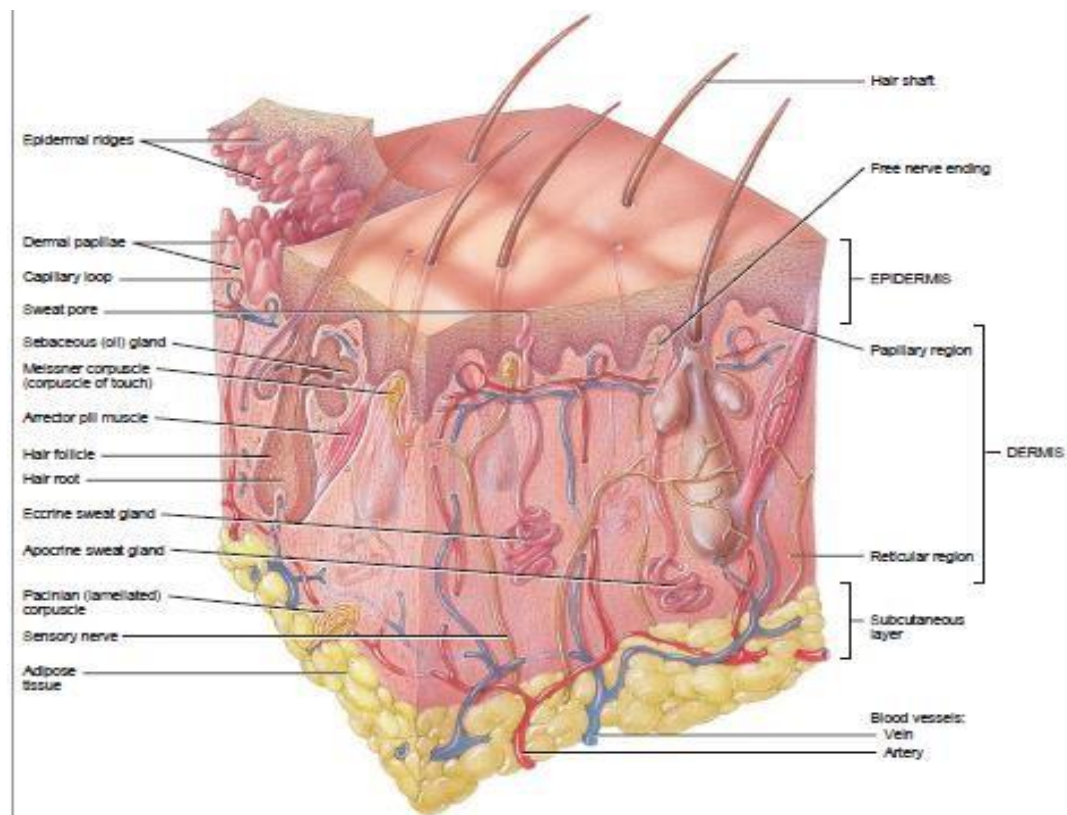


UNIT: 2

INTEGUMENTARY SYSTEM

- The **skin (also known as the cutaneous membrane or integument)** covers the external surface of the body and is the largest organ of the body in both surface area and weight.
- In adults, the skin covers an area of about 2 square meters (22 square feet) and weighs 4.5–5 kg (10–11 lb), about 16% of total body weight.
- It ranges in thickness from 0.5 mm (0.02 in.) on the eyelids to 4.0 mm (0.16 in.) on the heels. However, over most of the body it is 1–2 mm (0.04–0.08 in.) thick.
- Structurally, the skin consists of two main parts which is composed of *epithelial tissue*, is the **epidermis**. The deeper, thicker *connective tissue* portion is the **dermis**.
- Deep to the dermis, but not part of the skin, is the **subcutaneous layer**. Also called the **hypodermis** (*hypo*-below), this layer consists of areolar and adipose tissues.

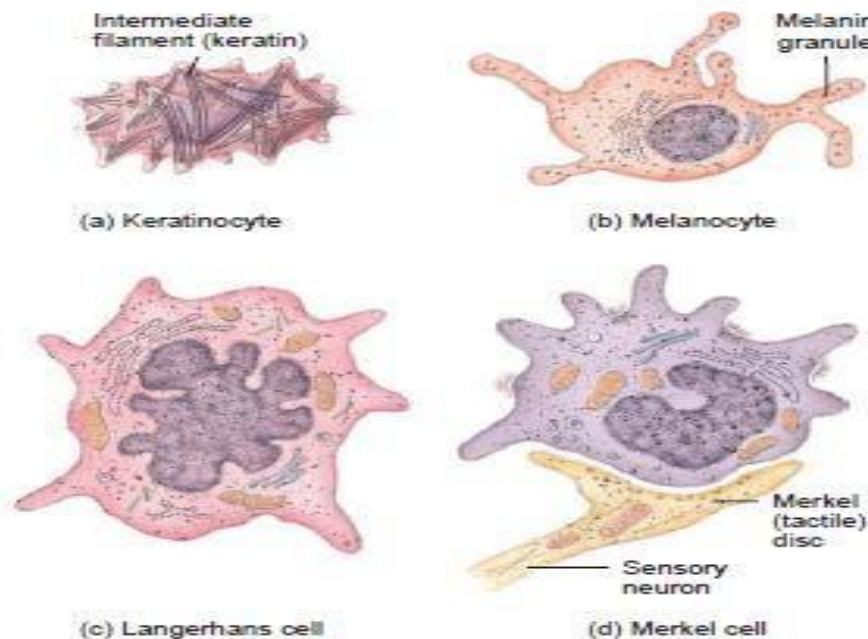


Epidermis

The epidermis is composed of keratinized stratified squamous epithelium.

It contains four principal types of cells:

- i. keratinocytes,
- ii. melanocytes,
- iii. Langerhans cells, and
- iv. Merkel cells.



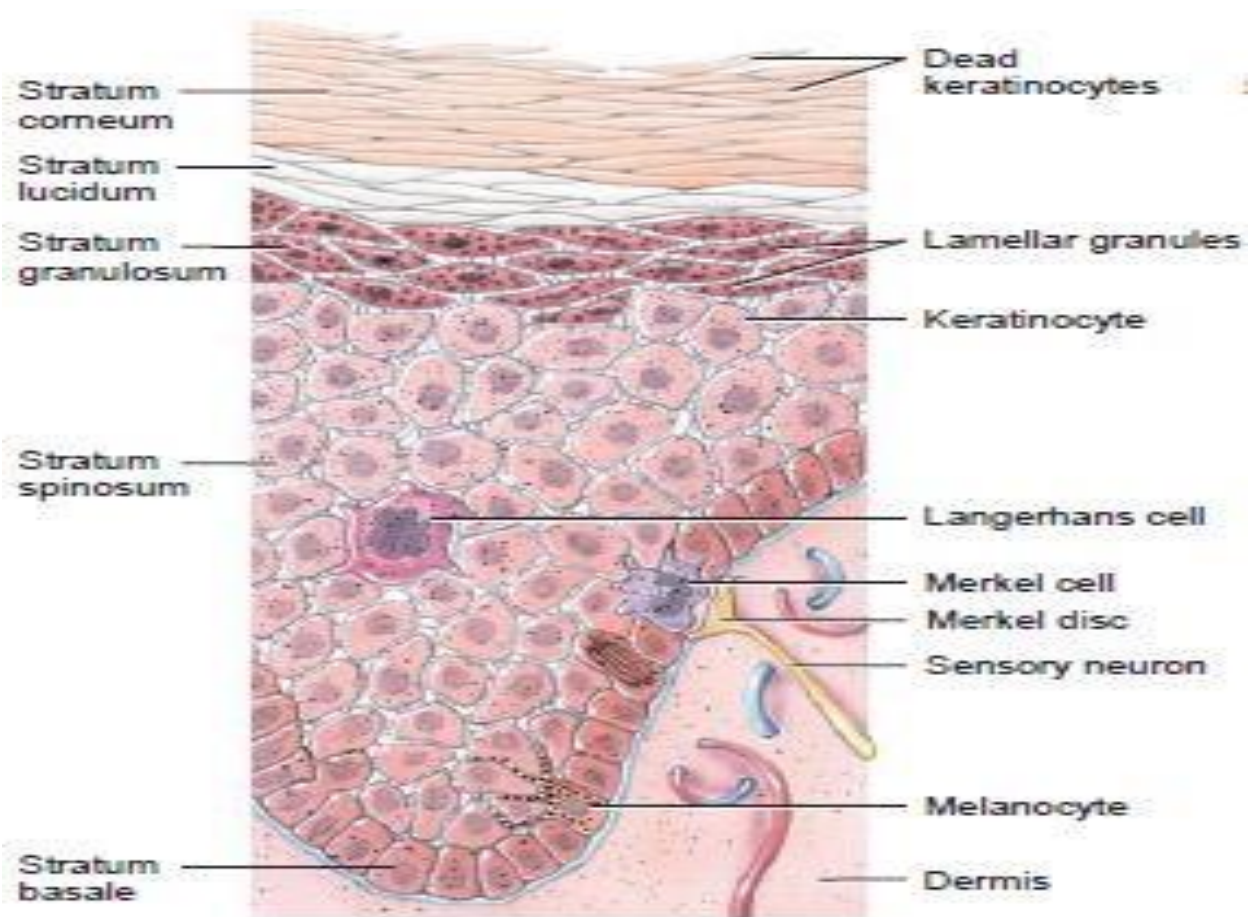
- A. About 90% of epidermal cells are **keratinocytes**. **keratin** is a tough, fibrous protein that helps protect the skin and underlying tissues from heat, microbes, and chemicals. Keratinocytes also produce lamellar granules, which release a water-repellent sealant that decreases water entry and loss and inhibits the entry of foreign materials.
- B. About 8% of the epidermal cells are **melanocytes** and produce the pigment melanin. **Melanin** is a yellow-red or brown-black pigment that contributes to skin color and absorbs damaging ultraviolet (UV) light.
- C. **Langerhans cells (LANG-er-hans)** arise from red bone marrow and migrate to the epidermis where they constitute a small fraction of the epidermal cells. They participate in immune responses mounted against microbes that invade the skin, and are easily

damaged by UV light. Their role in the immune response is to help other cells of the immune system recognize an invading microbe and destroy it.

- D. **Merkel cells are the least numerous of the epidermal cells.** They are located in the deepest layer of the epidermis, where they contact the flattened process of a sensory neuron (nerve cell), a structure called a **Merkel (tactile) disc**. Merkel cells and their associated Merkel discs detect touch sensations.

LAYERS OF EPIDERMIS

- In most regions of the body the epidermis has **four strata or layers**—**stratum basale, stratum spinosum, stratum granulosum, and a thin stratum corneum**. This is called thin skin.
- Where exposure to friction is greatest, such as in the fingertips, palms, and soles, the epidermis has **five layers**—**stratum basale, stratum spinosum, stratum granulosum, stratum lucidum, and a thick stratum corneum**. This is called thick skin.



Basale:

Deepest layer, composed of a single row of cuboidal or columnar keratinocytes that contain scattered tonofilaments (intermediate filaments); stem cells undergo cell division to produce new keratinocytes; melanocytes and Merkel cells associated with Merkel discs are scattered among the keratinocytes

Spinosum:

Eight to ten rows of many-sided keratinocytes with bundles of tonofilaments; includes armlike processes of melanocytes and Langerhans cells.

Granulosum:

Three to five rows of flattened keratinocytes, in which organelles are beginning to degenerate; cells contain the protein keratohyalin, which converts tonofilaments into keratin, and lamellar granules, which release a lipid-rich, water-repellent secretion.

Lucidum:

Present only in skin of fingertips, palms, and soles; consists of three to five rows of clear, flat, dead keratinocytes with large amounts of keratin.

Corneum:

Twenty-five to thirty rows of dead, flat keratinocytes that contain mostly keratin.

DERMIS

- The second, deeper part of the skin, the dermis, is composed of a strong connective tissue containing collagen and elastic fibers. This woven network of fibers has great tensile. The dermis also has the ability to stretch and recoil easily.

Papillary:

The superficial portion of the dermis (about one-fifth); consists of areolar connective tissue with thin collagen and fine elastic fibers; contains dermal ridges that house capillaries, Meissner corpuscles, and free nerve endings.

Reticular:

The deeper portion of the dermis (about four-fifths); consists of dense irregular connective tissue with bundles of thick collagen and some coarse elastic fibers. Spaces between fibers contain some adipose cells, hair follicles, nerves, sebaceous glands, and sudoriferous glands.

HYPODERMIS

- The subcutaneous tissue (also hypodermis and subcutis) is not part of the skin, and lies below the dermis of the cutis.
- Its purpose is to attach the skin to underlying bone and muscle as well as supplying it with blood vessels and nerves.
- It consists of loose connective tissue, adipose tissue and elastin.
- The main cell types are fibroblasts, macrophages and adipocytes (subcutaneous tissue contains 50% of body fat). Fat serves as padding and insulation for the body.

FUNCTIONS OF SKIN:

1. Thermoregulation:

- Recall that **thermoregulation is the homeostatic regulation of** body temperature. The skin contributes to thermoregulation in two ways: by liberating sweat at its surface and by adjusting the flow of blood in the dermis.
- In response to high environmental temperature or heat produced by exercise, sweat production from eccrine sweat glands increases; the evaporation of sweat from the skin surface helps lower body temperature.
- In addition, blood vessels in the dermis of the skin dilate; consequently, more blood flows through the dermis, which increases the amount of heat loss from the body. In response to low environmental temperature, production of sweat from eccrine sweat glands is decreased, which helps conserve heat.
- Also, the blood vessels in the dermis of the skin constrict (become narrow), which decreases blood flow through the skin and reduces heat loss from the body.

2. Blood Reservoir

- The dermis houses an extensive network of blood vessels that carry 8–10% of the total blood flow in a resting adult. For this reason, the skin acts as a **blood reservoir**.

3. Protection

- The skin provides **protection to the body in various ways**. Keratin protects underlying tissues from microbes, abrasion, heat, and chemicals and the tightly interlocked keratinocytes resist invasion by microbes.
- Lipids released by lamellar granules inhibit evaporation of water from the skin surface, thus guarding against dehydration; they also retard entry of water across the skin surface during showers and swims.
- The oily sebum from the sebaceous glands keeps skin and hairs from drying out and contains bactericidal chemicals that kill surface bacteria.
- The pigment melanin helps shield against the damaging effects of ultraviolet light. Two types of cells carry out protective functions that are immunological in nature.
- Epidermal Langerhans cells alert the immune system to the presence of potentially harmful microbial invaders by recognizing and processing them, and macrophages in the dermis phagocytize bacteria and viruses that manage to bypass the Langerhans cells of the epidermis.

4. Cutaneous Sensations

- Cutaneous sensations are sensations that arise in the skin, including tactile sensations—touch, pressure, vibration, and tickling—as well as thermal sensations such as warmth and coolness.
- Another cutaneous sensation, pain, usually is an indication of impending or actual tissue damage. There is a wide variety of nerve endings and receptors distributed throughout the skin, including the tactile discs of the epidermis, the corpuscles of touch in the dermis, and hair root plexuses around each hair follicle.

5. Excretion and Absorption

- The skin normally has a small role in **excretion, the elimination** of substances from the body, and **absorption, the passage of** materials from the external environment into body cells.

- Despite the almost waterproof nature of the stratum corneum, about 400 mL of water evaporates through it daily. A sedentary person loses an additional 200 mL per day as sweat; a physically active person loses much more.
- Besides removing water and heat from the body, sweat also is the vehicle for excretion of small amounts of salts, carbon dioxide, and two organic molecules that result from the breakdown of proteins—ammonia and urea.
- The absorption of water-soluble substances through the skin is negligible, but certain lipid-soluble materials do penetrate the skin. These include fat-soluble vitamins (A, D, E, and K), certain drugs, and the gases oxygen and carbon dioxide.

6. Synthesis of Vitamin D

- Synthesis of vitamin D requires activation of a precursor molecule in the skin by ultraviolet (UV) rays in sunlight.
- Enzymes in the liver and kidneys then modify the activated molecule, finally producing calcitriol, the most active form of vitamin D.
- Calcitriol is a hormone that aids in the absorption of calcium in foods from the gastrointestinal tract into the blood.
- Only a small amount of exposure to UV light (about 10 to 15 minutes at least twice a week) is required for vitamin D synthesis.