 4 mm thick in the palms and soles.
- ✚ It is composed mainly of **collagen** but also contains **elastic** and **reticular fibers**, fibroblasts, and the other cells typical of fibrous connective tissue. It is well supplied with blood vessels, sweat glands, sebaceous glands, and nerve endings.
- ✚ The hair follicles and nail roots are embedded in the dermis. Smooth muscles (**piloerector muscles**) associated with hair follicles contract in response to such stimuli as cold, fear, and touch. This makes the hairs stand on end, causes “goose bumps,” and wrinkles the skin in areas such as the **scrotum** and **areola**. In the face, skeletal muscles attach to dermal collagen fibers and produce such expressions as a smile, a wrinkle of the forehead, and the lifting of an eyebrow.
- ✚ The dermis is divided into two layers; the deeper **reticular layer** and the more superficial **papillary layer**.
- ✚ **The reticular layer** is the deeper layer forms about four fifths of the dermis, which is dense irregular connective tissue, is the main layer of the dermis.
 - It is continuous with the hypodermis and forms a mat of irregularly arranged fibers that are resistant to stretching in many directions.
 - The elastin and collagen fibers are oriented more in some directions than in others
- ✚ **The papillary layer** derives its name from projections called **papillae** that extend toward the epidermis. It forms about one-fifth of the thickness of the dermis

- It is less dense than the reticular layer and is sometimes called **loose connective tissue** because it has thin fibers that are somewhat loosely arranged.
- It also contains a large number of blood vessels that supply the overlying epidermis with nutrients, remove waste products, and aid in regulating body temperature.
- ✚ The boundary between the epidermis and dermis is histologically distinct and usually wavy. The upward waves are fingerlike extensions of the dermis called **dermal papillae** and the downward waves are extensions of the epidermis. In the hands and feet, the dermal papillae generate epidermal ridges (sweat from the epidermal ridges leaves fingerprints).

HYPODERMIS

Beneath the skin is a layer called the **hypodermis, subcutaneous tissue, or superficial fascia**. The boundary between the dermis and hypodermis is indistinct, but the hypodermis generally has more areolar and adipose tissue. The hypodermis binds the skin to the underlying tissues and pads the body. Drugs are introduced here by hypodermic injection because the subcutaneous tissue is highly vascular and absorbs them quickly.

Subcutaneous fat is hypodermis composed predominantly of adipose tissue. This fat serves as an energy reservoir and thermal insulation.

It is not uniformly distributed; for example, it is virtually absent from the scalp but relatively abundant in the breasts, abdomen, hips, and thighs. The subcutaneous fat averages about 8% thicker in women than in men, and is different in distribution. It also varies with age. Infants and elderly people have less subcutaneous fat than other people and are therefore more sensitive to cold.

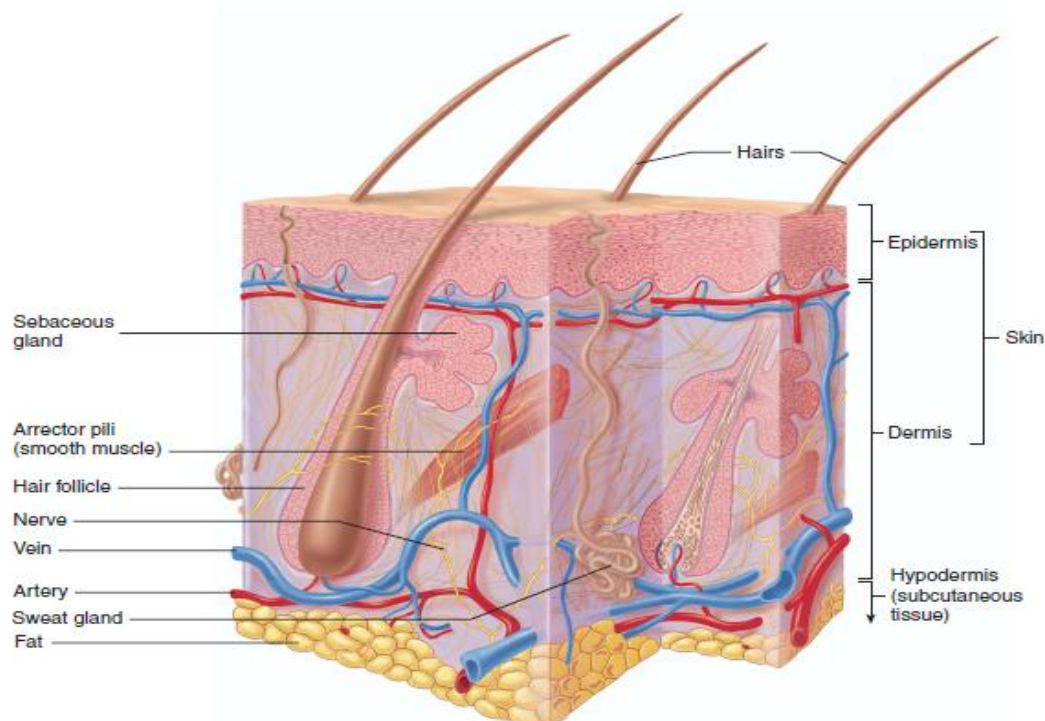


Figure 2: Skin structure

❏ *Thick and Thin Skin*

- ✚ Most of the skin is 1 to 2 mm thick. It ranges, however, from less than 0.5 mm on the eyelids to 6 mm between the shoulder blades. This difference is due mainly to variation in the thickness of the dermis.
- ✚ Skin is classified as **thick** or **thin skin** based on the relative thickness of the epidermis alone, especially the surface layer of dead cells called the *stratum corneum*.
 - **Thick skin** covers the palms, soles, and corresponding surfaces of the fingers and toes. It has an epidermis that is 400 to 600 μm thick, due to a very thick, tough stratum corneum. Thick skin has sweat glands but no hair follicles or sebaceous (oil) glands.
 - **Thin skin** covers the rest of the body, which has an epidermis 75 to 150 μm thick, with a thin stratum corneum. It possesses hair follicles, sebaceous glands, and sweat glands.

❏ *SKIN COLOR*

The most significant factor in skin color is **melanin**, which is produced by the melanocytes but which accumulates in the keratinocytes of the stratum basale and stratum spinosum.

There are **two forms** of melanin

- ▣ A brownish black **eumelanin** and
- ▣ A reddish yellow sulfur-containing pigment, **pheomelanin**.

People of different races have essentially the **same number** of melanocytes, but

- 🍂 In dark-skinned people, the melanocytes produce greater quantities of melanin, and the melanin in the keratinocytes breaks down more slowly. Thus, melanized cells may be seen throughout the epidermis, from stratum basale to stratum corneum.
- 🍂 In light-skinned people, the melanin breaks down more rapidly and little of it is seen beyond the stratum basale, if even there.

The amount of melanin in the skin also varies with exposure to the ultraviolet (UV) rays of sunlight, which stimulate melanin synthesis and darken the skin. The amount of melanin also varies substantially from place to place on the body. It is relatively concentrated in freckles and moles, on the dorsal surfaces of the hands and feet as compared to the palms and soles, in the nipple and surrounding area (areola) of the breast, around the anus, in the scrotum and penis, and on the lateral surface of the female genital folds (*labia majora*). The contrast between heavily melanized and lightly melanized regions of the skin is more pronounced in some races than in others, but it exists to some extent in nearly everyone.

✘ *Other factors in skin color are hemoglobin and carotene.*

- 🌍 **Hemoglobin**, the red pigment of blood, imparts reddish to pinkish hues to the skin. Its color is lightened by the white of the dermal collagen. The skin is redder in places such as the lips, where blood capillaries come closer to the surface and the hemoglobin shows through more brightly.

● **Carotene** is a yellow pigment acquired from egg yolks and yellow and orange vegetables. Depending on the diet, it can become concentrated to various degrees in the stratum corneum and subcutaneous fat. It is often most conspicuous in skin of the heel and in “corns” or calluses of the feet because this is where the stratum corneum is thickest.

✘ *The skin may also exhibit abnormal colors of diagnostic value:*

● **Cyanosis** is blueness of the skin resulting from a deficiency of oxygen in the circulating blood. Oxygen deficiency turns the hemoglobin a reddish violet color. It can result from conditions that prevent the blood from picking up a normal load of oxygen in the lungs, such as airway obstructions in drowning and choking, lung diseases such as emphysema, or respiratory arrest. Cyanosis also occurs in situations such as cold weather and cardiac arrest, when blood flows so slowly through the skin that most of its oxygen is extracted faster than freshly oxygenated blood arrives.

● **Erythema** is abnormal redness of the skin. It occurs in such situations as exercise, hot weather, sunburns, anger, and embarrassment. Erythema is caused by increased blood flow in dilated cutaneous blood vessels or by dermal pooling of red blood cells that have escaped from abnormally permeable capillaries.

● **Pallor** is a pale or ashen color that occurs when there is so little blood flow through the skin that the white color of the dermal collagen shows through. It can result from emotional stress, low blood pressure, circulatory shock, cold temperatures, or severe anemia.

● **Albinism** is a genetic lack of melanin that results in white hair, pale skin, and pink eyes. Melanin is synthesized from the amino acid tyrosine by the enzyme tyrosinase. People with albinism have inherited a recessive, nonfunctional tyrosinase gene from both parents.

▣ *CUTANEOUS GLANDS*

The major glands of the skin are the sebaceous glands and the sweat glands.

🌿 *Sebaceous Glands*

Sebaceous glands produce an oily secretion called **sebum**. They are flask-shaped, with short ducts that usually open into a hair follicle, although some of them open directly onto the skin surface. These are holocrine glands with little visible lumen. Their secretion consists of broken-down cells that are replaced by mitosis at the base of the gland. Sebum keeps the skin and hair from becoming dry, brittle, and cracked. The sheen of well-brushed hair is due to sebum distributed by the hairbrush.

🌿 *Sweat Glands*

Sweat glands, or **sudoriferous glands**, are of two kinds, merocrine and apocrine.

✚ **MEROCRINE (ECCRINE)**

The most numerous types produce watery perspiration that serves primarily to cool the body. There are 3 to 4 million merocrine sweat glands in the adult skin, with a total weight about equal to that of a kidney. They are especially abundant on the palms, soles, and forehead, but they are widely distributed over the rest of the body as

well. Each is a simple tubular gland with a twisted coil in the dermis or hypodermis and an undulating or coiled duct leading to a sweat pore on the skin surface. This duct is lined by a **stratified cuboidal epithelium** in the dermis and by keratinocytes in the epidermis.

✚ APOCRINE

Apocrine sweat glands are compound coiled tubular glands that usually open into hair follicles superficial to the opening of the sebaceous glands.

- ❑ In other mammals, these glands are widely distributed throughout the skin and help to regulate temperature.
- ❑ In humans, apocrine sweat glands are found in the axillae and genitalia (scrotum and labia majora) and around the anus and do not help to regulate temperature.
- ❑ In humans, they become active at puberty as a result of the influence of sex hormones. Their secretions contain organic substances, such as 3-methyl-2-hexenoic acid, that are essentially odorless when first released but that are quickly metabolized by bacteria to cause what commonly is known as **body odor**.
- ❑ Apocrine sweat is thicker and milkier than merocrine sweat because it has more fatty acids in it. Many mammals use scent as a means of communication and it has been suggested that the activity of apocrine sweat glands may be a sign of sexual maturity.

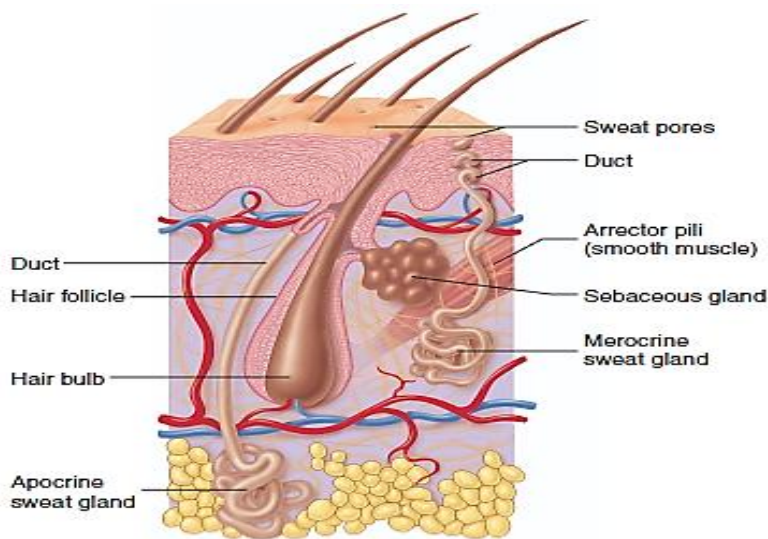


Figure 3: Glands of the skin

OTHER GLANDS

✚ Ceruminous Glands

Ceruminous glands are found only in the auditory (external ear) canal, where their secretion combines with sebum and dead epidermal cells to form earwax, or **cerumen**. They are simple, coiled, tubular glands with ducts leading to the skin surface. Cerumen keeps the eardrum pliable, waterproofs the canal, and kills bacteria.

✚ Mammary Glands

Mammary glands are modified apocrine sweat glands located in the breasts (*mammae*) and they are milk-producing glands under conditions of pregnancy and lactation.

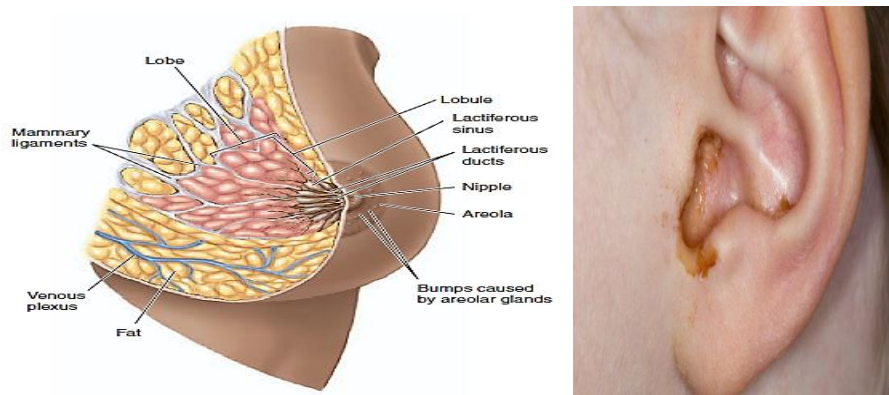


Figure 4: Mammary gland structure and Cerumen respectively

▣ HAIR AND NAILS

The hair, nails, and cutaneous glands are the **accessory organs (appendages)** of the skin. Hair and nails are composed mostly of dead, keratinized cells. While the stratum corneum of the skin is made of pliable **soft keratin**, the hair and nails are composed mostly of **hard keratin**. Hard keratin is more compact than soft keratin and is toughened by numerous cross-linkages between the keratin molecules.

✚ HAIR

A hair is also known as a **pilus**; in the plural, *pili*. It is a slender filament of keratinized cells that grows from an oblique tube in the skin called a **hair follicle**.

DISTRIBUTION AND TYPES

The presence of hair is one of the characteristics common to all mammals; if the hair is dense and covers most of the body surface, it is called fur. In humans, hair is found everywhere on the skin except the palms, soles, lips, nipples, parts of the external genitalia, and the distal segments of the fingers and toes. Hairless skin is sometimes called **glabrous skin**. The extremities and trunk have about 55 to 70 hairs per square centimeter, and the face has about 10 times as many. There are about 30,000 hairs in a man's beard and about 100,000 hairs on the average person's scalp. The number of hairs in a given area does not differ much from one person to another or even between the sexes. Differences in apparent hairiness are due mainly to differences in the texture and pigmentation of the hair. Not all hair is alike, even on one person.

▣ Over the course of our lives, we grow **three kinds of hair: lanugo, vellus, and terminal hair**.

- ✚ **Lanugo** is fine, downy, unpigmented hair of the fetus. By the time of birth, it is replaced by **vellus**, a similarly fine, unpigmented hair.
- ✚ **Vellus** constitutes about two-thirds of the hair of women, one-tenth of the hair of men, and all of the hair of children except for the **eyebrows, eyelashes, and hair of the scalp**.
- ✚ **Terminal hair** is longer, coarser, and pigmented. It forms the eyebrows and eyelashes, covers the scalp, and after puberty, it forms the axillary and pubic hair, the male facial hair, and some of the hair on the trunk and limbs.

FUNCTIONS OF HAIR

- ✓ Screen against foreign particles (eye lashes)
- ✓ In the nostrils trap dust particles in the inhaled air
- ✓ Protect openings from foreign particles.
- ✓ Insulation against cold in scalp. In most mammals, hair serves to retain body heat. Humans have too little hair to serve this purpose except on the scalp, where there is no insulating fat.

STRUCTURE OF THE HAIR AND FOLLICLE

☐ A hair is divisible into three zones along its length:

- ✗ The **bulb**, a swelling at the base where the hair originates in the dermis;
- ✗ The **root**, which is the remainder of the hair within the follicle; and
- ✗ The **shaft**, which is the portion above the skin surface.

Except near the bulb, all the tissue is dead. The hair bulb grows around a bud of vascular connective tissue called the **dermal papilla**, which provides the hair with its sole source of nutrition. Immediately above the papilla is a region of mitotically active cells, the **hair matrix**, which is the hair's growth center. All cells higher up are dead.

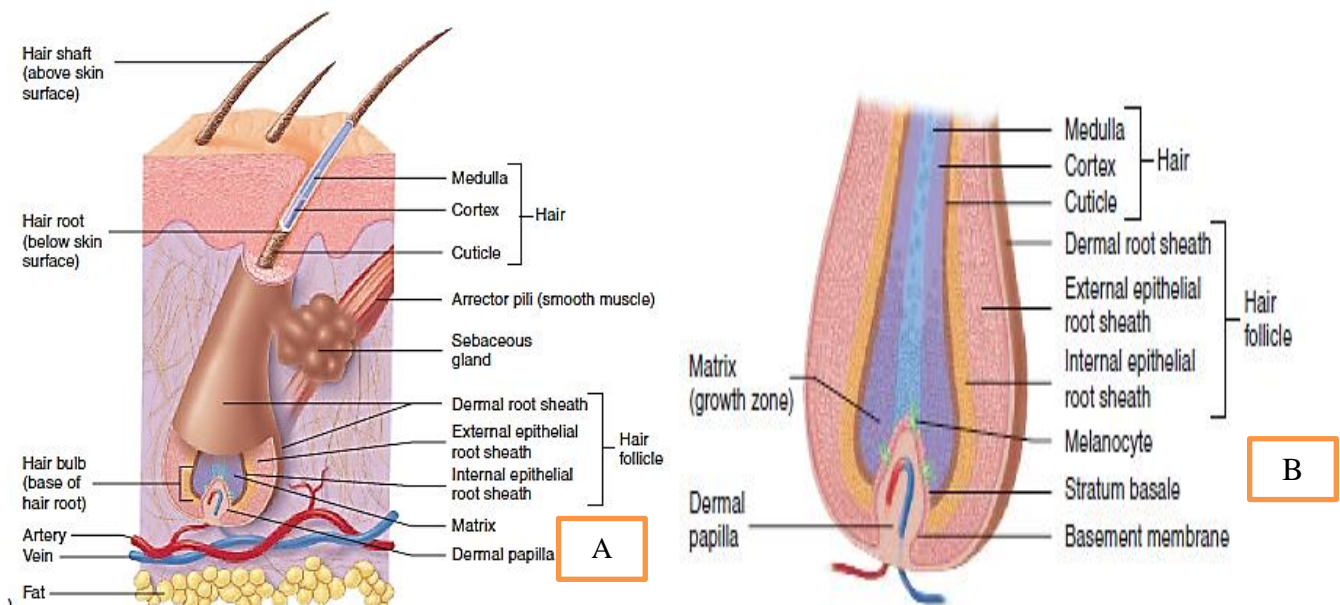


Figure 5: Hair follicle a. The hair follicle contains the hair and consists of a dermal and epithelial root sheath b. Enlargement of the hair follicle wall and hair bulb.

☐ In cross section, a hair reveals three layers:

- ✗ **Medulla**, a core of loosely arranged cells and air spaces found in thick hairs, but absent from thin ones;
- ✗ **Cortex**, a layer of keratinized cuboidal cells; and
- ✗ **Cuticle**, a surface layer of scaly cells that overlap each other like roof shingles, with their free edges directed upward.

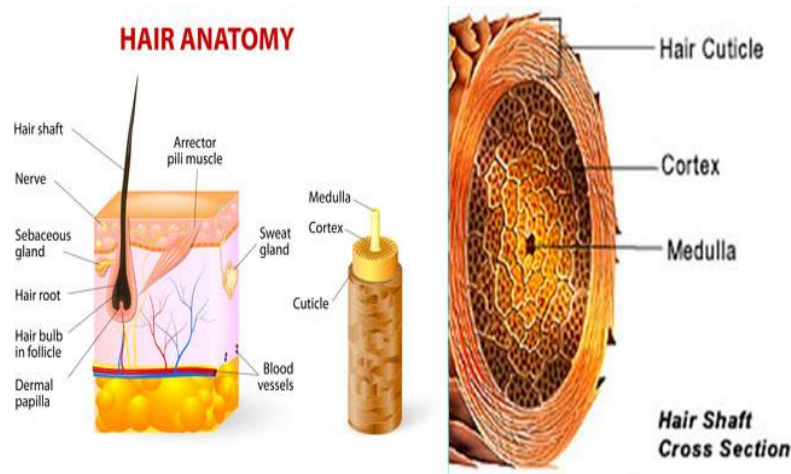


Figure 6: Cross section of a hair within a hair follicle.

Cells lining the follicle are like shingles facing in the opposite direction. They interlock with the scales of the hair cuticle and resist pulling on the hair. When a hair is pulled out, this layer of follicle cells comes with it.

The follicle is a diagonal tube that dips deeply into the dermis and sometimes extends as far as the hypodermis. It has two principal layers: an **epithelial root sheath** and a **connective tissue root sheath**.

- **Epithelial root sheath**, which is an extension of the epidermis, lies immediately adjacent to the hair root.
- **Connective tissue root sheath**, derived from the dermis, surrounds the epithelial sheath and is somewhat denser than the adjacent dermal connective tissue.

✘ *MUSCLE AND NERVES*

Nerve fibers called **hair receptors** twist each follicle and respond to hair movements. A **piloerector muscle (arrector pili)**, a bundle of smooth muscle cells extending from dermal collagen fibers to the connective tissue root sheath of the follicle and it has association with each hair. In response to cold, fear, or other stimuli, the sympathetic nervous system stimulates these muscles to contract and thereby makes the hair stand on end. In other mammals, this traps an insulating layer of warm air next to the skin or makes the animal appear larger and less vulnerable to a potential enemy. In humans, it pulls the follicles into a vertical position and causes “goose bumps” but serves no useful purpose.

HAIR TEXTURE AND COLOR

- ❖ The texture of hair is related to differences in cross-sectional shape; **straight hair is round, wavy hair is oval, and tightly curly hair is relatively flat.**
- ❖ Hair color is due to pigment granules in the cells of the cortex.
 - Brown and black hairs are **rich in eumelanin**.
 - Red hair has **less eumelanin** but a high concentration of pheomelanin.
 - Blond hair has an **intermediate amount of pheomelanin** but very little eumelanin.
 - Gray and white hair results from a **scarcity or absence of melanins** in the cortex and the presence of air in the medulla.

HAIR GROWTH

Hair is produced in cycles that involve a **growth stage** and a **resting stage**.

- ✘ During the growth stage, hair is formed by cells of the matrix that differentiate, become keratinized, and die. The hair grows longer as cells are added at the base of the hair root. Eventually hair growth stops; the hair follicle shortens and holds the hair in place.
- ✘ A resting period follows after which a new cycle begins, and a new hair replaces the old hair, which falls out of the hair follicle. Thus loss of hair normally means that the hair is being replaced.

The length of each stage depends on the hair, **eyelashes** grow for approximately 30 days and rest for 105 days, whereas **scalp hairs** grow for a period of 3 years and rest for 1–2 years. At any given time an estimated 90% of the scalp hairs are in the growing stage, and loss of approximately 100 scalp hairs per day is normal.

Hair Thinning and Baldness

The most common kind of permanent hair loss is “pattern baldness.” Hair follicles are lost, and the remaining hair follicles revert to producing vellus hair, which is very short, transparent, and for practical purposes invisible. Although more common and more pronounced in certain men, baldness can also occur in women. Genetic factors and the hormone testosterone are involved in causing pattern baldness. The average rate of hair growth is approximately 0.3 mm per day, although hairs grow at different rates even in the same approximate location. Cutting, shaving, or plucking hair does not alter the growth rate or the character of the hair, but hair can feel coarse and bristly shortly after shaving because the short hairs are less flexible. Maximum hair length is determined by the rate of hair growth and the length of the growing phase. For example, scalp hair can become very long, but eyelashes are short.

Nail

The distal ends of primate digits have nails, whereas most other mammals have claws or hooves. Nails protect the ends of the digits, aid in manipulation and grasping of small objects, and are used for scratching.

- ▣ A nail consists of the **proximal nail root** and the **distal nail body**.
 - The nail root is covered by skin, and the nail body is the visible portion of the nail.
 - The lateral and proximal edges of the nail are covered by skin called the **nail fold**, and the edges are held in place by the **nail groove**.
 - The nail root and the nail body attach to the **nail bed**, the proximal portion of which is the nail matrix. Only the *stratum germinativum* is present in the nail bed and nail matrix. The nail matrix is thicker than the nail bed and produces most of the nail, although the nail bed does contribute. The nail bed is visible through the clear nail and appears pink because of blood vessels in the dermis.
 - A small part of the nail matrix, the **lunula**, is seen through the nail body as a whitish, crescent-shaped area at the base of the nail. The lunula, seen best on the thumb, appears white because the blood vessels cannot be seen through the thicker nail matrix.

- The nail is stratum corneum. It contains a hard keratin which makes the nail hard. The nail cells are produced in the nail matrix and pushed distally over the nail bed.
- Nails grow at an average rate of 0.5–1.2 mm per day, and fingernails grow more rapidly than toenails. Nails, like hair, grow from the base. Unlike hair, they grow continuously throughout life and do not have a resting phase.



Figure 7: Anatomy of nail

The Aging Integumentary System

- As the body ages, the skin is more easily damaged because the epidermis becomes thin and the amount of collagen in the dermis decreases.
- Skin infections are more likely, and repair of the skin occurs more slowly.
- A decrease in the number of elastic fibers in the dermis and loss of fat from the hypodermis cause the skin to sag and wrinkle.
- The skin becomes drier with age as sebaceous gland activity decreases.
- A decrease in the activity of sweat glands and a decrease in the blood supply to the dermis result in a poor ability to regulate body temperature.
- Death from heat prostration can occur in elderly individuals who do not take proper precautions.
- The number of functioning melanocytes generally decreases, but in some localized areas, especially on the hands and the face, melanocytes increase in number to produce age spots.
- White or gray hairs also occur because of a decrease in or lack of melanin production.
- Skin that is exposed to sunlight appears to age more rapidly than non-exposed skin. This effect is observed on areas of the body, such as the face and hands, which receive sun exposure.
- The effects of chronic sun exposure on the skin, however, are different from the effects of normal aging. In skin exposed to sunlight, normal elastic fibers are replaced by an interwoven mat of thick, elastic like material, the number of collagen fibers decreases, and the ability of keratinocytes to divide is impaired.

