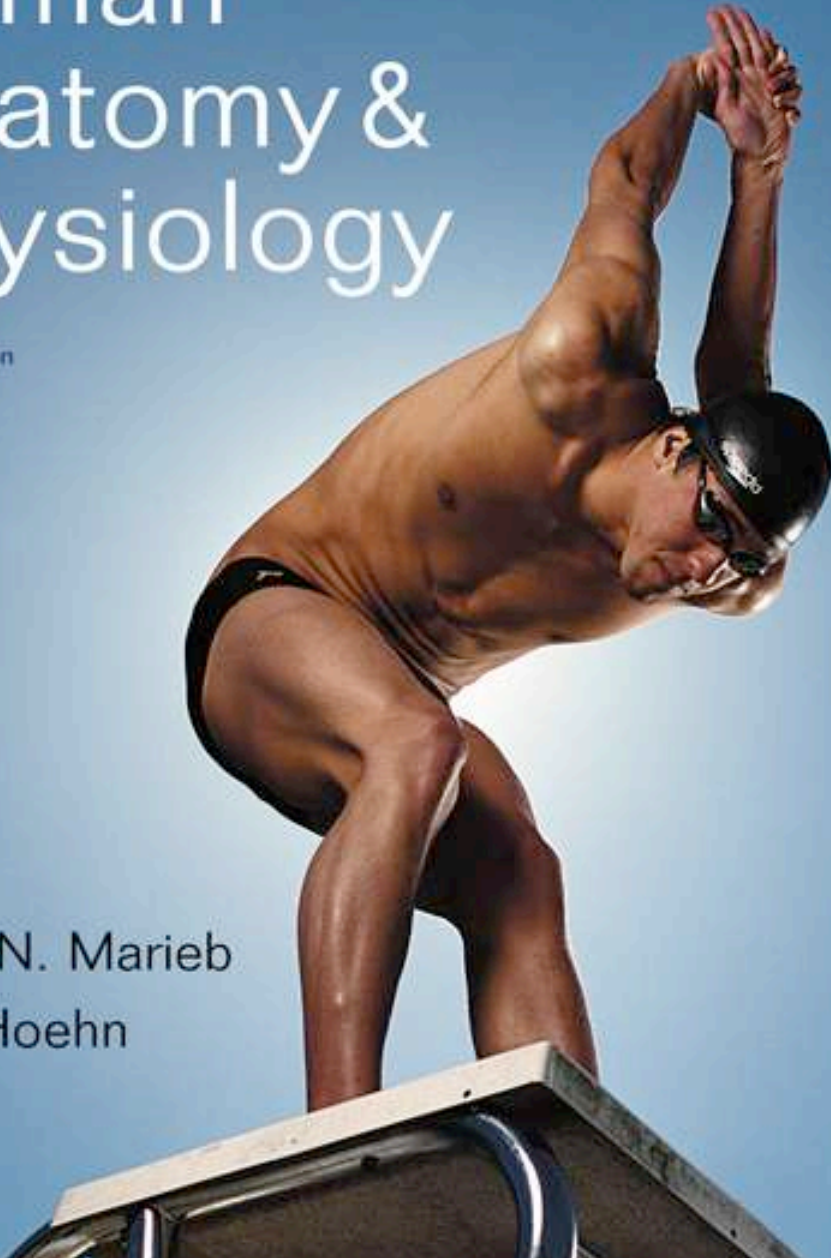


Human Anatomy & Physiology

Eighth Edition

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PowerPoint® Lecture Slides
prepared by
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Mount Royal College

CHAPTER 5

The Integumentary System

Skin (Integument)

- Consists of three major regions
 1. **Epidermis**—superficial region
 2. **Dermis**—middle region
 3. **Hypodermis (superficial fascia)**—deepest region
 - Subcutaneous layer deep to skin (not technically part of skin)
 - Mostly adipose tissue

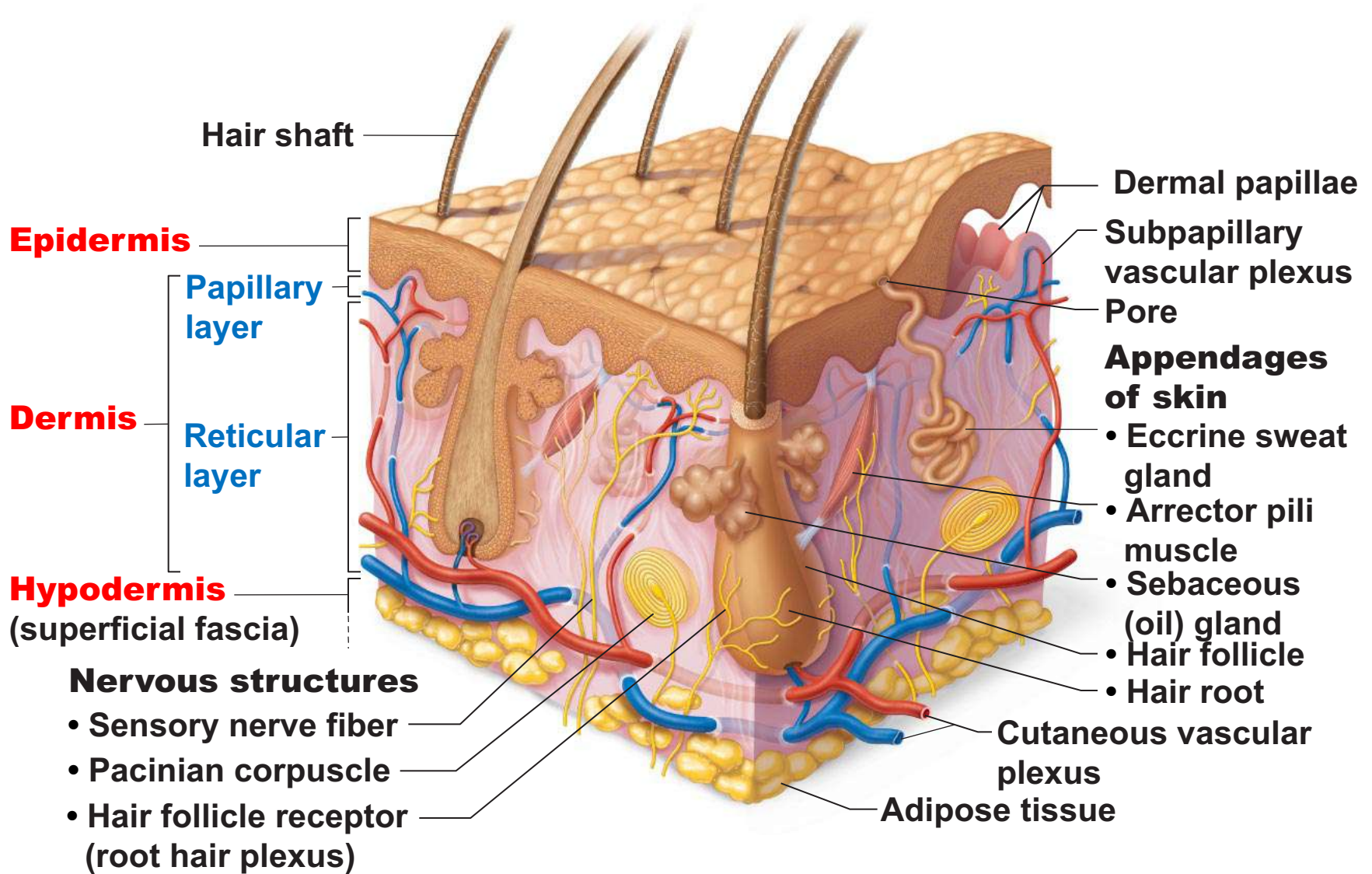


Figure 5.1

Epidermis

- Keratinized stratified **squamous epithelium**
- Cells of epidermis
 - **Keratinocytes**—produce fibrous protein keratin
 - **Melanocytes** - 10–25% of cells in lower epidermis & Produce pigment melanin
 - **Epidermal dendritic (Langerhan's)** cells—macrophages that help activate immune system
 - Tactile (**Merkel**) cells – base of epidermis; associated with nerve endings of the dermis; touch receptors
 - Strongly held together by desmosomes
 - Basement layer attaching it to the dermis

Layers of the Epidermis

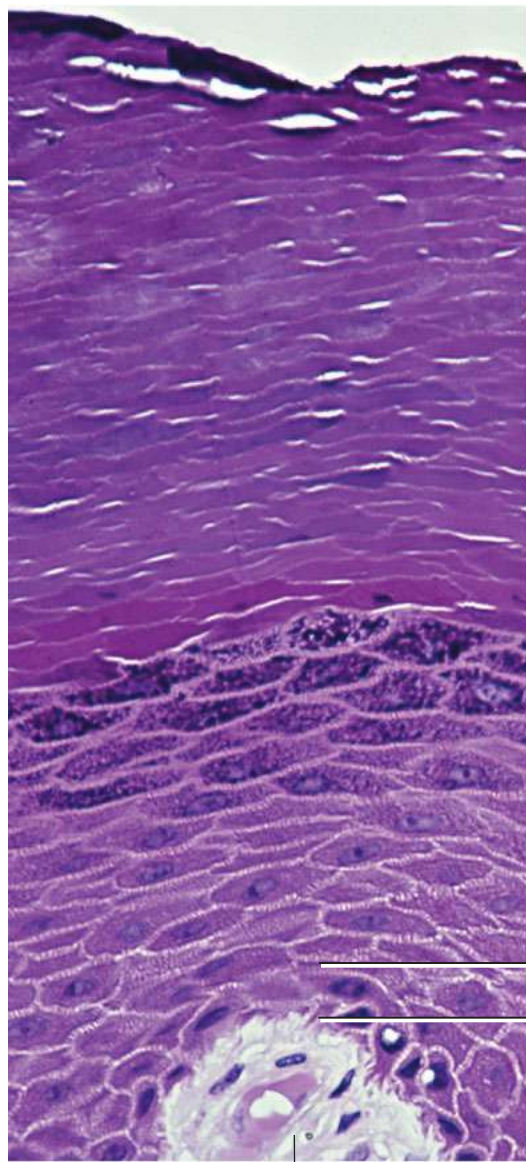
Stratum Basale

Stratum Spinosum

Stratum Granulosum

Stratum Lucidum (thick skin only)

Stratum Corneum



(a) Dermis

Stratum corneum

Most superficial layer; 20–30 layers of dead cells represented only by flat membranous sacs filled with keratin. Glycolipids in extracellular space.

Stratum granulosum

Three to five layers of flattened cells, organelles deteriorating; cytoplasm full of lamellated granules (release lipids) and keratohyaline granules.

Stratum spinosum

Several layers of keratinocytes unified by desmosomes. Cells contain thick bundles of intermediate filaments made of pre-keratin.

Stratum basale

Deepest epidermal layer; one row of actively mitotic stem cells; some newly formed cells become part of the more superficial layers. See occasional melanocytes and epidermal dendritic cells.

Layers of the Epidermis:

Stratum Basale (Basal Layer)

- Deepest epidermal layer firmly attached to the wavy papillae layer of the dermis
- Single row of stem cells
- Also called **stratum germinativum**: cells undergo rapid division
- Merkel cells & melanocytes
- Journey from basal layer to surface
 - Takes 25–45 days

Layers of the Epidermis:

Stratum Spinosum (Prickly Layer)

- Cells contain a weblike system of intermediate prekeratin filaments attached to **desmosomes**
- Abundant melanin granules (transferred from the melanocytes of the basal layer)
- **Langerhans' cells (dendritic cells)**

Layers of the Epidermis:

Stratum Granulosum (Granular Layer)

- Thin; three to five cell layers in which the cells flatten (squamos)
- Nucleus & organelles begin disintegrate; cells begin die; keratinocytes begin to “toughen up”
- **Keratohyaline** (protein called keratin)
- **Lamellated granules** (glycolipid)
- Plasma membranes thicken cytosol proteins bind to inner membrane wall

Layers of the Epidermis:

Stratum Lucidum (Clear Layer; Not shown in diagram)

- In **thick skin**
- Palms of hands and soles of feet
- Thin, transparent band superficial to the stratum granulosum
- A few rows of flat, dead keratinocytes

Layers of the Epidermis:

Stratum Corneum (Horny Layer)

- 20–30 rows of dead, flat (squamos), keratinized membranous sacs (cell remnants)
- Shingle-like arrangement
- Three-quarters of the epidermal thickness
- Protects from abrasion (**keratohyaline**) and penetration
- Waterproofs (**lamellated granules**)
- Barrier against biological, chemical, and physical assaults

Stratum corneum

Most superficial layer; 20–30 layers of dead cells represented only by flat membranous sacs filled with keratin. Glycolipids in extracellular space.

Stratum granulosum

Three to five layers of flattened cells, organelles deteriorating; cytoplasm full of lamellated granules (release lipids) and keratohyaline granules.

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Stratum basale

Deepest epidermal layer; one row of actively **mitotic stem cells**; some newly formed cells become part of the more superficial layers. See occasional **melanocytes** and epidermal **dendritic cells**.

(b)

Desmosomes
Melanin granule
Melanocyte

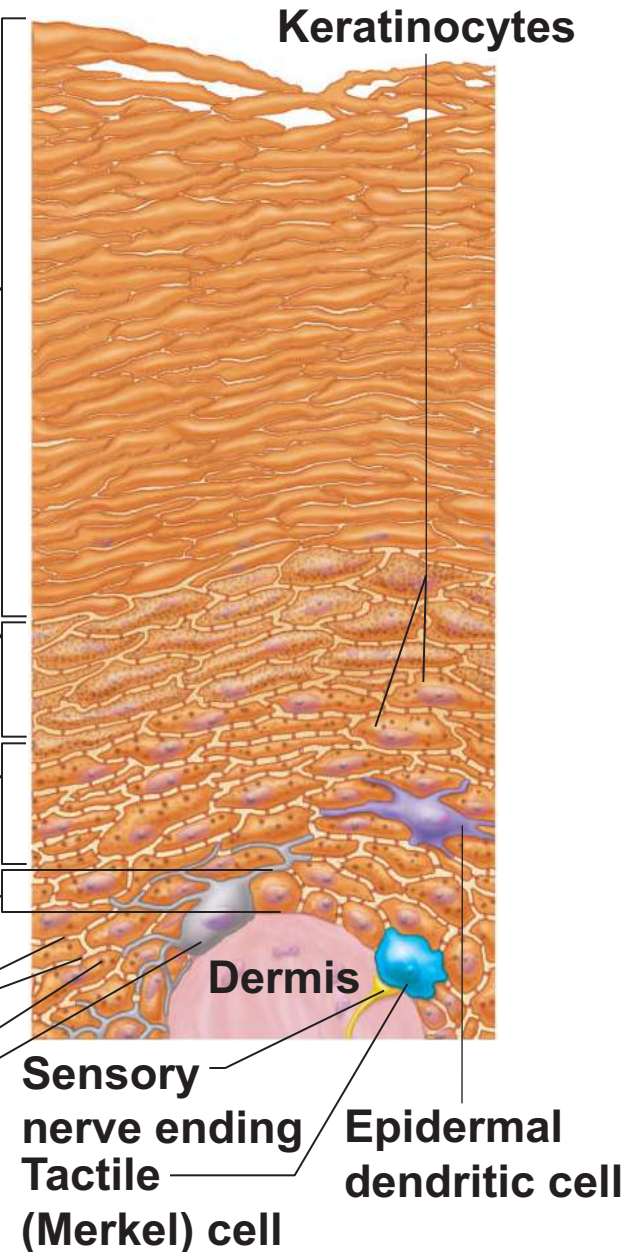


Figure 5.2b

Dermis

- Strong, flexible connective tissue
- Cells include fibroblasts, macrophages, and occasionally mast cells and white blood cells
- Two layers:
 - Papillary
 - Reticular

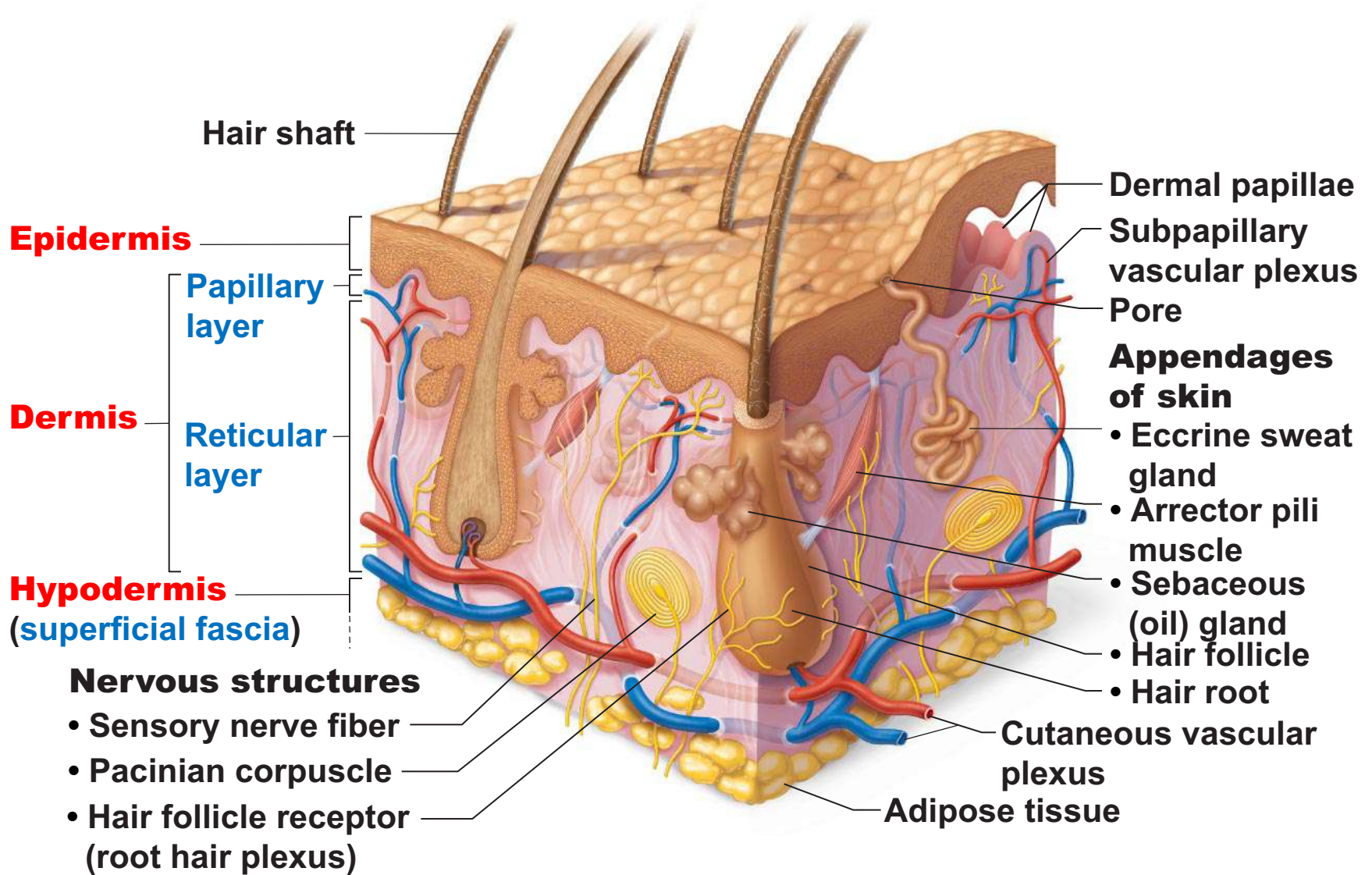


Figure 5.1

Layers of the Dermis: Papillary Layer

- **Papillary layer**
 - **Areolar connective tissue** with collagen and elastic fibers and blood vessels
 - Dermal papillae contain: (capillary loops, areolar connective tissue, pain receptors, dermal ridges, Meissner's corpuscles, wavey, capillaries, free nerve endings)

Layers of the Dermis: Reticular Layer

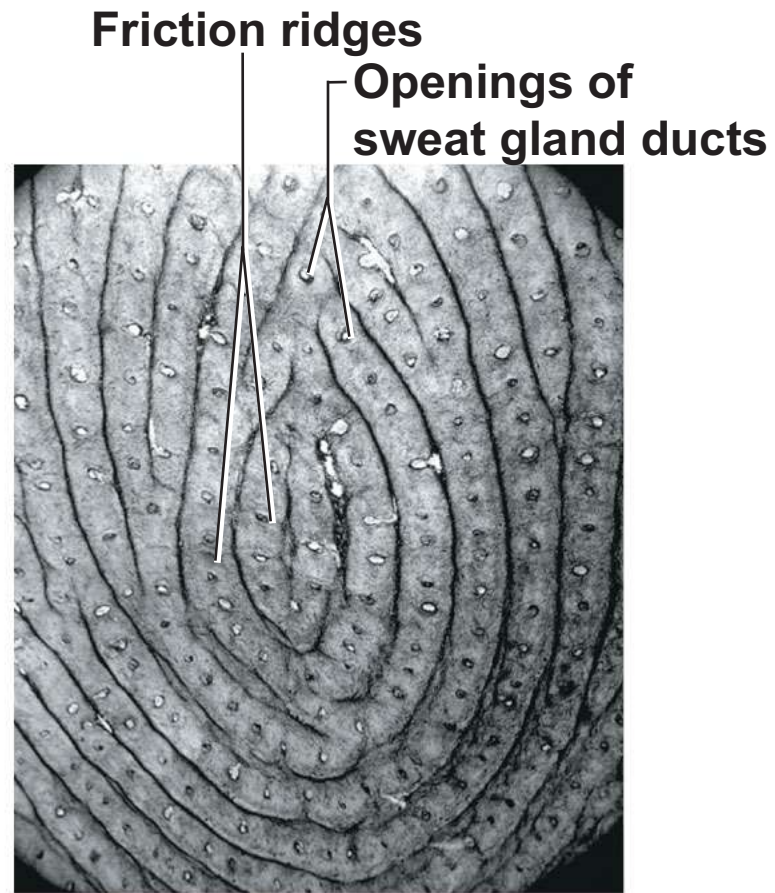
- **Reticular layer**

- ~80% of the thickness of dermis
- Dense irregular connective tissue
(collagen fibers provide strength and resiliency, elastic fibers provide stretch-recoil properties)

Cleavage lines, flexure lines, Pacinian corpuscles (pressure receptors)

Skin Markings: Friction Ridges

- **Epidermal ridges** lie atop deeper dermal papillary ridges to form friction ridges of fingerprints



(a)

Skin Markings: Cleavage Lines

- Collagen fibers arranged in bundles form **cleavage (tension) lines**
- Incisions made parallel to cleavage lines heal more readily



(b)

Figure 5.4b

Skin Color

- Three pigments contribute to skin color:
 1. **Melanin**
 - Yellow to reddish-brown to black, responsible for dark skin colors
 - Produced in **melanocytes**; migrates to **keratinocytes** where it forms “pigment shields” for nuclei
 - Freckles and pigmented moles
 - Local accumulations of melanin

Skin Color

2. Carotene

- Yellow to orange, most obvious in the palms and soles, from foods

3. Hemoglobin

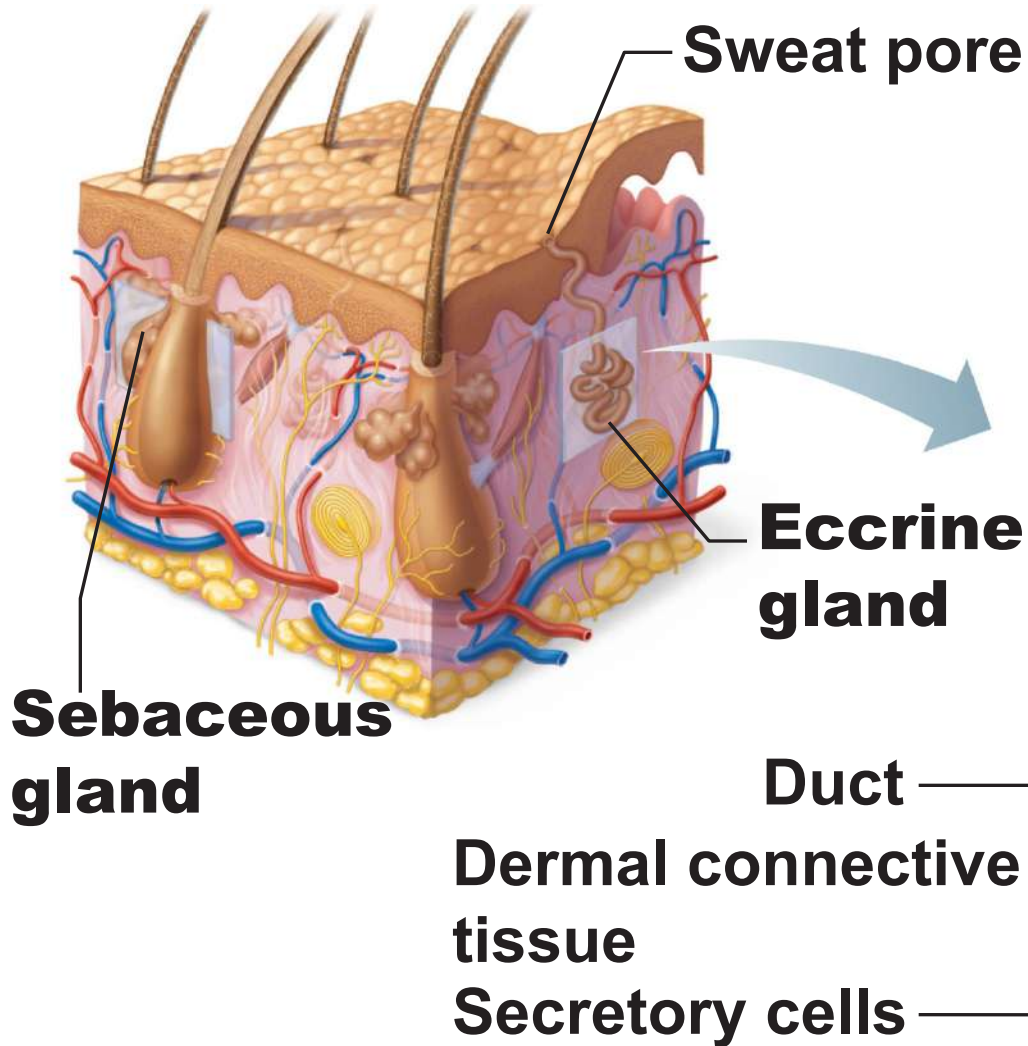
- Responsible for the pinkish hue of skin

Appendages of the Skin

- Derivatives of the epidermis
 - Sweat glands
 - Oil glands
 - Hairs and hair follicles
 - Nails

Sweat Glands (sudoriferous)

- Two main types of sweat (sudoriferous) glands
 1. **Eccrine** (**merocrine**) sweat glands—abundant on palms, soles, and forehead
 - Sweat: 99% water, NaCl, vitamin C, antibodies, dermcidin, metabolic wastes
 - Ducts connect to pores
 - Function in thermoregulation



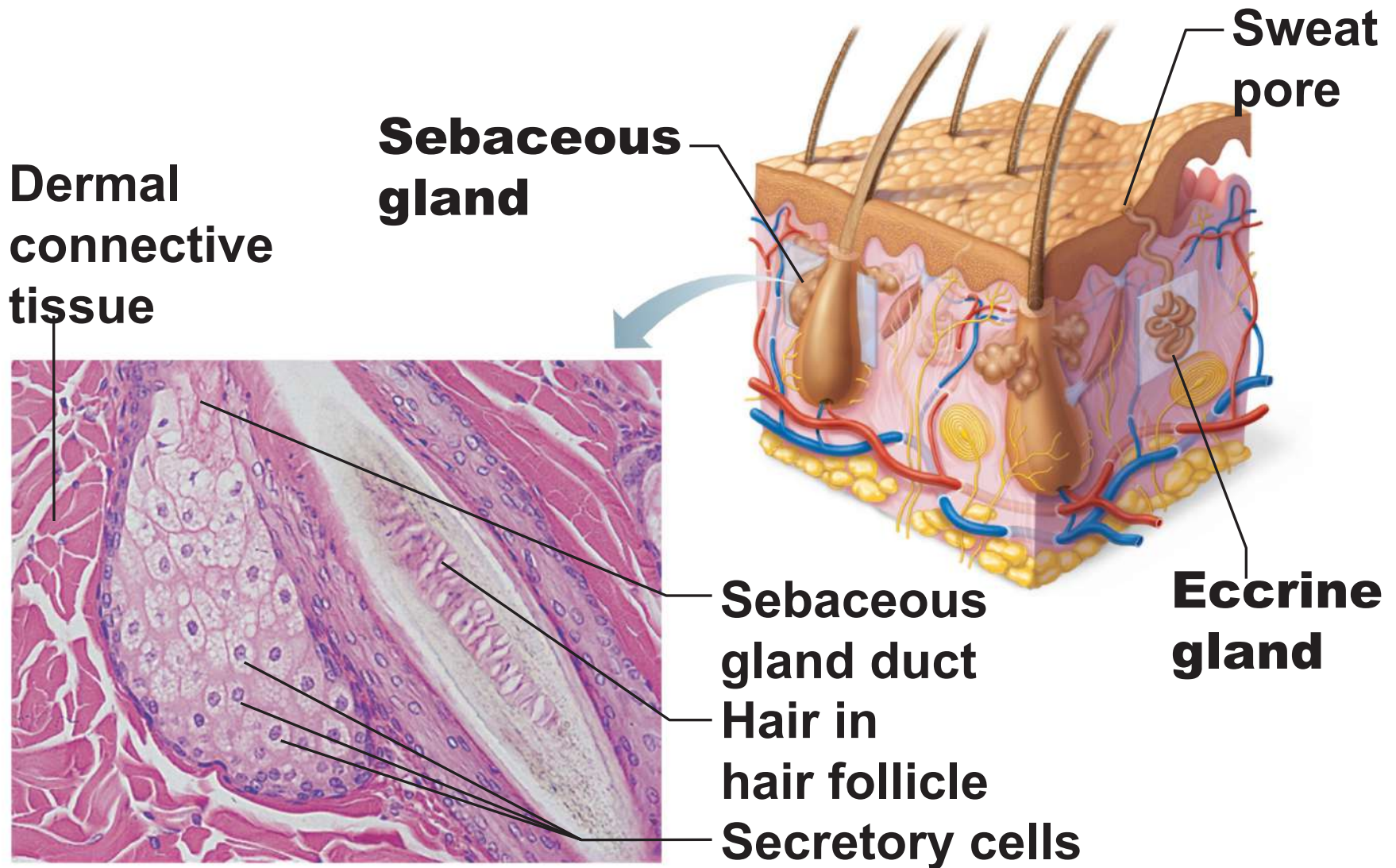
(b) Photomicrograph of a sectioned eccrine gland (220x)

Sweat Glands (sudoriferous)

2. **Apocrine sweat glands** —confined to axillary and anogenital areas
 - **Sebum**: sweat + fatty substances and proteins
 - Ducts connect to hair follicles
 - Functional from puberty onward (as sexual scent glands?)
- Specialized apocrine glands
 - **Ceruminous glands**—in external ear canal; secrete **cerumen**
 - **Mammary glands**

Sebaceous (Oil) Glands (holocrine)

- Widely distributed
- Most develop from hair follicles
- Become active at puberty
- Sebum
 - Oily holocrine secretion
 - Bactericidal
 - Softens hair and skin



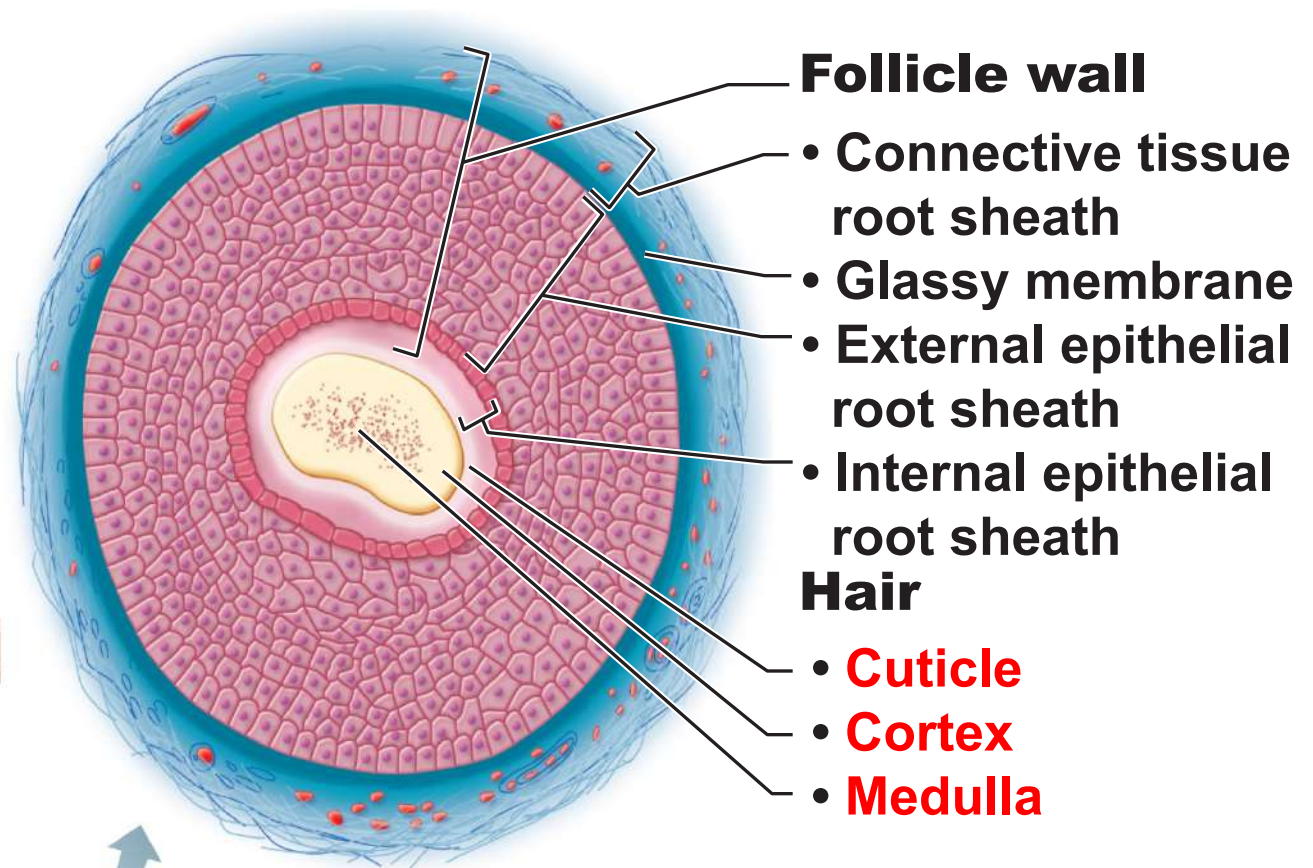
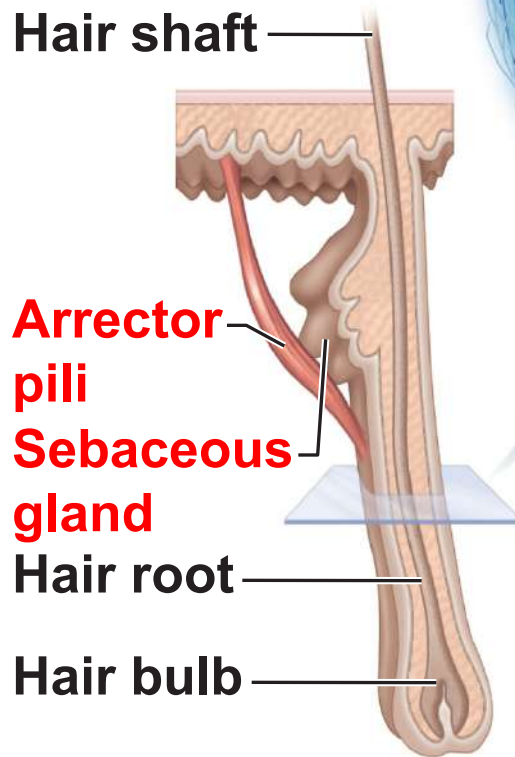
(a) Photomicrograph of a sectioned sebaceous gland (220x)

Hair

- Functions
 - Alerting the body to presence of insects on the skin
 - Guarding the scalp against physical trauma, heat loss, and sunlight
- Distribution
 - Entire surface except palms, soles, lips, nipples, and portions of external genitalia

Hair

- Consists of dead keratinized cells
- Contains **hard keratin**; more durable than soft keratin of skin
- Shape of the shaft determines hair texture
- Hair pigments: melanins (yellow, rust brown, black)
 - Gray/white hair: decreased melanin production, increased air bubbles in shaft



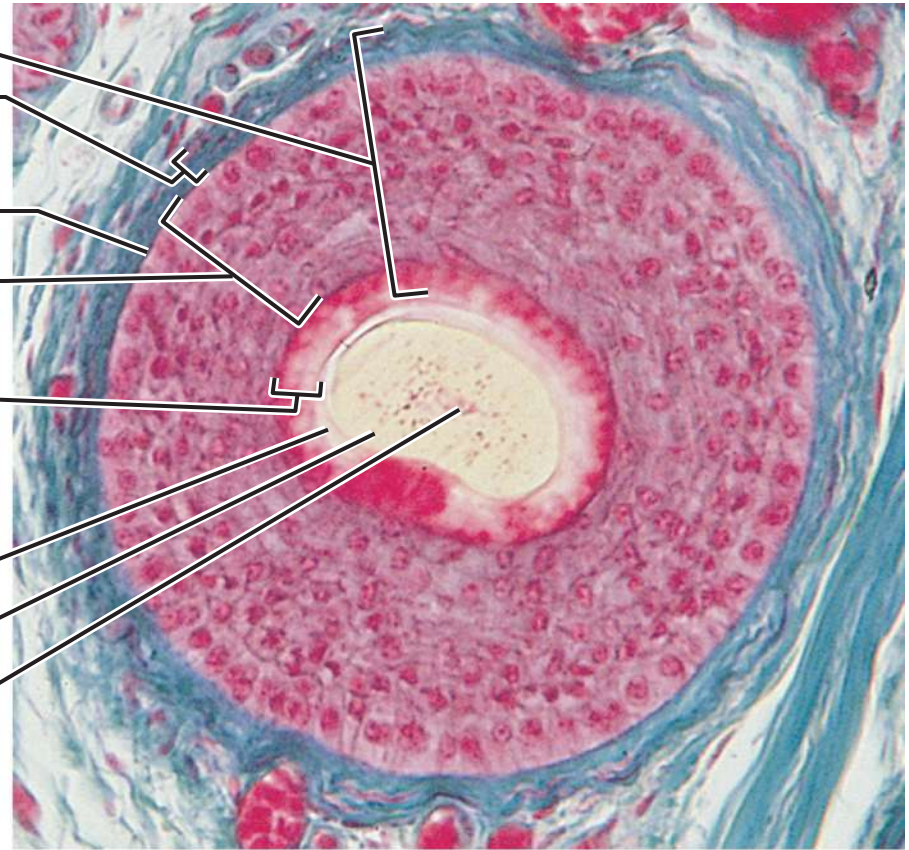
(a) Diagram of a cross section of a hair within its follicle

Follicle wall

- **Connective tissue**
root sheath
- **Glassy membrane**
- **External epithelial**
root sheath
- **Internal epithelial**
root sheath

Hair

- **Cuticle**
- **Cortex**
- **Medulla**



(b) Photomicrograph of a cross section of a hair and hair follicle (250x)

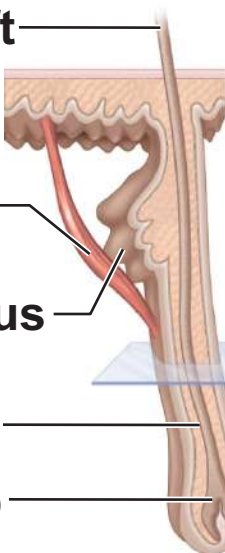
Hair shaft

Arrector pili

Sebaceous gland

Hair root

Hair bulb

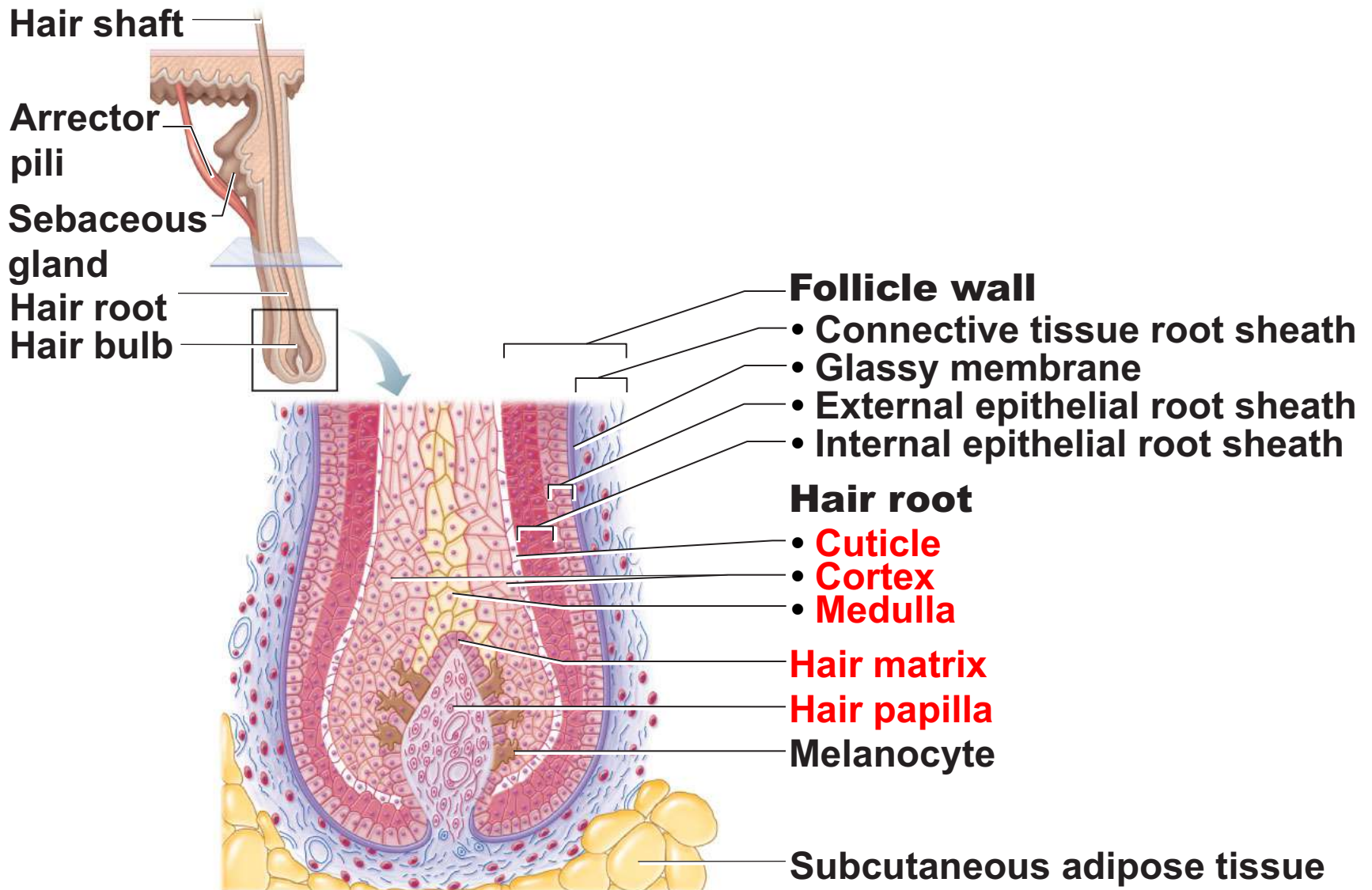


Hair Follicle

- Extends from the epidermal surface into dermis
- Two-layered wall: outer connective tissue root sheath, inner epithelial root sheath
- Hair bulb: expanded deep end

Hair Follicle

- Hair follicle receptor (root hair plexus)
 - Sensory nerve endings around each hair bulb
 - Stimulated by bending a hair
- **Arrector pili**
 - Smooth muscle attached to follicle
 - Responsible for “goose bumps”



(c) Diagram of a longitudinal view of the expanded hair bulb of the follicle, which encloses the matrix

Follicle wall

- **Connective tissue**
- **root sheath**
- **Glassy membrane**
- **External epithelial**
- **root sheath**
- **Internal epithelial**

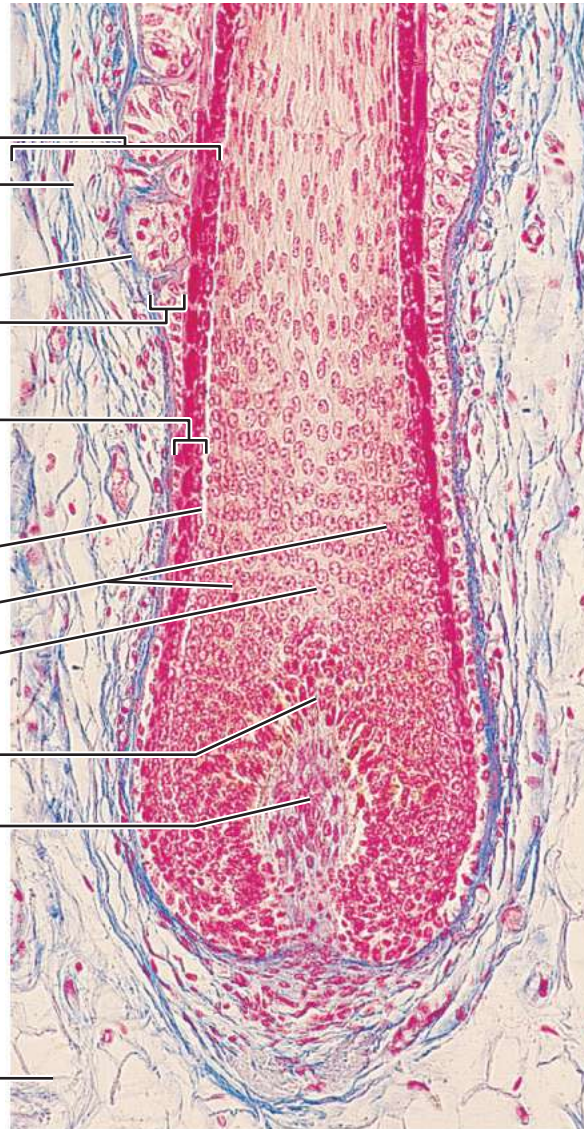
Hair root

- **Cuticle**
- **Cortex**
- **Medulla**

Hair matrix

Hair papilla

Subcutaneous adipose tissue

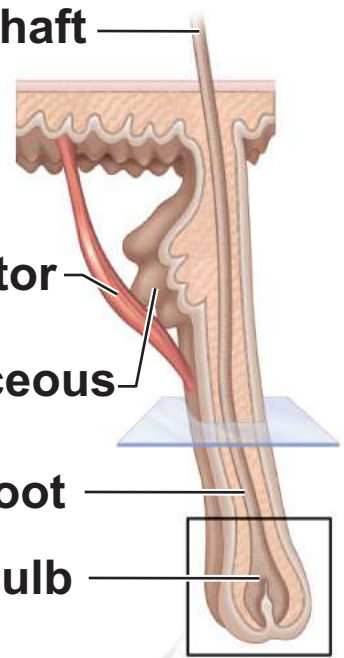


Hair shaft

Arrector pili Sebaceous gland

Hair root

Hair bulb



(d) Photomicrograph of longitudinal view of the hair bulb in the follicle (160x)

Types of Hair

- **Vellus**—pale, fine body hair of children and adult females
- **Terminal**—coarse, long hair of eyebrows, scalp, axillary, and pubic regions (and face and neck of males)

Types of Hair

- Hair Growth
 - Growth phase (weeks to years) followed by regressive stage and resting phase (1–3 months)
 - Growth phase varies (6–10 years in scalp, 3–4 months in eyebrows)

Hair Thinning and Baldness

- **Alopecia**—hair thinning in both sexes after age 40
- True (frank or pattern baldness) baldness
 - Genetically determined and sex-influenced condition
 - Male pattern baldness is caused by follicular response to DHT

Structure of a Nail

- Scalelike modification of the epidermis on the distal, dorsal surface of fingers and toes

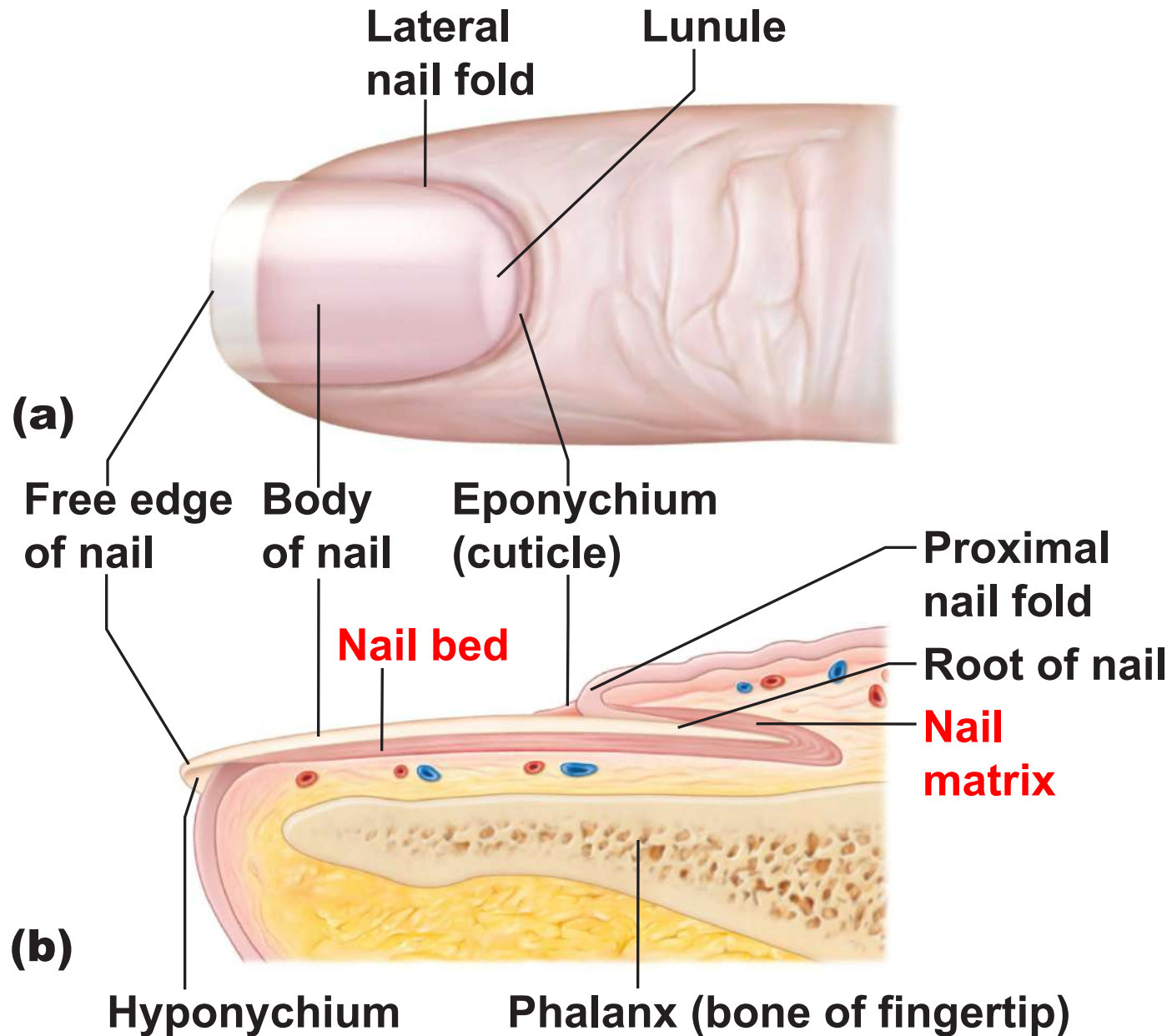


Figure 5.7

Functions of the Integumentary System

1. Protection—three types of barriers
 - Chemical
 - Low pH secretions (acid mantle) and defensins retard bacterial activity

Functions of the Integumentary System

- Physical/mechanical barriers
 - Keratin and glycolipids block most water and water- soluble substances
 - Limited penetration of skin by lipid-soluble substances, plant oleoresins (e.g., poison ivy), organic solvents, salts of heavy metals, some drugs
- Biological barriers
 - Dendritic cells, macrophages, and DNA

Functions of the Integumentary System

2. Body temperature regulation

- ~500 ml/day of routine insensible perspiration (at normal body temperature)
- At elevated temperature, dilation of dermal vessels and increased sweat gland activity (sensible perspirations) cool the body

3. Cutaneous sensations

- Temperature, touch, and pain

Functions of the Integumentary System

4. Metabolic functions

- Synthesis of vitamin D precursor and collagenase
- Chemical conversion of carcinogens and some hormones

5. Blood reservoir—up to 5% of body's blood volume

6. Excretion—nitrogenous wastes and salt in sweat

Skin Cancer

- Most skin tumors are benign (do not metastasize)
- Risk factors
 - Overexposure to UV radiation
 - Frequent irritation of the skin
- Some skin lotions contain enzymes in liposomes that can fix damaged DNA

Skin Cancer

- Three major types:
 - Basal cell carcinoma
 - Least malignant, most common
 - Squamous cell carcinoma
 - Second most common
 - Melanoma
 - Most dangerous

Basal Cell Carcinoma

- Stratum basale cells proliferate and slowly invade dermis and hypodermis
- Cured by surgical excision in 99% of cases



(a) Basal cell carcinoma

Squamous Cell Carcinoma

- Involves keratinocytes of stratum spinosum
- Most common on scalp, ears, lower lip, and hands
- Good prognosis if treated by radiation therapy or removed surgically



(b) Squamous cell carcinoma

Melanoma

- Involves melanocytes
- Highly metastatic and resistant to chemotherapy
- Treated by wide surgical excision accompanied by immunotherapy

Melanoma

- Characteristics (ABCDE rule)
 - A: Asymmetry; the two sides of the pigmented area do not match
 - B: Border exhibits indentations
 - C: Color is black, brown, tan, and sometimes red or blue
 - D: Diameter is larger than 6 mm (size of a pencil eraser)
 - E: Elevation



(c) Melanoma

Burns

- Heat, electricity, radiation, certain chemicals



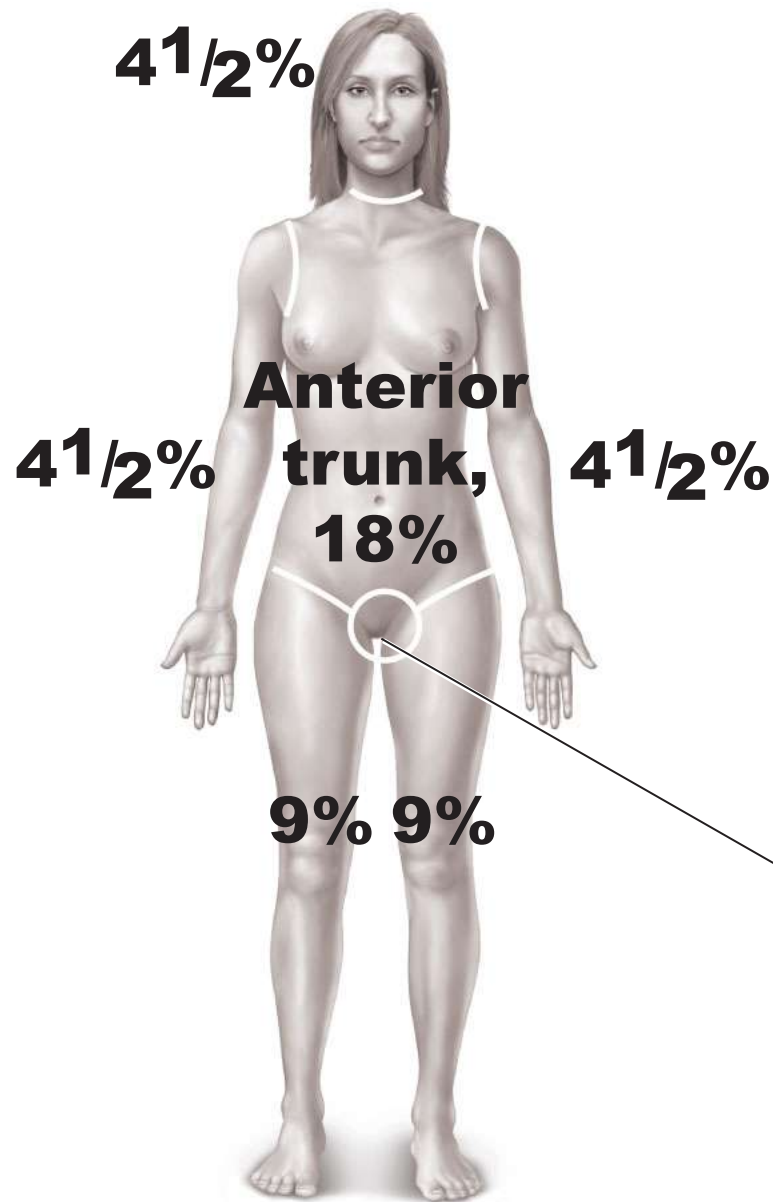
Burn

(tissue damage, denatured protein, cell death)

- Immediate threat:
 - Dehydration and electrolyte imbalance, leading to renal shutdown and circulatory shock

Rule of Nines

- Used to estimate the volume of fluid loss from burns



Totals

Anterior and posterior
head and neck, 9%

Anterior and posterior
upper limbs, 18%

Anterior and posterior
trunk, 36%

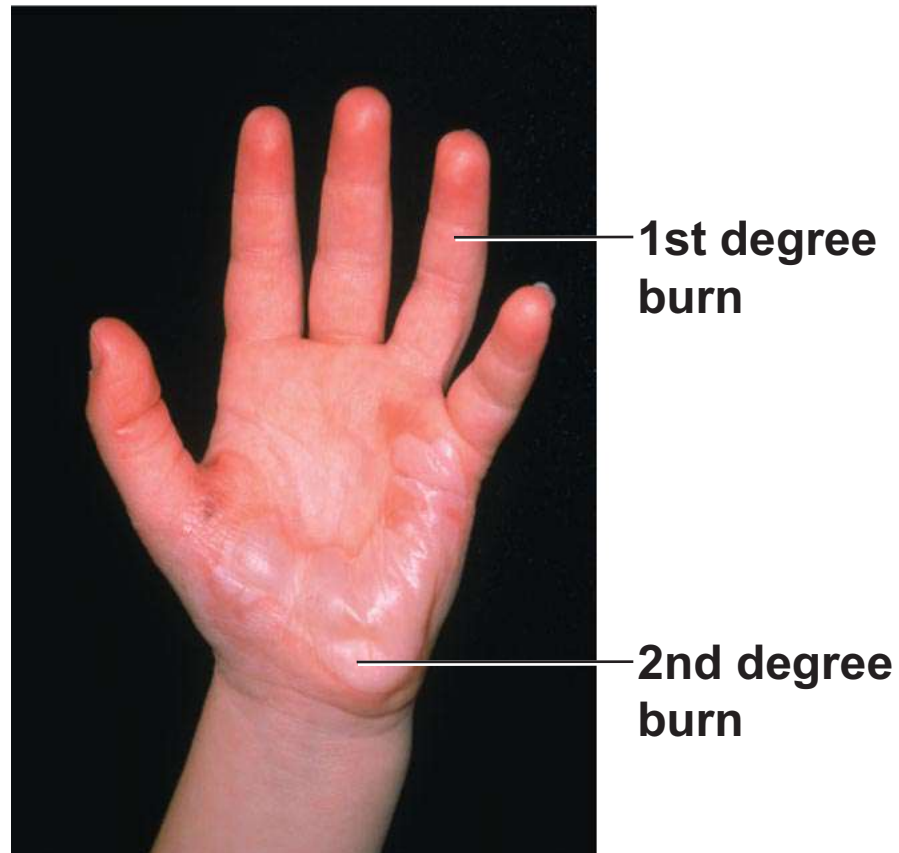
(Perineum, 1%)

Anterior and posterior
lower limbs, 36%

100%

Partial-Thickness Burns

- **First degree**
 - Epidermal damage only
 - Localized redness, edema (swelling), and pain
- **Second degree**
 - Epidermal and upper dermal damage
 - Blisters appear



(a) Skin bearing partial thickness burn (1st and 2nd degree burns)

Full-Thickness Burns

- **Third degree**
 - Entire thickness of skin damaged
 - Gray-white, cherry red, or black
 - No initial edema or pain (nerve endings destroyed)
 - Skin grafting usually necessary



3rd
degree
burn

**(b) Skin bearing full
thickness burn
(3rd degree burn)**

Severity of Burns

- Critical if:
 - >25% of the body has second-degree burns
 - >10% of the body has third-degree burns
 - Face, hands, or feet bear third-degree burns

Developmental Aspects: Fetal

- Ectoderm → epidermis
- Mesoderm → dermis and hypodermis
- Lanugo coat: covering of delicate hairs in 5th and 6th month
- Vernix caseosa: sebaceous gland secretion; protects skin of fetus

Developmental Aspects: Adolescent to Adult

- Sebaceous gland activity increases
- Effects of cumulative environmental assaults show after age 30
- Scaling and dermatitis become more common

Developmental Aspects: Old Age

- Epidermal replacement slows, skin becomes thin, dry, and itchy
- Subcutaneous fat and elasticity decrease, leading to cold intolerance and wrinkles
- Increased risk of cancer due to decreased numbers of melanocytes and dendritic cells