

# Lecture Outline: The Integumentary System and Membranes

## I. Introduction to the Integumentary System and Membranes

- A. Chapter focus: Integumentary system and membranes, as not all membranes are part of the integumentary system.
- B. The term "integument" means **covering**.
- C. The **Integumentary System** primarily includes the **skin**, **hair**, and **nails**.
- D. The skin is a **multicellular membrane**, also known as the **cutaneous membrane**.
- E. The skin is the **largest and heaviest organ** of the body.
- F. Biological Hierarchy: Cells form tissues, tissues form organs. The skin is an organ composed of different tissue types.
- G. The skin's position is primarily **superficial**, serving as a barrier between the body and the environment.

## II. Types of Membranes

### A. Cutaneous Membrane (Skin)

- 1. The skin is a **dry membrane**, unlike mucous membranes.
- 2. The outermost epidermis consists of **dead cells**.

### B. Mucous Membranes (Mucosa)

- 1. Line **internal hollow structures** that open to the outside of the body.
- 2. Examples include the entire **alimentary canal** (mouth to anus), vagina, and trachea.
- 3. Produce **mucus**, a thick, viscous, and slippery fluid.
- 4. Function: **Lubrication** (e.g., for food during mastication and deglutition) and protection.
- 5. These membranes remain **moist** due to continuous mucus production.

### C. Serous Membranes (Serosa)

1. Adjective of "serum," meaning a **watery, thin fluid**.
2. Found in places where an organ moves considerably against its surroundings.
3. Function: Allow for **movement of structures without damage** from abrasion.
4. Each membrane is a single membrane folded back on itself, forming two layers:
  - a. **Visceral layer**: The deeper layer, directly in contact with the organ.
  - b. **Parietal layer**: The more superficial layer, forming a wall with the surroundings.
5. The small space between the two layers is filled with **serous fluid**, produced by the membrane itself.
6. Examples:
  - a. **Pericardium**: Surrounds the heart.
  - b. **Pleura**: Surrounds each lung.
7. Analogy: A fist pushed into a partially water-filled balloon.

#### D. **Synovial Membranes**

1. Line fluid-filled spaces in **highly movable joints** (e.g., knee, ankle).
2. The fluid-filled space is called the **synovial cavity**.
3. The fluid within is **synovial fluid**, which has the consistency of raw egg white and is very lubricating (thicker than serous fluid).
4. Part of the membrane is formed by **hyaline cartilage** on the bone surfaces, providing cushioning and slipperiness.

### III. **Functions of the Integumentary System**

#### A. **Protection from Mechanical Damage**

1. The skin is a tough, pliable, self-healing material.
2. Toughness is due to **keratin**, a fibrous protein found in skin cells (soft keratin).
3. Outer epidermal cells become **cornified** (hardened, horny).
4. A layer of **adipose tissue** (fat cells) deep to the skin provides cushioning.

5. **Sensory receptors** in the skin detect mechanical stimuli (e.g., touch, pressure).
6. Pain receptors alert the body to potential harm.

#### B. **Protection from Chemical Damage**

1. The skin is resistant to moderate changes in pH (acids and bases).

#### C. **Protection from Micro Damage (Infection)**

1. Acts as an effective **physical barrier** against microorganisms.
2. Produces the **acid mantle**: A thin layer of acidic and salty solution that inhibits bacterial growth.
3. Contains **phagocytes** (e.g., dendritic cells) that engulf and digest foreign invaders.
4. Historical note: Simple cuts were routinely fatal before antibiotics (e.g., penicillin in the 1940s).

#### D. **Protection from Ultraviolet (UV) Radiation**

1. UV radiation can damage DNA, leading to mutations and cancer.
2. The skin produces **melanin**, a pigment that absorbs UV light.
3. Melanin molecules cluster on the superficial side of the cell's nucleus, acting as a parasol.
4. Skin cells also have mechanisms to repair DNA damage.

#### E. **Protection from Thermal Damage**

1. Sensory receptors in the skin detect excessively hot or cold temperatures, prompting withdrawal.

#### F. **Protection from Desiccation (Drying Out)**

1. Deeper body tissues must remain moist for chemical reactions (life) to occur.
2. The skin is largely **waterproof** due to **glycolipids** secreted between epidermal cells.
3. The epidermis, with its tightly packed cells, acts like "bricks and mortar."

#### G. **Thermoregulation (Maintenance of Body Temperature)**

1. A critical aspect of homeostasis.

## 2. **Sweating:**

- a. Sweat glands in the skin produce sweat (mostly water and salt).
- b. Evaporation of sweat from the skin surface removes a significant amount of heat from the body, leading to cooling.
- c. Evaporation cools because it removes the fastest (highest energy) molecules from the liquid surface.

## 3. **Blood Flow Adjustment:**

- a. When the body is too hot, blood flow to the skin increases (**flushing**), allowing heat to be lost conductively to the environment.
- b. When the body is too cold, blood flow to the skin decreases (**paling**), conserving heat within the body's core.

## H. **Excretion** (minor function)

1. Sweat contains small amounts of **urea** and uric acid, which are nitrogen-containing waste products.
2. The liver converts toxic ammonia into urea, which is primarily filtered by the kidneys.

## I. **Synthesis of Vitamin D**

1. Vitamin D is unique among vitamins as the body can manufacture it (though dietary intake is also important).
2. Process involves the skin and UV radiation:
  - a. **Cholesterol** in skin cells is converted by UV light into **cholecalciferol**.
  - b. Cholecalciferol travels to the **liver**, where it's converted to **calcidiol**.
  - c. Calcidiol travels to the **kidneys**, where it's converted to **calcitriol** (the active form of vitamin D).
  - d. Calcitriol then acts on the **small intestines** to enhance the absorption of **calcium**.
3. Vitamin D is crucial for calcium absorption, which is vital for bone health and many other bodily functions.

## IV. **Anatomy of the Skin and Accessory Structures**

### A. **Layers of the Skin**

## 1. Epidermis:

- a. The most superficial layer, composed of **epithelial tissue**.
- b. Thinner than the dermis.
- c. Classified as a **stratified squamous epithelium** (many layers, flat cells at the apical/free surface).
- d. Cells are continuously produced at the basal layer and migrate superficially, eventually dying and shedding.
- e. Stratified layers (strata), from deep to superficial:
  - (1) **Stratum Basale (Basily)**: Deepest layer, cuboidal cells, undergoes frequent **mitosis** to produce new cells.
  - (2) Contains two main cell types:
    1. **Keratinocytes**: Most abundant, produce keratin, give skin strength.
    2. **Melanocytes**: Produce **melanin**, which is transferred to keratinocytes via phagocytosis of their extensions, protecting DNA from UV.
  - (3) **Stratum Spinosum**: Cells appear "spiny" due to desmosome connections when prepared for microscopy. Keratinocytes continue producing keratin fibers.
  - (4) **Stratum Granulosum**: Cells produce **granules** (proteins that strengthen keratin network) and **lamellar bodies** (lipid-rich for waterproofing).
  - (5) **Stratum Corneum**: Outermost layer, composed of hardened, dead, flattened cells called **corneocytes**. It is highly stratified and waterproof.
  - (6) **Stratum Lucidum**: An additional, clear stratum found **only in thick skin** (palms, soles), located between the stratum granulosum and stratum corneum.
- f. Other epidermal cells:
  - (1) **Merkel cells**: Sensory receptors, superficially placed and sensitive to light touch.
  - (2) **Dendritic cells**: Immune cells that surveil the skin, engulf

foreign material, and present it to white blood cells.

## 2. **Dermis:**

- a. Deep to the epidermis, primarily composed of **connective tissue**.
- b. Much thicker than the epidermis.
- c. Subdivided into two layers:
  - (1) **Papillary layer:** The superficial part of the dermis, characterized by **dermal papillae** (finger-like projections) that interlock with the epidermis. These papillae contain **capillaries** that supply blood to the living epidermal cells.
  - (2) **Reticular layer:** The deeper part of the dermis, named for its dense network of collagen and elastic fibers oriented in all directions, providing strength.
- f. Contains hair follicles, glands, sensory receptors, and blood vessels.

## 3. **Hypodermis:**

- a. Located below the dermis, but **not technically part of the skin**.
- b. Composed mostly of **adipose tissue** (fat cells).
- c. Functions as **thermal insulation** and cushioning.
- d. Major blood vessels are located deep in the dermis, superficial to the hypodermis, to allow for effective heat shedding when needed.

## B. **Hair**

- 1. The visible part is the **hair shaft**; the living part is within the **hair follicle** (located in the dermis).
- 2. Composed of three concentric layers from deep to superficial:
  - a. **Medulla** (deepest).
  - b. **Cortex**.
  - c. **Cuticle** (most superficial): Features overlapping, shingle-like structures that help anchor the hair within the follicle.
- 3. Hair is much tougher than skin due to the presence of **hard keratin**.
- 4. The **hair papilla** within the follicle contains a rich blood supply for cell division and hair growth.

5. Visible hair is dead, which is why cutting it does not cause pain.
6. **Erector Pili Muscle**: Tiny muscles attached to hair follicles in the dermis.
  - a. Contraction pulls the hair upright (**erects pili**).
  - b. This action is called **horripilation** and can trap a thicker layer of insulating air, providing warmth.

### C. Glands in the Skin

#### 1. Sweat Glands:

- a. **Eccrine (Merocrine) Sweat Glands**: Widespread across the skin, produce watery sweat for **thermoregulation** via evaporation.
  - b. **Apocrine Sweat Glands**: Located mainly in the axillae (armpits) and perineum; produce an odorless solution that bacteria break down to create body odor.
2. **Ceruminous Glands**: Produce **cerumen** (ear wax) in the ear canal.
  3. **Sebaceous Glands**: Produce **sebum** (body oil), usually associated with hair follicles, to lubricate hair and skin.

### D. Nails

1. Part of the integumentary system; the **toughest** of the three major structures.
2. Contain significantly more **hard keratin** than hair.
3. **Free edge**: The part of the nail that is cut.
4. **Nail bed**: The skin beneath the main body of the nail.
5. The visible nail is dead.
6. **Nail matrix**: The living part of the nail, located under a fold of skin, where cell division occurs to produce new nail cells that are pushed distally.
7. **Cuticle**: A hardened piece of skin near the base of the visible nail.
8. **Lunula**: The white, crescent-shaped area at the base of the nail, meaning "little moon."
9. Nails serve as important tools.