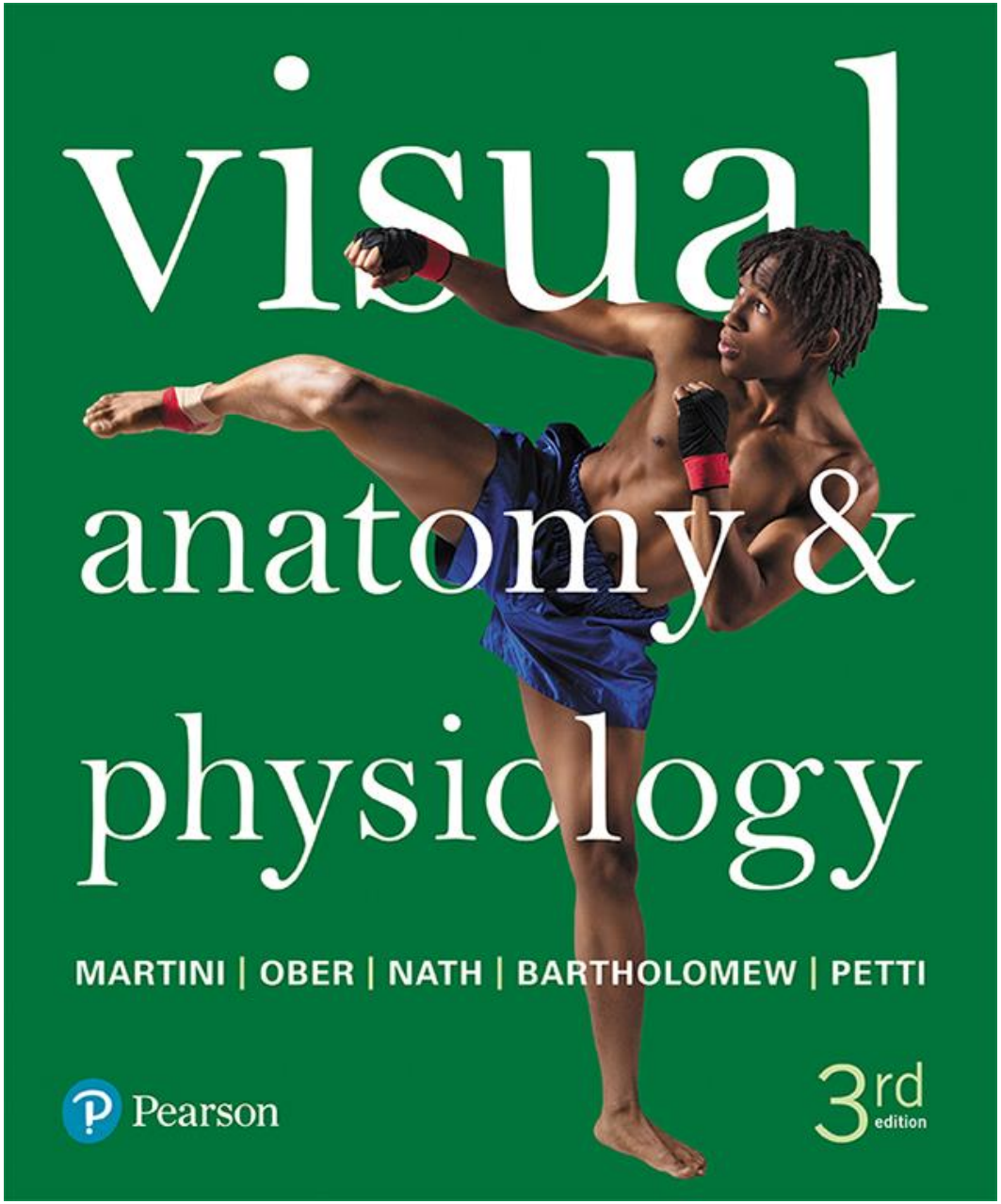


5

The Integumentary System

Lecture Presentation by
Lori Garrett

Section 1: Functional Anatomy of the Skin

Learning Outcomes

5.1 Describe the tissue structure of the integument and the functions of the integumentary system.

5.2 Describe the main structural features of the epidermis, and explain the functional significance of each feature.

5.3 Explain what accounts for individual differences in skin color, and compare basal cell carcinoma with malignant melanoma.

Section 1: Functional Anatomy of the Skin

Learning Outcomes (continued)

5.4 Describe the structures and functions of the dermis and subcutaneous layer.

5.5 **Clinical module:** Describe the classification of burns and the types of skin grafts.

Module 5.1: The integumentary system consists of the skin and various accessory structures

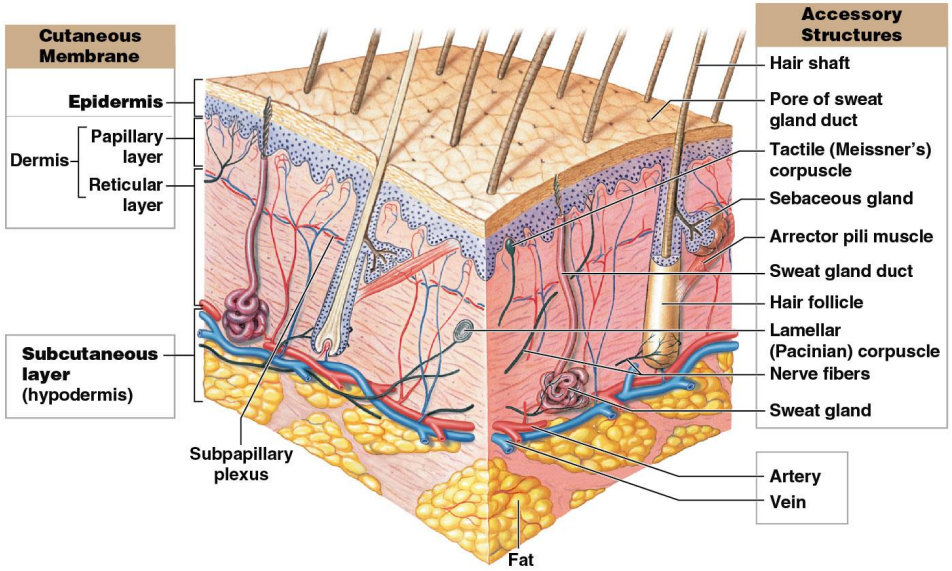
Integumentary system overview

- Most accessible organ system
- Can be referred to as skin or **integument**
- 16 percent of total body weight
- 1.5–2 m^2 in surface area
- Body's first line of defense against environment
- Has two major components
  1. **Cutaneous membrane**
  2. **Accessory structures**

Module 5.1: Functional anatomy of the skin

Integumentary system components

1. **Cutaneous membrane**
   - **Epidermis** (*epi*, above)
     - Composed of stratified squamous epithelium
   - **Dermis**
     - Papillary layer (areolar connective tissue)
     - Reticular layer (dense irregular connective tissue)

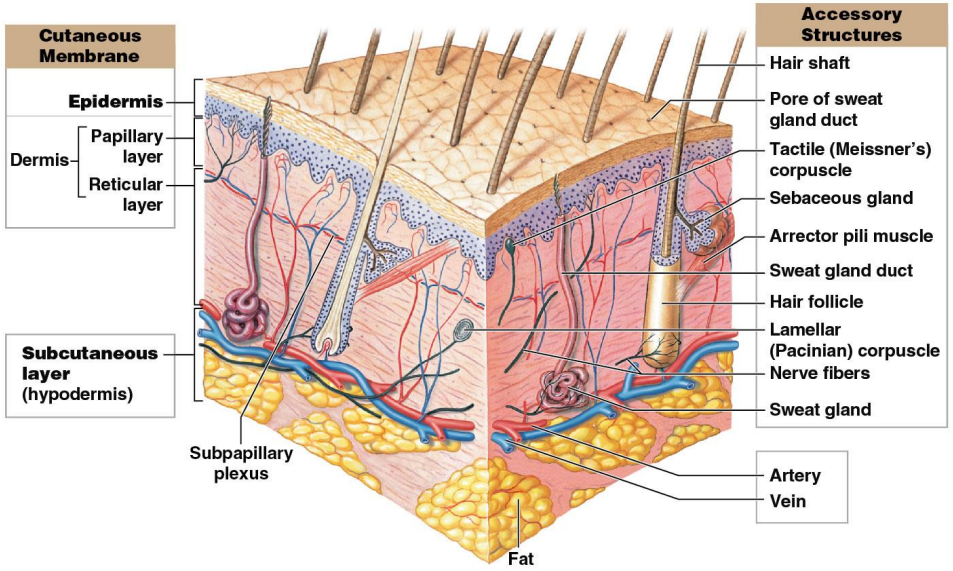


Module 5.1: Functional anatomy of the skin

Integumentary system components (continued)

2. **Accessory structures**

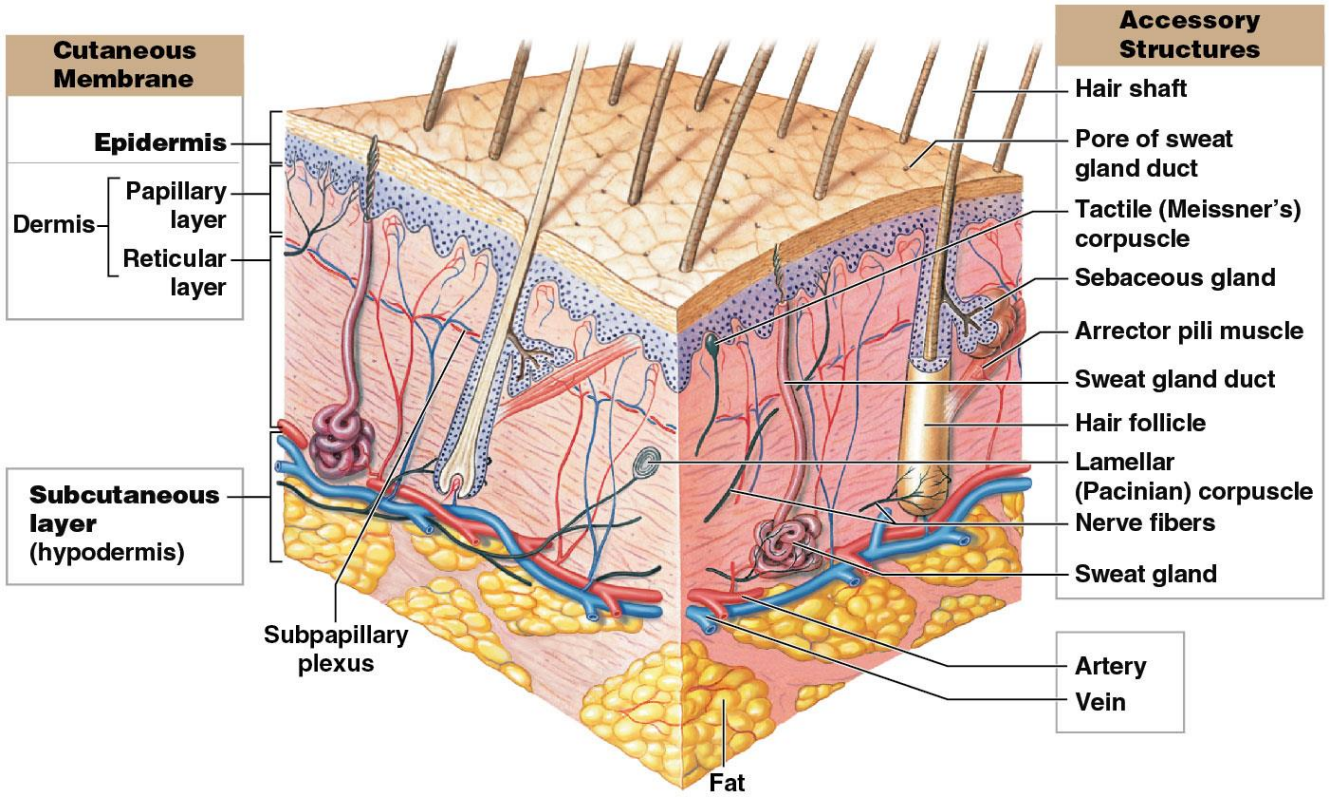
- Hairs
- Nails
- Exocrine glands
  - Sebaceous glands
  - Sweat glands
- Sensory receptors and nerve fibers
- Arrector pili muscles
- **Cutaneous plexus** (network of blood vessels)



Module 5.1: Functional anatomy of the skin

Subcutaneous layer (hypodermis)

- Not part of integument
  - Separates integument from deep fascia



Functions of the integumentary system

Functions of the Integumentary System

- Protect underlying tissues and organs against impact, abrasion, fluid loss, and chemical attack
- Excrete salts, water, and organic wastes by integumentary glands
- Maintain normal body temperature through either insulation or evaporative cooling, as needed
- Produce melanin, which protects underlying tissue from ultraviolet radiation
- Produce keratin, which protects against abrasion and serves as a water repellent
- Synthesize vitamin D_3, a steroid that is subsequently converted to calcitriol, a hormone important to normal calcium metabolism
- Store lipids in adipocytes in the dermis and in adipose tissue in the subcutaneous layer
- Detect touch, pressure, pain, and temperature stimuli, and relay that information to the nervous system

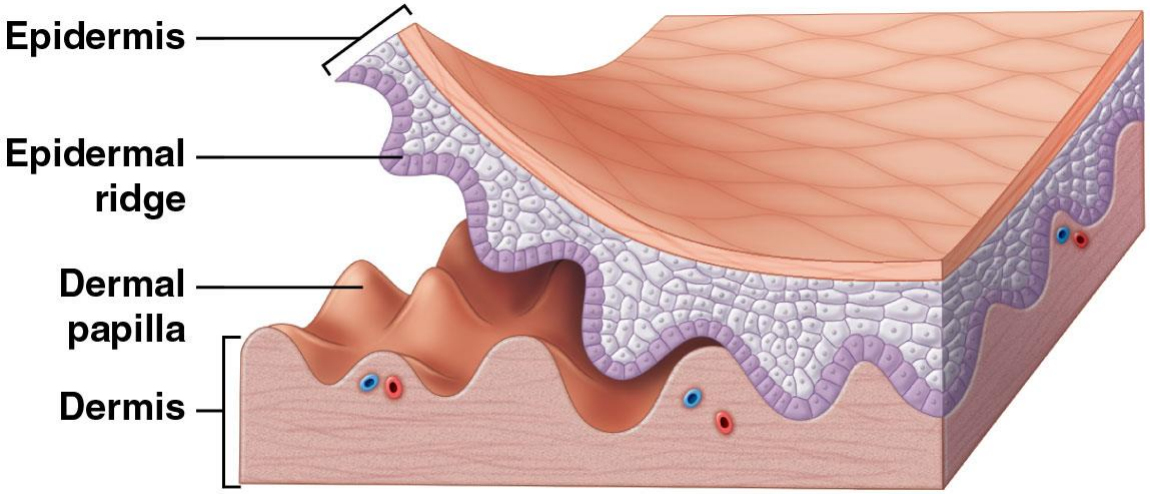
Module 5.1: Review

A. Identify the two major components of the cutaneous membrane.
B. Identify the major functions of the integumentary system.

Learning Outcome: Describe the tissue structure of the integument and the functions of the integumentary system.

Module 5.2: The epidermis is composed of strata (layers) that have various functions

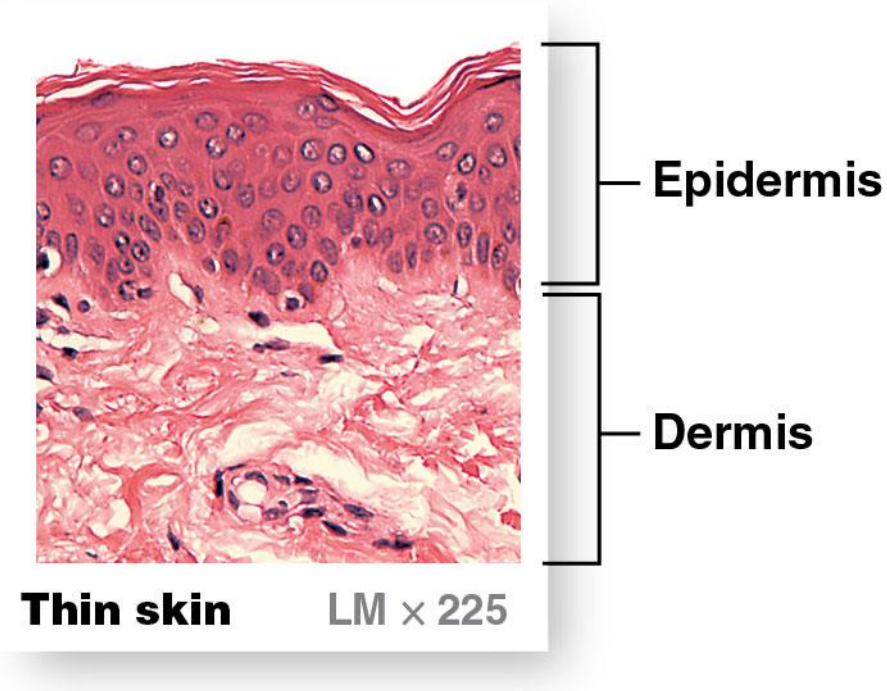
- Multiple layers of cells (**strata**)
- Primary cell type in epidermis is **keratinocyte**
- Deeper layers of epidermis form **epidermal ridges**
  - Adjacent to **dermal papillae** (*papilla*, nipple-shaped mound)
  - Increase surface area for better attachment



Module 5.2: The epidermis

Thin skin

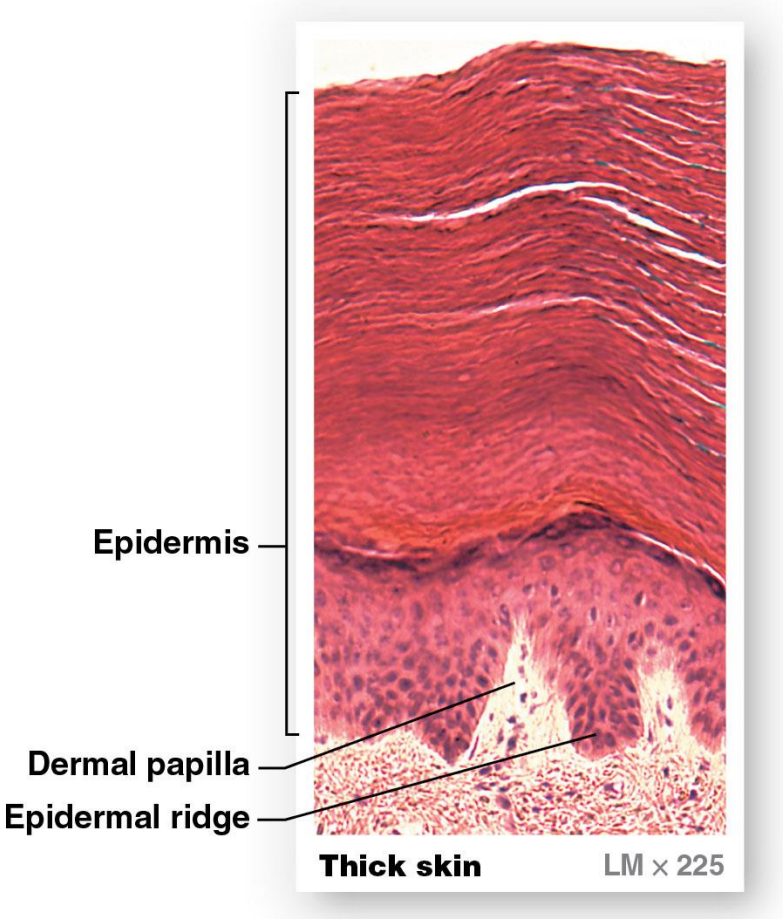
- Covers most of body surface
- Contains four strata (layers)



Module 5.2: The epidermis

Thick skin

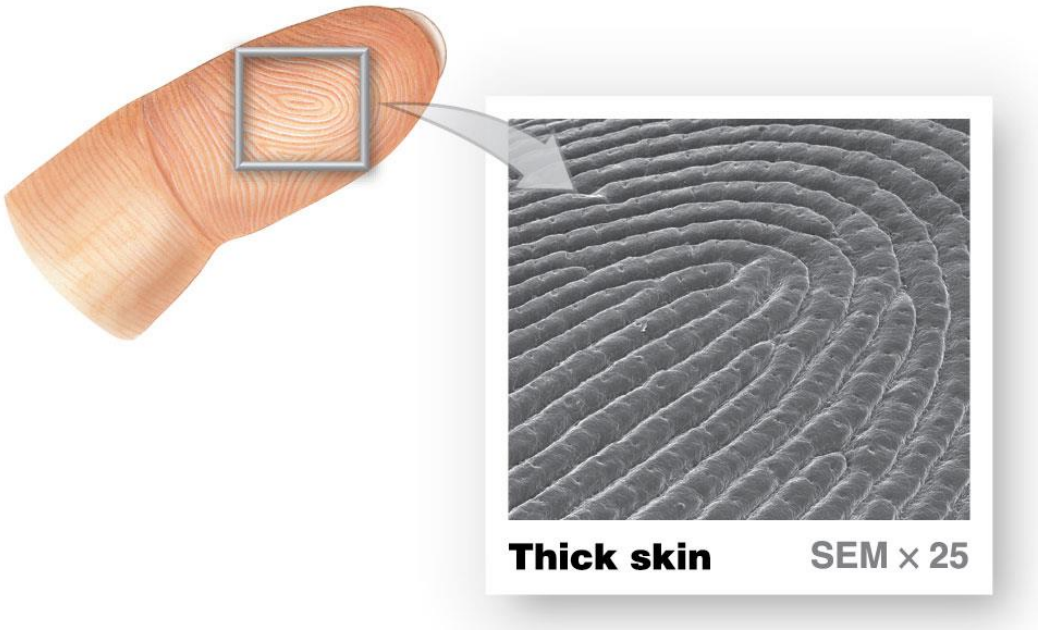
- Found on palms of hands and soles of feet
- Contains five strata (layers)



Module 5.2: The epidermis

Fingerprints

- Pattern of epidermal ridges on surface of fingertips
- Unique pattern that does not change during lifetime
  - Prints of these patterns (fingerprints) used to identify individual



Module 5.2: The epidermis

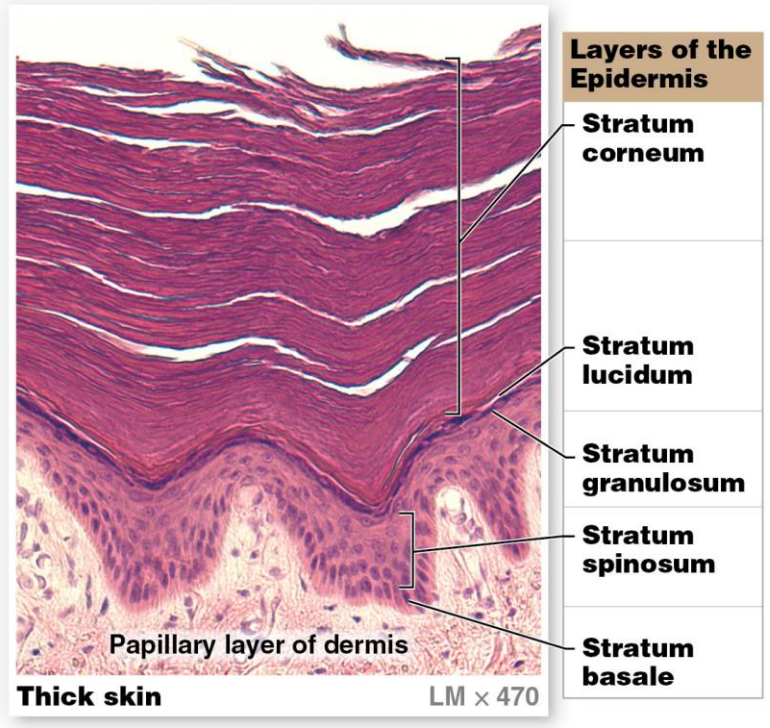
Epidermal layers overview

- Entire epidermis lacks blood vessels
  - Cells get oxygen and nutrients from capillaries in the dermis
  - Cells with highest metabolic demand are closest to the dermis
  - Takes about 7–10 days for cells to move from the deepest stratum to the most superficial layer
  - Cells in surface layer (**stratum corneum**) remain about 2 weeks before being shed or washed away

Module 5.2: The epidermis

Epidermal layers deep to superficial

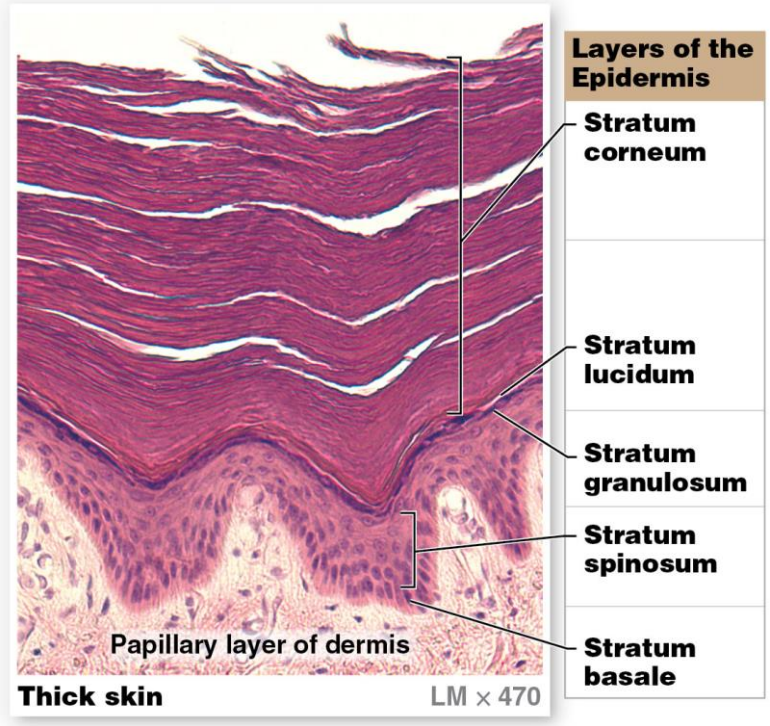
1. **Stratum basale**
   - Attached to basement membrane by hemidesmosomes
   - Most cells here are **basal cells**, stem cells that divide to replace more superficial keratinocytes
   - Merkel cells that respond to touch are also found here



Module 5.2: The epidermis

Epidermal layers deep to superficial (continued)

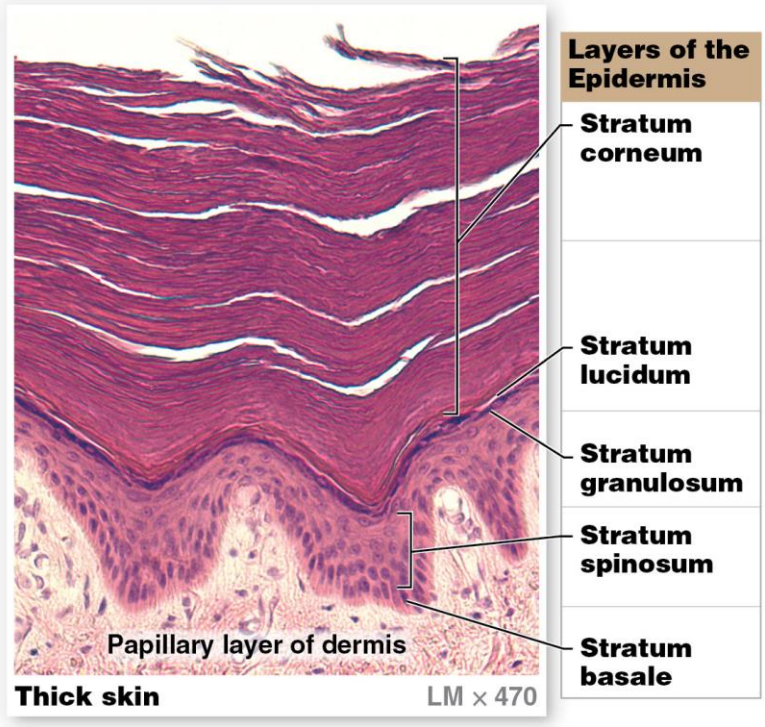
2. **Stratum spinosum** (“spiny layer”)
   - Composed of 8–10 layers of keratinocytes bound together by desmosomes
     - Only looks spiny when on a prepared slide
     - Contains **dendritic** (**Langerhans**) **cells**
       - Part of immune response defending against microorganisms and superficial skin cancers



Module 5.2: The epidermis

Epidermal layers deep to superficial (continued)

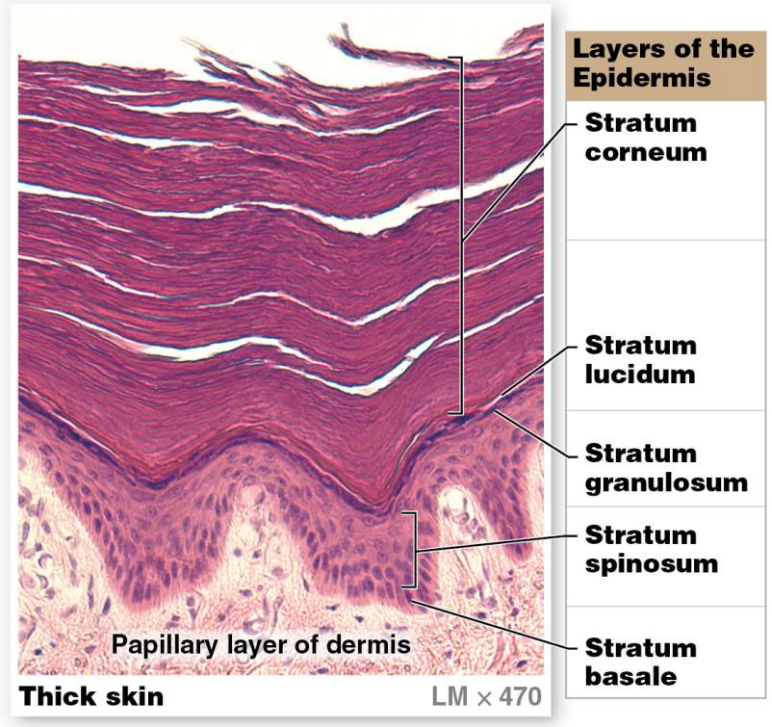
3. **Stratum granulosum** (“grainy layer”)
   - Composed of 3–5 layers of keratinocytes
   - Most cells have stopped dividing and started producing **keratin** and **keratohyalin**
   - Cells grow thinner and flatter
   - Cell membranes thicken and become less permeable



Module 5.2: The epidermis

Epidermal layers deep to superficial (continued)

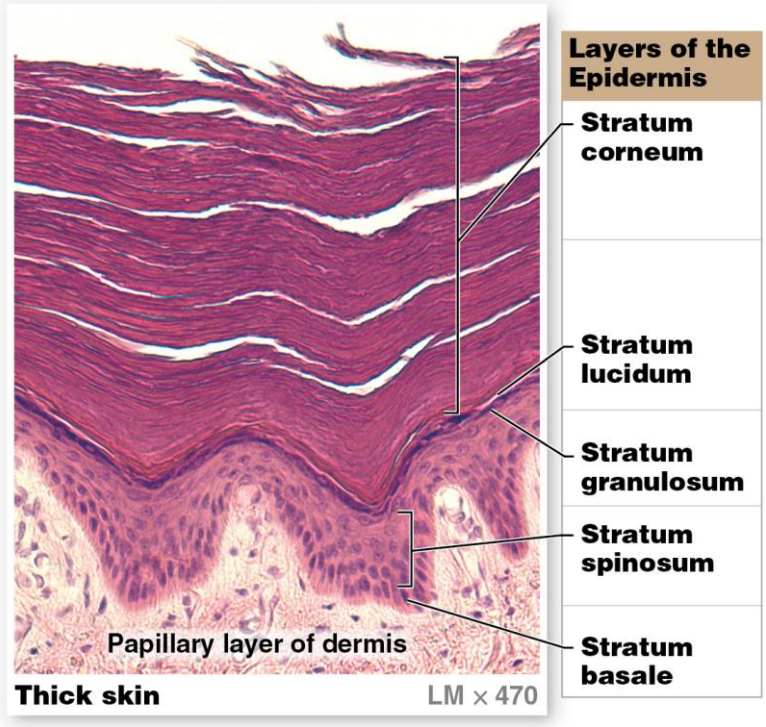
4. **Stratum lucidum** (“clear layer”)
   - Found only in thick skin
   - Separates stratum corneum from underlying layers
   - Flattened, densely packed dead cells filled with **keratin** and **keratohyalin**



Module 5.2: The epidermis

Epidermal layers deep to superficial (continued)

5. **Stratum corneum** (*cornu*, horn)
   - Outermost, protective region with 15–30 layers of keratinized cells (filled with **keratin**)
   - Dead cells still tightly connected by desmosomes
   - Water resistant, not waterproof
     - Lose water through **insensible perspiration** (unable to see or feel) and **sensible perspiration** (sweat)



Module 5.2: Review

A. Compare thin skin with thick skin.
B. Identify the five layers of the epidermis (from superficial to deep).
C. Dandruff is caused by excessive shedding of cells from the outer layer of skin on the scalp. So, dandruff is composed of cells from which epidermal layer?
D. A splinter that penetrates to the third layer of the epidermis of the palm is lodged in which layer?

Learning Outcome: Describe the main structural features of the epidermis, and explain the functional significance of each feature.

Module 5.3: Factors influencing skin color include epidermal pigmentation and dermal circulation

Factors influencing skin color

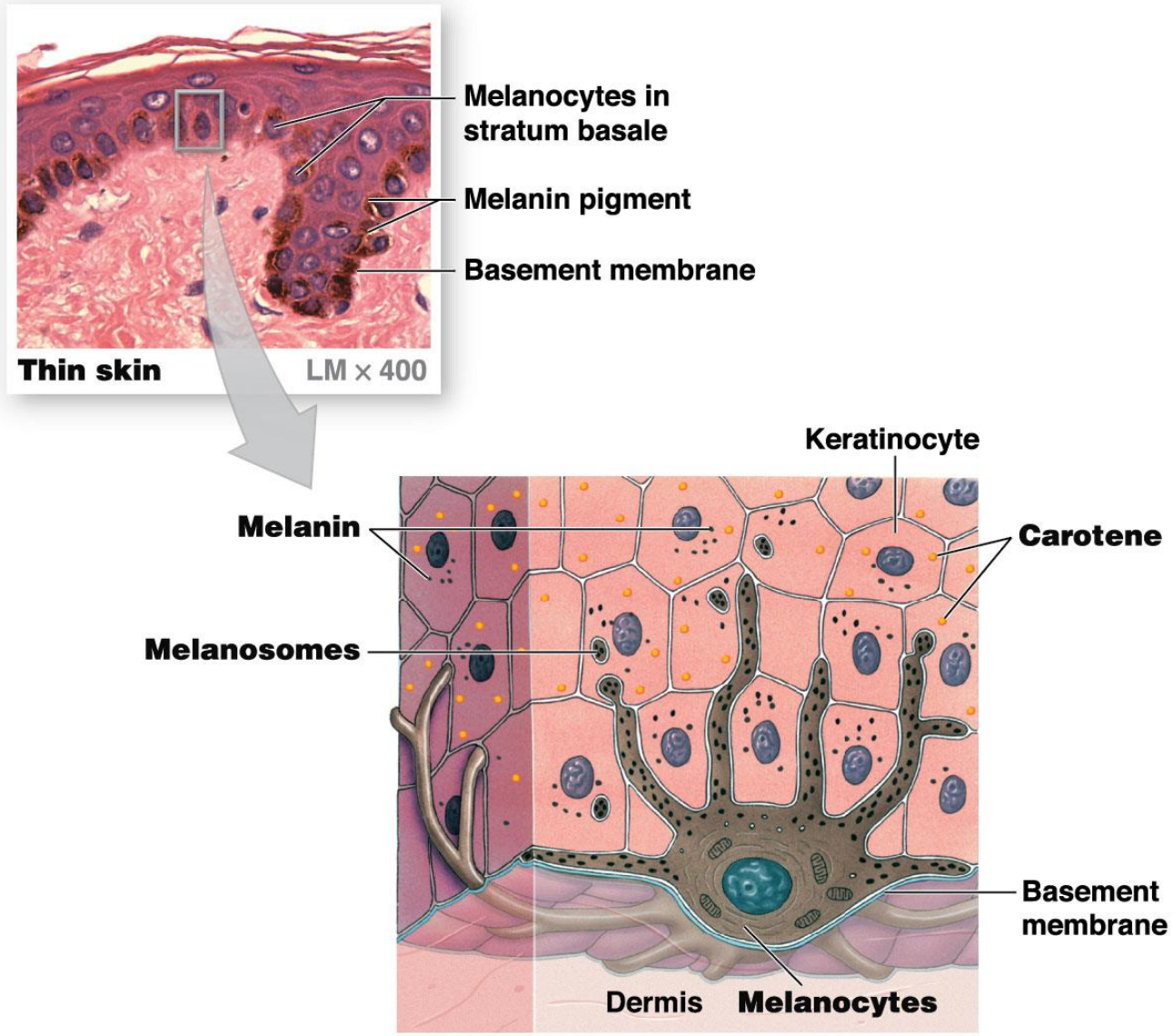
- Presence of pigments in the skin
  - **Carotene**
  - **Melanin** (absence of this leads to **albinism**)
- Degree of dermal circulation
- Thickness and degree of keratinization in the epidermis
- Exposure to ultraviolet (UV) radiation
  - Can increase pigmentation even though skin color genetically determined

Module 5.3: Skin color

Skin coloration primary pigments

- **Carotene**
  - Orange-yellow pigment
- **Melanin**
  - Brown, yellow-brown, or black pigment
  - Produced by **melanocytes** in stratum basale
    - Differences in skin pigmentation are from amount of melanin produced, not from number of melanocytes
  - Packaged into **melanosomes** (vesicles)
    - Melanosomes transferred to keratinocytes
    - Size of melanosomes and point of transfer varies with skin color

Factors influencing skin color

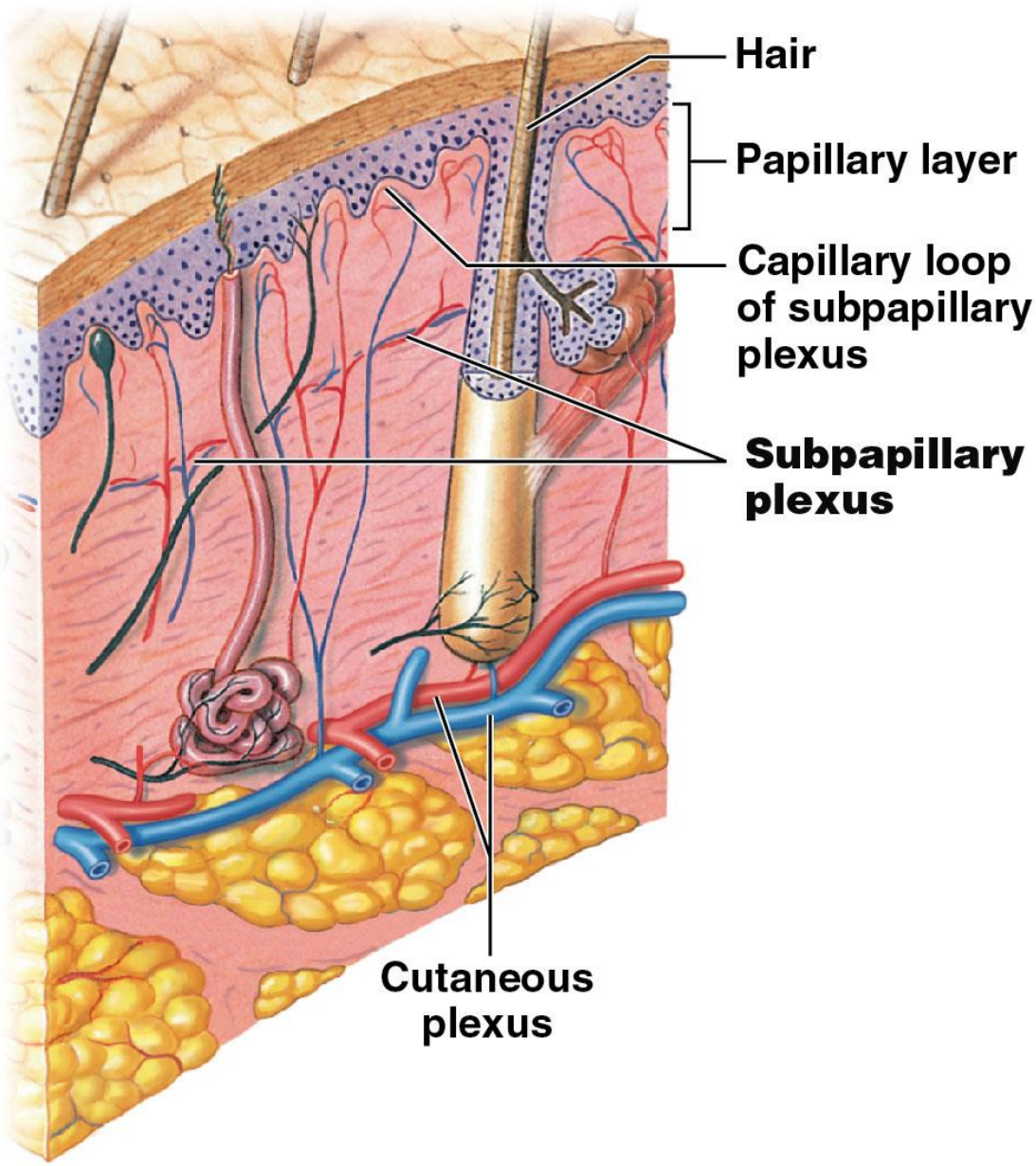


Module 5.3: Skin color

Effects of blood supply on skin color

- Hemoglobin is red pigment found in red blood cells
- Blood flows to dermis through **subpapillary plexus**
  - More blood flow to region results in redder color
  - Less blood flow to region initially results in pale color
    - Sustained reduction of blood flow decreases available oxygen
    - From surface view, skin has bluish color (**cyanosis**)
    - Most apparent in very thin skin (lips, beneath nails)

Effects of blood supply on skin color



Module 5.3: Skin color

Basal cell carcinoma

- Most common form of skin cancer
- Originates in stratum basale due to mutations caused by overexposure to UV radiation
- Virtually no metastasis and most people survive

Module 5.3: Skin color

Malignant melanoma

- Extremely dangerous
- Cancerous melanocytes grow rapidly and metastasize through lymphatic system
- If detected early and removed surgically, the 5-year survival rate is 99 percent
- If not detected until after metastasis, the 5-year survival rate drops to 14 percent

Module 5.3: Review

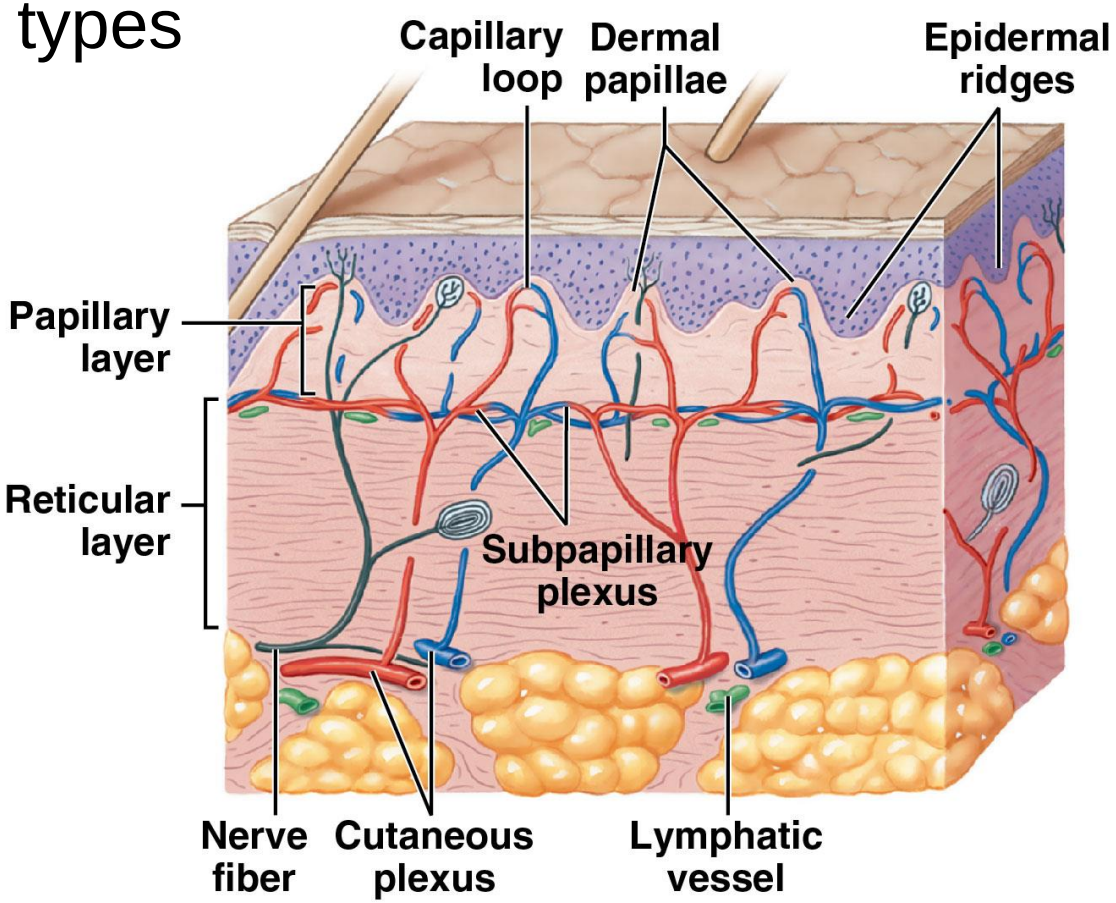
A. Name the two pigments contained in the epidermis.
B. Why does exposure to sunlight or sunlamps darken skin?
C. Why does the skin of a light-skinned person appear red during exercise in hot weather?
D. Why is basal cell carcinoma considered less dangerous than malignant melanoma?
E. Explain why a healthy 6-month-old might have yellow-orange skin.

Learning Outcome: Explain what accounts for individual differences in skin color, and compare basal cell carcinoma with malignant melanoma.

Module 5.4: The subcutaneous layer connects the dermis to underlying tissues

Dermis overview

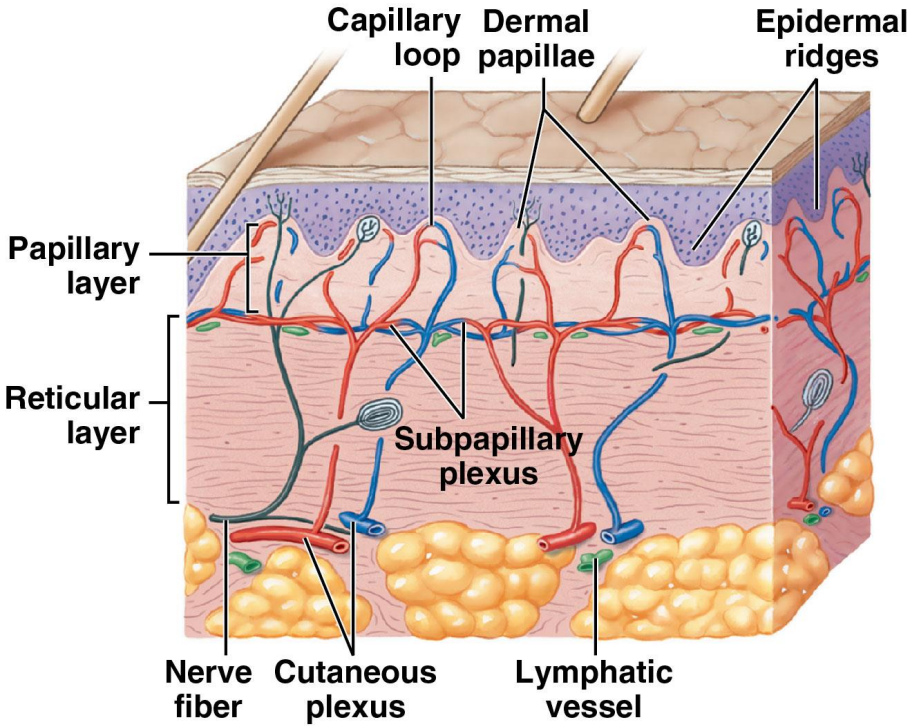
- Between the epidermis and hypodermis
- Contains two fiber types
  1. Collagen fibers
  2. Elastic fibers



Module 5.4: The dermis and subcutaneous layer

Dermis layers

1. **Papillary layer**
   - Named for dermal papillae in this region
   - Composed of areolar tissue
   - Contains capillaries, lymphatic vessels, and sensory neurons

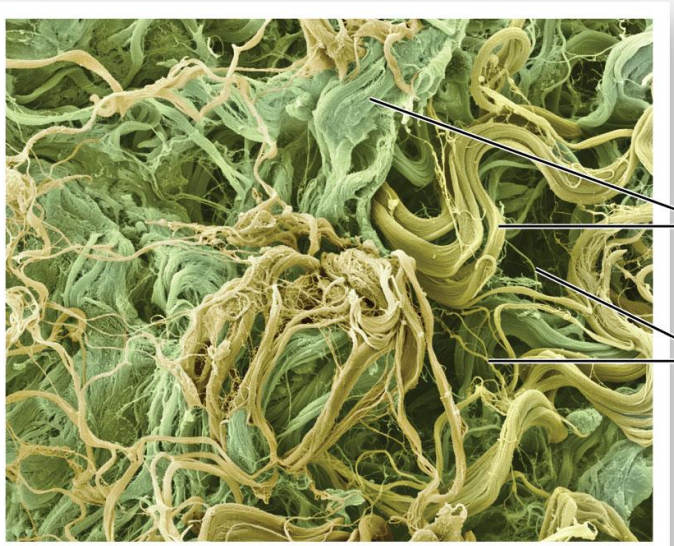


Module 5.4: The dermis and subcutaneous layer

Dermis layers (continued)

2. **Reticular layer**

- Interwoven meshwork of dense, irregular connective tissue with collagen and elastic fibers
- Contains blood vessels, lymphatic vessels, nerve fibers, and accessory organs (hair follicles, sweat glands)

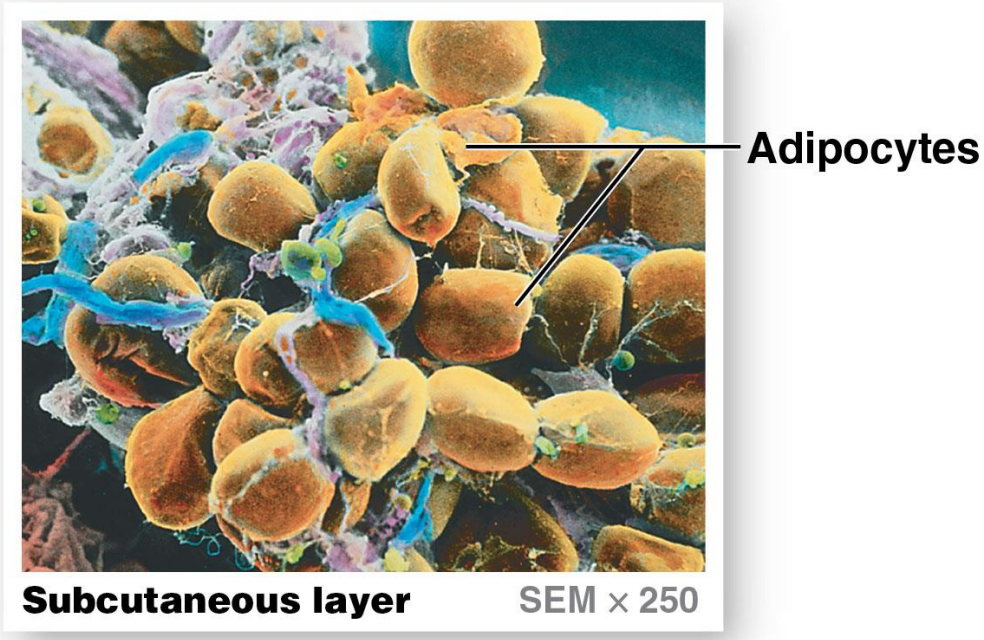


Reticular layer of dermis SEM × 1500

Module 5.4: The dermis and subcutaneous layer

Subcutaneous layer (not part of skin)

- Separates skin from deeper structures
- Dominated by adipose tissue
  - Important energy storage site



Module 5.4: The dermis and subcutaneous layer

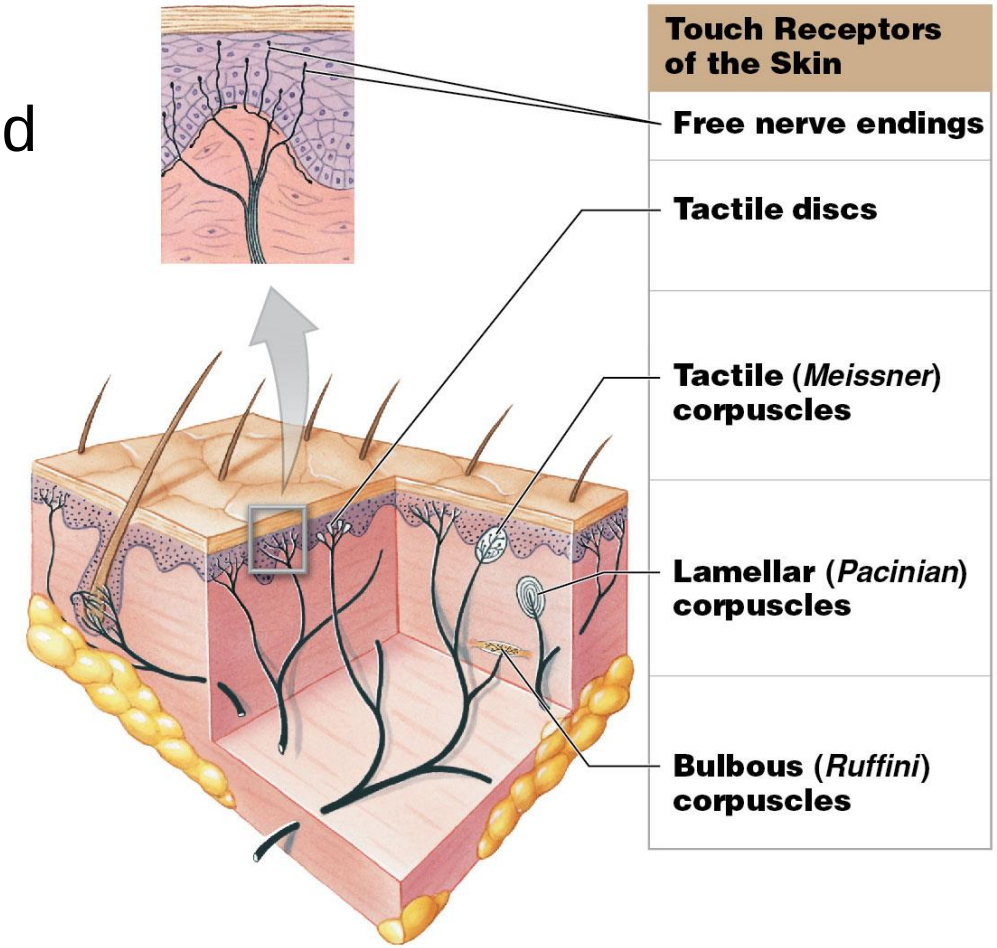
Adipose accumulation pattern

- Accumulation in men
  - Neck, arms, lower back, buttocks
- Accumulation in women
  - Breasts, buttocks, hips, thighs
- For both adult sexes
  - Few cells on back of hands and surfaces of feet
  - More in abdominal region (“potbelly”)

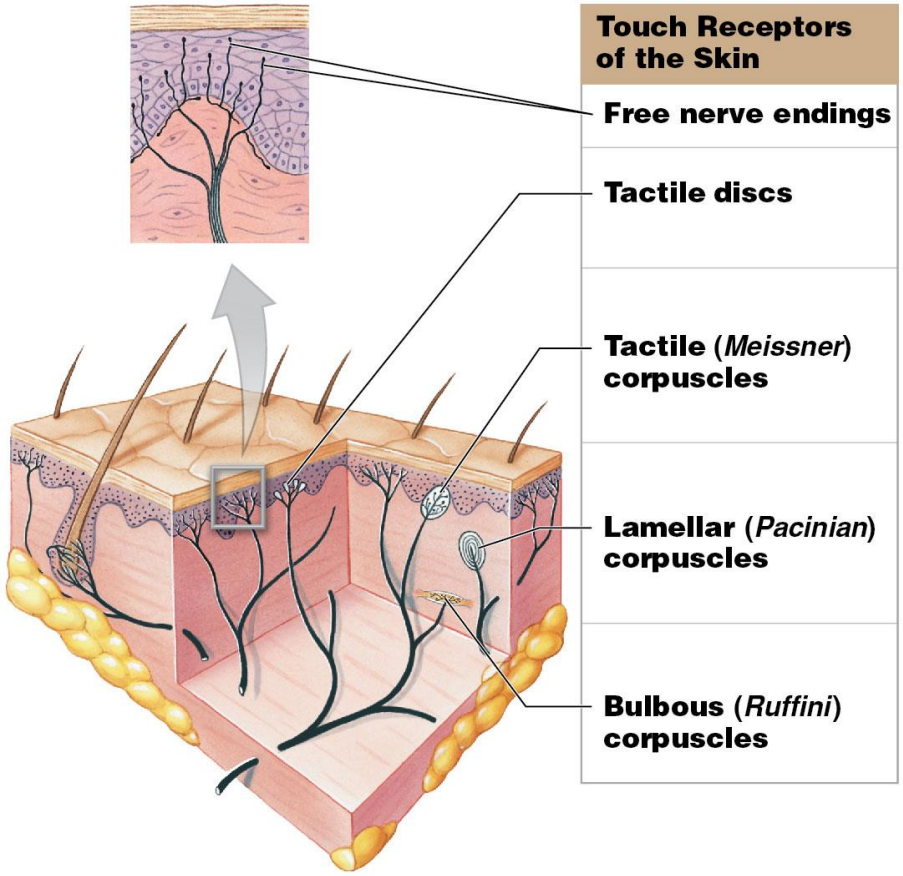
Module 5.4: The dermis and subcutaneous layer

Sensory receptors in the epidermis

- **Free nerve endings**
  - Sensitive to touch and pressure
- **Tactile corpuscles**
  - Detect texture and steady pressure



Module 5.4: The dermis and subcutaneous layer



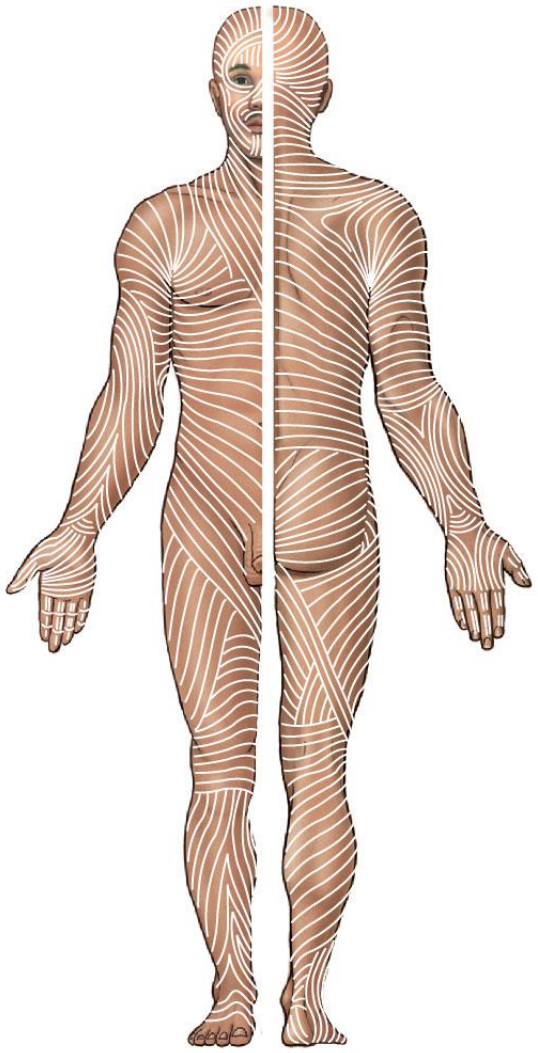
Sensory receptors in the dermis

- **Meissner corpuscles**
  - Detect light touch, pressure, and vibration
- **Pacinian corpuscles**
  - Detect deep pressure and vibration
- **Ruffini corpuscles**
  - Sensitive to pressure and stretching of skin

Module 5.4: The dermis and subcutaneous layer

Tension (cleavage) **lines**

- Formed by arrangement of collagen and elastic fibers in the skin
- Clinically significant for surgery and wound healing
  - Cuts parallel to cleavage
    - Heal better and with less scarring
  - Cuts perpendicular to cleavage
    - Tend to pull open, resulting in more scarring



Module 5.4: Review

A. Describe the layers of the dermis.
B. Predict the degree of scarring after the healing of a horizontal cut on the forehead just above the eyebrow.

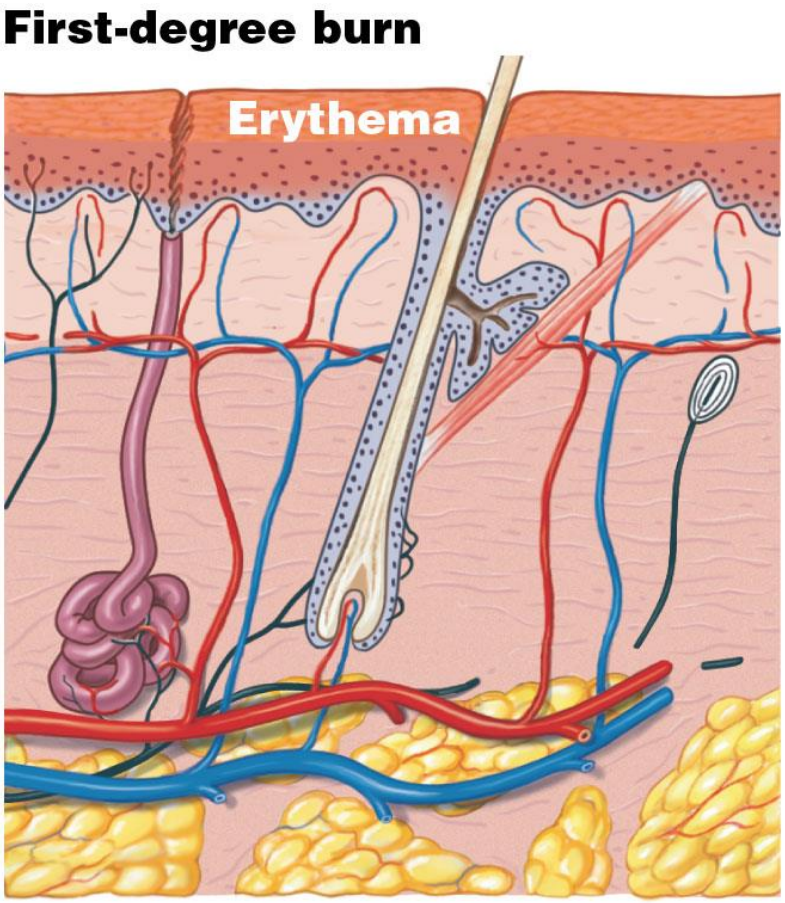
Learning Outcome: Describe the structures and functions of the dermis and subcutaneous layer.

Module 5.5: CLINICAL MODULE: Burns are significant injuries that damage skin integrity

Burns are significant injuries

- Result from exposure to heat, friction, radiation, electrical shock, strong chemical agents
- Can damage large areas of skin compromising many essential functions
  - Dehydration and electrolyte imbalance can lead to
    - Kidney impairment and circulatory shock
- Severity depends on:
  - Depth of penetration
  - Total area affected

Module 5.5: CLINICAL MODULE: Burns



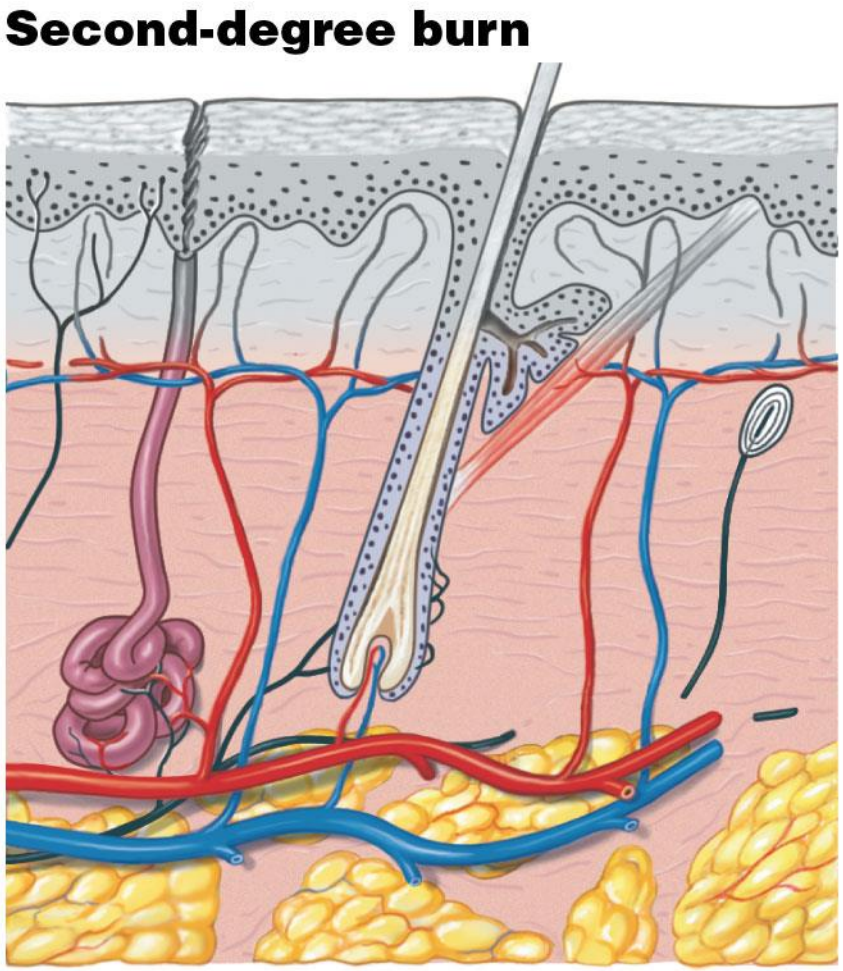
Partial-thickness burns

- **First-degree burn**
  - Only the surface of the epidermis affected
  - *Example:* most sunburns
    - Skin redness (**erythema**) results from inflammation

Module 5.5: CLINICAL MODULE: Burns

Partial-thickness burns (continued)

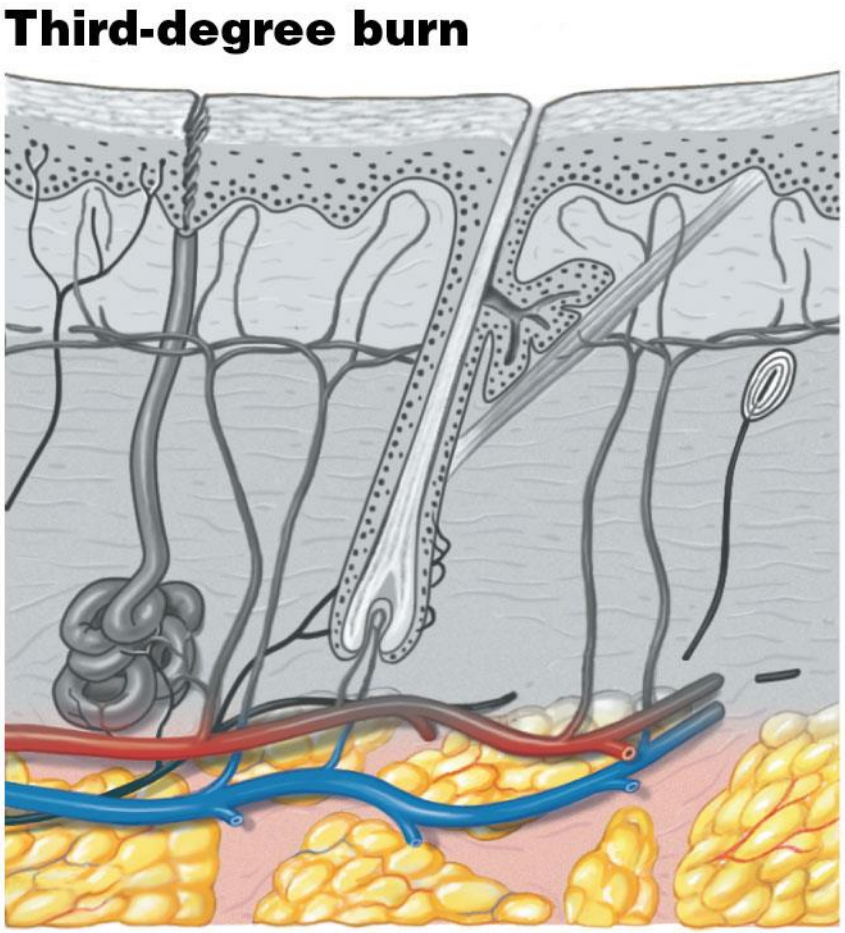
- **Second-degree burn**
  - Entire epidermis and maybe some of dermis damaged
  - Accessory structures not affected
  - Blistering, pain, and swelling occur
    - Infection can develop from ruptured blisters
  - Healing takes 1–2 weeks



Module 5.5: CLINICAL MODULE: Burns

Full-thickness burns

- **Third-degree burns**
  - Destroys epidermis, dermis, and damage extends into subcutaneous layer
  - Less painful than second-degree burns
  - Extensive burns of this type cannot repair themselves
    - Skin grafting usually necessary



Burns threaten homeostatic functions of skin

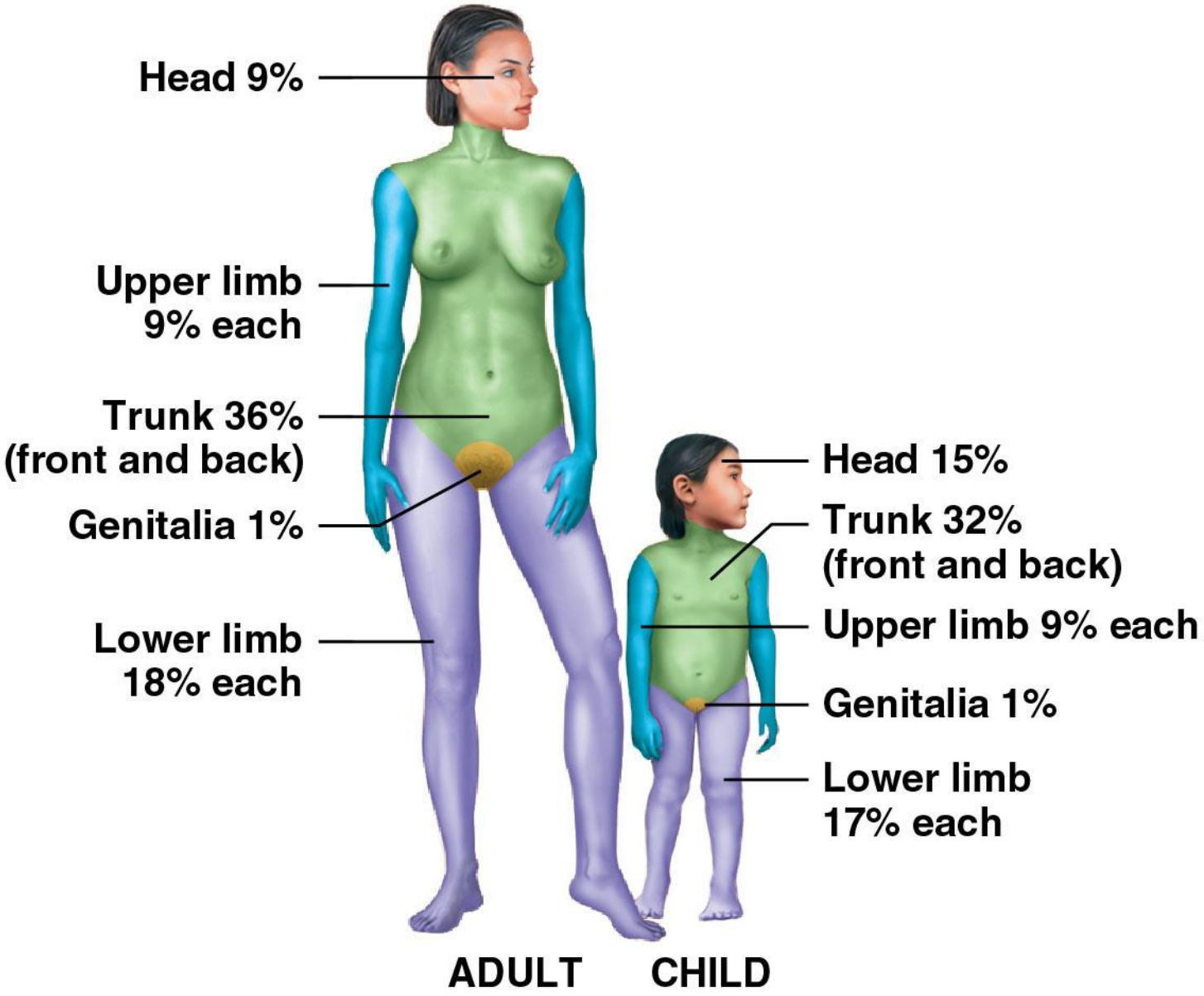
Skin Functions Affected by Burns
• Fluid and Electrolyte Balance.
• Thermoregulation.
• Protection from Infection.

Module 5.5: CLINICAL MODULE: Burns

Evaluating burns in a clinical setting

1. Depth of burns
   - Assessed with a pin
   - Absence of reaction to pin prick indicates third-degree burn (loss of sensation)
2. Percentage of skin that has been burned
   - **Rule of nines**
     - Method of estimating percentage of surface area affected by burns
     - Modified for children (different body proportions)

Rule of nines



Module 5.5: CLINICAL MODULE: Burns

Emergency treatment of burns

- Replacing lost fluids and electrolytes
- Providing sufficient nutrients
  - Increased metabolic demands for thermoregulation and healing
- Preventing infection
  - Cleaning and covering burn
  - Administering antibiotics
- Assisting tissue repair with **skin grafts**
  - Areas of intact skin are transplanted to cover the burn site

Module 5.5: CLINICAL MODULE: Burns

Skin grafts

- Split-thickness graft (transfer of epidermis and superficial portions of dermis)
- Full-thickness graft (transfer of epidermis and both layers of dermis)
- Source of material
  - **Autograft**—patient's own undamaged skin
    - Best choice if possible; no rejection by immune system
  - **Allograft**—frozen skin from a cadaver
  - **Xenograft**—animal skin

Module 5.5: CLINICAL MODULE: Burns

Burn recovery

- Young patients with burns over 80 percent of the body
  - Have 50 percent chance of recovery
  - Assuming access to medical treatment, including grafting
- Advances in cell culturing improving survival rates
  - New epidermis can be grown in the laboratory and transplanted to cover burn

Module 5.5: Review

A. Distinguish among a first-degree, second-degree, and third-degree burn.
B. Which type of burn usually requires skin grafting? Why?
C. Describe the three types of skin grafts. Which one is best? Why?
D. A 32-year-old woman is admitted to the hospital with third-degree burns on her entire right leg, entire right arm, and the back of her trunk. Estimate the percentage of her body surface area affected by these burns.

Learning Outcome: Describe the classification of burns and types of skin grafts.

Section 2: Accessory Structures of the Skin

Learning Outcomes

5.6 Describe the main functions of the accessory structures of the integumentary system.

5.7 Describe the mechanisms of hair production, and explain the structural basis for hair texture and color.

5.8 Describe the various kinds of exocrine glands in the skin, and discuss the secretions of each.

5.9 Describe the structure of a typical nail.

Section 2: Accessory Structures of the Skin

Learning Outcomes (continued)

5.10 **Clinical module:** Summarize the effects of aging on the skin.

5.11 Describe the interaction between sunlight and endocrine functioning as they relate to the skin.

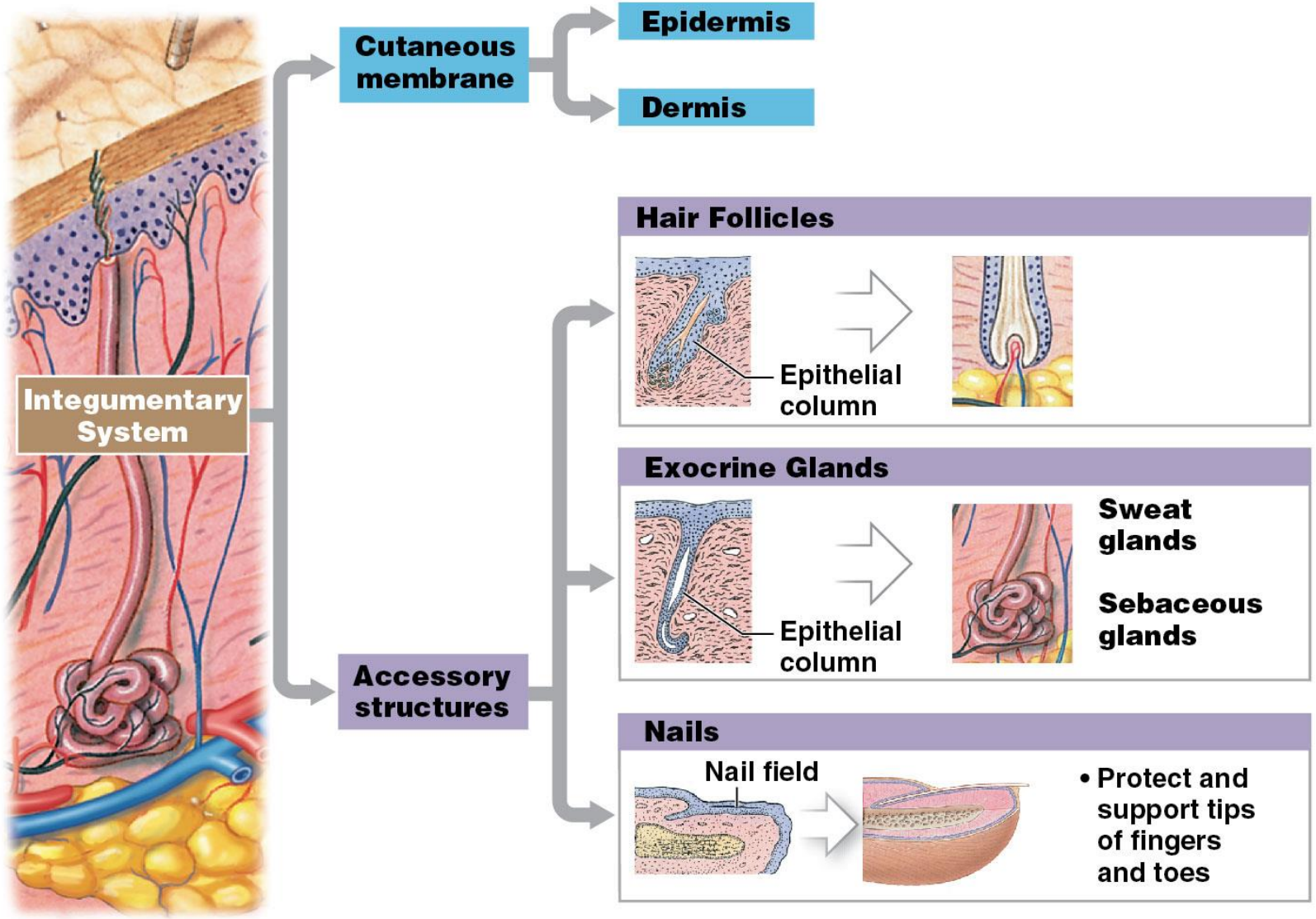
5.12 **Clinical module:** Explain how the skin responds to injury and is able to repair itself.

Module 5.6: Hair follicles, exocrine glands, and nails are also components of the integumentary system

Accessory structures of the integument

- Called *epidermal derivatives*
  - Originate from epidermis during embryological development
  - Hair follicles and exocrine glands develop from **epithelial columns**
    - Cords of epidermal cells growing into the dermis
  - Nails form from thickened epidermal cells nestled into the dermis forming a **nail field**
- Located in the dermis, but project through epidermis to surface

Accessory structures of the skin



Module 5.6: Accessory structures of the skin

Accessory structures

- **Hair follicles**
  - Produce hairs that protect skull
  - Produce hairs that provide delicate touch sensations
- **Exocrine glands**
  - **Sweat glands** (assist in thermoregulation and excrete wastes)
  - **Sebaceous glands** (lubricate epidermis)
- **Nails**
  - Protect and support tips of fingers and toes

Module 5.6: Review

A. What are epidermal derivatives?
B. Which exocrine glands are in the integument?

Learning Outcome: Describe the main functions of the accessory structures of the integumentary system.

Module 5.7: Hair is composed of dead, keratinized cells produced in a specialized hair follicle

Hair overview

- Found almost everywhere on the body
  - Except palms of hands, sides and soles of feet, sides of fingers and toes, lips, parts of external genitalia
- Each hair produced by a **hair follicle**
  - Complex structure composed of epithelial and connective tissue that forms a single hair

Module 5.7: Hair

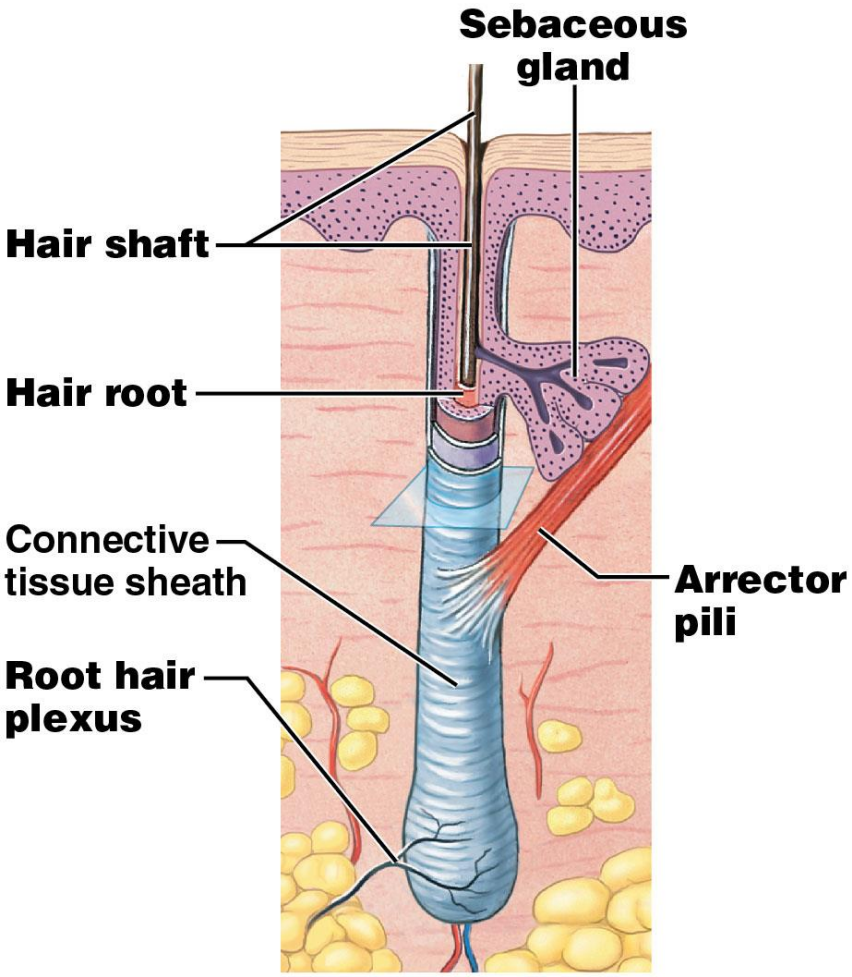
Two types of hair

1. **Terminal hairs**
   - Large, coarse, darkly pigmented
   - *Examples:* hairs found on scalp or in armpit
2. **Vellus hairs**
   - Smaller, shorter, delicate
   - Found on general body surface

Module 5.7: Hair

Hair regions and associated structures

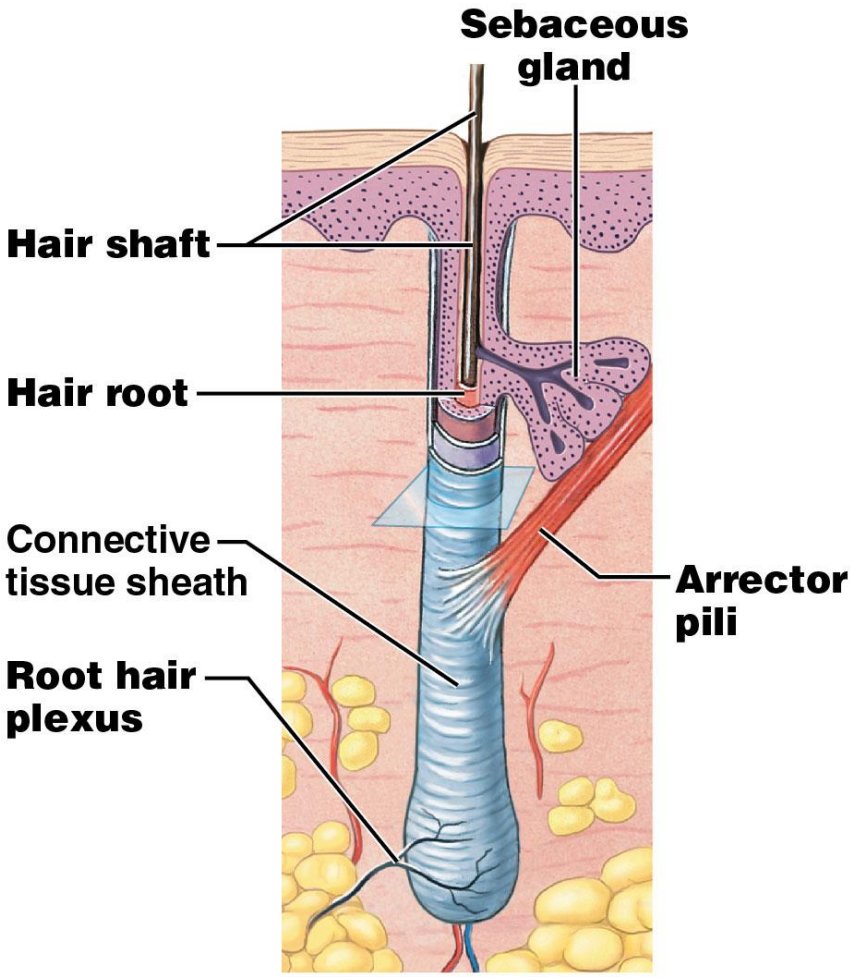
- **Hair shaft**—begins deep within hair follicle, but can be seen on the surface
- **Hair root**—anchors the hair into the skin
  - Extends from base of follicle to point where hair shaft loses connection with follicle walls



Module 5.7: Hair

Hair regions and associated structures (continued)

- **Root hair plexus**—collection of sensory nerves surrounding the base of the follicle
- **Arrector pili**—smooth muscle attached to hair follicle; contraction pulls hair erect
- **Sebaceous gland**—produces secretions to oat hair and skin surface

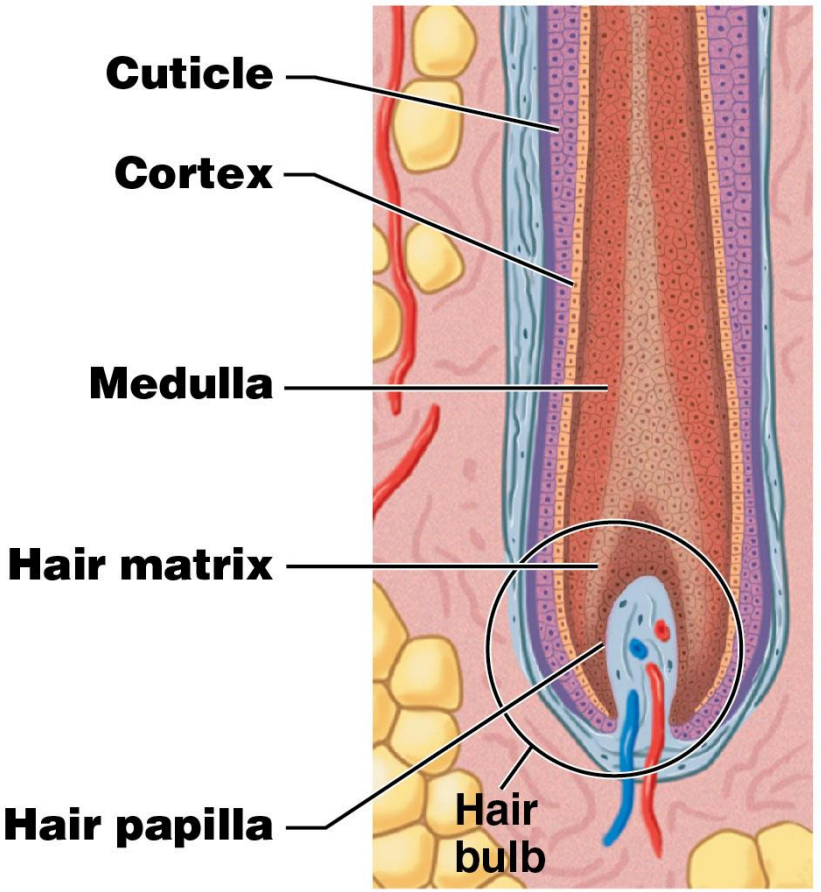


Module 5.7: Hair

Hair formation

Begins at **hair bulb**—expanded base of hair follicle

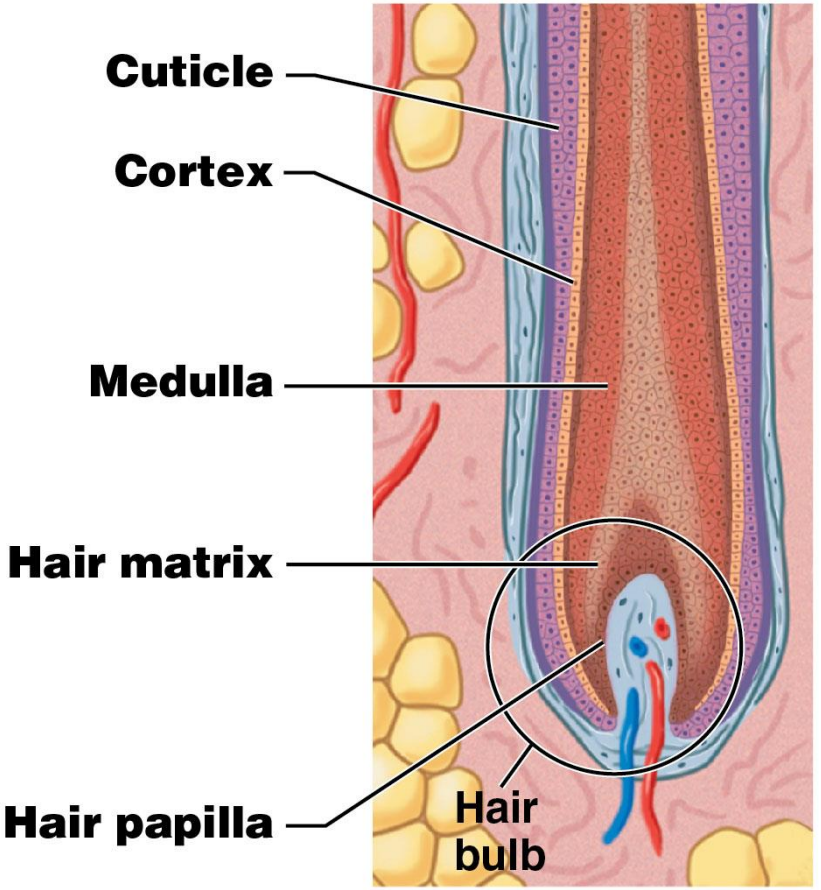
- Bulb surrounds **hair papilla**—peg of connective tissue filled with blood vessels and nerves
- **Hair matrix**—actively dividing basal cells in contact with hair papilla



Module 5.7: Hair

Hair formation (continued)

- **Medulla**—layer of daughter cells formed at the center of the matrix
- **Cortex**—intermediate layer deep to the cuticle
- **Cuticle**—daughter cells produced at edges of the matrix; forms surface of the hair



Module 5.7: Hair

Keratin in hair

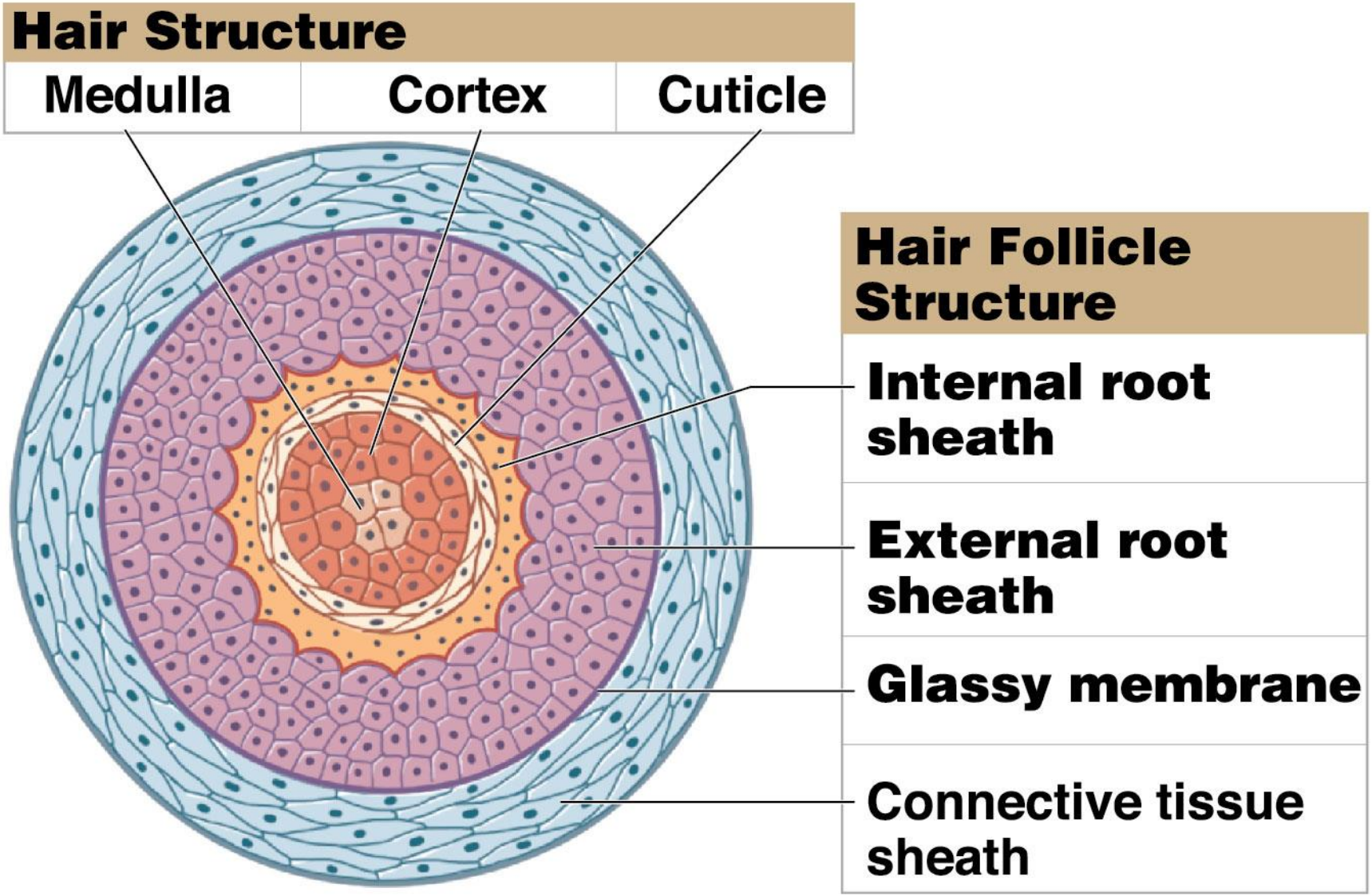
- Medulla or core of hair
  - Contains flexible, **soft keratin**
- Cortex
  - Contains thick layers of **hard keratin**
  - Gives hair stiffness
- Cuticle
  - Contains hard keratin
  - Thin, but very tough

Module 5.7: Hair

Internal hair follicle structure

- **Internal root sheath**
  - Surrounds hair root and deeper portion of shaft
  - Produced from hair matrix
- **External root sheath**
  - Extends from skin surface to hair matrix
- **Glassy membrane**
  - Thickened, clear basement membrane
- Connective tissue sheath
  - Surrounds the epithelial cells of the hair follicle

Internal hair follicle structure

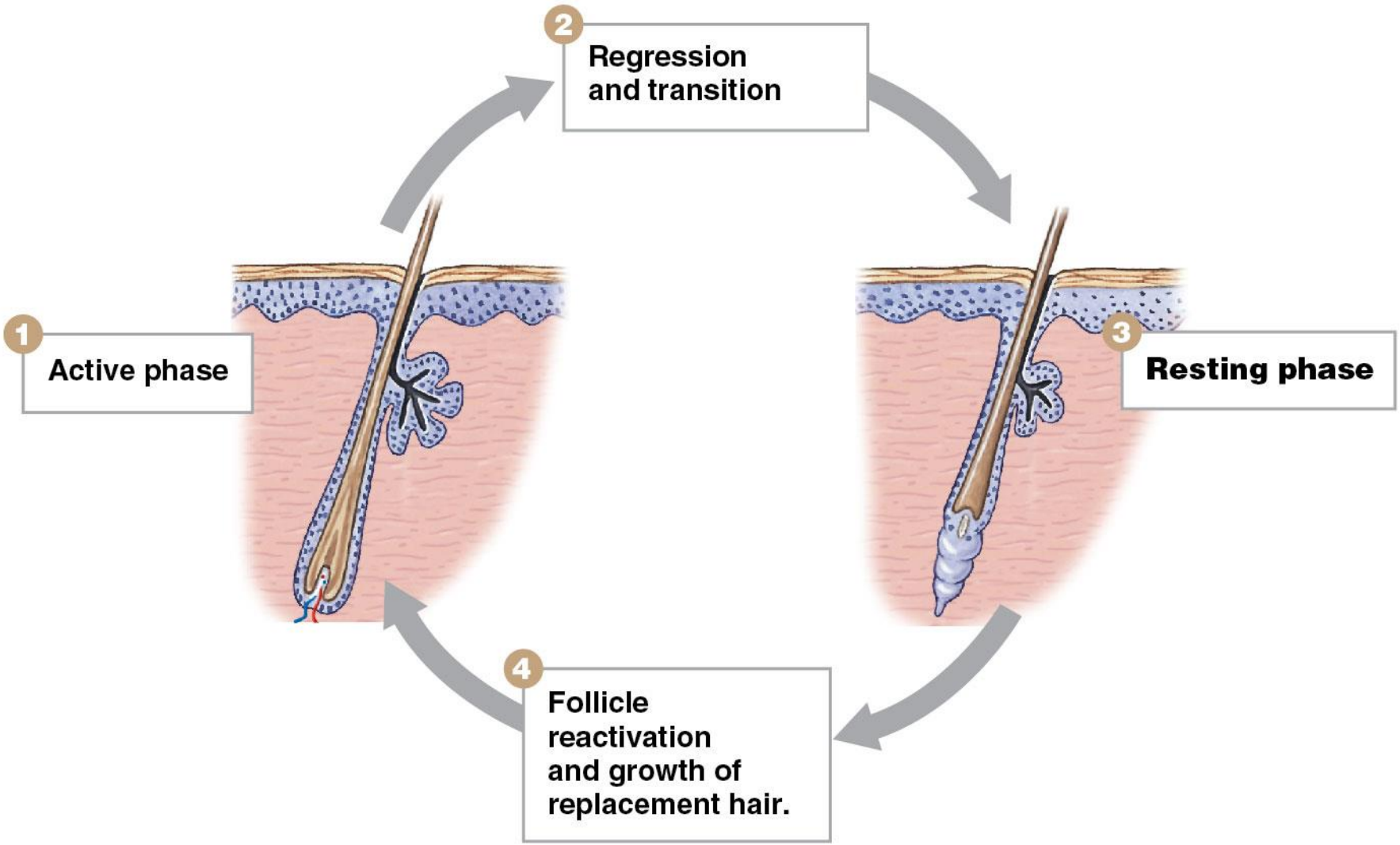


Module 5.7: Hair

Hair growth

- Hairs grow and shed in **hair growth cycle**
  - *Active phase*
    - Lasts 2–5 years
    - Hair grows at rate of 0.33 mm/day
  - *Resting phase*
    - Hair loses attachment to follicle
    - Becomes **club hair**
    - Club hair is shed when follicle is reactivated
    - New hair formation begins
- Variations in growth rate and duration of cycle result in different lengths of uncut hair

Hair growth



Module 5.7: Review

A. Describe a typical strand of hair.
B. What happens when an arrector pili muscle contracts?
C. Describe the four phases of the hair growth cycle.
D. Why is pulling a hair painful, yet cutting a hair is not?

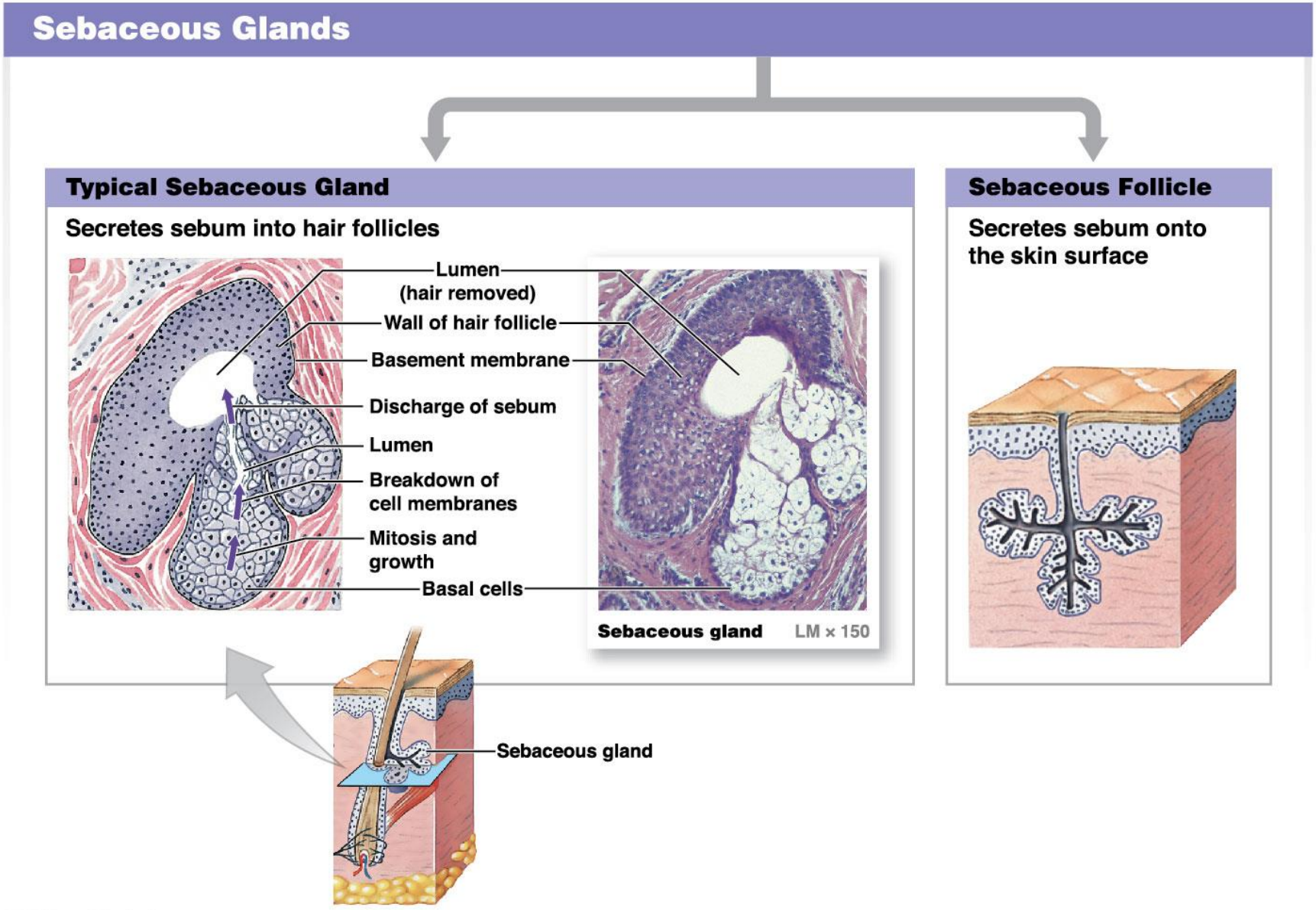
Learning Outcome: Describe the mechanisms of hair production, and explain the structural basis for hair texture and color.

Module 5.8: Sebaceous glands and sweat glands are exocrine glands in the skin

Sebaceous glands

- Holocrine glands that discharge an oily lipid secretion
- Contractions of arrector pili muscle cause release of **sebum** onto follicle and skin surface
  - **Sebum**
    - Mixture of triglycerides, cholesterol, proteins, and electrolytes
    - Lubricates hair shaft and is antimicrobial

Sebaceous glands



Module 5.8: Exocrine glands of the skin

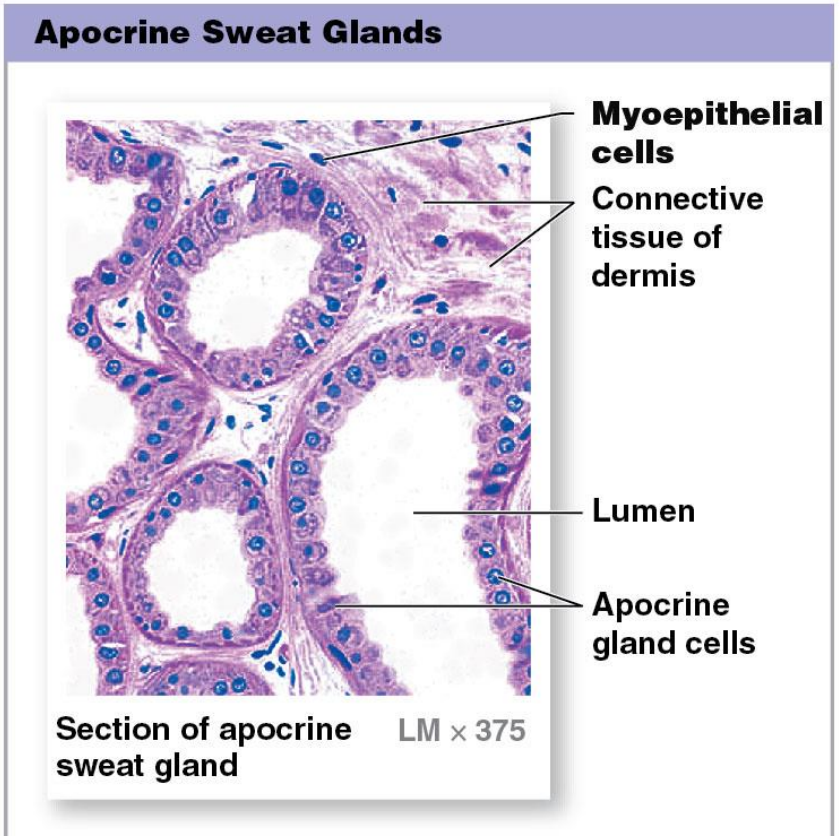
Sweat glands

- Produce watery secretion by merocrine secretion
- **Myoepithelial cells** (*myo*-, muscle)
  - Squeeze gland to discharge secretion
- Function to wash epidermal surface
- Two types
  1. **Apocrine sweat glands**
  2. **Merocrine sweat glands**

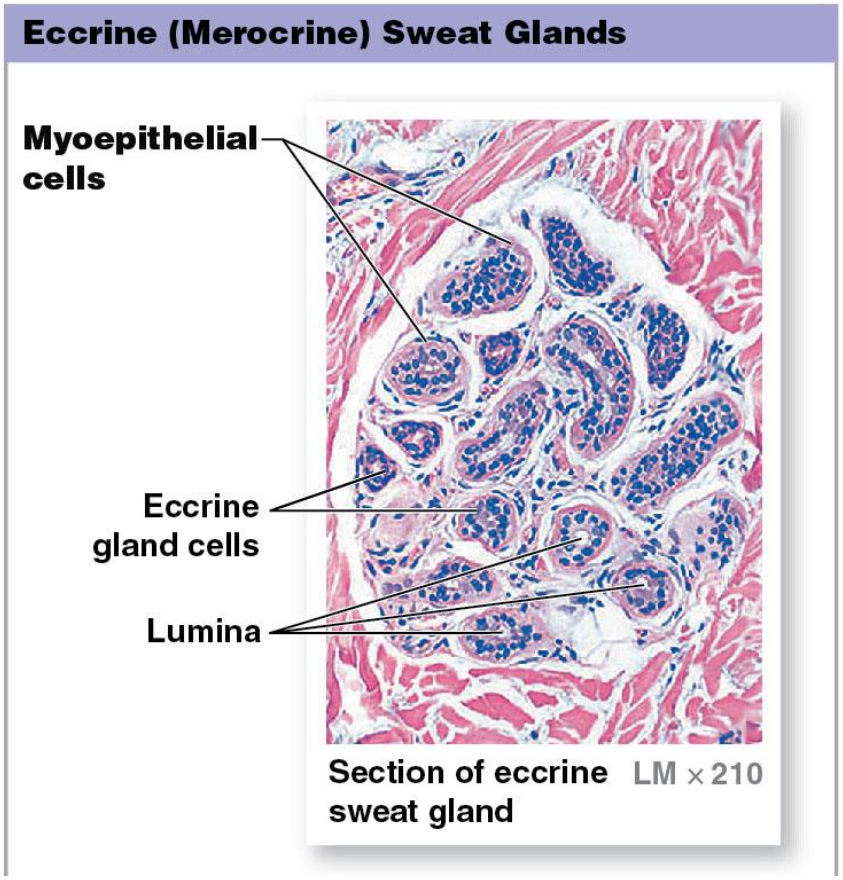
Module 5.8: Exocrine glands of the skin

Apocrine sweat glands

- Found in axillae, around nipples, and in pubic region
- Produce sticky, cloudy, odorous secretion with complex composition
- Strongly influenced by hormones
- Include ceruminous glands and mammary glands



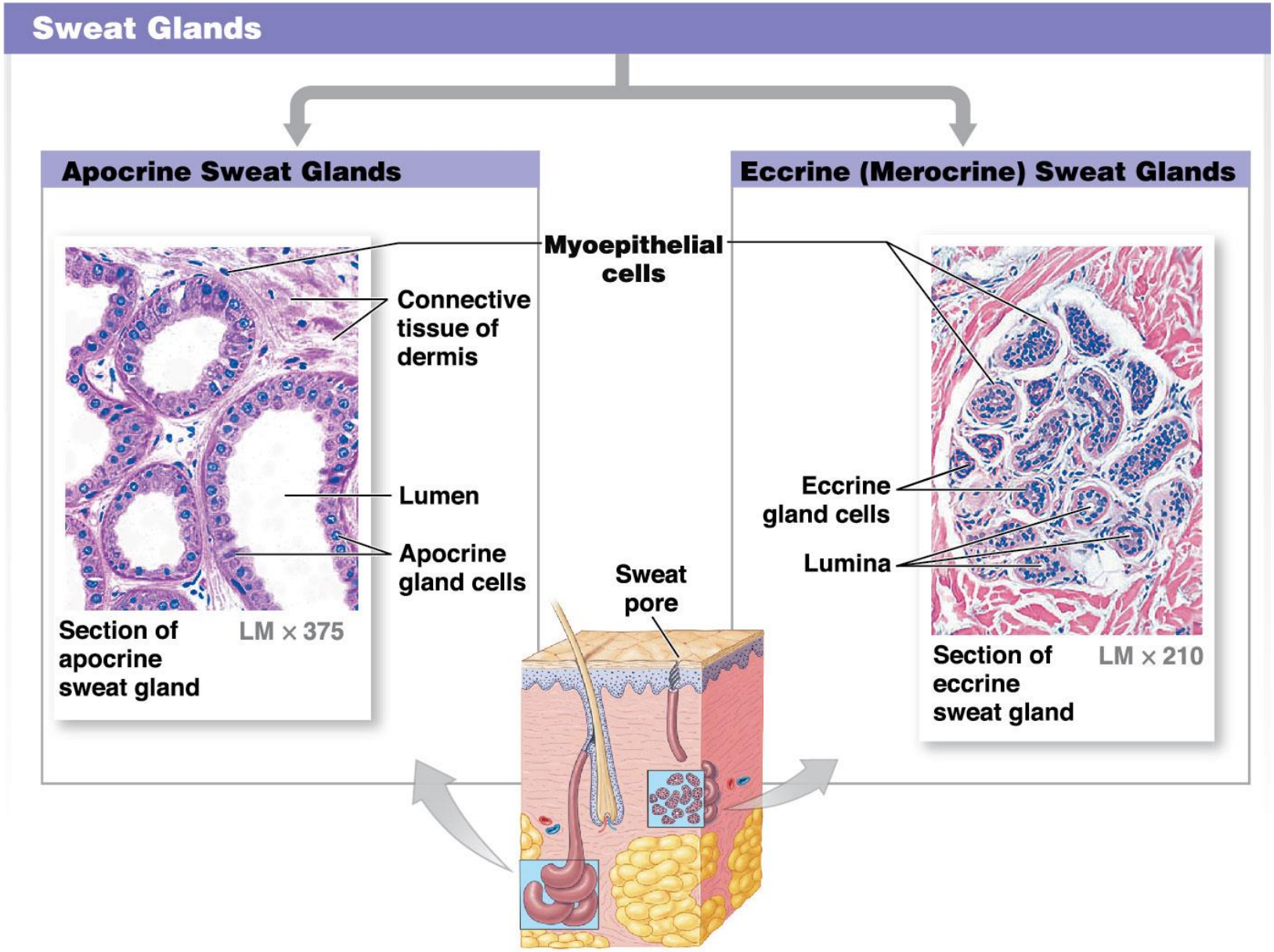
Module 5.8: Exocrine glands of the skin



Eccrine/merocrine sweat glands

- Secrete directly onto surface of the skin
- Highest number found on palms (~500 glands/cm^2 [~3000/in.^{2}]) and soles
- Produce watery secretions with electrolytes
- Important in thermoregulation and excretion

Sweat glands



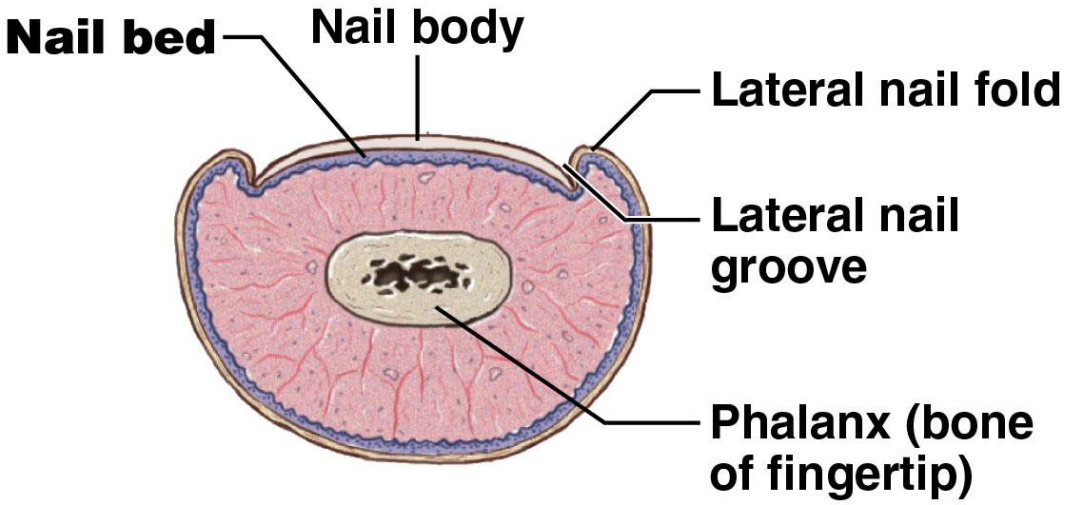
Module 5.8: Review

A. Identify and describe the general functions of the exocrine glands found in the skin.
B. Describe the secretory method and functions of sebum.
C. Deodorants are used to mask the effects of secretions from which type of skin gland?
D. Name the type of cell that assists the discharge of merocrine secretions, and list the glands in which such cells are present.

Learning Outcome: Describe the various kinds of exocrine glands in the skin and discuss the secretions of each.

Module 5.9: Nails are thick sheets of keratinized epidermal cells that protect the tips of fingers and toes

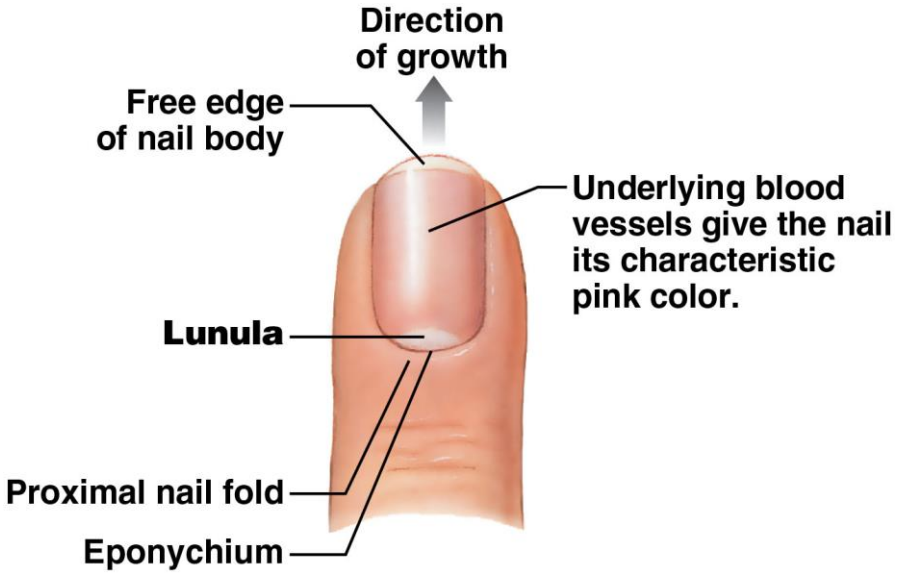
- Thick sheets of keratinized epidermal cells
- Protect exposed dorsal surfaces of tips of fingers and toes
- Help limit distortion of digits under physical stress
- **Nail body** is composed of dead cells packed with keratin



Module 5.9: Nails

Nail body

- Visible portion of nail
- Bordered by **lateral nail grooves** (depressions) and **lateral nail folds** (ridges)
  - Covers **nail bed** (underlying epidermis)
  - **Lunula** (pale crescent on proximal part of nail body)
  - Free edge (distal part of nail body)



Nail root

- Epidermal fold where nail production occurs

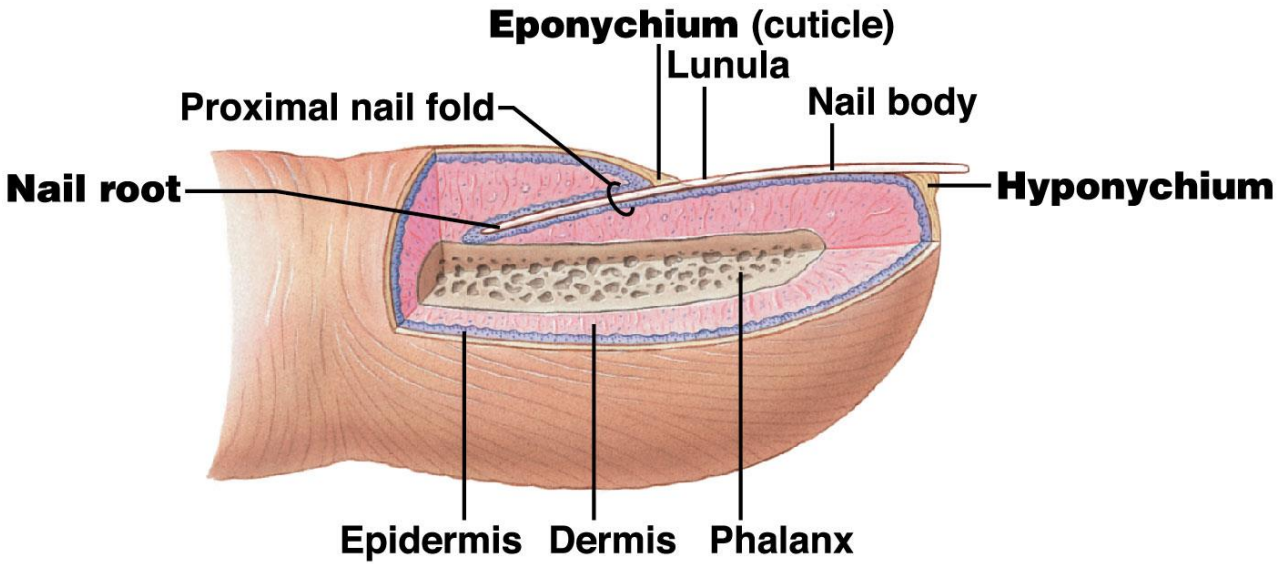
Module 5.9: Nails

Eponychium (*epi-*, over; *onyx*, nail)

- Portion of stratum corneum of nail root extending over exposed nail
- Also known as **cuticle**

Hyponychium

- Area of thickened stratum corneum under free edge



Module 5.9: Nails

Nail appearance used for diagnosis

- Cells producing nails can be affected by conditions that alter body metabolism
  - *Examples:*
    - Nails pitted and distorted: **psoriasis**
    - Concave nails: some blood disorders

Module 5.9: Review

A. Where does nail production occur?
B. Define *hyponychium*.
C. Why does the free edge of a nail appear white?

Learning Outcome: Describe the structure of a typical nail.

Module 5.10: CLINICAL MODULE: Age-related changes affect the integument

Fewer melanocytes

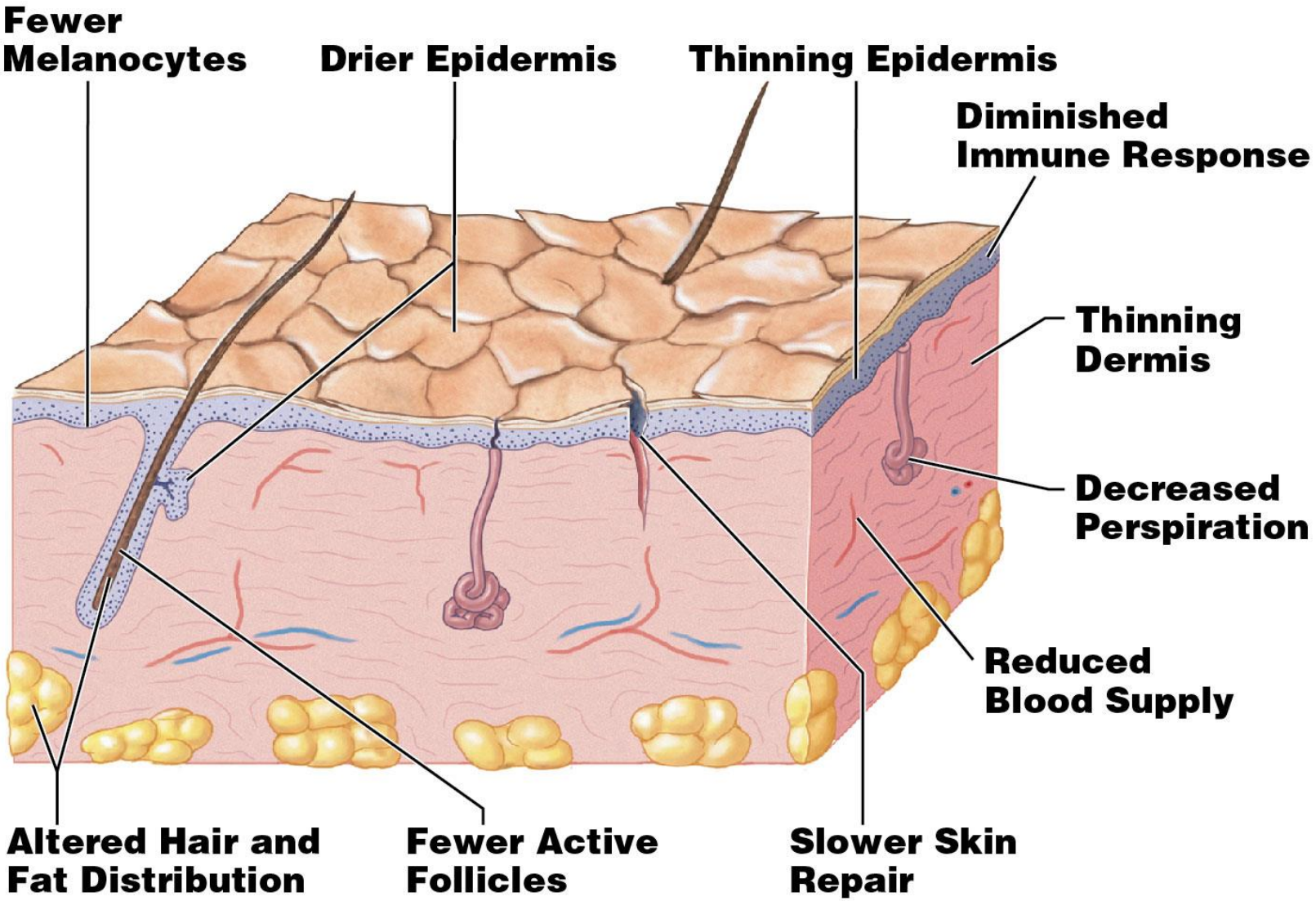
- In light-skinned people, skin becomes very pale
- Increased sensitivity to sun exposure, more likely to sunburn

Drier epidermis (decreased sebaceous gland activity)

Thinning epidermis (declining basal cell activity)

- Connections between epidermis and dermis weaken
- More prone to injury, skin tears, and skin infection
- Reduced vitamin D_3 production
  - Causes muscle weakness and brittle bones

Age-related integument changes



Module 5.10: CLINICAL MODULE: Age-related changes affect the integument

Diminished immune response

- Declining numbers of dendritic cells (to about half of levels at age 21)
- Increased chance of skin damage and infection

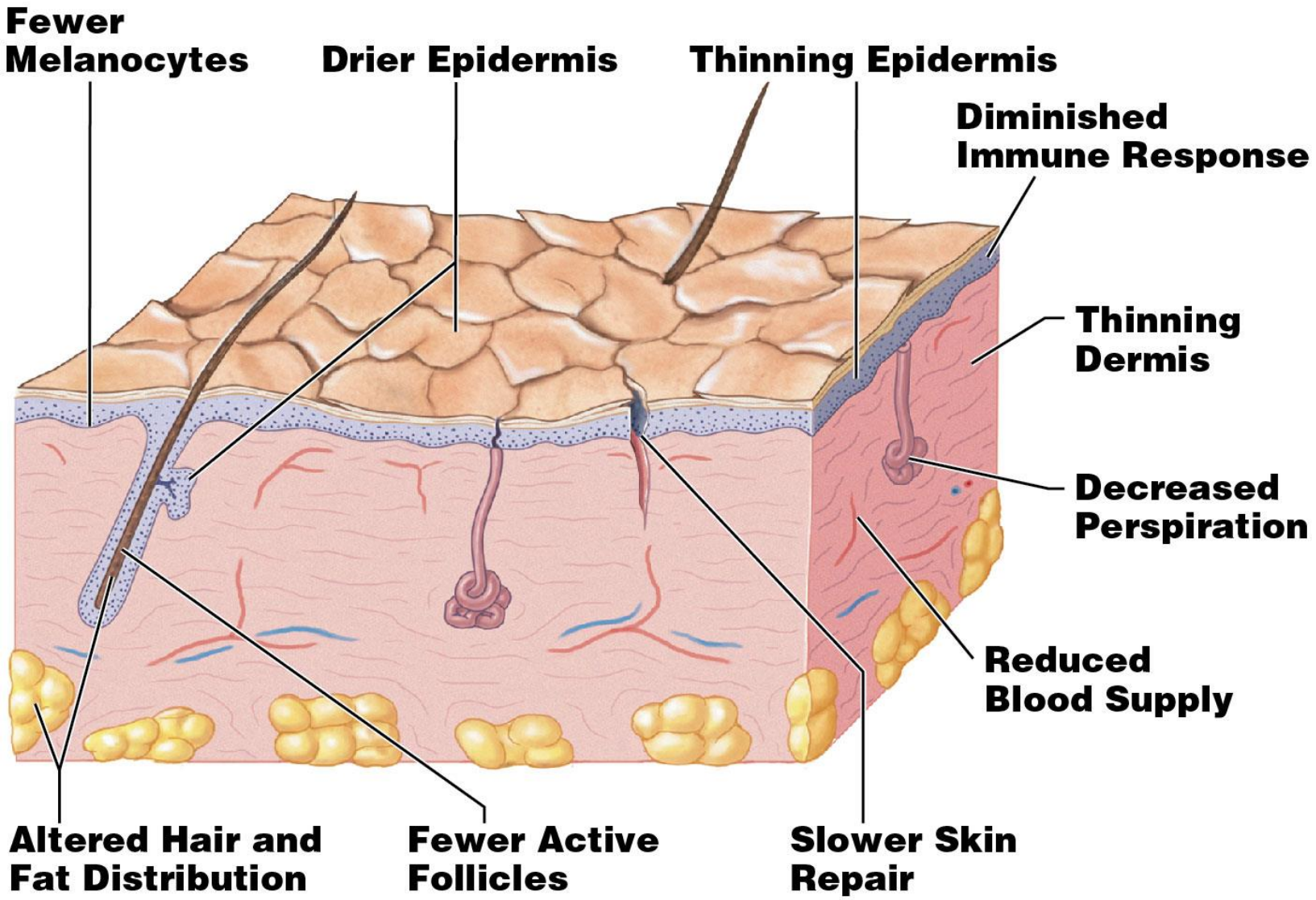
Thinning dermis

- Fewer elastic fibers
- Sagging and wrinkling are the results

Decreased perspiration

- Sweat glands are less active
- Greater risk of overheating

Age-related integument changes



Module 5.10: CLINICAL MODULE: Age-related changes affect the integument

Reduced blood supply

- Cools skin and stimulates thermoreceptors
- Makes person feel cold even in warm room
- Decreased ability to lose heat

Slower skin repair

- *Example:* blister repair 3–4 weeks in young adult takes 6–8 weeks in 65- to 75-year-old

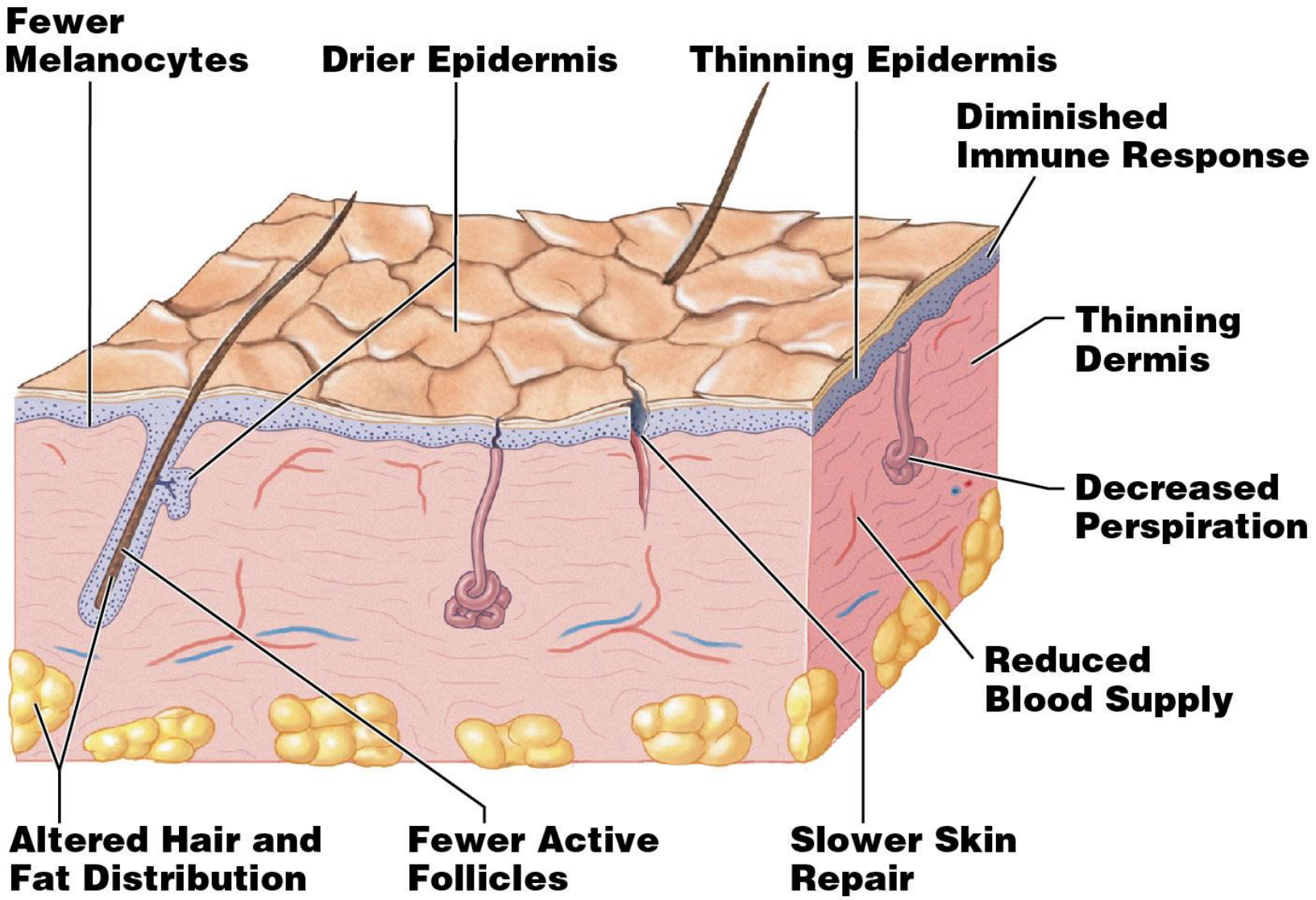
Module 5.10: CLINICAL MODULE: Age-related changes affect the integument

Fewer active follicles

- Thinner, finer hairs (gray or white from decreased melanocyte activity)

Altered hair and fat distribution (decreased sex hormone levels)

Age-related integument changes



Module 5.10: Review

A. Why does hair turn white or gray with age?
B. Why do people tolerate summer heat less well and become more susceptible to heat-related illness when they become older?

Learning Outcome: Summarize the effects of aging on the skin.

Module 5.11: The integument responds to circulating hormones and has endocrine functions that are stimulated by ultraviolet radiation

Circulating hormones

- Allow communication between skin and the rest of the body
- Steroid hormones (**glucocorticoids**)
  - Loosen intercellular connections and reduce epidermis effectiveness as a barrier to infection
- **Thyroid hormones**
  - Maintain normal blood flow to subpapillary plexus

Module 5.11: Endocrine and integumentary system interactions

Circulating hormones (continued)

- **Sex hormones**
  - Increase epidermal thickness
  - Accelerate wound healing
  - Increase number of dendritic cells protecting against cancer cells and pathogens

Module 5.11: Endocrine and integumentary system interactions

Circulating hormones (continued)

- **Growth factors**
  - Stimulate cell growth and cell division
  - **Epidermal growth factor** (**EGF**)
    - Peptide that has widespread effects on epithelia
    - Produced by salivary glands and glands in duodenum
    - Functions
      - Promotes basal cell division in stratum basale and stratum spinosum
      - Accelerates production of keratin
      - Stimulates epidermal development and repair
      - Stimulates synthesis and secretion in glands

Module 5.11: Endocrine and integumentary system interactions

Circulating hormones (continued)

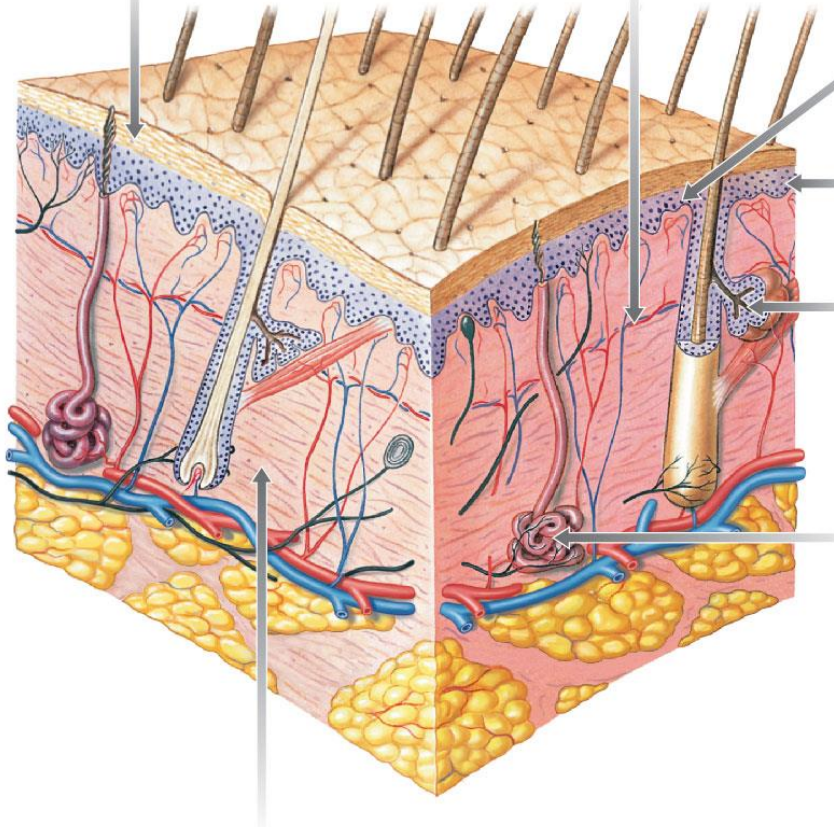
- **Growth hormone** (**GH**)
  - Stimulates fibroblast activity and collagen production
  - Stimulates basal cell division
    - Thickens epidermis
    - Promotes wound repair

Endocrine and integumentary system interactions

Glucocorticoids loosen the connections between keratinocytes and reduce the effectiveness of the epidermis as a barrier to infection.

Thyroid Hormones maintain normal blood flow to the subpapillary plexus.

Sex Hormones stimulate epidermal cell divisions, increasing epidermal thickness and accelerating wound repair.



Growth Factors are compounds produced in the body that stimulate cell growth and cell division.

Epidermal growth factor (EGF)

EGF plays a role in:

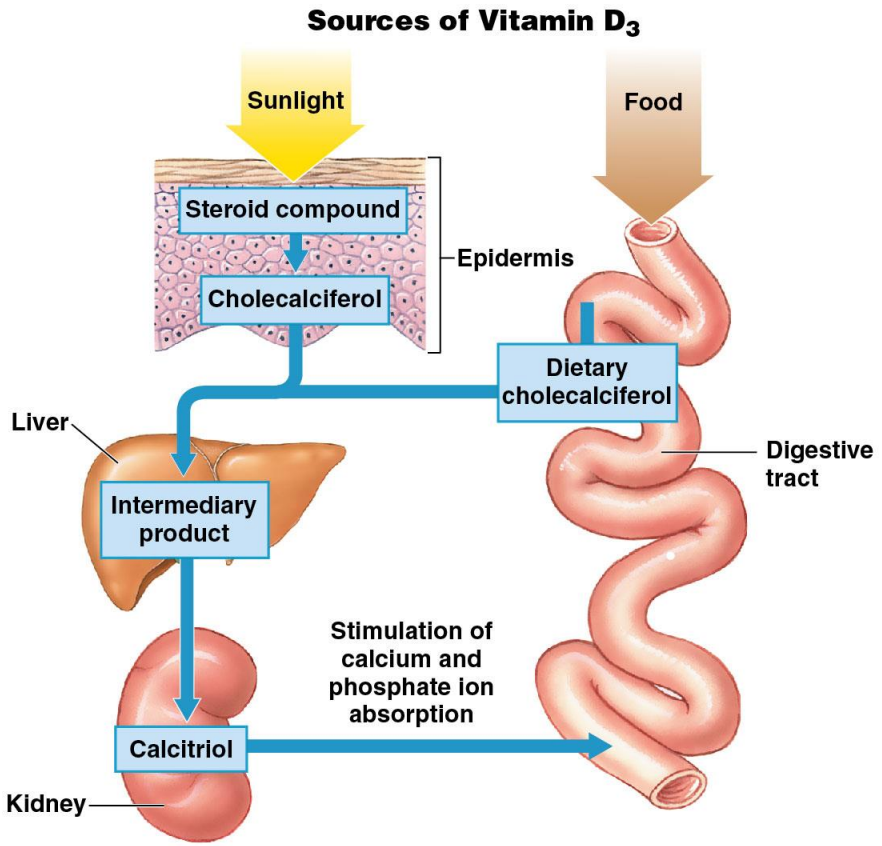
- Promoting basal cell division in the stratum basale and stratum spinosum
- Accelerating keratin production in maturing keratinocytes
- Stimulating epidermal development and epidermal repair after injury
- Stimulating synthetic activity and secretion by epithelial glands

Growth Hormone (GH) stimulates fibroblast activity and collagen synthesis.

Module 5.11: Endocrine and integumentary system interactions

Vitamin D_3 production

- **Sunlight**
  - UV radiation causes epidermal cells of stratum spinosum and stratum basale to convert steroid to **cholecalciferol** (**vitamin D_3**)

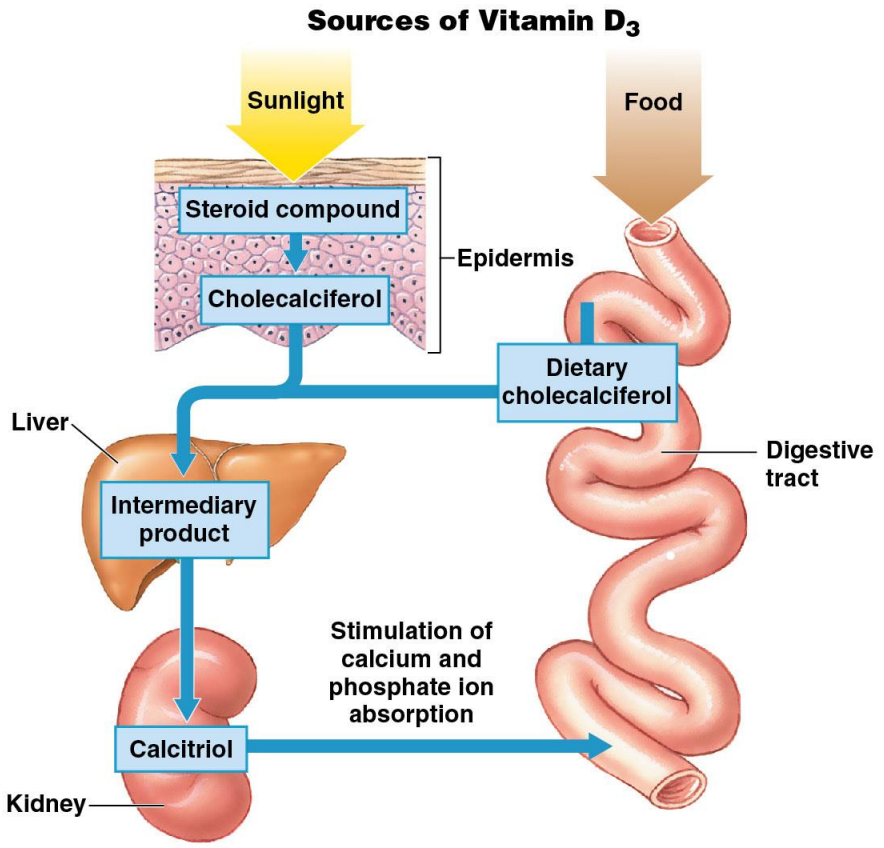


  - Liver creates intermediate product; then converted to **calcitriol** by kidneys
  - Calcitriol allows calcium and phosphate absorption in small intestine

Module 5.11: Endocrine and integumentary system interactions

Vitamin D_3 production (continued)

- Sources
  - Diet
    - Naturally from fish, fish oils, and shellfish
    - From fortified food products



Module 5.11: Endocrine and integumentary system interactions

Inadequate supply of calcitriol leads to impaired bone growth and maintenance

- In children, leads to **rickets**
  - Flexible, poorly mineralized bones
  - From not enough sunlight or not enough dietary cholecalciferol (vitamin D_3)
  - Bone matrix has insufficient calcium and phosphate
  - Uncommon in United States (vitamin D_3 added to milk)

Module 5.11: Endocrine and integumentary system interactions

Inadequate supply of calcitriol leads to impaired bone growth and maintenance (continued)

- Decreased bone density in elderly
  - Partially from insufficient dietary intake
  - Additionally, skin production of cholecalciferol decreases by 75 percent
  - Increases risk for fractures
  - Slows healing process

Module 5.11: Review

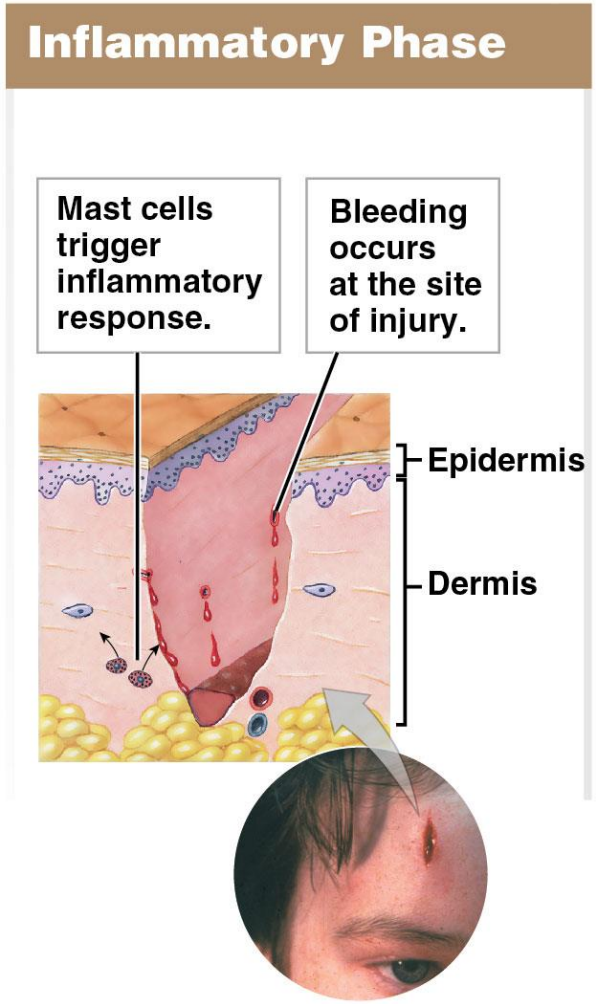
A. List some hormones that are necessary for maintaining a healthy integument.
B. Explain the relationship between sunlight exposure and vitamin D_3.
C. In some cultures, females must be covered from head to toe when they go outdoors. Explain why these women are at increased risk of developing bone problems later in life.

Learning Outcome: Describe the interaction between sunlight and endocrine functioning as they relate to the skin.

Module 5.12: CLINICAL MODULE: The integument can often repair itself, even after extensive damage

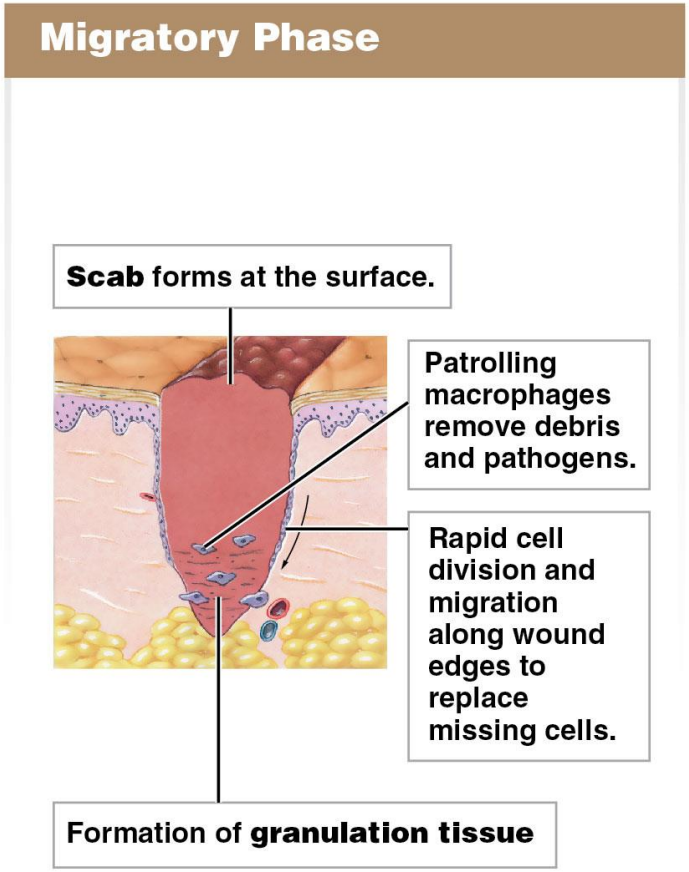
Four phases in skin regeneration after injury

1. **Inflammation phase**
   - Initial injury causes bleeding and mast cell activation
   - Mast cells stimulate inflammation
   - Produces swelling, redness, heat, and pain



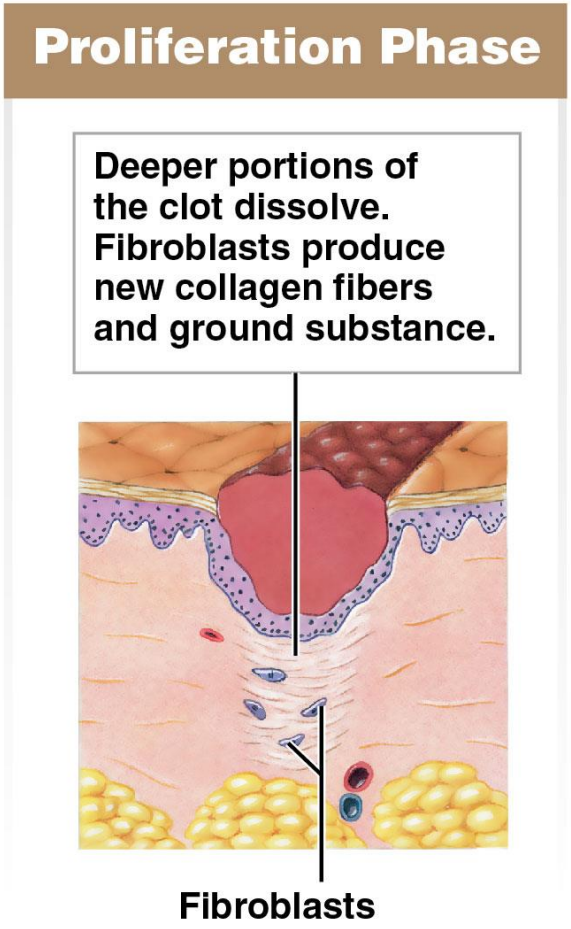
Module 5.12: CLINICAL MODULE: Integumentary system repair

2. **Migration phase** (after several hours)
   - Blood clot (**scab**) forms at surface
   - Cells of stratum basale divide and migrate along wound edges
   - Macrophages remove debris and pathogens
   - If damage into dermis, combination of fibroblasts, blood clot, and capillary network form **granulation tissue** as part of repair process



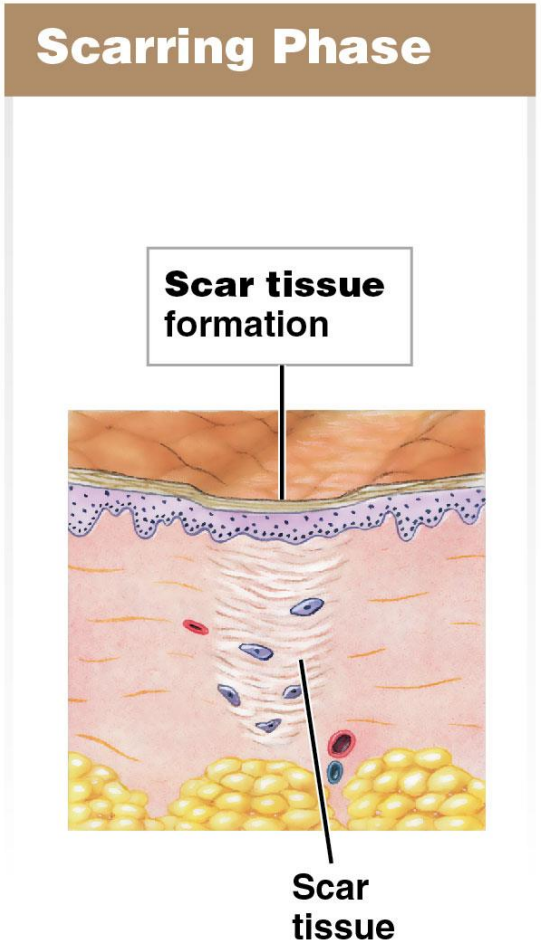
Module 5.12: CLINICAL MODULE: Integumentary system repair

3. **Proliferation phase** (one week after injury)
   - Scab undermined by migrating epidermal cells
   - Phagocytic activity almost complete
   - Blood clot disintegrating
   - Fibroblasts have formed collagen fibers and ground substance

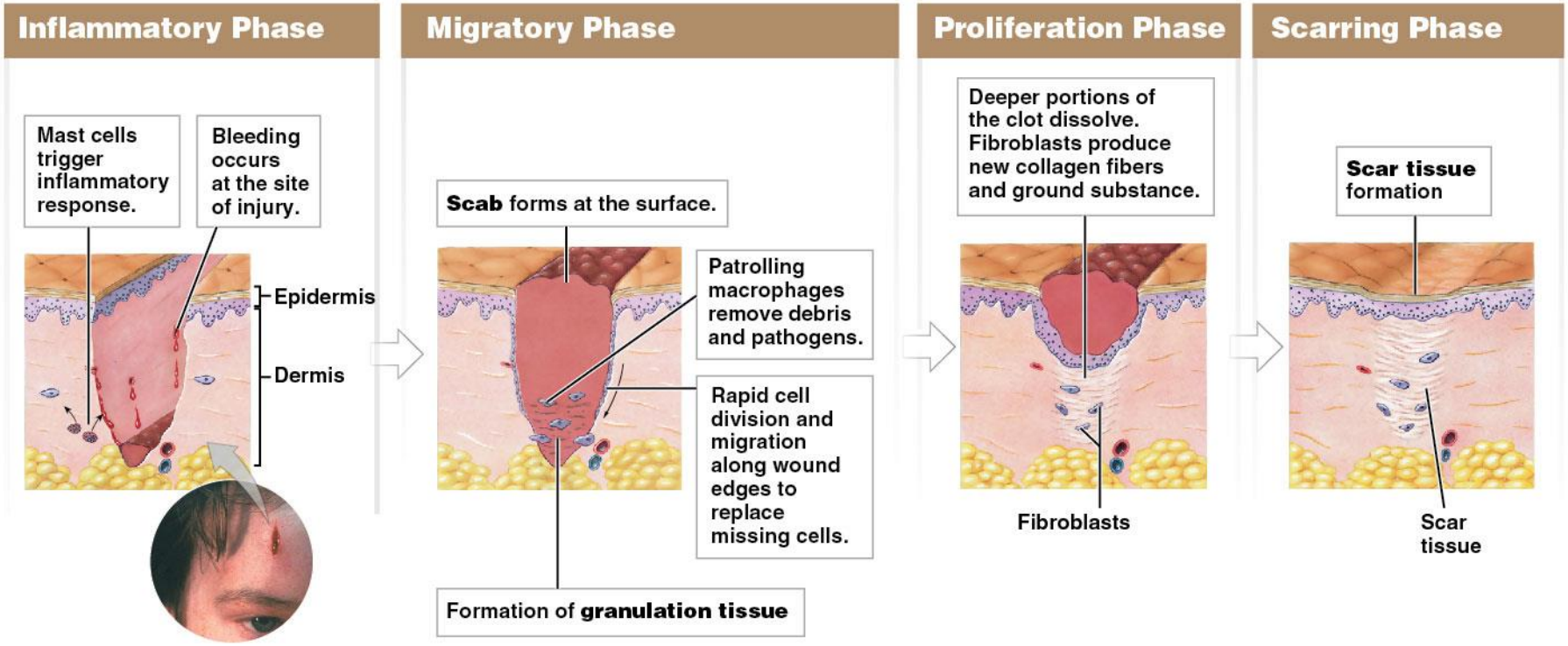


Module 5.12: CLINICAL MODULE: Integumentary system repair

4. **Scarring phase** (several weeks after injury)
   - Scab is shed; epidermis is complete
   - Shallow depression marks injury site
   - Fibroblasts continue to create **scar tissue**—inflexible, fibrous, noncellular material



Integumentary system repair



Module 5.12: CLINICAL MODULE: Integumentary system repair

Keloids

- Raised, thickened mass of scar tissue that begins at injury site and grows into the surrounding dermis
  - Covered by shiny, smooth epidermal surface
  - Most common on upper back, shoulders, anterior chest, earlobes
  - A form of body decoration in some cultures

Module 5.12: Review

A. Identify the first step in skin repair.
B. Describe granulation tissue.
C. Why can skin regenerate effectively even after considerable damage?

Learning Outcome: Explain how the skin responds to injury and is able to repair itself.