Part 1: 6.1 The Integument
Interactive: pages 179-184
Skin and Its Tissues

- Two or more types of tissues grouped together and performing specialized functions constitute an organ.
- Skin is the largest organ in body by weight.
- Skin is also called the cutaneous membrane.
- The skin and its accessory structures (hair, nails, glands, sensory receptors) make up the integumentary system.
- Composed of several tissue types.
- Contains 2 layers: epithelial tissue overlying connective tissue.
- Outer layer is the epidermis.
- Deeper layer is the dermis.
**Figure 6.1 Skin and Its Tissues**

**Epidermis:**
- Outer layer
- Stratified squamous epithelium
- Basement membrane between epidermis and dermis

**Dermis:**
- Inner layer
- Thicker of the 2 layers of the skin
- Connective tissue
- Contains collagenous and elastic fibers

**Subcutaneous layer (hypodermis):**
- Beneath dermis; insulating layer
- Areolar and adipose connective tissue
- Not considered part of the skin
- Contains blood vessels that supply skin
Figure 6.2 Basic Structure of the Skin

(a) Diagram showing the layers and structures of the skin, including the epidermis, dermis, and subcutaneous layer.

(b) Microscopic view of the skin, highlighting various structures such as hair shaft, stratum corneum, stratum basale, basement membrane, sweat gland pore, dermal papilla, capillary, tactile (Meissner's) corpuscle, sebaceous gland, arrector pili muscle, lamellated (Pacinian) corpuscle, merocrine sweat gland, hair bulge, hair follicle, adipose tissue, blood vessels, nerve cell process, and muscle layer.

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Epidermis

**Epidermis**: Stratified squamous epithelium; rests on basement membrane

Lacks blood vessels

Deepest layer, *stratum basale*, nourished by blood vessels in dermis

As cells grow, they migrate toward free surface, away from nutrient supply

As they migrate, older cells, keratinocytes, begin to flatten and die

**Keratinization**: Process of hardening, dehydration, and keratin accumulation that occurs in epidermal cells as they migrate outward

**Keratin**: Tough, fibrous, waterproof protein made and stored in the cells

As cells reach outer surface, become tightly packed, develop desmosomes, form outer layer, *stratum corneum*

Stratum corneum cells are eventually shed from skin surface

Thickest on palms and soles (0.8-1.4mm)

Most of body has thinner epidermis, 0.07 – 0.12 mm
Figure 6.3 Epidermis

5 Layers of Epidermis:
- **Stratum corneum**: outermost layer; dead, keratinized cells
- **Stratum lucidum**: only in thick skin – palms, soles
- **Stratum granulosum**
- **Stratum spinosum**
- **Stratum basale/germinativum**: deepest, mitotic layer

Functions of epidermis: Protects against water loss, harmful chemicals, mechanical injury, pathogens
Table 6.1 Layers of the Epidermis

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratum corneum</td>
<td>Outermost layer</td>
<td>Many layers of keratinized, dead epithelial cells that are flattened and non-nucleated</td>
</tr>
<tr>
<td>Stratum lucidum (only present in thick skin)</td>
<td>Between stratum corneum and stratum granulosum on soles and palms</td>
<td>Cells appear clear; nuclei, organelles, and cell membranes are no longer visible</td>
</tr>
<tr>
<td>Stratum granulosum</td>
<td>Beneath the stratum corneum</td>
<td>Three to five layers of flattened granular cells that contain shrunken fibers of keratin and shriveled nuclei</td>
</tr>
<tr>
<td>Stratum spinosum</td>
<td>Beneath the stratum granulosum</td>
<td>Many layers of cells with centrally located, large, oval nuclei and developing fibers of keratin; cells becoming flattened</td>
</tr>
<tr>
<td>Stratum basale (basal cell layer)</td>
<td>Deepest layer</td>
<td>A single row of cuboidal or columnar cells that divide and grow; this layer also includes melanocytes</td>
</tr>
</tbody>
</table>
**Figure 6.4 Epidermis: Melanocytes**

*Melanocytes* located in the stratum basale produce the dark pigment melanin.

Absorbs UV light from sunlight and provides skin color.

Melanin is distributed into keratinocytes, to protect skin cells from damaging effects of UV light (DNA damage, fibroblast damage, skin cancer).
Epidermis: Skin Color

Factors Affecting Skin Color:

**Hereditary Factors:**
- All people have same number of melanocytes, but vary in amount of melanin produced (this is under genetic control)
- Varying distribution and size of melanin granules
- Albinos inherit mutation in melanin genes; lack melanin

**Environmental Factors**
- Sunlight
- UV light from sunlamps
- X-rays

**Physiological Factors:**
- Oxygenation in blood of dermal blood vessels: pinkish, cyanosis
- Vasodilation/vasoconstriction of dermal blood vessels
- Accumulation of carotene pigment from diet
- Jaundice
Clinical Application 6.1

Indoor Tanning and Skin Cancer

Exposure to sunlight or a tanning bed causes melanocytes to produce more melanin, and skin darkens.

Tanning bed uses doses of UV radiation that can overwhelm body’s natural protective responses against skin cancer.

Basal cell carcinoma and squamous cell carcinoma arise from epithelial cells in skin.

Melanomas arise from melanocytes.

Melanomas are least common (4%) skin cancers, but cause 80% of skin cancer deaths.
Dermis:

- Inner layer of skin
- Average of 1-2 mm thick
- Contains dermal papillae between epidermal ridges
- Binds epidermis to underlying tissues
- Connective tissue layer
- Contains muscle fibers
- Nerve cell processes
- Dermal blood vessels supply nutrients to all skin cells
- Hair follicles, sweat & sebaceous glands
- Sensory receptors: Lamellated (Pacinian) corpuscles for pressure, Tactile (Meissner’s) corpuscles for light touch
Dermis (2)

The dermis consists of 2 layers:

**Papillary layer:**
- Superficial layer
- Areolar connective tissue
- Thinner of the 2 layers
- Location of dermal papillae

**Reticular layer:**
- Deeper layer
- Dense irregular connective tissue
- Thicker of 2 layers
Part 2: 6.2-6.5
The Accessory Structures
Of the Integument, Homeostasis, & Healing

Interactive: pages 185-196
Accessory Structures of the Skin

Accessory structures originate from the epidermis, extend into dermis or hypodermis

Accessory structures of the skin:
• Hair follicles
• Nails
• Skin glands (sweat and sebaceous)

If accessory structures remain intact, injured/burned dermis can regenerate
**Figure 6.6 Nails**

**Nails**: Protective coverings on ends of fingers and toes

3 parts of a nail:
- **Nail plate**: overlies nail bed
- **Nail bed**: surface of skin, under nail plate
- **Lunula**: most active growing region; pale, half-moon-shaped region at base of nail plate
Hair is present on all surfaces of skin except palms, soles, lips, nipples, parts of external reproductive organs.

**Hair follicle:** Tube-like depression of epidermal cells from which hair develops; extends into dermis or the subcutaneous layer.

3 parts of hair:
- Hair bulb (dividing cells)
- Hair root
- Hair shaft (dead, epidermal cells)

Hair papilla contains blood vessels to nourish hair.

Hair color is due to type and amount of melanin. Arrector pili muscle (goosebumps).
Clinical Application 6.2

Hair Loss

Most common type of baldness is pattern baldness; top of head loses hair (called *androgenic alopecia*).

Associated with lowered level of testosterone (men) or estrogen (women).

Progenitor cells are lacking in bald spots, but stem cells are present.

*Alopecia areata*: body produces antibodies that attack hair follicles; autoimmune hair loss.
**Sebaceous Glands:**
- Holocrine glands
- Usually associated with hair follicles
- Produce **sebum**, which consists of fatty material and cellular debris
- Sebum keeps hair and skin soft and waterproof
- Excess sebum can result in acne
- Absent on palms and soles
Clinical Application 6.3

Acne

*Acne vulgaris* is a disorder of sebaceous glands

Common at puberty, because sebaceous glands are excessively responsive to androgens

Sebaceous glands become clogged with extra sebum and epithelial cells

Clogged glands provide good environment for anaerobic bacteria; infection results in inflammation

Affects 80% of people between 11 and 30 years of age

Treated best with Vitamin A derivatives, systemic antibiotics, salicylic acid, benzoyl peroxide
Figure 6.10 Skin Glands: Sweat Glands

**Sweat Glands:**
- Also called sudoriferous glands
- Widespread in skin
- Originate in deeper dermis or hypodermis as ball-shaped coils

**Eccrine (merocrine) glands:**
- Most numerous
- Respond to elevated body temperature

**Apocrine sweat glands:**
- Axillary and groin areas
- Secrete by exocytosis
- Respond to emotions, pain

Ceruminous glands—ear wax
Mammary glands—milk
# Table 6.2 Skin Glands

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Function</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebaceous glands</td>
<td>Groups of specialized epithelial cells</td>
<td>Keep hair soft, pliable, waterproof</td>
<td>Near or connected to hair follicles, everywhere but on palms and soles</td>
</tr>
<tr>
<td>Merocrine sweat glands</td>
<td>Abundant sweat glands with odorless secretion</td>
<td>Lower body temperature</td>
<td>Originate in deep dermis or subcutaneous layer and open to surface on forehead, neck, and back</td>
</tr>
<tr>
<td>Apocrine sweat glands</td>
<td>Less numerous sweat glands with secretions that develop odors</td>
<td>Wet skin during pain, fear, emotional upset, and sexual arousal</td>
<td>Near hair follicles in armpit and groin</td>
</tr>
<tr>
<td>Ceruminous glands</td>
<td>Modified sweat glands</td>
<td>Secrete ear wax</td>
<td>External acoustic meatus</td>
</tr>
<tr>
<td>Mammary glands</td>
<td>Modified sweat glands</td>
<td>Secrete milk</td>
<td>Breasts</td>
</tr>
</tbody>
</table>
Skin Functions

Skin is versatile, and vital for homeostasis.

Functions of the skin:
• Protective covering, barrier against harmful substances and microorganisms
• Prevents some water loss
• Contains sensory receptors
• Excretes some wastes
• Helps produce Vitamin D
• Helps regulate body temperature
Regulation of Body Temperature

Important to regulate body temperature; slight shift can disrupt rates of metabolic reactions

Set point is monitored by Hypothalamus

Deep body temperature stays close to set point of 37°C or 98.6°F

Skin plays key role in homeostatic mechanisms that regulate body temperature
Heat Production and Loss

• Heat is a product of cellular metabolism
• The most active body cells are major heat producers: skeletal muscle, cardiac muscle, cells of the liver
• When body is too warm, body responds with vasodilation of dermal blood vessels and vasoconstriction of deep blood vessels. Heat can escape through skin.

• Methods of heat loss:
  1. Radiation: Primary method, infrared heat rays escape
  2. Conduction: Heat moves from skin to cooler objects
  3. Convection: Heat loss into circulating air currents
  4. Evaporation: Sweat changes into a gas, carries heat away
When body temperature rises:
• Thermoreceptors signal hypothalamus
• Vasodilation of dermal blood vessels
• Sweat glands are activated

When body temperature falls:
• Thermoreceptors signal hypothalamus
• Vasoconstriction of dermal blood vessels
• Sweat glands are inactive
• Muscles contract involuntarily (shivering)
Problems in Temperature Regulation

**Hyperthermia**: abnormally high body temperature
- Can occur on hot, humid day, when sweat cannot evaporate
- When air temperature is high, radiation is less effective
- Body may gain heat from hotter air
- Skin becomes dry, person gets weak, dizzy, nauseous, with headache, rapid pulse

**Hypothermia**: abnormally low body temperature
- Can result from prolonged exposure to cold, or illness
- Shivering is involuntary skeletal muscle contraction, caused by hypothalamus
- Progresses to confusion, lethargy, loss of reflexes and consciousness
- Without treatment, organs shut down
Clinical Application 6.4

Elevated Body Temperature

Loss of ability of homeostatic temperature control mechanism to function in an extremely hot environment:

• Exposure to very high heat can overwhelm temperature control mechanisms, leading to hyperthermia
• If body heat builds up faster than heat can be lost from body, body temperature will rise, even when set point is normal
• Extreme vasodilation can collapse cardiovascular system; can be fatal

Fever:

• Set point is elevated by the immune system, to fight infection
• Phagocytes release pyrogens in response to presence of bacteria, viruses; hypothalamus increases set point and raises body temperature
• Elevated body temperature helps destroy pathogens
Inflammation is a normal response to injury or stress. Inflammation is body’s attempt to restrict spread of infection. Blood vessels in affected tissues dilate and become more permeable, allowing fluids to leak into the damaged tissues. Inflamed skin may become:

- Reddened
- Swollen
- Warm
- Painful
Cuts

A shallow cut, which affects only the epidermis, results in epidermal cells along its margin dividing more rapidly than usual, to fill gap

A deep cut, reaching dermis or subcutaneous layer, results in blood vessels breaking; released blood forms a clot

- Clot consists of fibrin, blood cells and platelets
- Clot and dried tissue fluid form scab
- Epithelial cells reproduce, fill in the wound
- Fibroblasts secrete collagen fibers to bind wound together
- Growth factors stimulate new tissue formation
- Phagocytic cells remove dead cells and debris, scab sloughs off
- Excess collagenous fibers may form elevated mass called a scar
Figure 6.13 Healing of a Wound

(a) Wound
(b) Blood clot
(c) Blood clot
(d) Scab

White blood cell
Dermis
Epidermis
Macrophages
Fibroblast
White blood cells
Macrophages
Regrowth of blood vessel
Fibroblast
Granulation tissue
Regenerated epidermis
Scar tissue (fibrosis)
Fibroblast
Burns

Burns are classified by extent of tissue damage:

**Superficial, partial-thickness (first degree) burn:**
- Injures only epidermis, as in sunburn; redness, heat, inflammation
- Healing takes days-weeks, no scarring

**Deep, partial-thickness (second degree) burn:**
- Destroys epidermis and some dermis, as in burn from hot liquid
- May blister, healing varies with severity of burn & stem cell survival
- Stem cells in hair follicles and glands can help regenerate skin
- Usually recovers completely, no scarring

**Full-thickness (third degree) burn:**
- Destroys epidermis, dermis, accessory structures
- Results from prolonged exposure to heat, flames, hot liquids
- Some healing from margins
- Often requires skin graft, skin substitutes
Treatment of burn patients involves estimating extent of injured body surface. “Rule of Nines” divides body surface into regions of 9% or multiples of 9.

From this estimate, plans to replace fluids, electrolytes, and skin can be figured.
Life-Span Changes

- Cell cycle slows, skin becomes scaly, age spots appear
- Epidermis and dermis become thinner
- Loss of fat in subcutaneous layer; person feels cold
- Wrinkling, sagging of skin occur
- Sebaceous glands secrete less oil; skin becomes dry
- Melanin production slows; hair whitens
- Hair thins
- Number of hair follicles decreases
- Nail growth becomes impaired
- Sensory receptors decline
- Body temperature regulation becomes less effective
- Diminished ability to produce Vitamin D