The Integumentary System

Integumentary System Components

- **Integumentary System (Integument):** composed of *skin, hair, nails, sweat glands, oil glands, & mammary glands*

Integumentary Functions

- Physical protection
- Regulation of body temperature (sweating, vasodilation/vasoconstriction)
- Excretion (secretion)
- Nutrition (synthesis of Vitamin D precursor)
- Sensation (via sensory receptors)
- Immune defense

Integumentary Structures

- **Skin** = cutaneous membrane:
  - *Epidermis* = stratified squamous epithelium
  - *Dermis* = underlying, loose CT.
    - *Subcutaneous layer* (not part of cutaneous membrane) is deep to the dermis
- **Accessory structures**: hair, nails, + many multicellular exocrine glands
Skin Structures & Functions

The skin is also known as the cutaneous membrane.

**EPIDERMIS**
- Protects dermis from trauma, chemical
- Controls skin permeability, prevents water loss
- Prevents entry of pathogens
- Synthesizes vitamin D3
- Sensory receptors detect touch, pressure, pain, and temperature
- Coordinates immune response to pathogens and skin cancers

**DERMIS**
- Nourishes and supports epidermis

**PAPILLARY LAYER**
- Nourishes and supports epidermis

**RETICULAR LAYER**
- Restricts spread of pathogens percolating epidermis
- Stores lipid reserves
- Attaches skin to deeper tissues
- Sensory receptors detect touch, pressure, pain, vibration, and temperature
- Vessels assist in thermoregulation

Accessory Structures and Functions

**ACCESSORY STRUCTURES**

**HAIR FOLLICLES**
- Produce hairs that protect skin
- Produce hairs that provide delicate touch sensations on general body surface

**EXOCRINE GLANDS**
- Assist in thermoregulation
- Excrete wastes
- Lubricate epidermis

**NAILS**
- Protect and support tips of fingers and toes

Integumentary Tissues

- All 4 tissue types are present:
  - **Epithelium** covers the surface.
  - **CT** provides underlying stability.
    - Abundant blood vessels
  - **Smooth muscle** in walls of blood vessels and attached to hairs
    - Arrector pili
  - **Neural tissue** provides sensation; controls blood vessel diameter

The Integumentary System
Epidermal Cell Types

- **Keratinocytes** = most abundant cells
  - 4-5 layers in most areas
- **Melanocytes**: pigment cells
  - Deep in epidermis
- **Merkel cells**: sensory cells
- **Langerhans cells**: have immune functions
  - Also known as Dendritic cells

Layers of the Epidermis

<table>
<thead>
<tr>
<th>TABLE 4.1</th>
<th>Epidermal Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer</td>
<td>Characteristics</td>
</tr>
<tr>
<td>Stratum corneum</td>
<td>Multiple layers of flattened, dead, interlocking keratinocytes. Typically relatively dry. Water-resistant, but not waterproof. Permits slow water loss by insensible perspiration.</td>
</tr>
<tr>
<td>Stratum lucidum</td>
<td>Appears as a “glistening” layer in thick skin only</td>
</tr>
<tr>
<td>Stratum granulosum</td>
<td>Keratinocytes produce keratohyalin and keratin. Keratin fibers develop as cells become thinner and flatter. Gradually the cell membranes thicken, the organelles disintegrate, and the cells die.</td>
</tr>
<tr>
<td>Stratum spinosum</td>
<td>Keratinocytes, now bound together by desmosomes, attached to tonofibrils of the cytoskeleton. Some keratinocytes divide in this layer. Langerhans cells and melanocytes are often present.</td>
</tr>
<tr>
<td>Stratum germinativum</td>
<td>Innermost, basal layer. Attached to basal lamina. Contains epidermal stem cells, melanocytes, and Merkel cells.</td>
</tr>
</tbody>
</table>

Epidermal Cross-section

- **Keratinocytes** are present in all epidermal layers
  - Change characteristics as they are pushed to the surface & die
  - It takes 15-30 days for a keratinocyte to reach the surface

Epidermal Layers & Cells

- **Stratum germinativum (stratum basale)** = deepest layer
  - Attached to basal lamina
  - Cell types:
    - **Basal cells** (stem cells for keratinocyte production): divide in this layer
    - **Melanocytes** = pigment-producing cells; secrete pigment (melanin)
      - Melanin is taken up by keratinocytes
**Epidermal Layers & Cells**

- **Stratum spinosum**
  - Contains primarily keratinocytes and melanocytes
  - Langerhans cells = primarily in this layer
    - Compose ~5% of all cells in epidermis
- **Stratum granulosum**
  - Keratinocytes manufacture large amounts of proteins (keratohyalin & keratin)
  - Keratinocytes become thinner/flatter and eventually die

**Epidermal Layers & Cells**

- **Stratum lucidum**: *only in thick skin*
  - Present in palms & soles.
  - Cells similar to those in granulosum, but do not stain well = “clear layer”
- **Stratum corneum** = surface layer; *dead cells*
  - 5-30 layers of flatted, dead, interlocking cells.
    - Connected cells are shed in sheets.
- **Keratinized skin** (cornified) = epithelium containing a large amount of keratin.
  - Everywhere on skin surface, except eyelids

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**Thick vs. Thin Skin (Relative Epidermal Thickness)**

- Skin: Fingerprints & Skin Color

Epidermal ridges form complex whorls in thick skin (e.g., fingerprints)

Skin Color is determined by multiple factors, including pigments, such as melanin (of which there is more than one type)
**The Dermis & Hypodermis**

The Dermis & Hypodermis has 2 parts: the **papillary layer** & the **reticular layer**

The subcutaneous layer is also known as the hypodermis & superficial fascia

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**Hair Follicles & Hair**

- **Hair follicles** = hair forming organs
  - Of epidermal origin
- **Hair** is a nonliving, keratinized structure
  - Extends past skin surface
    - Found in most areas
  - ~5 million hairs on body
    - ~2% are on the head!
  - Terminal (heavy) vs. Vellus (“fuzz”)

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**Hair Follicle & Growth**

- **Hair matrix** = basal cells divide & push hair outward
- 2 major hair layers:
  - **Medulla** = inner portion. Contains soft keratin = flexible.
  - **Cortex** = outer cells of the hair matrix. **Hard keratin** = stiff.
- **Cuticle** = outer layer, dead cells: coats hair
- **Hair root** = portion of hair attached to follicle
- **Shaft** = portion of hair exposed at surface

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**Hair Growth Cycle**

Hair Follicles go through **Active (growth)** and **Resting** stages

- **Continued growth** in approximately 0.33 mm/day
- **Regression**
- **Leukemia of attachment satellite**
- **Action phase** 2-5 years
- **Reactivation** Loss of club hair
Skin Glands: Sebaceous & Sweat (Sudoriferous)

EXOCRINE GLANDS
- Assist in thermoregulation
- Excrete wastes
- Lubricate epidermis

SEBACEOUS GLANDS
- Secrete oily lipid (sebum) that coats hair shaft and epidermis
- Provide lubrication and antibacterial action

SWEAT GLANDS
- Produce watery solution by merocrine secretion
- Flush epidermal surface
- Perform other special functions

APOCRINE SWEAT GLANDS
- Limited distribution (armpit, groin, nipples)
- Produce a viscid secretion of complex composition
- Prefereable function in communication
- Strongly influenced by hormones

CERUMINOUS GLANDS
- Secrete waxy cerumen into external ear canal

MAMMARY GLANDS
- Apocrine glands specialized for milk production

MEROCRINE SWEAT GLANDS
- Widespread
- Produce thin secretions, mostly water
- Secretion is excretory
- Controlled primarily by nervous system
- Important in thermoregulation and excretion
- Some antibacterial action

Nails

Nail production occurs at the nail root

The eponychium is also known as the cuticle