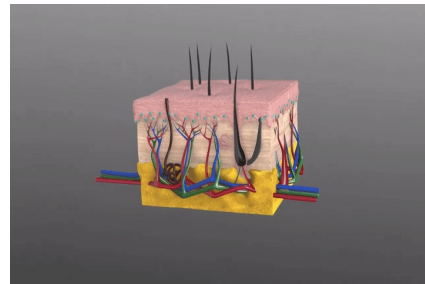




## Physiology of Integumentary System

### Part I: Skin

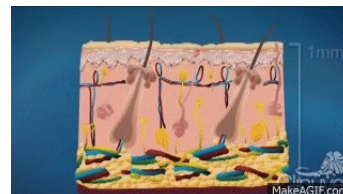
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### Contents:

- Components of the integumentary system.
- Characteristics of the Skin.
- Principal Cells of the Epidermis.
- Layers of the Epidermis
- Epidermal ridges.
- The Structural Basis of Skin Color.
- Functions of the Integumentary System.
- Interactions with other systems.

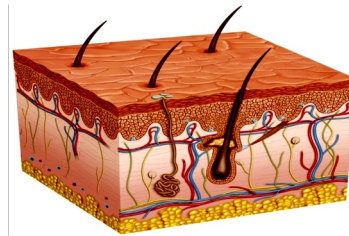


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## Objectives:

**By the end of this lecture, you will be able to:**

1. Know components of the integumentary system.
2. Describe the characteristics of the skin.
3. Describe the cells, layers and regions of the skin parts.
4. Explain the basis for different skin colors.
5. Know functions of the integumentary system.

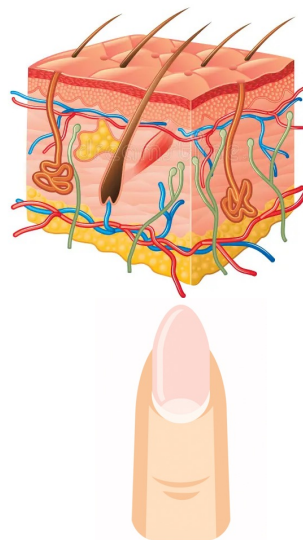


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## Components of the Integumentary system:

■ **The system includes:**

- **Skin,**
- **Hair,**
- **Accessory glands**
  - ✓ Oil gland
  - ✓ Sweat gland
- **Nails, and**
- **Sensory receptors.**



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## Characteristics of the Skin:

- The largest organ of the body **in weight**.
- It also known as the **cutaneous membrane**.
- Covers the external surface of the body.
- Dimensions (In adults):
  - Area:  $\sim 2 \text{ m}^2$ .
  - **Weight:** 4.5–5 kg ( $\sim 16\%$  of total body).
  - **Thickness:** 1–2 mm thick (Over most of the body).
  - ✓ 0.5 mm (the eyelids)
  - ✓ 4.0 mm (the heels).



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## Characteristics of the Skin:

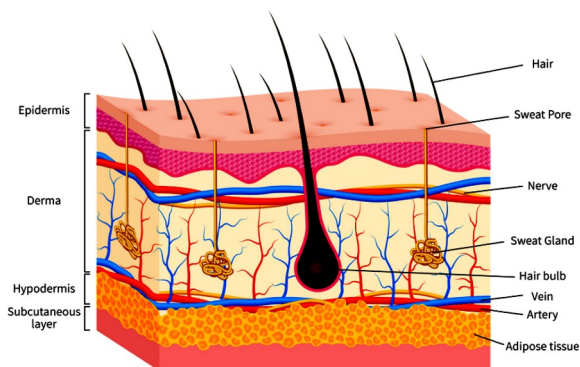
- The skin consists of 2 main parts:

### 1. The Epidermis:

- Superficial,
- **Avascular**,
- **Thinner portion**,
- **Epithelial tissue**.

### 2. The Dermis:

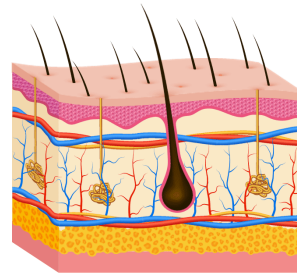
- Deeper,
- **Vascular**,
- **Thicker portion**,
- **Connective tissue**.



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## Characteristics of the Skin:

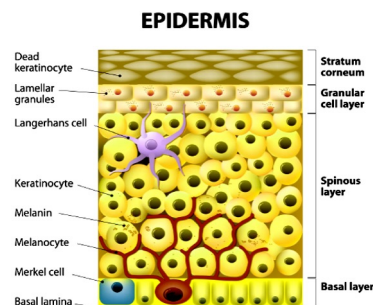
- **The Subcutaneous layer:**  
(not part of the skin)
  - is also called **hypodermis**,
  - is deep to the dermis. consists of **areolar and adipose tissues**
  - anchors the dermis to underlying tissues and organs,
  - contains lamellated (or **pacinian**) corpuscles  
(nerve endings → **sensitive to pressure**)



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## Layers of the Skin: ① Epidermis:

- Composed of keratinized stratified squamous epithelium.
- Contains 4 principal types of cells:
  1. **Keratinocytes,**
  2. **Melanocytes,**
  3. **Intraepidermal macrophages,**
  4. **Tactile epithelial cells**  
(or **Merkel cells**).

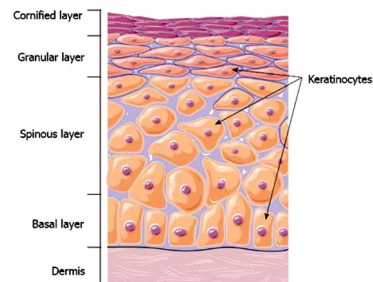
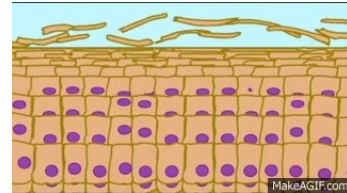


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## Principal Cells of the Epidermis:

### 1. Keratinocytes

- ~90% of the total epidermis
  - 4-5 layers
  - produce the protein **keratin**.
- **Keratin** is a tough, fibrous protein that helps protect the skin and underlying tissues from abrasions, heat, microbes, and chemicals.
- They produce **lamellar granules**, which release a **water-proof sealant** that:
    - decreases water entry and loss
    - inhibits the entry of foreign materials.

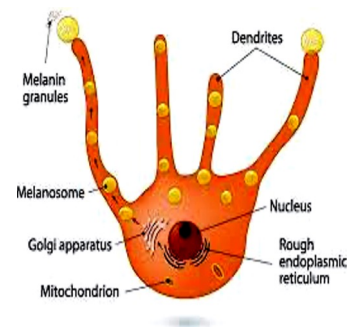


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## Principal Cells of the Epidermis:

### 2. Melanocytes:

- ~8% of the epidermal cells
  - produce the pigment **melanin**.
- **Melanin** is a yellow-red or brown-black pigment that contributes to skin color and absorbs damaging ultraviolet (UV) light.
- **Melanocytes** have long, **slender projections** that extend between the keratinocytes and transfer melanin granules to them.



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## Principal Cells of the Epidermis:

### Q. How do melanin protect the skin from being damaged by UV light?

- Once inside keratinocytes, the melanin granules cluster to form a protective veil over the nucleus, on the side toward the skin surface. In this way, they shield the nuclear DNA from damage by UV light.
- Although their melanin granules effectively protect keratinocytes, melanocytes themselves are particularly susceptible to damage by UV light.

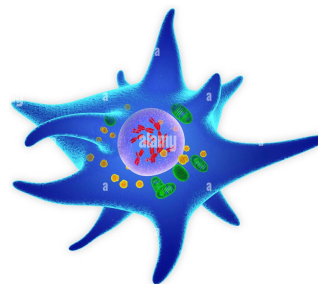


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## Principal Cells of the Epidermis:

### 3. Intraepidermal Macrophages: (Langerhans Cells)

- constitute a **small fraction** of the epidermal cells.
- participate in immune responses mounted against microbes that invade the skin (help other cells of the immune system recognize an invading microbe and destroy it).
- they are easily damaged by UV light.

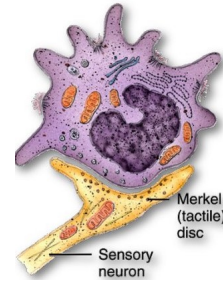


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## Principal Cells of the Epidermis:

### 4. Tactile epithelial cells (or Merkel cells).

- are associated with sensory neurons.
- These mechanoreceptors are located in the basal layer of the epidermis.
- are slowly adapting mechanoreceptors responsible for prolonged light touch and are mainly found in areas with high tactile sensitivity, such as the lips, palms, soles, and oral cavity.

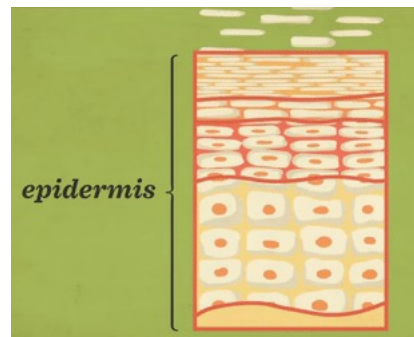


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## Layers of the Epidermis:

■ In most regions of the body the epidermis has 4 strata (layers)

- Stratum basale (**germinativum**),
- Stratum spinosum,
- Stratum granulosum, and
- a **thin** stratum corneum.



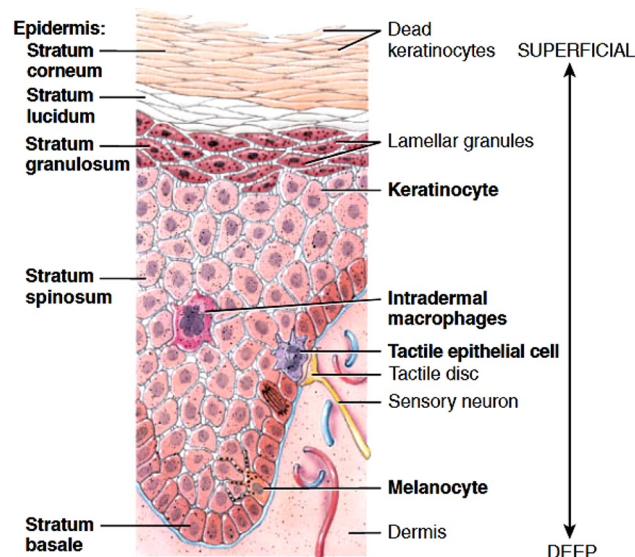
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## Layers of the Epidermis:

- Where exposure to friction is greatest, such as in the fingertips, palms, and soles, **the epidermis has 5 layers:**
  - Stratum basale,
  - Stratum spinosum,
  - Stratum granulosum,
  - **Stratum lucidum,**
  - A **thick** stratum corneum.

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## Layers and Principal Cells of The Epidermis:



Four principal cell types in epidermis of thick skin

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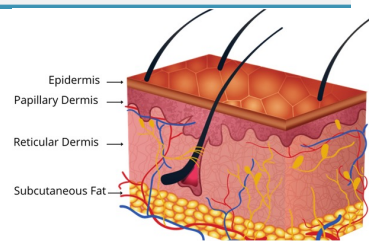
## Layers of the Skin: ② Dermis:

- Composed of **dense irregular connective tissue**.
- Containing collagen and elastic fibers providing great tensile strength.
- Resists **pulling** or **stretching** forces.
- It has the ability to **stretch** and **recoil** easily.
- It is **much thicker** than the epidermis.
- Its thickness varies from region to region in the body, reaching its greatest thickness on the palms and soles.
- It can be divided (based on its tissue structure) into:
  - a **thin superficial papillary region**
  - a **thick deeper reticular region**.

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## Papillary and Reticular Regions of the Dermis:

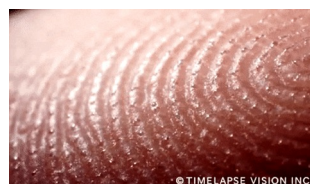
REGION	DESCRIPTION
<b>Papillary</b>	Superficial portion of dermis (about one-fifth); consists of areolar connective tissue with thin collagen and fine elastic fibers; contains dermal ridges that house blood capillaries, corpuscles of touch, and free nerve endings.
<b>Reticular</b>	Deeper portion of dermis (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.



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### Epidermal ridges (ER):

- The surfaces of the palms, fingers, soles, and toes have a series of ridges and grooves. They appear either as straight lines or as a pattern of loops and whorls, as on the tips of the digits.
- They create a strong bond between the epidermis and dermis in a region of high mechanical stress.
- They also increase the surface area of the epidermis and thus increase the grip of the hand or foot by increasing friction.



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### Epidermal ridges (ER):

- They greatly increase surface area, which increases the number of corpuscles of touch and thus increases tactile sensitivity.
- Because the ducts of sweat glands open on the tops of the ER as sweat pores, **the sweat and ridges form fingerprints (or footprints) on touching a smooth object.**

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## Epidermal ridges (ER):

- The ER pattern is in part genetically determined and is unique for each individual. Even identical twins have different patterns.
- Normally, the ridge pattern does not change during life.
- It can serve as the basis for identification.
- **Dermatoglyphics** is the study of the pattern of ER.



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## The Structural Basis of Skin Color:

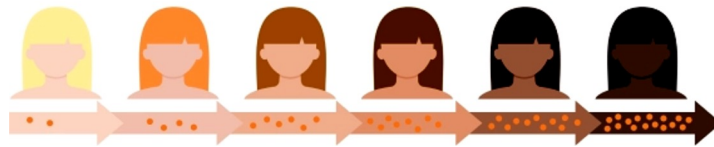
- Melanin, hemoglobin, and carotene are three pigments that impart a wide variety of colors to skin.
- The amount of melanin causes the skin's color to vary from pale yellow to reddish-brown to black.
- The two forms of melanin are:
  - **Pheomelanin (yellow to red)**
  - **Eumelanin (brown to black).**



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## The Structural Basis of Skin Color:

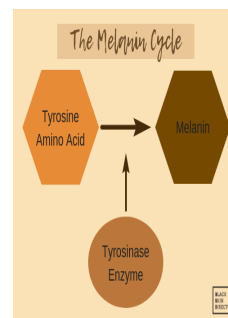
- The number of melanocytes is about the same in all people, so the differences in skin color are due mainly to:
  - **The amount of pigment the melanocytes produce and transfer to keratinocytes.**



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## The Structural Basis of Skin Color:

- Melanocytes synthesize melanin from the amino acid **tyrosine** in the presence of an enzyme called **tyrosinase**.
- Synthesis occurs in an organelle called a melanosome.
- Exposure to ultraviolet (UV) light increases the enzymatic activity within melanosomes and thus increases melanin production.
- Both the **amount** and **darkness of melanin** increase on UV exposure, which gives the skin a **tanned** appearance and helps protect the body against further UV radiation.
- Melanin absorbs UV radiation, prevents damage to DNA in epidermal cells.



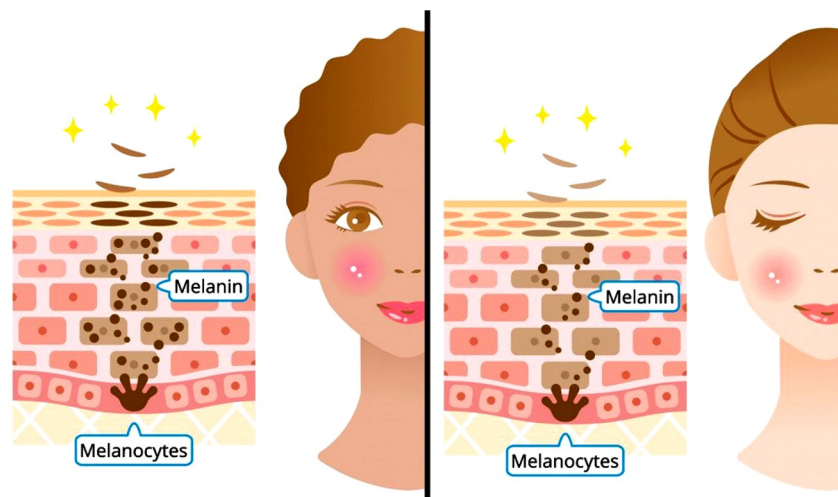
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### The Structural Basis of Skin Color:

- **Dark-skinned individuals** have large amounts of melanin in the epidermis, so their skin color ranges from yellow to reddish-brown to black.
- **Light-skinned individuals** have little melanin in the epidermis. Thus, the epidermis appears translucent, and skin color **ranges from pink to red** depending on the oxygen content of the blood moving through capillaries in the dermis. The red color is due to hemoglobin.
- **Carotene** is a yellow-orange pigment that gives egg yolks and carrots their color.

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### The Structural Basis of Skin Color:

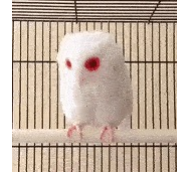


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## Clinical Conditions of Skin Color:

### ■ Albinism:

- Is the inherited inability of an individual to produce melanin.
- Most albinos, have melanocytes that are unable to synthesize **tyrosinase**.
- Melanin is missing from their hair, eyes, and skin.
- This results in problems with vision and a tendency of the skin to burn easily on overexposure to sunlight.



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## Clinical Conditions of Skin Color:

### ■ Vitiligo:

- the partial or complete loss of melanocytes from patches of skin produces irregular **white spots**.
- The loss of melanocytes is related to an immune system malfunction in which antibodies attack the melanocytes.



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### Functions of the Integumentary System:

1. **Regulates body temperature.**
2. **Stores blood.**
3. **Protects body from external environment.**
4. **Detects cutaneous sensations.**
5. **Excretes and absorbs substances.**
6. **Synthesizes vitamin D.**

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### Interactions With Other Systems:

- The integumentary system is very active in working with other organ systems to maintain the body's homeostasis.
- **Examples of how the skin helps each body system maintain homeostasis include:**

#### 1. Immune System

- Antimicrobial peptides and lipids on the skin also act as a biomolecular barrier that disrupts bacterial membranes.
- Both **myeloid** and **lymphoid** cells are present in the skin.

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## Interactions With Other Systems:

### 2. Digestive System

- The skin synthesizes vit. D which is required to absorb  $\text{Ca}^+$

### 3. Cardiovascular System (CVS):

- The skin works with the CVS by helping to **conserve** or **release heat** by **constricting or dilating the blood vessels**.

### 4. Nervous System

- The skin functions, via its nerve receptors, to transmit sensations (pain, heat, cold, and other sensations) to the nervous system to be interpreted by the brain.

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## Interactions With Other Systems:

### 5. Musculoskeletal System

- Vit.D synthesis promotes  $\text{Ca}^+$  absorption.
- $\text{Ca}^+$  is needed for the:
  - ✓ growth and maintenance of bones.
  - ✓ muscle contractions.

### 6. Endocrine System

- Vit. D, produced by the skin, can act as a hormone in the body.
- Every cell in our body has a nucleus with the ability to interact with vit. D.

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## Interactions With Other Systems:

### 7. Respiratory System

- The small hairs in the nose (part of the integumentary system) act as a filter to remove harmful particles which may otherwise be inhaled into the lungs.

### 8. Urinary System

- The skin functions to excrete waste products (such as salts and some nitrogenous wastes) into the sweat; this helps the kidneys maintain the body's proper balance of electrolytes as well as maintaining the normal pH balance.

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## Questions and Comments:



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