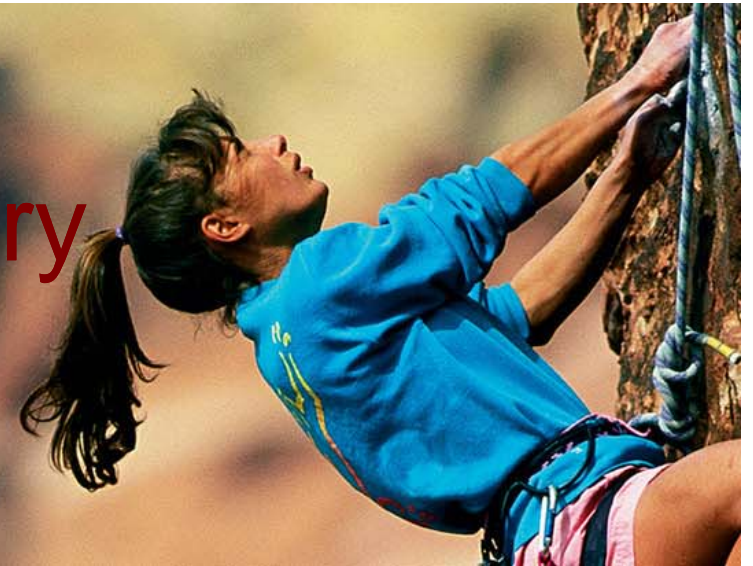


***Essentials of Anatomy & Physiology*, 4th Edition**
Martini/Bartholomew

5 The Integumentary
System



PowerPoint® Lecture Outlines
prepared by Alan Magid, Duke University

Slides 1 to 51

Integumentary Structure/Function

Integumentary System Components

- Cutaneous membrane
 - *Epidermis*
 - *Dermis*
 - Accessory structures
- Subcutaneous layer (*hypodermis*)

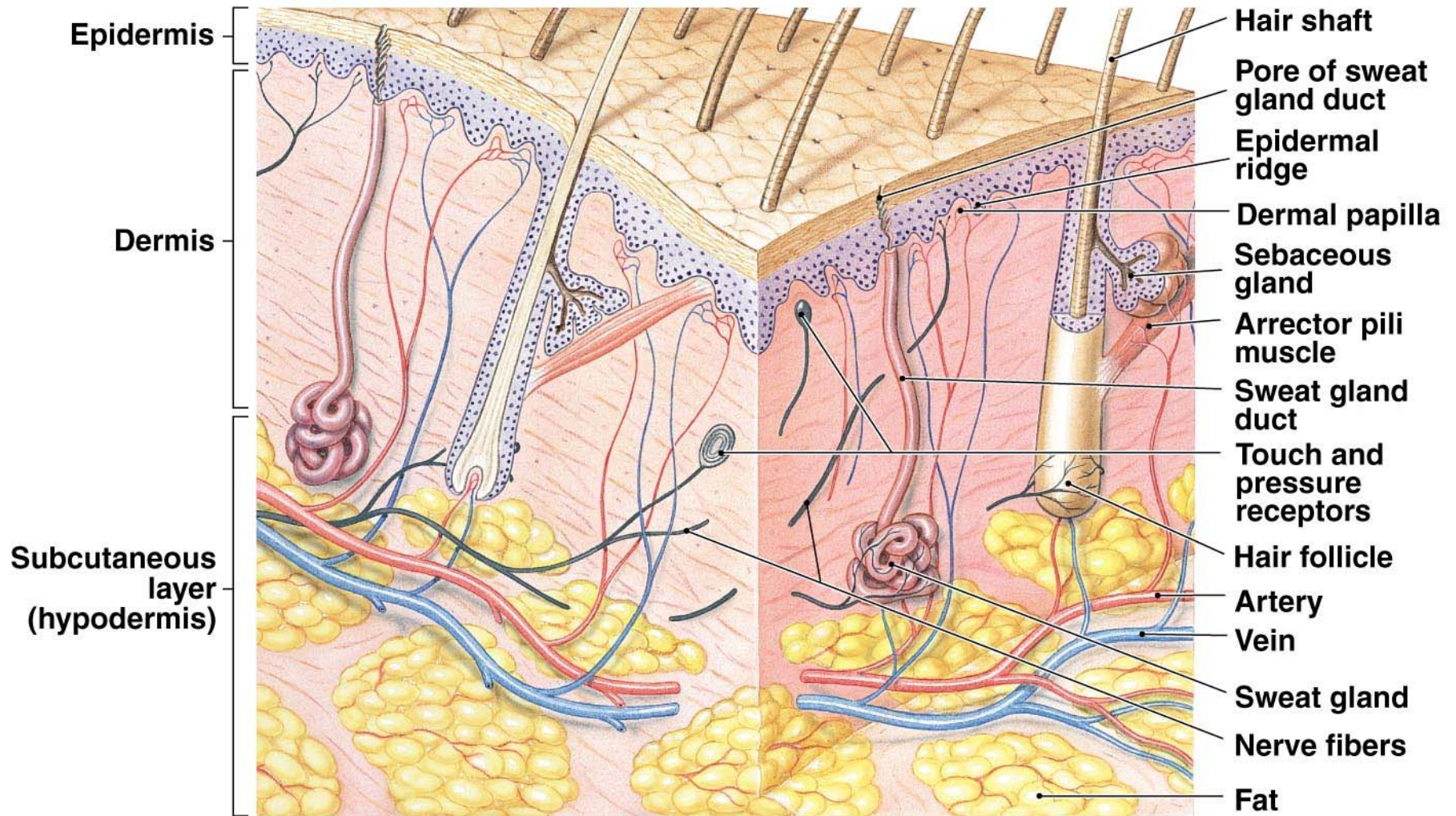
Integumentary Structure/Function

Main Functions of the Integument

- Protection
- Temperature maintenance
- Synthesis and storage of nutrients
- Sensory reception
- Excretion and secretion

Integumentary Structure/Function

Components of the Integumentary System



Integumentary Structure/Function

The Epidermis

- Stratified squamous epithelium
- Several distinct cell layers
 - Thick skin—five layers
 - On palms and soles
 - Thin skin—four layers
 - On rest of body

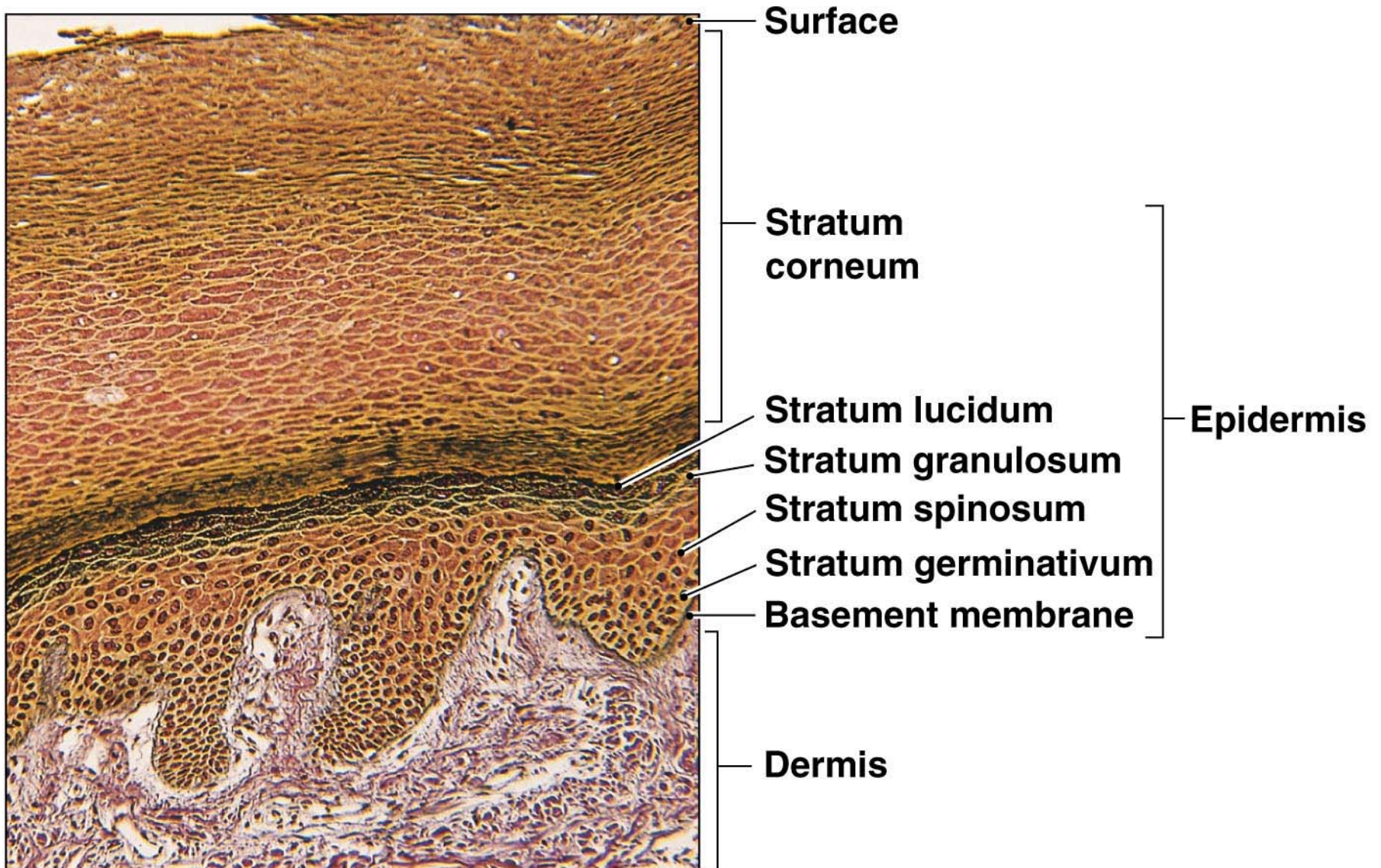
Integumentary Structure/Function

Cell Layers of The Epidermis

- *Stratum germinativum*
- *Stratum spinosum*
- *Stratum granulosum*
- *Stratum lucidum* (in thick skin)
- *Stratum corneum*
 - Dying superficial layer
 - *Keratin* accumulation

Integumentary Structure/Function

The Structure of the Epidermis



Integumentary Structure/Function

Cell Layers of The Epidermis

- *Stratum germinativum*
 - Basal layer
 - Stem cells
 - Cell division layer
 - Source of replacement cells
- *Melanocytes*
 - Synthesize *melanin*

Integumentary Structure/Function

Cell Layers of the Epidermis

- Intermediate strata
 - *Stratum spinosum* (spiny layer)
 - Superficial to stratum germinativum
 - *Stratum granulosum* (grainy layer)
 - Keratin granules in cytoplasm
 - No cell division
 - *Stratum lucidum* (clear layer)

Integumentary Structure/Function

Cell Layers of the Epidermis

- *Stratum corneum*
 - Most superficial layer
 - Flattened (squamous) cells
 - Dead cells
 - Abundant keratin
 - *Keratinized* (also, *cornified*)
 - Tough, water-resistant protein

Integumentary Structure/Function

Sources of Skin Color

- *Melanocytes*
 - Make *melanin*
 - Melanin provides UV protection
 - Gives reddish-brown to brown-black color
- *Carotene*
 - Contributes orange-yellow color
 - Provided from diet
- *Hemoglobin*
 - Blood pigment

Integumentary Structure/Function

Melanocytes

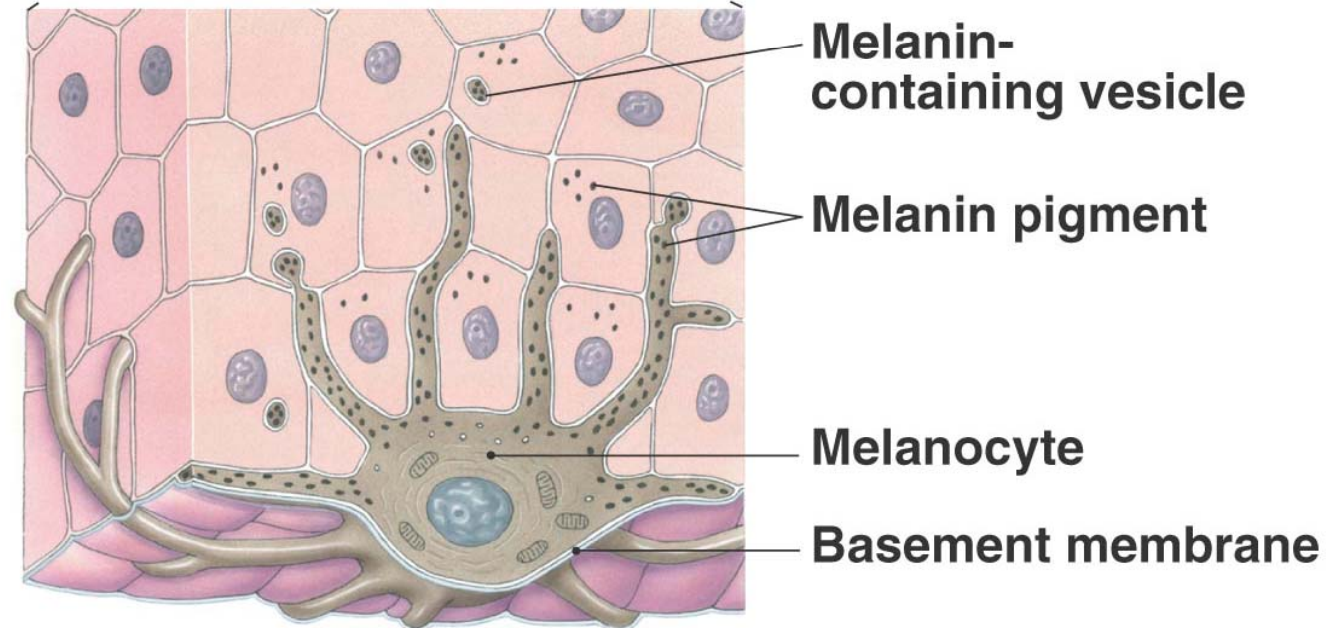
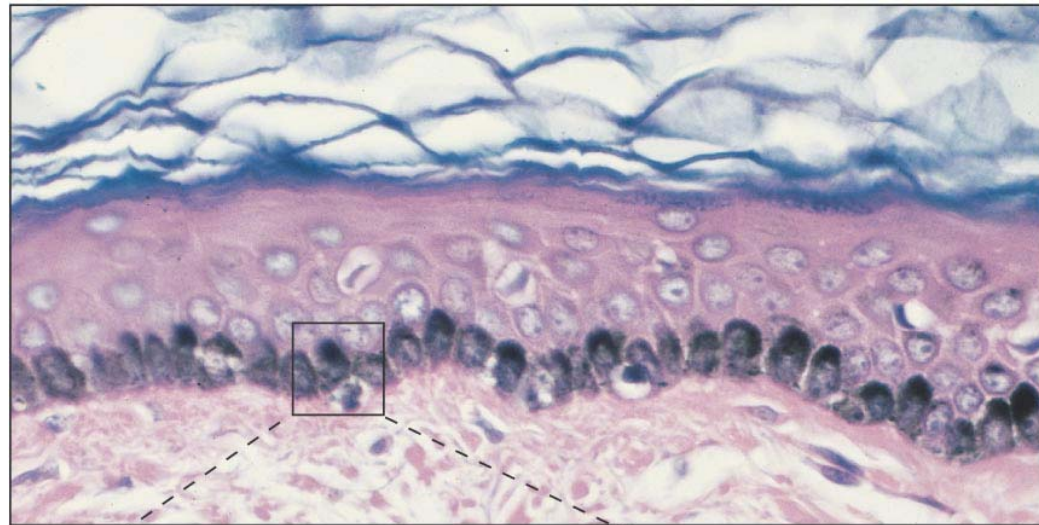


Figure 5-3

Integumentary Structure/Function

Effects of UV Radiation

- Beneficial effect
 - Activates synthesis of *vitamin D₃*
- Harmful effects
 - Sun burn
 - Wrinkles, premature aging
 - *Malignant melanoma*
 - *Basal cell carcinoma*

Integumentary Structure/Function

Two Important Types of Skin Cancer



(a) Basal cell carcinoma



(b) Melanoma

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<http://drmelton.com/Chicago/skincancerpictures/>

Figure 5-4

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Integumentary Structure/Function

Key Note

The epidermis is a multi-layered, flexible, self-repairing barrier that prevents fluid loss, provides protection from UV radiation, produces vitamin D₃, and resists damage from abrasion, chemicals, and pathogens

Integumentary Structure/Function

Layers of the Dermis

- *Papillary layer*
 - Underlies epidermis
 - Named for *dermal papillae*
 - Loose connective tissue
 - Supports, nourishes epidermis
 - Provides sensory nerves, *lymphatics*, and *capillaries*

Integumentary Structure/Function

Layers of the Dermis

- *Reticular layer*
 - Tough, dense, fibrous layer
 - *Collagen* fibers
 - Limit stretch
 - Elastic fibers
 - Provide flexibility
 - Blends into papillary layer (above)
 - Blends into subcutaneous layer (below)

Integumentary Structure/Function

Other Dermal Components

- Epidermal accessory organs
- Cells of connective tissues proper
- Communication with other organ systems
 - Cardiovascular
 - Lymphatic
 - Nervous
 - Sensation
 - Control of blood flow and secretion

Integumentary Structure/Function

Key Note

The dermis provides mechanical strength, flexibility, and protection for underlying tissues. It is highly vascular and contains a variety of sensory receptors that provide information about the external environment.

Integumentary Structure/Function

The Subcutaneous Layer

- Composed of loose connective tissue
- Stabilizes skin position
 - Loosely attached to dermis
 - Loosely attached to muscle
- Contains many fat cells
 - Provides thermal insulation
 - Cushions underlying organs
- Safely receives *hypodermic* needles

Integumentary Structure/Function

Accessory Structures

- *Hair follicle*
 - A hair
 - *Shaft*
 - *Medulla*
 - *Cortex*
 - *Cuticle*
 - *Arrector pili* muscle
 - “Goose bumps”

Integumentary Structure/Function

Hair Follicles

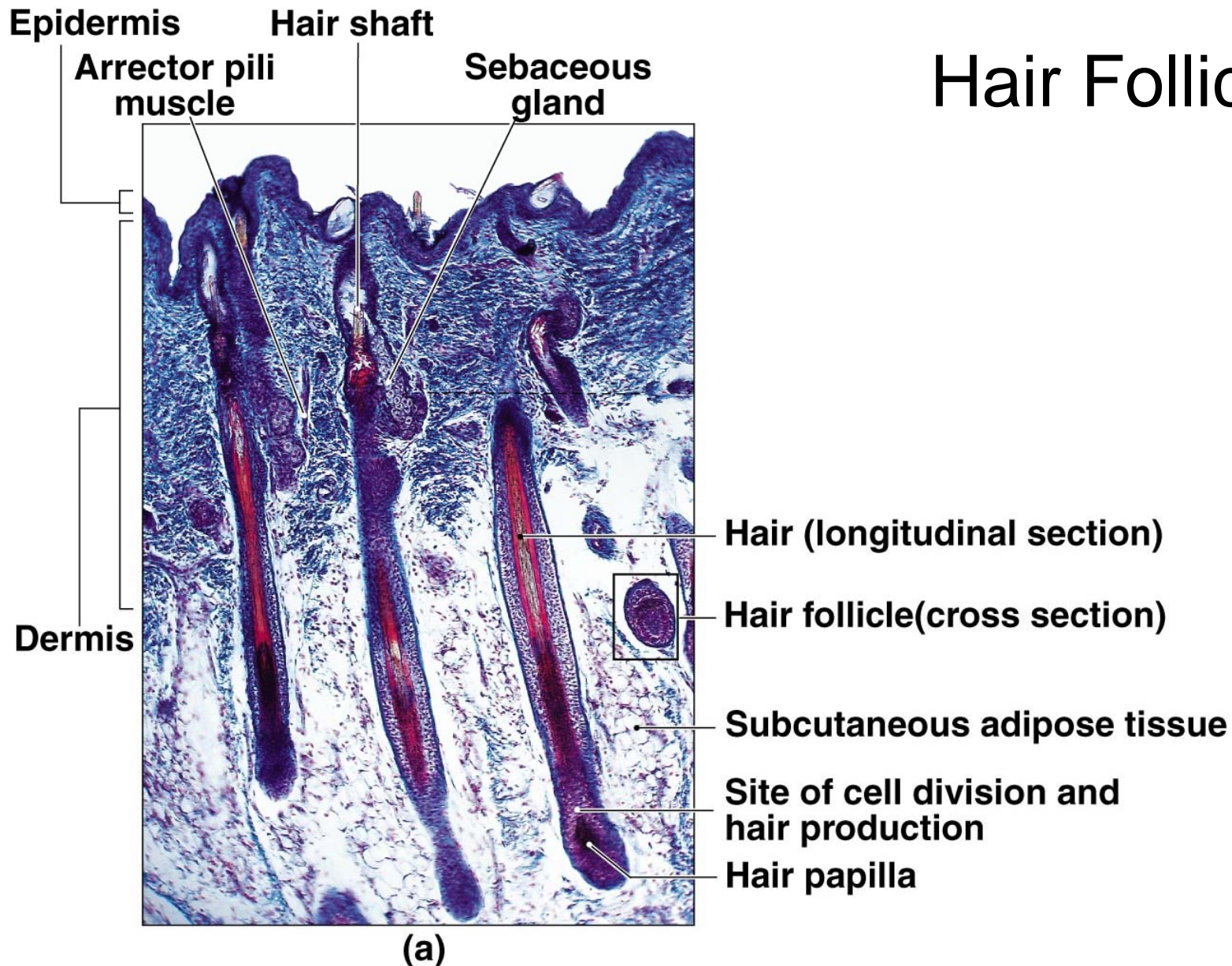
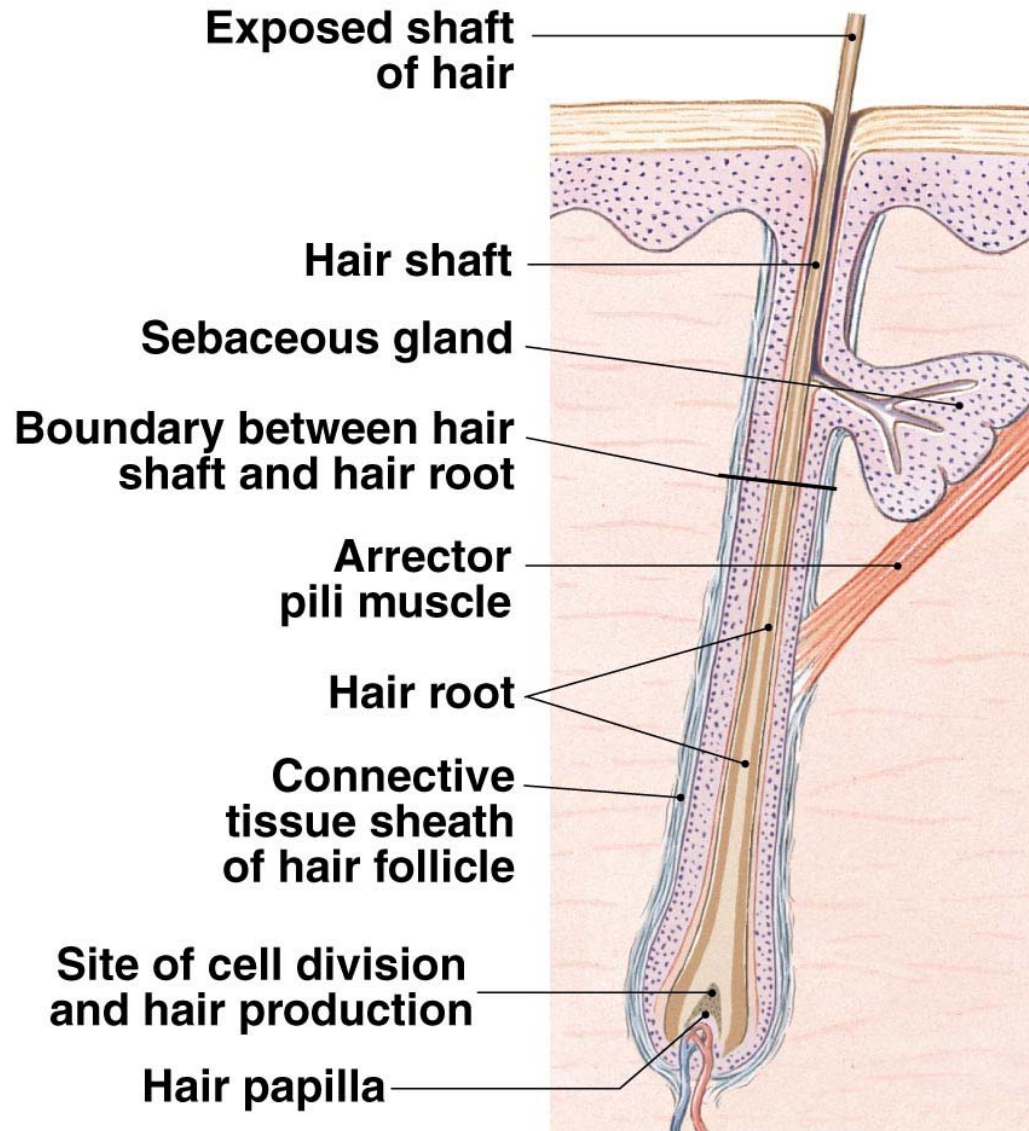


Figure 5-5(a)

Integumentary Structure/Function



Hair Follicles

Figure 5-5(b)

(b)

Integumentary Structure/Function

Hair Follicles

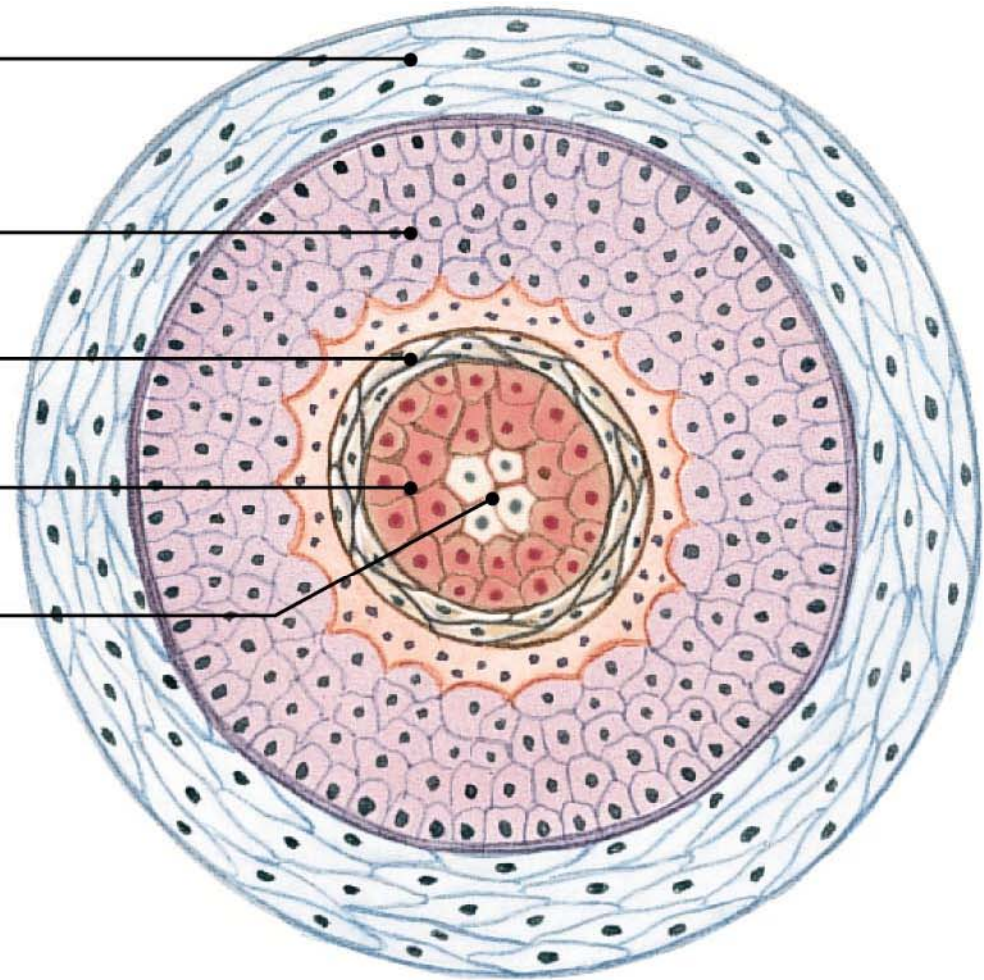
Connective tissue sheath

Wall of hair follicle

Cuticle of hair

Cortex of hair

Medulla of hair



(c)

Integumentary Structure/Function

Accessory Structures

- Hair growth cycle
 - 0.3 mm/day growth rate
 - 2–5 years growth
 - 2–5 years follicle rest
 - Follicle reactivation
 - Old hair shedding

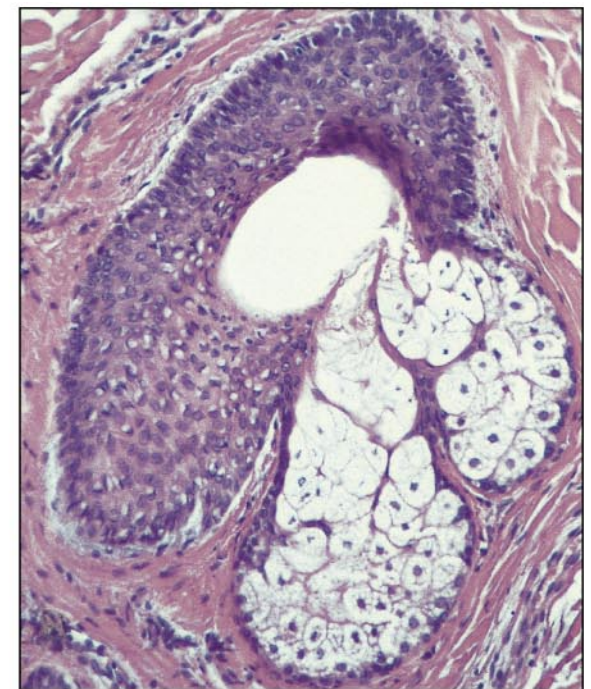
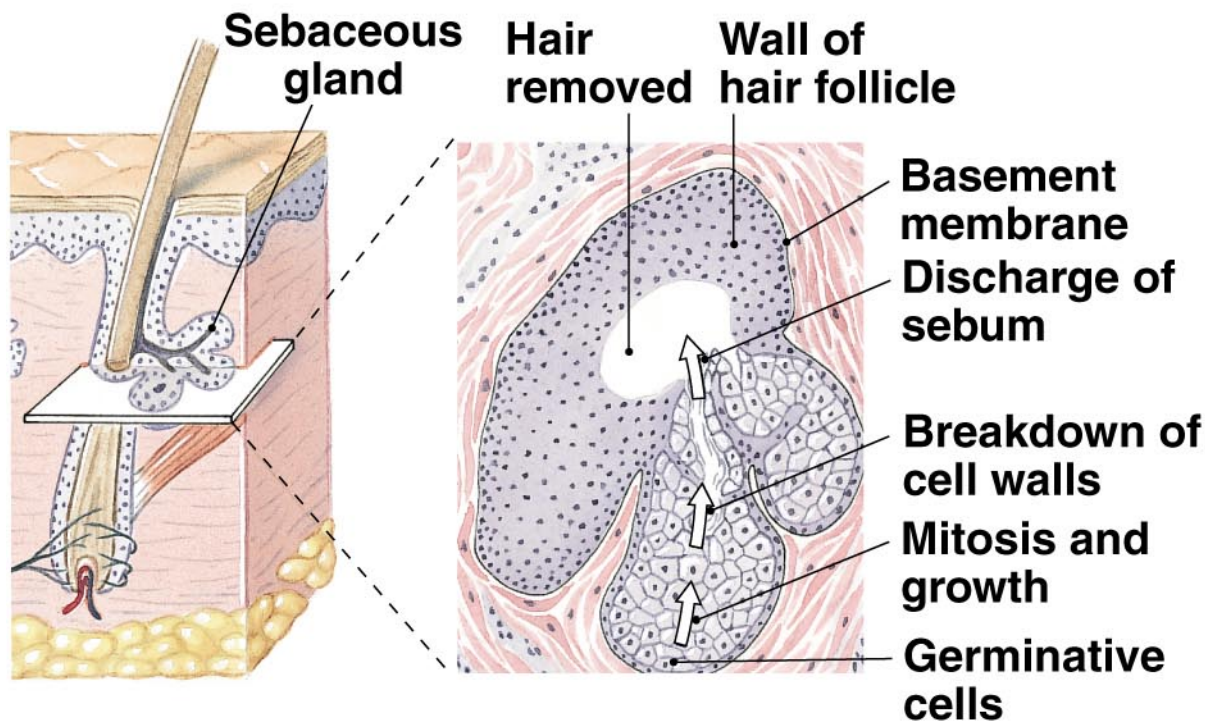
Integumentary Structure/Function

Accessory Structures

- *Sebaceous glands* (oil glands)
 - *Holocrine* gland
 - Oily secretion
 - *Sebum*
 - Hair shaft lubricant
- *Sebaceous follicle*
 - Skin lubricant
 - Skin waterproofing

Integumentary Structure/Function

The Structure of Sebaceous Glands and Their Relationship to Hair Follicles



Sebaceous gland

LM × 150

Integumentary Structure/Function

Sweat Glands

- *Apocrine*
 - Odorous secretion (“*funky*”)
 - Absent before puberty
 - Present in axilla, areola, groin
- *Merocrine*
 - Watery sweat (~1% NaCl)
 - For heat loss
 - Widely present in skin (up to 500/cm²)

Integumentary Structure/Function

Sweat Glands

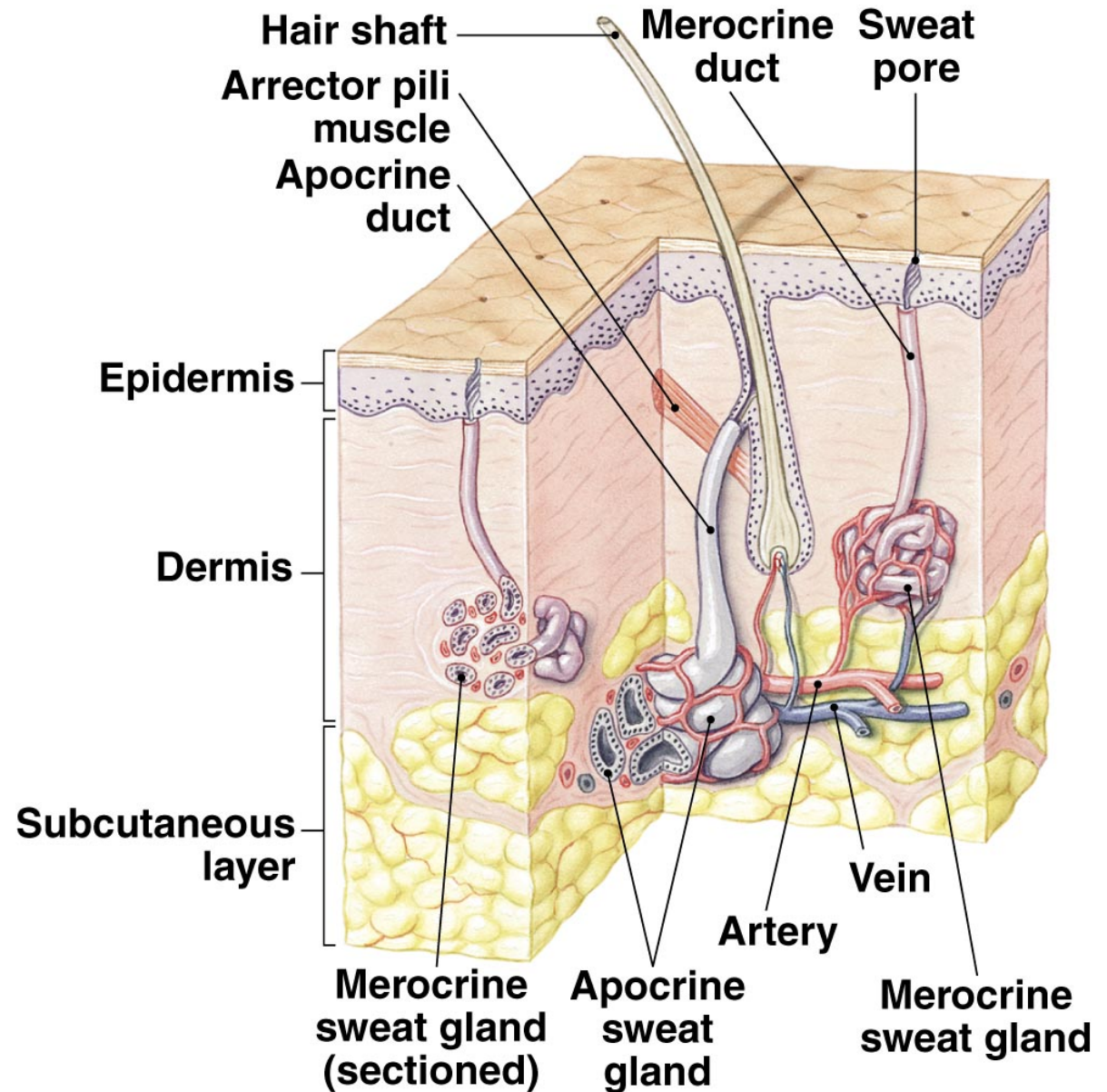


Figure 5-7

Integumentary Structure/Function

Key Note

The skin plays a major role in controlling body temperature. It acts as a radiator, with the heat being delivered by the dermal circulation and removed primarily by the evaporation of sweat or perspiration.

Integumentary Structure/Function

Accessory Structures: Nails

- Nail body
 - Dense mass of *keratinized* cells
- Nail bed
- Nail root
- Cuticle (*eponychium*)
- Lunula

Integumentary Structure/Function

The Structure of a Nail

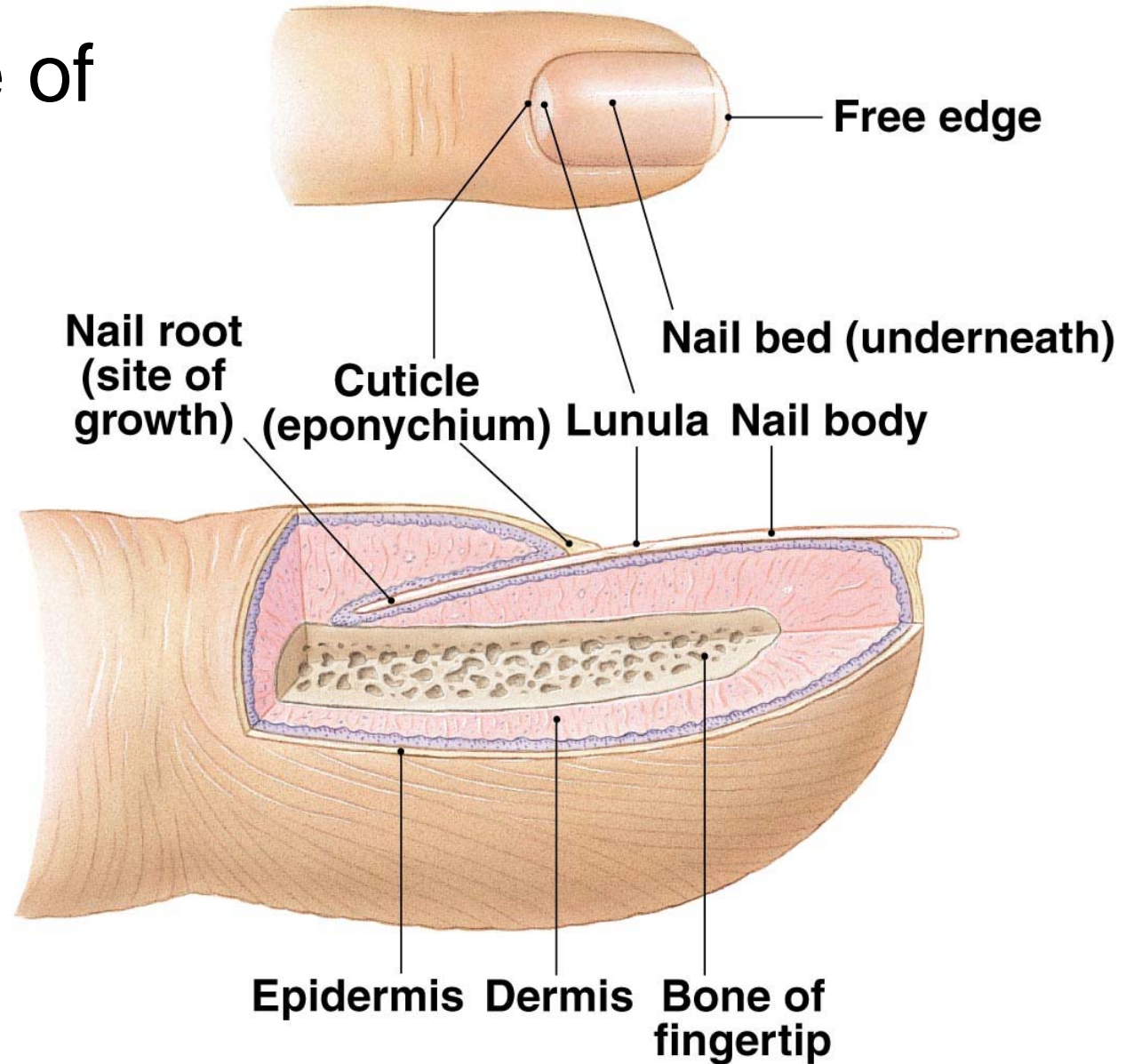


Figure 5-8

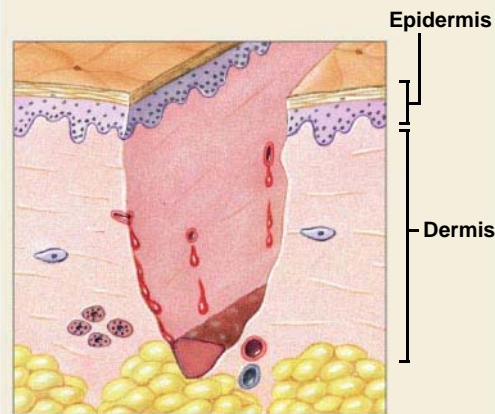
Skin Injury and Repair

Four Stages in Skin Healing

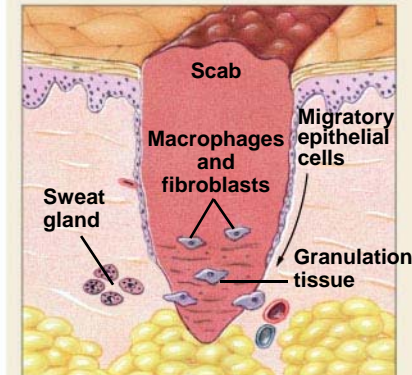
- Inflammation
 - Blood flow increases
 - Phagocytes attracted
- Scab formation
- Cell division and migration
- Scar formation

STEP 1

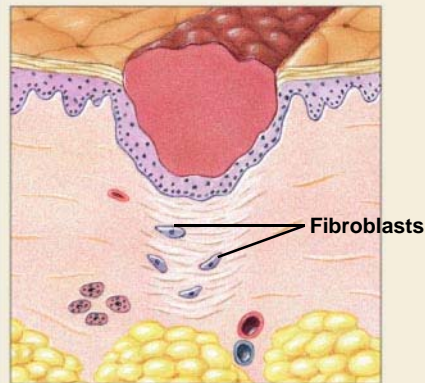
Bleeding occurs at the site of injury immediately after the injury, and mast cells in the region trigger an inflammatory response.

**STEP 2**

After several hours, a scab has formed and cells of the stratum germinativum are migrating along the edges of the wound. Phagocytic cells are removing debris, and more of these cells are arriving with the enhanced circulation in the area. Clotting around the edges of the affected area partially isolates the region.

**STEP 3**

One week after the injury, the scab has been undermined by epidermal cells migrating over the meshwork produced by fibroblast activity. Phagocytic activity around the site has almost ended, and the fibrin clot is disintegrating.

**STEP 4**

After several weeks, the scab has been shed, and the epidermis is complete. A shallow depression marks the injury site, but fibroblasts in the dermis continue to create scar tissue that will gradually elevate the overlying epidermis.

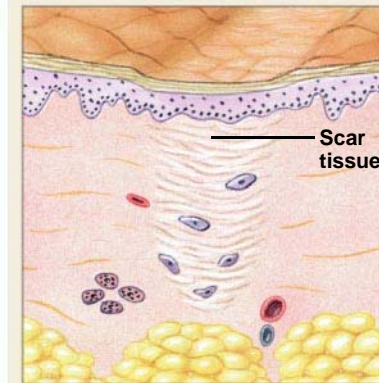


Figure 5-9
1 of 5

STEP 1

Bleeding occurs at the site of injury immediately after the injury, and mast cells in the region trigger an inflammatory response.

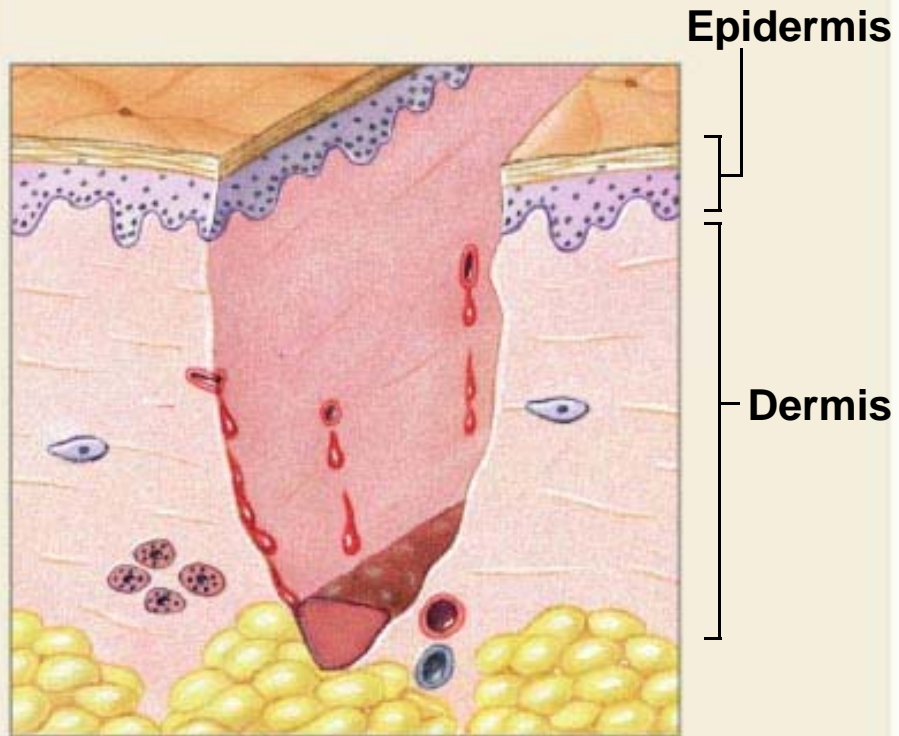
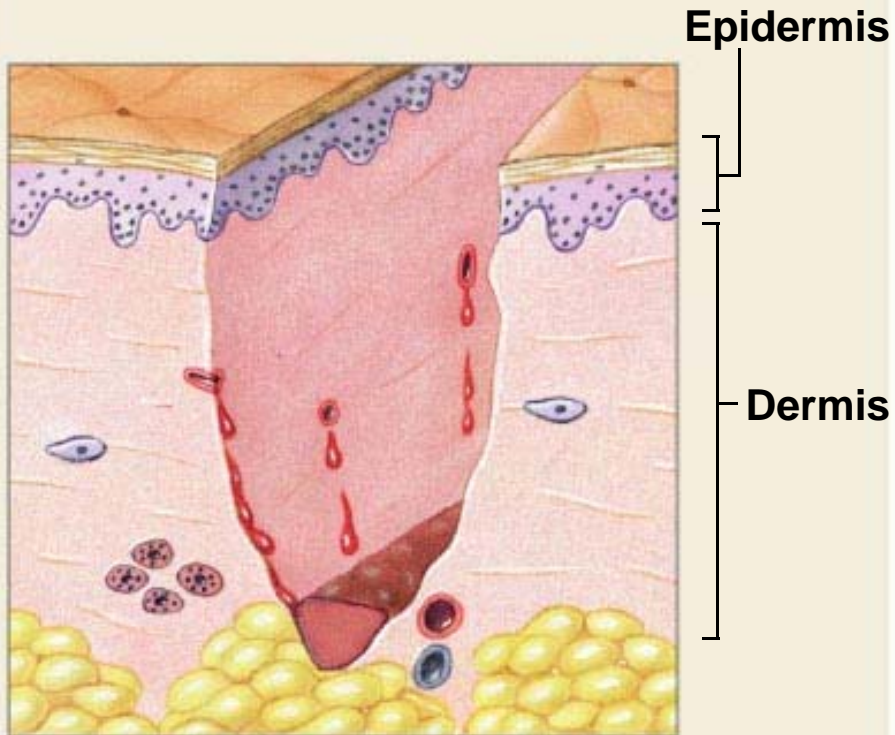


Figure 5-9
2 of 5

STEP 1

Bleeding occurs at the site of injury immediately after the injury, and mast cells in the region trigger an inflammatory response.



STEP 2

After several hours, a scab has formed and cells of the stratum germinativum are migrating along the edges of the wound. Phagocytic cells are removing debris, and more of these cells are arriving with the enhanced circulation in the area. Clotting around the edges of the affected area partially isolates the region.

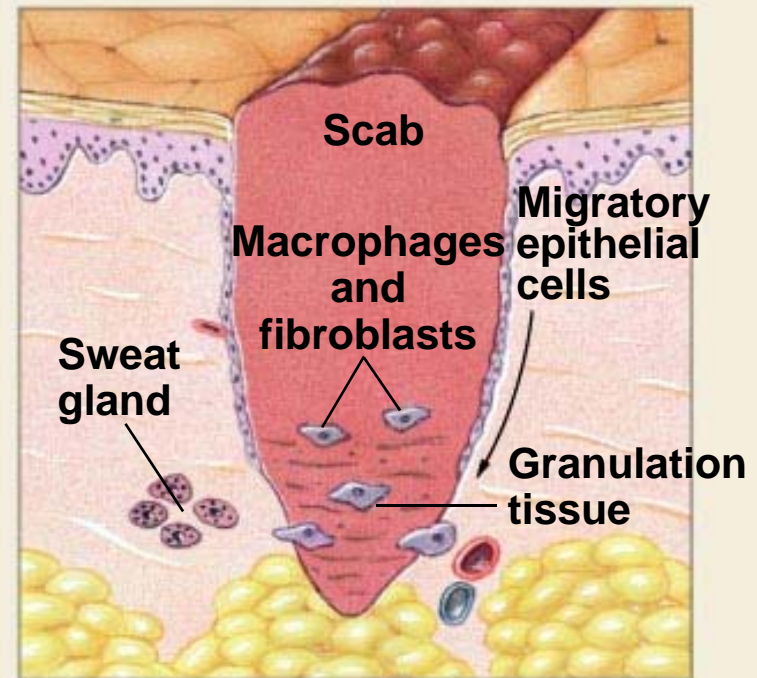


Figure 5-9
3 of 5

STEP 3

One week after the injury, the scab has been undermined by epidermal cells migrating over the meshwork produced by fibroblast activity. Phagocytic activity around the site has almost ended, and the fibrin clot is disintegrating.

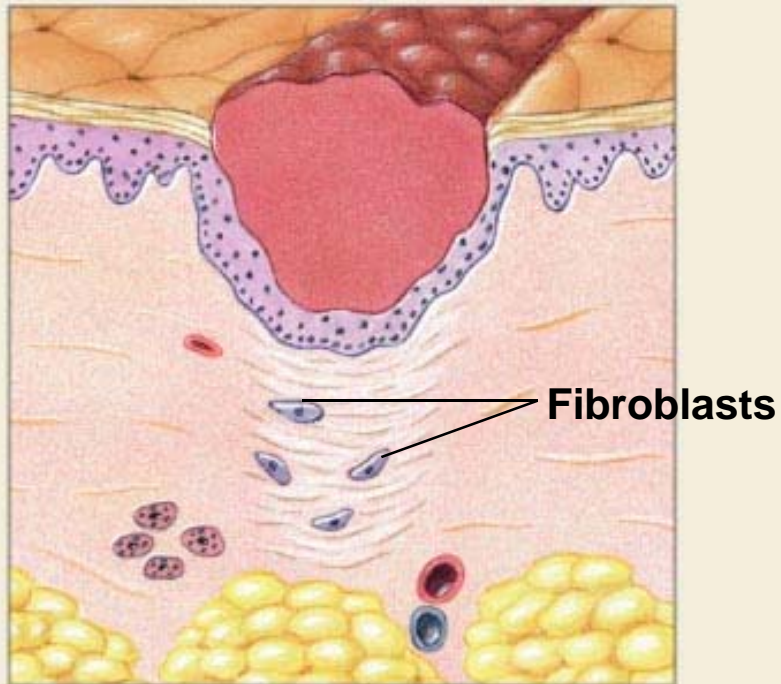
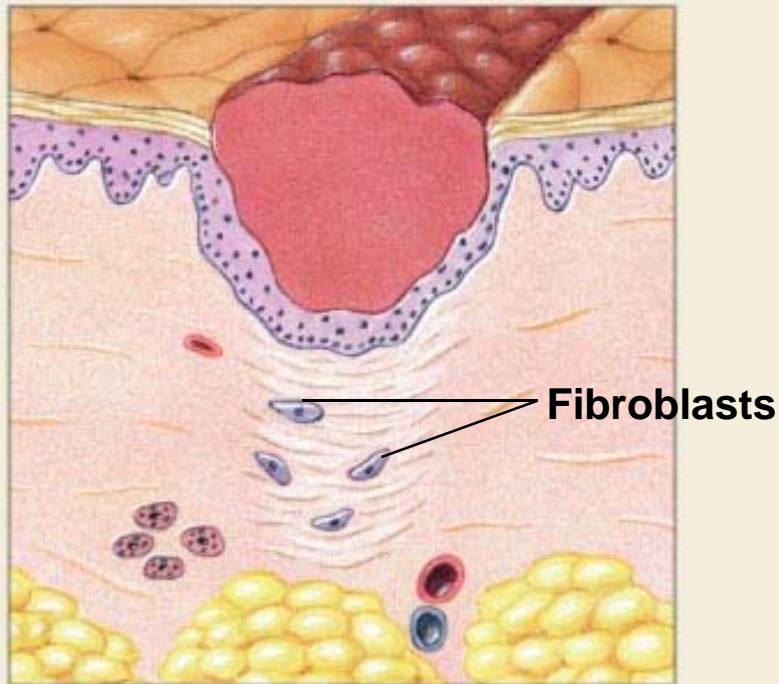


Figure 5-9
4 of 5

STEP 3

One week after the injury, the scab has been undermined by epidermal cells migrating over the meshwork produced by fibroblast activity. Phagocytic activity around the site has almost ended, and the fibrin clot is disintegrating.



STEP 4

After several weeks, the scab has been shed, and the epidermis is complete. A shallow depression marks the injury site, but fibroblasts in the dermis continue to create scar tissue that will gradually elevate the overlying epidermis.

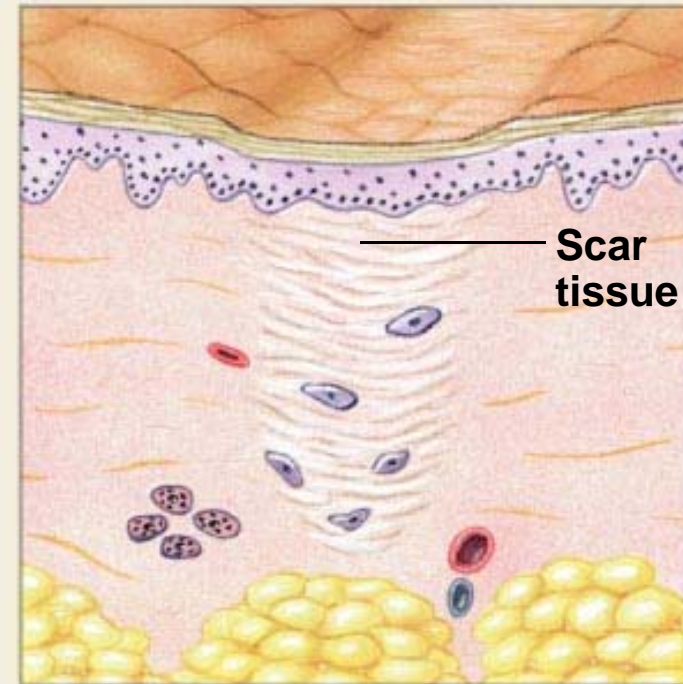


Figure 5-9
5 of 5

Skin Injury and Repair

TABLE 5 - 1 *A Common Classification of Burns*

CLASSIFICATION	DAMAGE REPORT	APPEARANCE AND SENSATION
FIRST-DEGREE BURN	<i>Killed:</i> superficial cells of epidermis <i>Injured:</i> deeper layers of epidermis, papillary dermis	Inflamed; tender
SECOND-DEGREE BURN	<i>Killed:</i> superficial and deeper cells of epidermis; dermis may be affected <i>Injured:</i> damage may extend into reticular layer of the dermis, but many accessory structures are unaffected	Blisters; very painful
THIRD-DEGREE BURN	<i>Killed:</i> all epidermal and dermal cells <i>Injured:</i> hypodermis and deeper tissues and organs	Charred; no sensation at all

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Table 5-1

Aging of the Skin

Major Age-Related Changes

- Injury and infection increase
- Immune cells decrease
- Sun protection diminishes
- Skin becomes dry, scaly
- Hair thins, grays
- Sagging, wrinkles occur
- Heat loss decreases
- Repair slows

The Integumentary System in Perspective

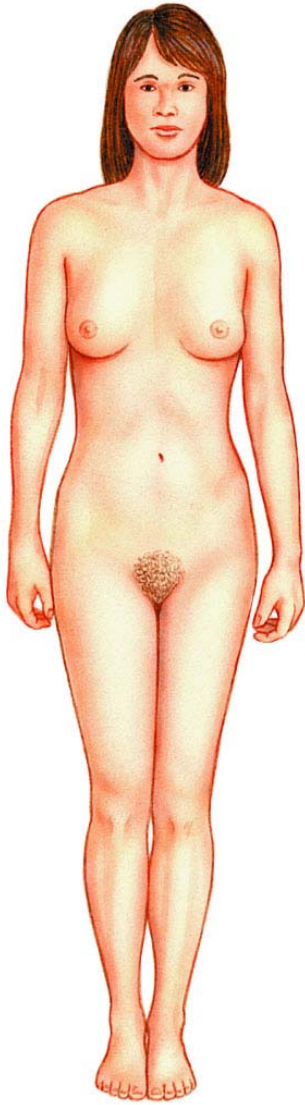
FIGURE 5-10

Functional Relationships Between
the Integumentary System and Other Systems

Figure 5-10

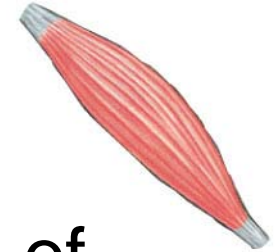
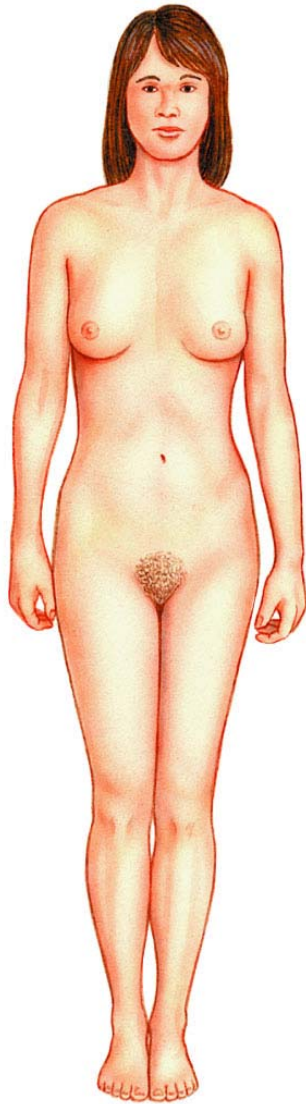
1 of 11

The Skeletal System



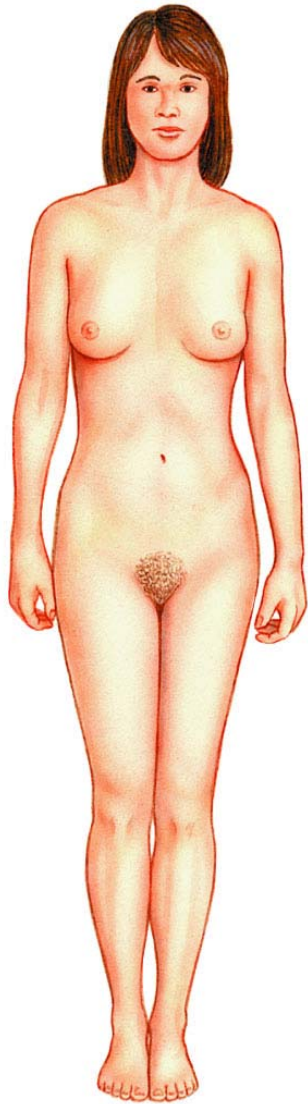
- ◀ • Provides structural support
- ▶ • Synthesizes vitamin D₃, essential for calcium and phosphorus absorption (bone maintenance and growth)

The Muscular System



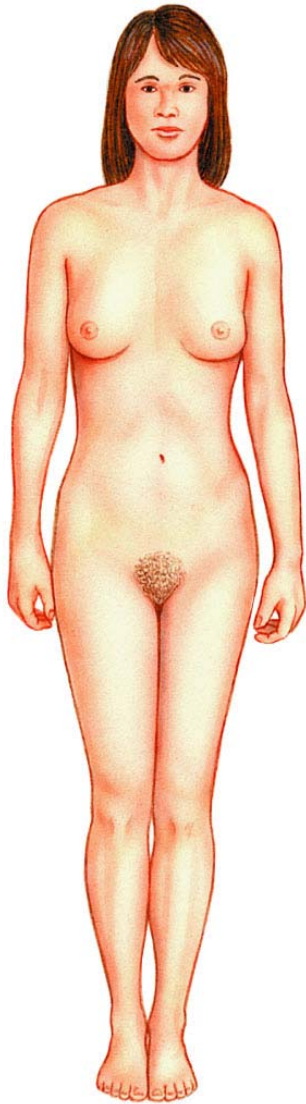
- ◀ • Contractions of skeletal muscle pull against skin of face, producing facial expressions important in communication
- ▶ • Synthesizes vitamin D_3 , essential for normal calcium absorption (calcium ions play an essential role in muscle contraction)

The Nervous System



- ◀ • Controls blood flow and sweat gland activity for thermoregulation; stimulates contraction of arrector pili muscles to elevate hairs
- ▶ • Receptors in dermis and deep epidermis provide sensations of touch, pressure, vibration, temperature, and pain

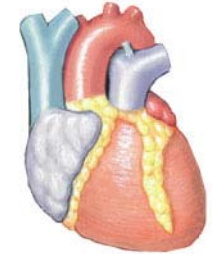
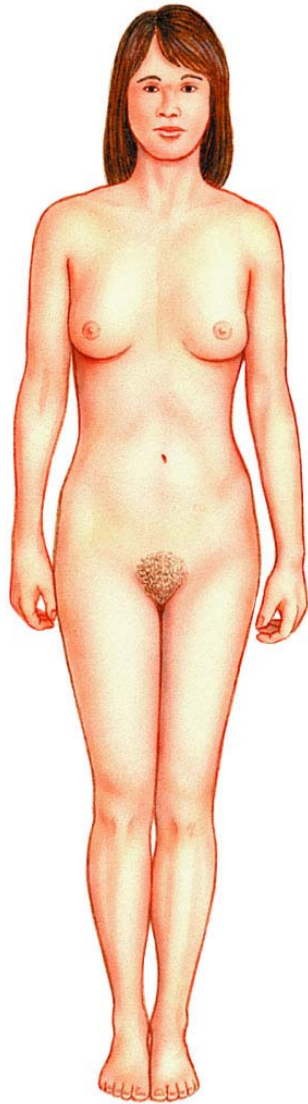
The Endocrine System



- ◀ • Sex hormones stimulate sebaceous gland activity; male and female sex hormones influence hair growth, distribution of subcutaneous fat, and apocrine sweat gland activity; adrenal hormones alter dermal blood flow and help mobilize lipids from adipocytes
- ▶ • Synthesizes vitamin D₃, precursor of calcitriol

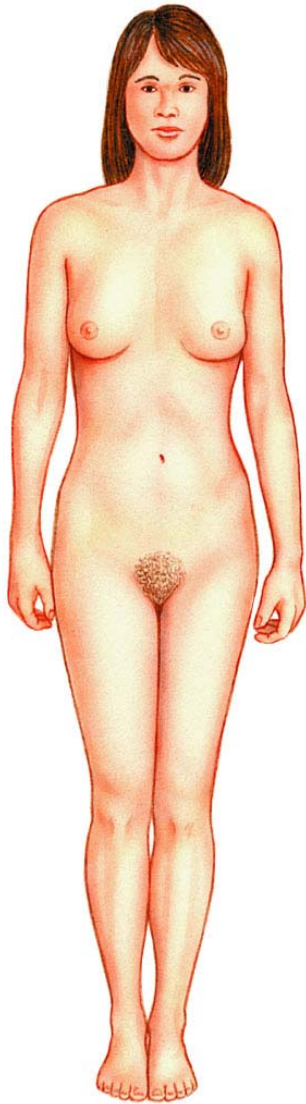


The Cardiovascular System



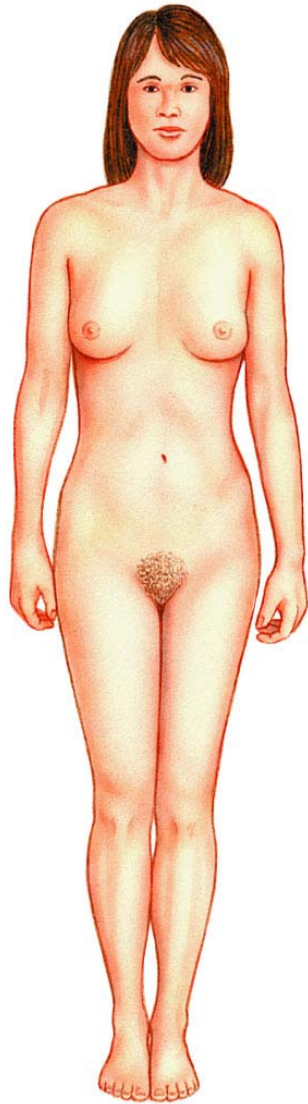
- ◀ • Provides oxygen and nutrients; delivers hormones and cells of immune system; carries away carbon dioxide, waste products, and toxins; provides heat to maintain normal skin temperature
- ▶ • Stimulation by mast cells produces localized changes in blood flow and capillary permeability

The Lymphatic System



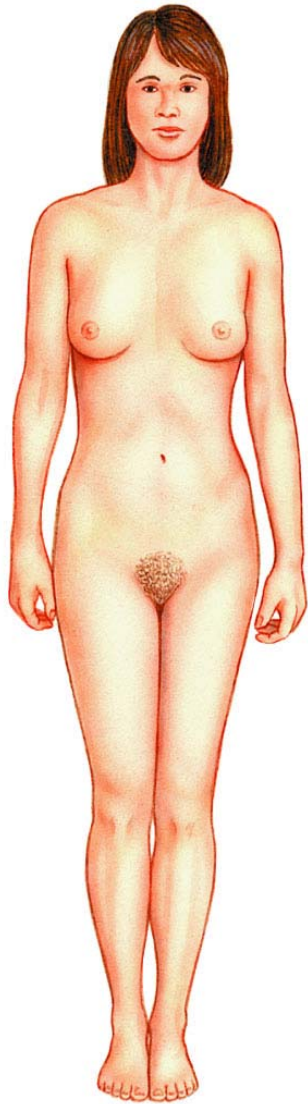
- ◀ • Assists in defending the integument by providing additional macrophages and mobilizing lymphocytes
- ▶ • Provides physical barriers that prevent pathogen entry; macrophages resist infection; mast cells trigger inflammation and initiate the immune response

The Respiratory System



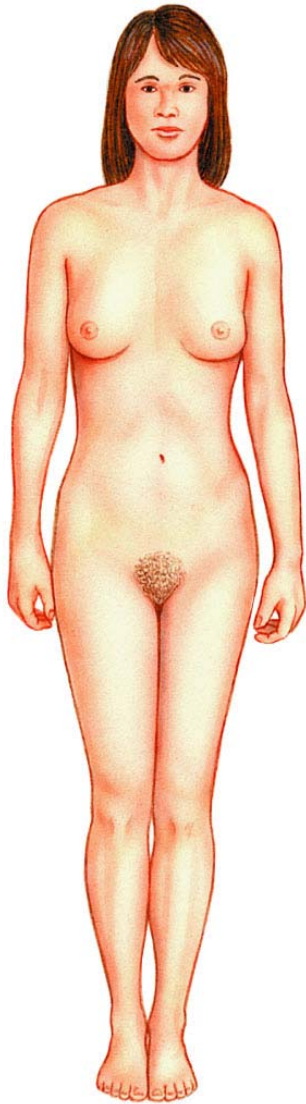
- ◀ • Provides oxygen and eliminates carbon dioxide
- ▶ • Hairs guard entrance to nasal cavity

The Digestive System



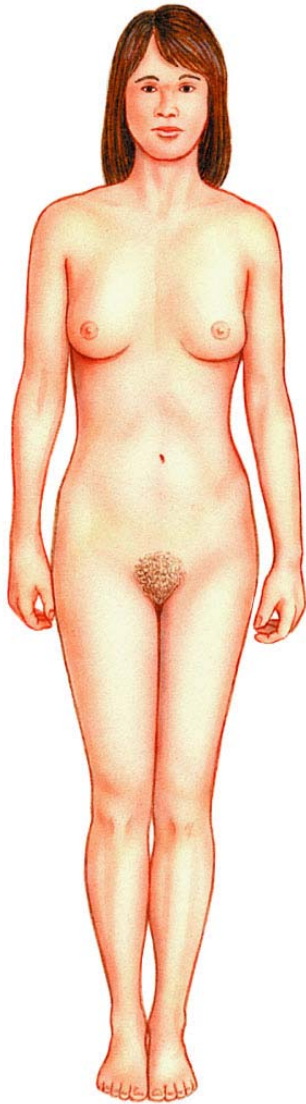
- ◀ • Provides nutrients for all cells and lipids for storage by adipocytes
- ▶ • Synthesizes vitamin D₃, needed for absorption of calcium and phosphorus

The Urinary System



- ◀ • Excretes waste products, maintains normal body fluid pH and ion composition
- ▶ • Assists in elimination of water and solutes; keratinized epidermis limits fluid loss through skin

The Reproductive System



- ◀ • Sex hormones affect hair distribution, adipose tissue distribution in subcutaneous layer, and mammary gland development
- ▶ • Covers external genitalia; provides sensations that stimulate sexual behaviors; mammary gland secretions provide nourishment for newborn infant

