The Integumentary System

The integumentary system includes the skin or cutaneous membrane and accessory organs such as hair, nails, sebaceous (oil) glands, and sudoriferous (sweat) glands.

Functions

1. **Protection**
   
   a. chemical barriers - sebum (oil), skin secretions, and the pigment melanin protect against bacteria.
   
   b. physical barriers - cells containing the protein keratin provide structural and mechanical support.
   
   c. biological barriers - Langerhan's cells ingest and destroy bacteria by phagocytosis.

2. **Aids in homeostasis by regulating body temperature** - When body temperature increases, blood vessels in the lower layer of the skin or dermis dilate and sweat glands are stimulated to secrete sweat. Evaporation of sweat carries heat away from the body. If body temperature falls below normal, the blood vessels of the dermis constrict and warm blood by-passes the skin and remains deeper in the body.

3. **Receives stimuli** from the external environment. Cutaneous sensory receptors react to touch, pressure, pain, heat, and cold.

4. **Excretion** - Small quantities of nitrogenous wastes, such as ammonia, uric acid, and urea are removed through sweat.

5. **Synthesis of Vitamin D** - Vitamin D is absorbed by the blood vessels of the dermis and transported to other parts of the body where it is used in calcium metabolism and it is required for absorption of calcium from the digestive tract.

6. **Reservoir for Blood** - The vascular system of the skin contains about 5% of the total volume of blood.

The integument consists of two distinct layers: the epidermis and the dermis. They are separated by a basement membrane which is an adhesive layer composed of substances secreted by the epidermis and the dermis. It functions in resisting tearing and stretching of the skin.
**Epidermis**

In thick skin of the palms of the hands, soles of the feet, fingertips, and tips of the toes, the epidermis consists of five layers. The majority of the body is covered with thin skin consisting of four layers.

1. **stratum basale** (basal layer) - the deepest layer which rests on the basement membrane. It is composed of a single layer of column-shaped **keratinocytes**. Keratinocytes produce **keratin** and the cells are pushed toward the surface of the skin as they undergo rapid cell division by mitosis.

   **Melanocytes**, which are spider-shaped cells, are also present. They produce the pigment **melanin** which ranges in color from yellow to brown to black. Melanocytes have branching processes which extend around and surround cells and reach into the next layer of the epidermis. Melanin moves to the ends of the processes and is ingested by keratinocytes through phagocytosis. The melanin accumulates on the upper surface of the nucleus in the keratinocytes and protects it from ultra-violet radiation.

   **Merkel cells**, which function in light touch reception are also present.

2. **stratum spinosum** (spiny layer) - The keratinocytes are flattened, irregularly shaped cells containing thick bundles of **keratin filaments** called **tonofilaments** ("tension filaments"). The cells have tiny projections on the outer surface and are sometimes referred to as **prickle cells**.

   **Langerhan’s cells** are found in the greatest abundance in this layer.

   Mitosis is less frequent than in the stratum basale. The stratum basale and the stratum spinosum are sometimes collectively called the **stratum germinativum** because they produce or germinate new cells.

3. **stratum granulosum** (granular layer) - It consists of three to five layers of flattened keratinocytes. **Keratinization** begins in this layer. The cells contain granules of **keratohyalin** and the plasma membrane of the cells thickens ("toughening up").

4. **stratum lucidum** (clear layer) - this layer is absent in thin skin. It consists of a few layers of dead keratinocytes and forms a translucent layer. Keratohyalin granules become associated with tonofilaments and form **keratin fibrils**.

5. **stratum corneum** (horny layer) - The layer consists of 20-30 layers of flat, dead **cornified** or **horny cells** completely filled with keratin fibrils. The cells are continuously shed and replaced by cells that move up from the lower layers of the epidermis.

   The stratum corneum protects the lower layers of the epidermis from water loss and chemical, physical and biological damage.
Dermis

The dermis is located below the basement membrane and it contributes to the strength and elasticity of the skin. It has a rich supply of blood vessels, nerve fibers, sense receptors and lymphatic vessels. Hair follicles, sebaceous (oil) glands, and sudoriferous (sweat) glands are found in the dermis, but they are produced by cells from the epidermis.

The dermis consists of two layers:

1. **papillary layer** - it is a thin layer of loose areolar connective tissue containing numerous blood vessels. The upper layer forms small, fingerlike projections that extend into the epidermis and push it upwards forming dermal papillae. Some dermal papillae contain free nerve endings which respond to pain and Meissner’s corpuscles for touch reception.
   The dermal papillae form patterns of loops and whorls on the tips of the fingers and toes and lines on the palms and soles called epidermal ridges. The patterns are genetically determined and ducts to sweat glands open on the surface of the ridges. When an object is touched, the sweat leaves characteristic fingerprints.

2. **reticular layer** - it forms 80% of the dermal layer. It is composed of dense, irregularly arranged interlocking bundles of collagen and elastic fibers which gives the skin elasticity, strength, and extensibility (stretch). Adipose tissue, hair follicles, sebaceous and sweat glands are located between the fibers.

Hypodermis

The hypodermis is the subcutaneous layer and it is not considered as part of the integument (cutaneous layer). It consists of loose connective tissue and adipose tissue which functions in attaching the skin to muscle and the underlying organs. The adipose tissue acts as insulation to conserve body heat.

Skin Color

Skin color is the result of a combination of three pigments:

1. **melanin** - a yellow to brown to black pigment found in the melanocytes of the stratum basale and the stratum spinosum.

2. **carotene** - a yellow to orange pigment found in the stratum corneum and adipose tissue of the dermis and hypodermis.

3. **hemoglobin** - a red pigment found in the small blood vessels of the dermis.
Accessory Organs of the Skin

There are three major types of glands:

1. **sebaceous glands** - they are oil glands which are located all over the body except on the palms of the hands and soles of the feet. They are usually associated with hair follicles, but some open through pores in the epidermis of the skin.

   The glands secrete an oily substance called **sebum** which contains fats, cholesterol, proteins, and inorganic salts. Sebum functions in moisturizing hair, softening and lubricating the skin, preventing water loss from evaporation, and in destroying bacteria.

2. **sudoriferous glands** - they are the sweat glands and they consist of two types based on their structure and function.
   a. **apocrine glands** - They respond to emotional stress and consist of simple, branched tubular glands. They are located in the **axilla** (arm pit), **pubic region**, and **areolae** (pigmented area) of the breasts. Apocrine glands open into hair follicles and they secrete a thick or viscous fluid which is composed of water, salts, urea, uric acid, ammonia, sugar, lactic acid, proteins, and fats.
   b. **eccrine glands** - They respond to elevated body temperature and consist of simple, coiled, tubular glands. They are distributed throughout the body and are abundant on the palms, soles, and forehead. Eccrine glands open through pores on the surface of the epidermis and they secrete a watery fluid which is composed of water, salts, urea, uric acid, ammonia, lactic acid, vitamin C, and antibodies.

3. **ceruminous glands** - They are modified apocrine glands and they consist of simple, coiled tubules located in the external auditory meatus or ear canal. The ceruminous glands are located below the sebaceous glands and open through pores in the epidermis of the ear canal or into sebaceous ducts. The combined secretions of the sebaceous glands and the ceruminous glands is called **cerumen** or ear wax. Cerumen functions in blocking bacteria and other substances from entering the ear.