Integumentary Physiology

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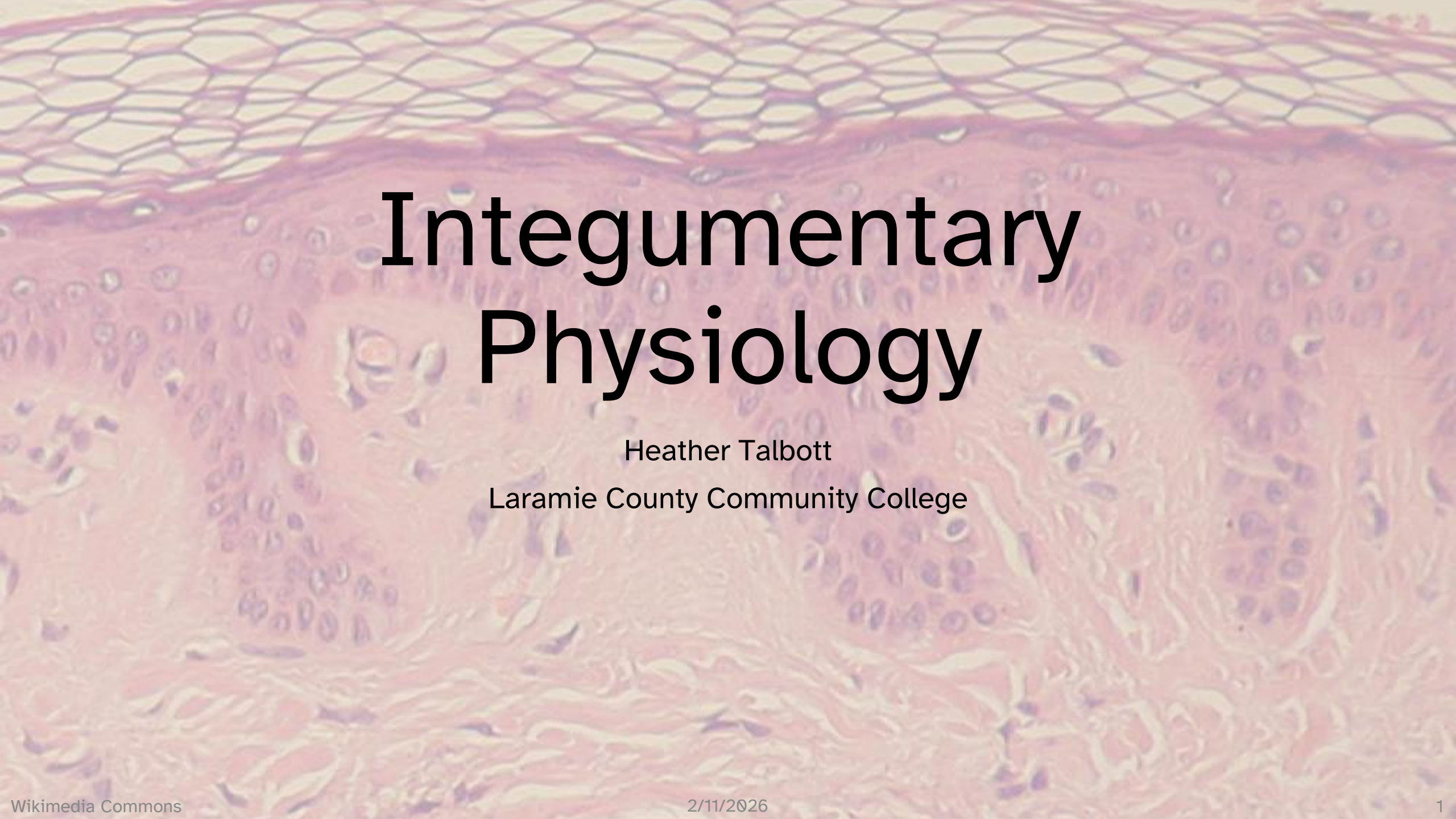
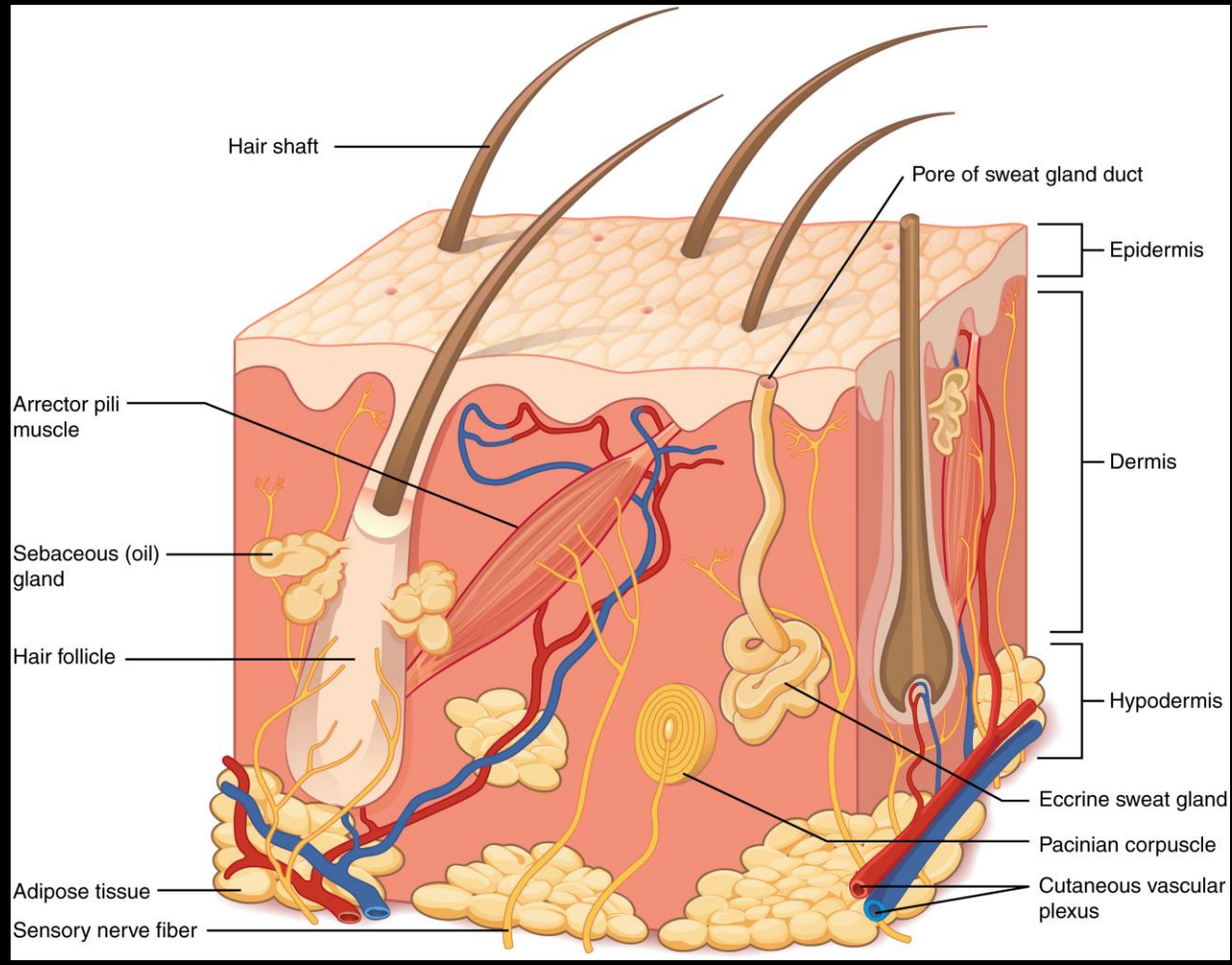


Overview of Integument Physiology

- Protection & Barrier Functions
- Immune Defense
- Sensory Reception
- Thermoregulation
- Water Balance
- Blood Reservoir
- Vitamin D Synthesis
- Repair & Aging

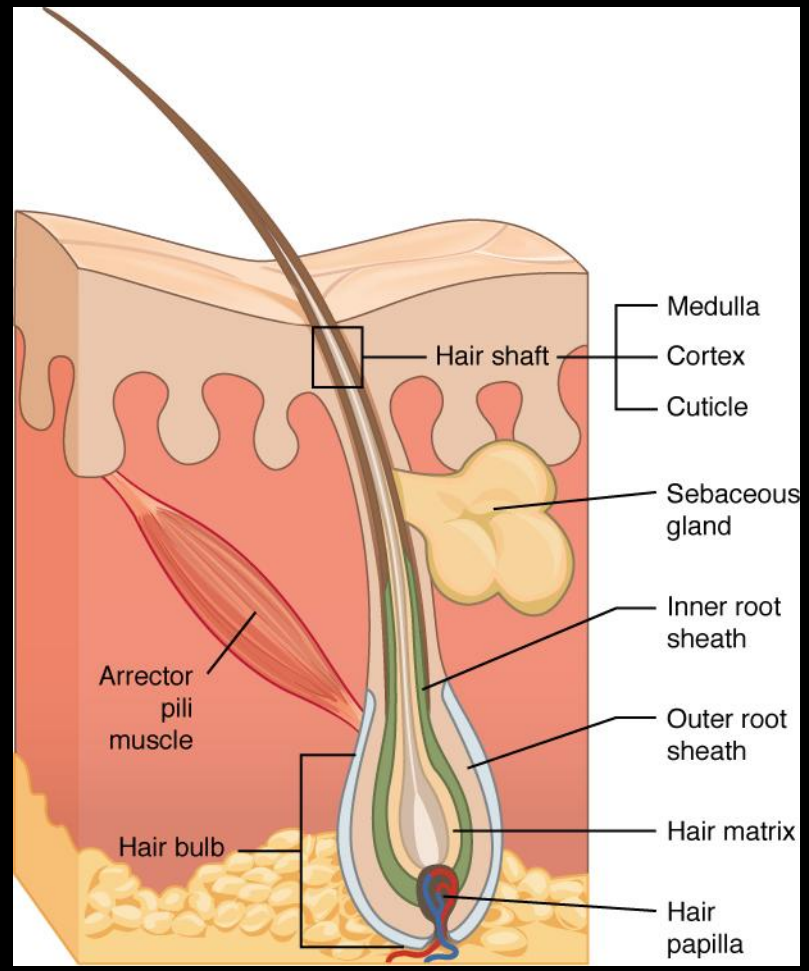


Skin (Primary Barrier)

- Forms a **physical barrier** against injury and abrasion; keratinized epithelium limits mechanical and chemical damage
- **Prevents water loss** and dehydration from lipids
- Contains **keratin** for strength and toughness
- Produces **antimicrobial substances**
- Houses **immune cells** that help detect & remove invaders

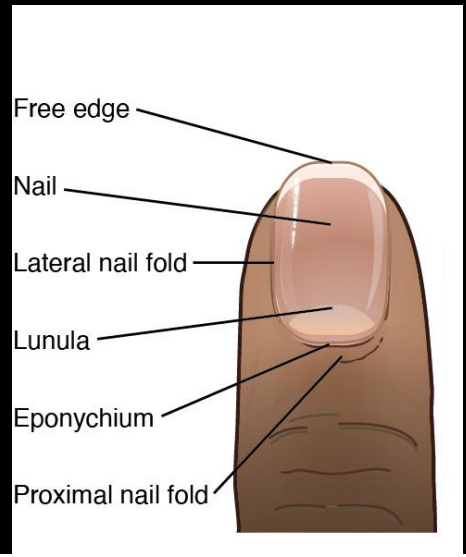
Hair (Protective Covering)

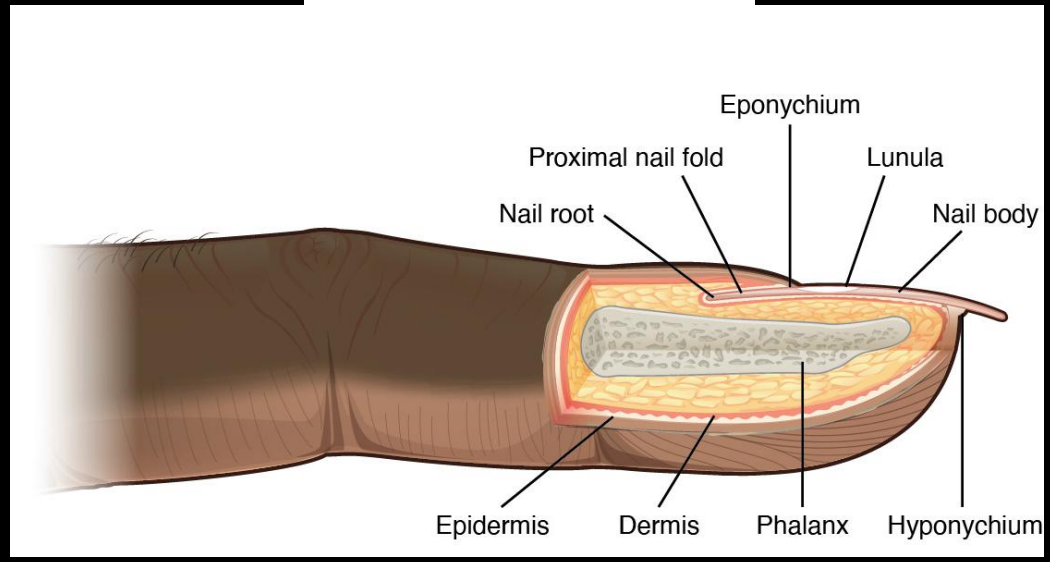
- Helps protect the **scalp from UV radiation**
- Reduces **heat loss** from the head
- Filters dust and particles in **nose and ears**
- Provides **early warning** when touched (sensory role)
- Enhances tactile sensitivity



Nails (Structural Protection)

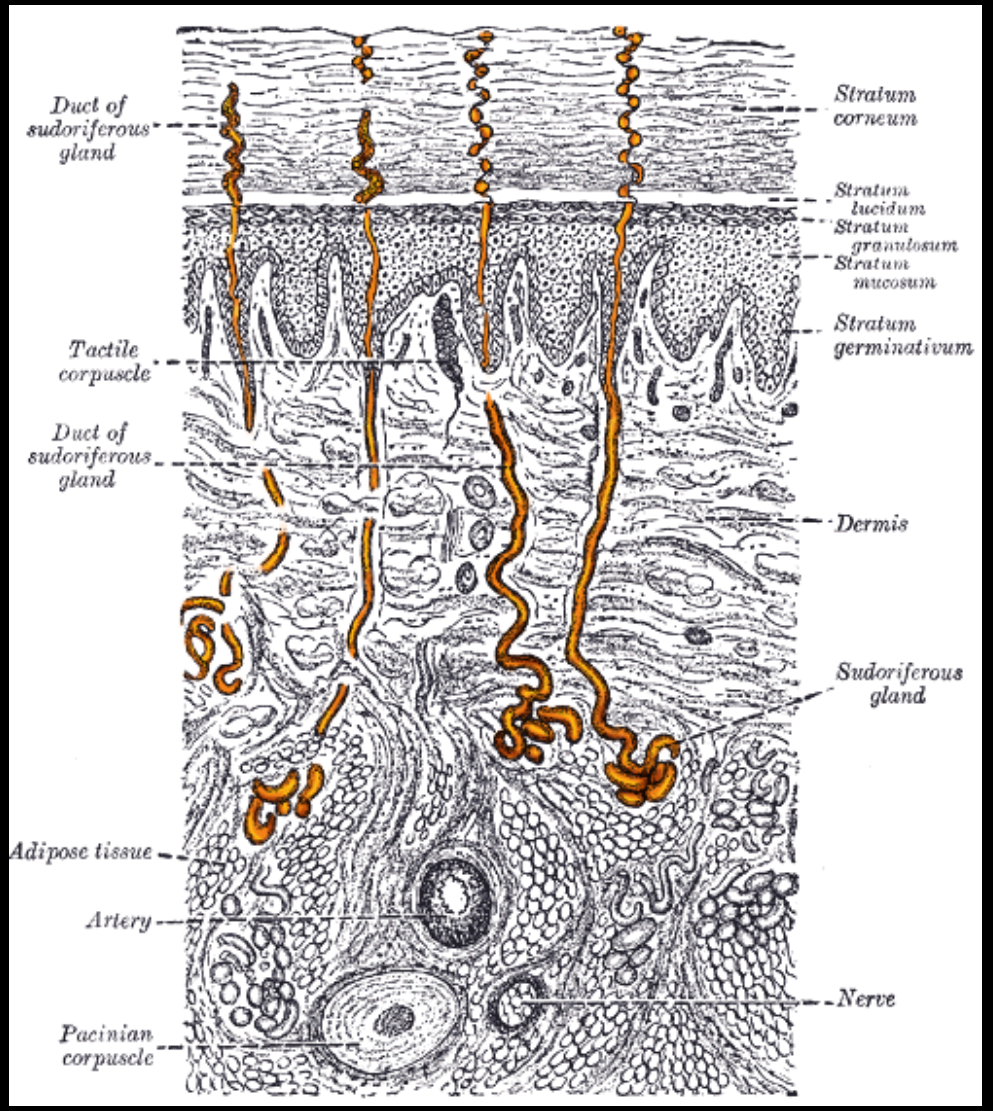
- Protect the tips of fingers and toes
- Prevent damage to underlying tissues
- Help with grasping and manipulating objects
- Assist in detecting small surface textures





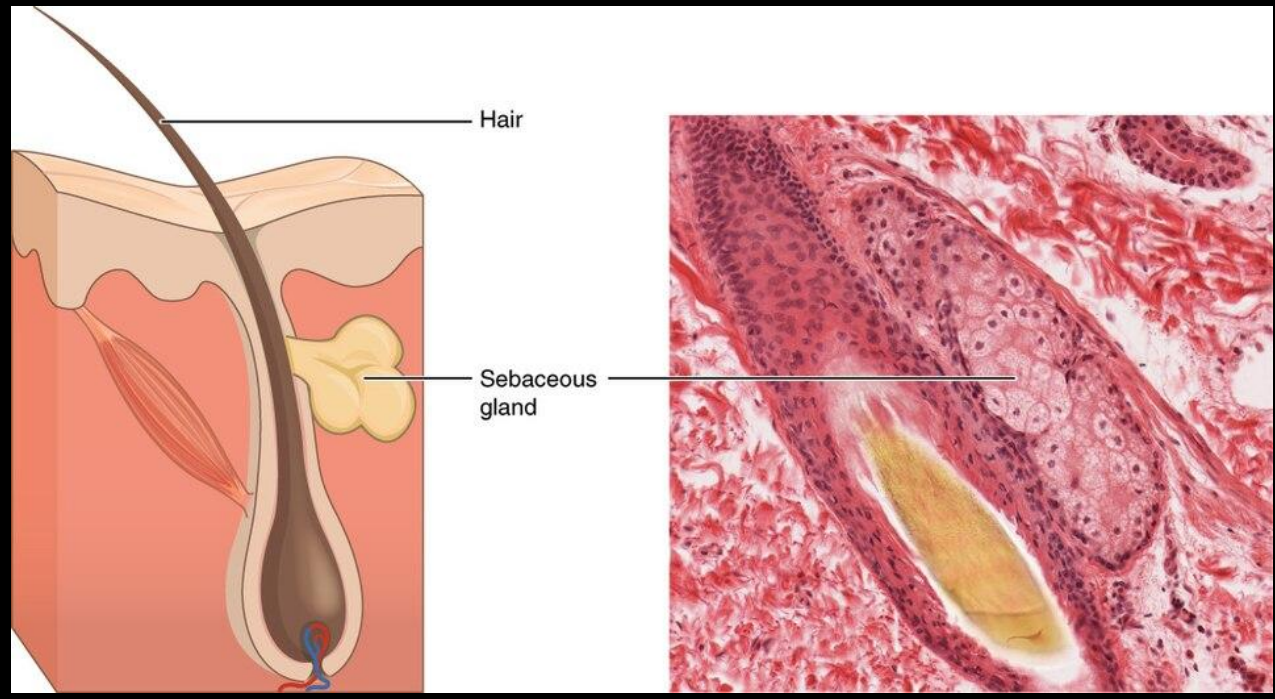
Sweat Glands (Chemical & Mechanical Protection)

- Produce sweat that **flushes dirt and microbes** from skin
- Sweat contains **antimicrobial compounds**
- Helps maintain **slightly acidic pH**, discouraging bacteria
- Supports skin health by keeping surface clean



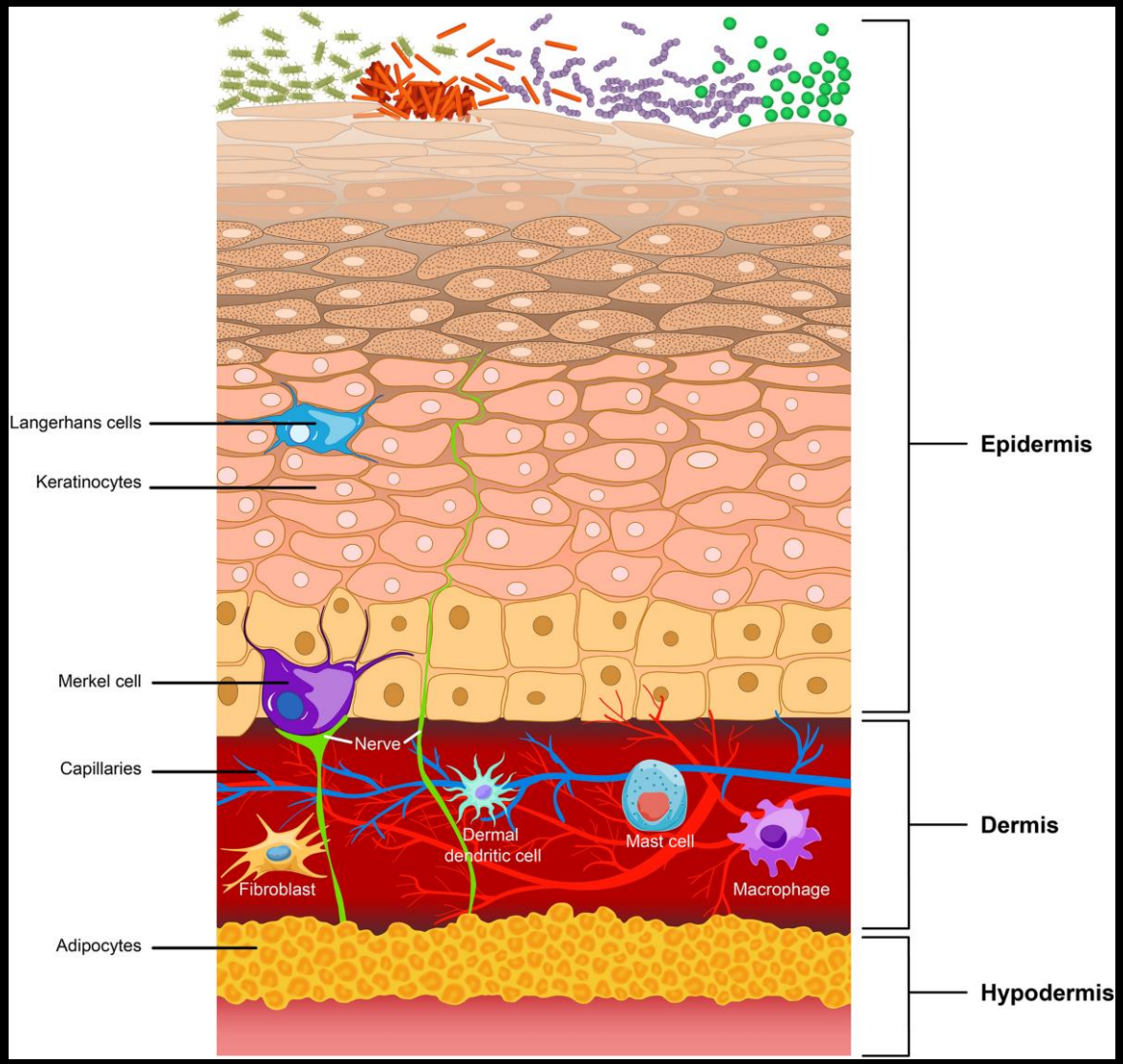
Sebaceous Glands (Oil Protection)

- Secrete **sebum (oil)** onto skin and hair
- Keeps skin **soft and flexible**
- Prevents **cracking and drying**
- Has **antibacterial properties**
- Helps form a **water-resistant barrier**



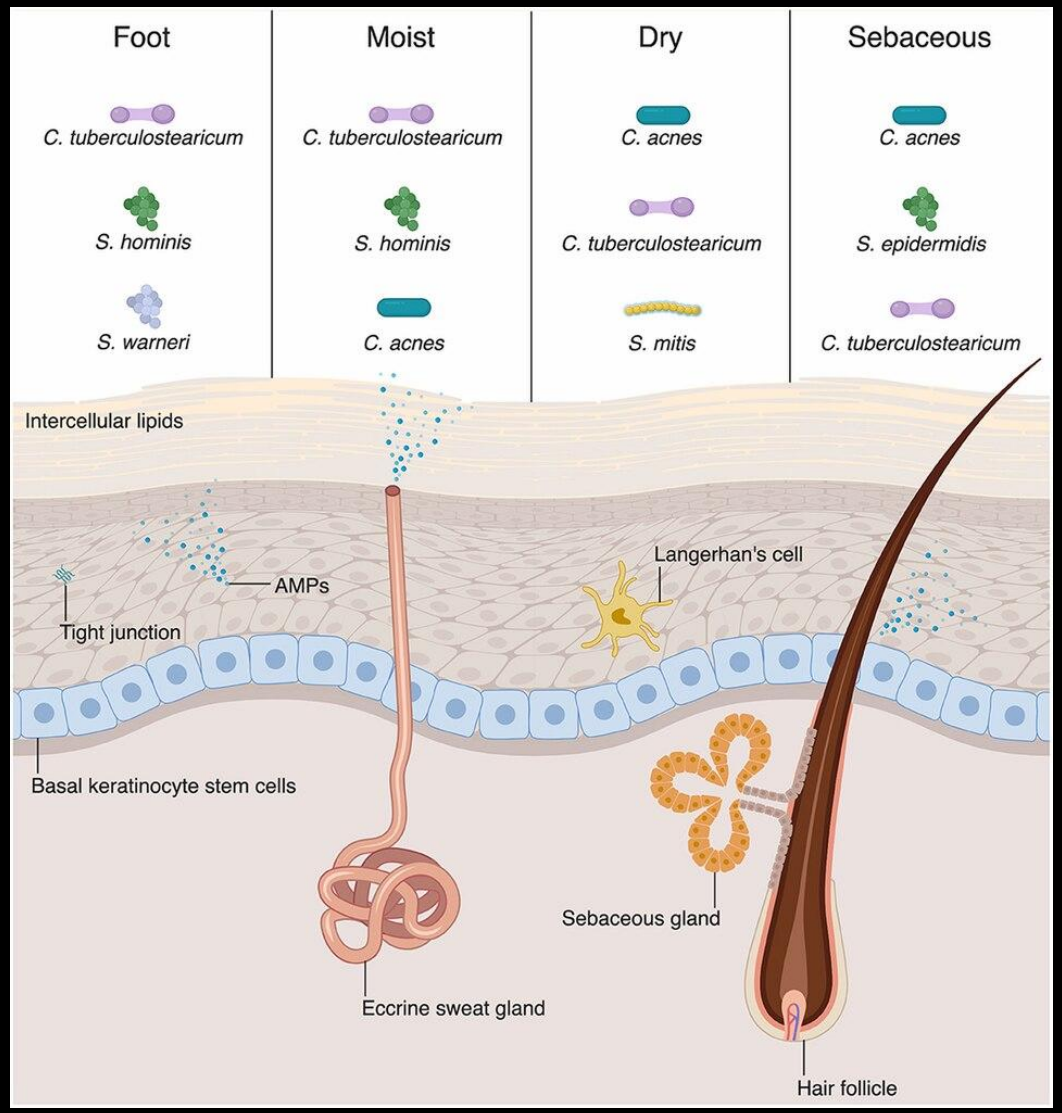
Immune Defense – Human Cells

- **Dendritic cells**: process antigen material and present it to lymphocytes of the immune system
- **Macrophages**: patrol cells that engulf and digest debris and foreign substances
- **Keratinocytes:** produce antimicrobial substances
- **Antimicrobial secretions**: substances that defend against pathogens from keratinocytes, sebaceous glands, and sudoriferous glands



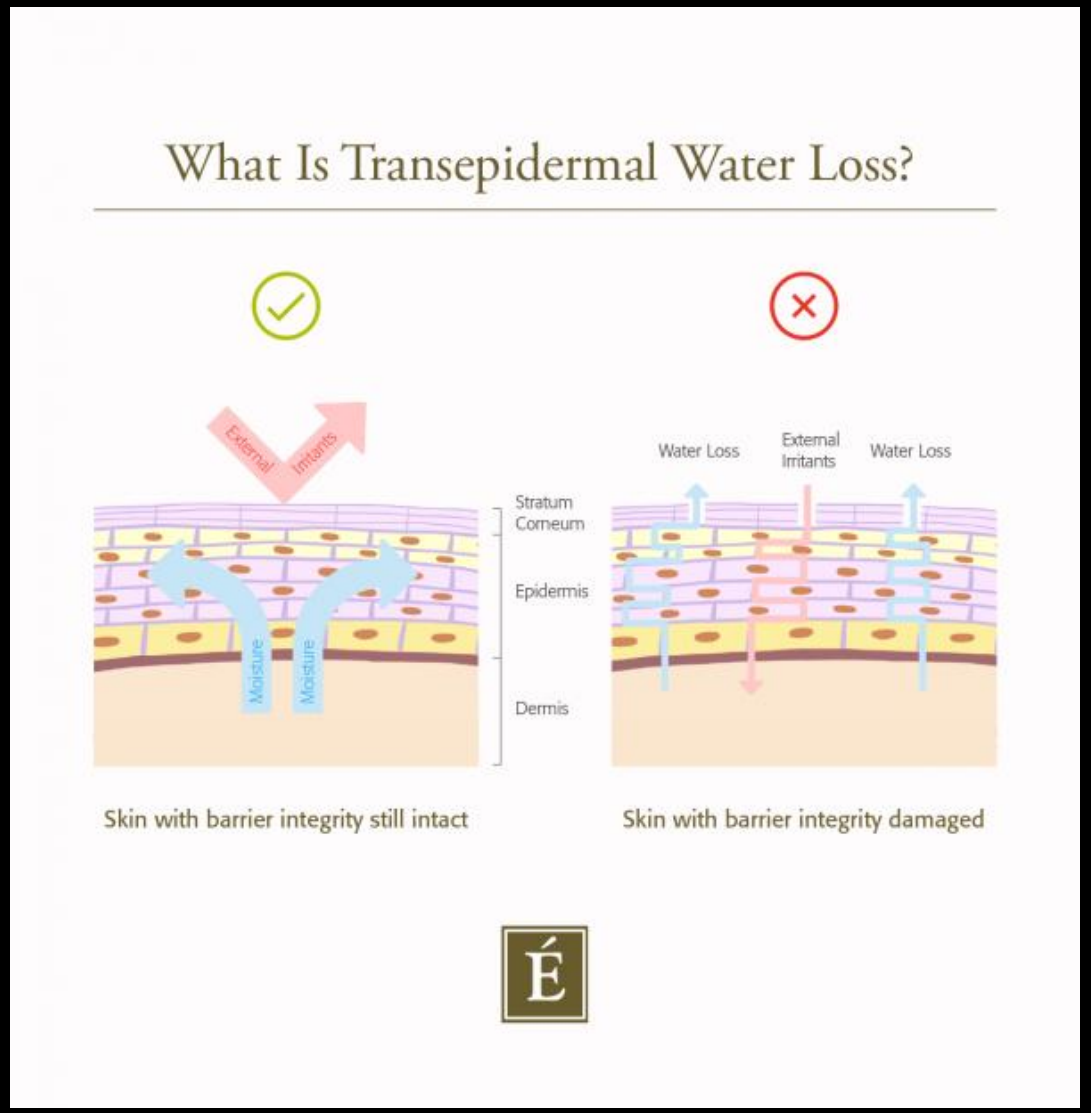
Immune Defense - Microorganisms

- **Normal microbiome**: diverse ecosystem of microorganisms that live on and inside the integumentary system
  - Competes with pathogens
  - Regulates immune system
  - Maintains barrier integrity



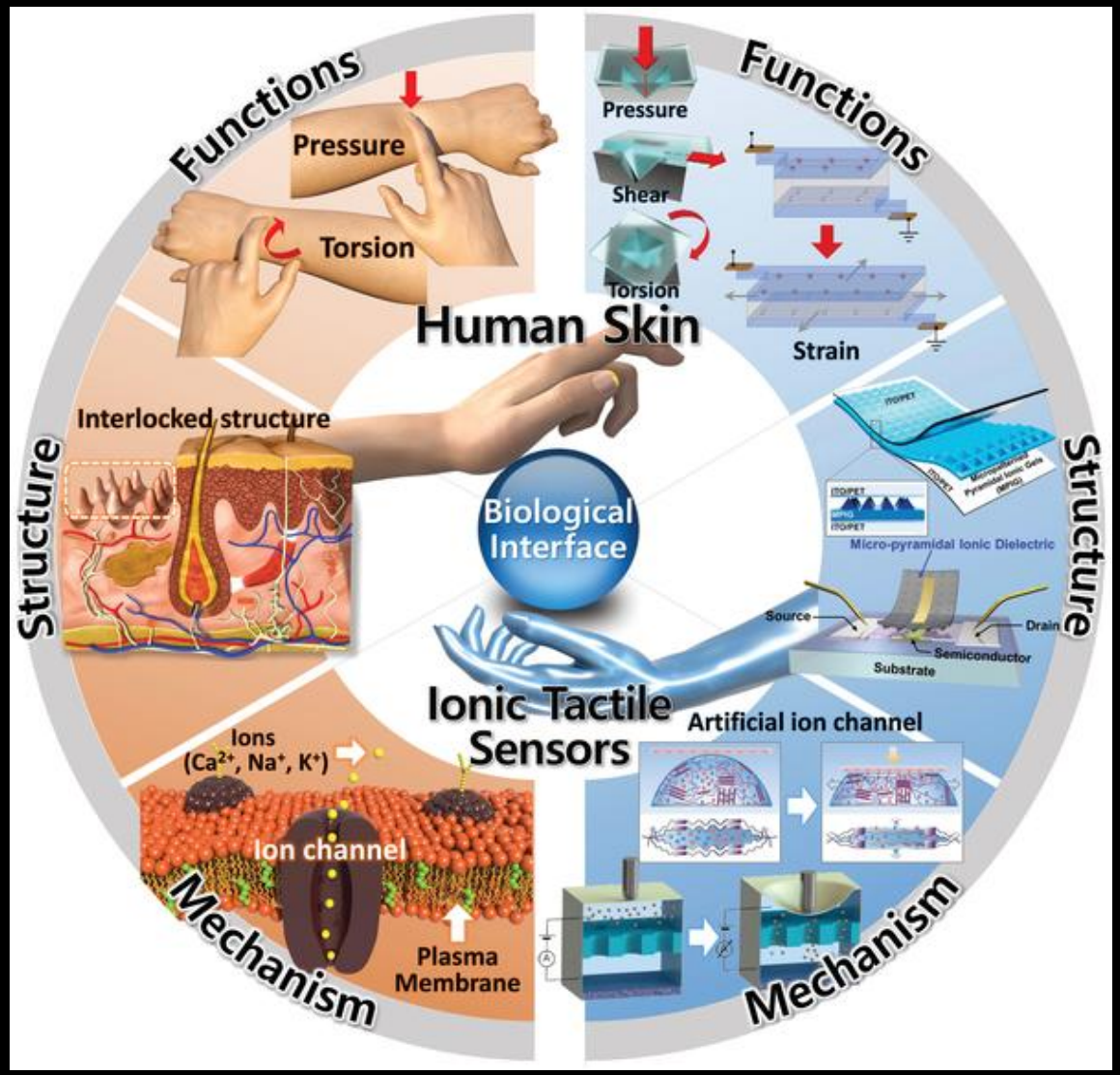
Water Balance

- Epithelial cells reduce the permeability of skin to water
  - By using lipids in epithelium to slow water movement
  - Prevents dehydration
  - Limits entry of harmful substances



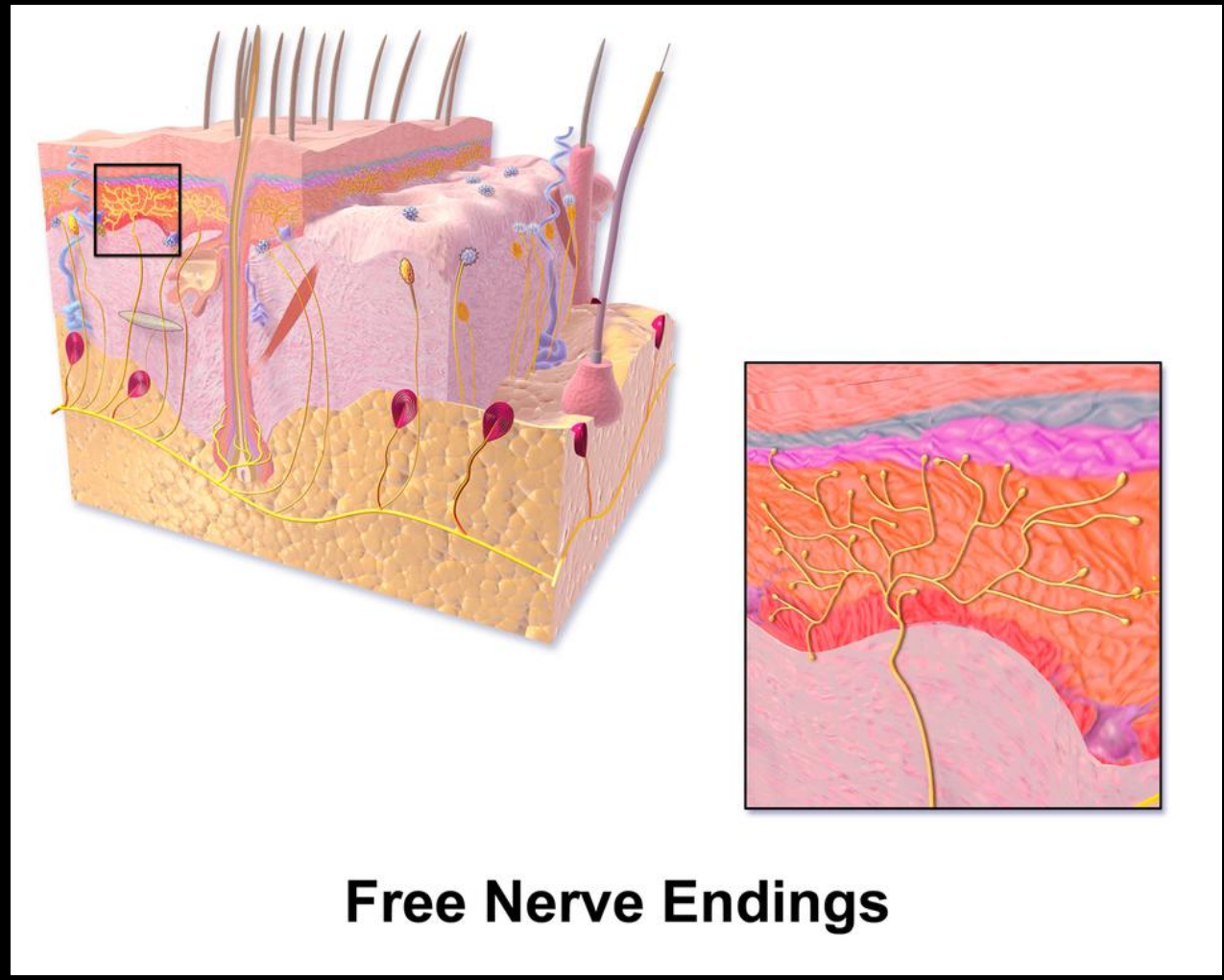
Types of Receptors & Effectors

- The integument functions in both sensing and responding
- Receptors/Sensors: detect environmental changes, send signals to CNS
  - Pain/Temperature
  - Touch
  - Hair movement
- **Effectors**: structures that carry out responses from CNS
  - Arrector pili
  - Glands



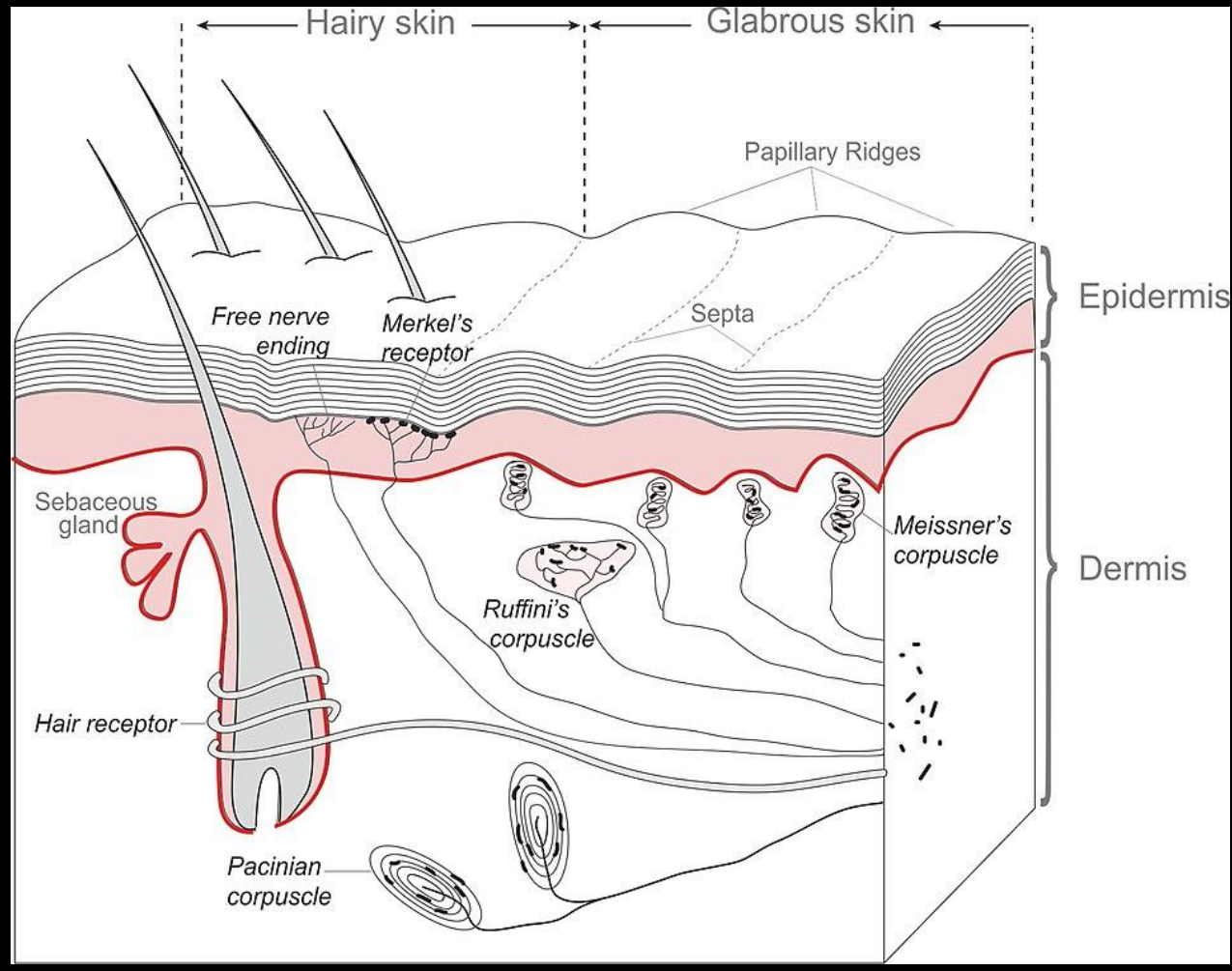
Pain & Temperature Receptors

- **Free nerve endings:** unspecialized structures that detect pain, temperature and light touch
- **Structure:** Dendrites of sensory neurons lacking specialized encapsulation.
- **Location:** dermis and epidermis
- **Function:** Warn of **potential tissue damage** and trigger protective reflexes



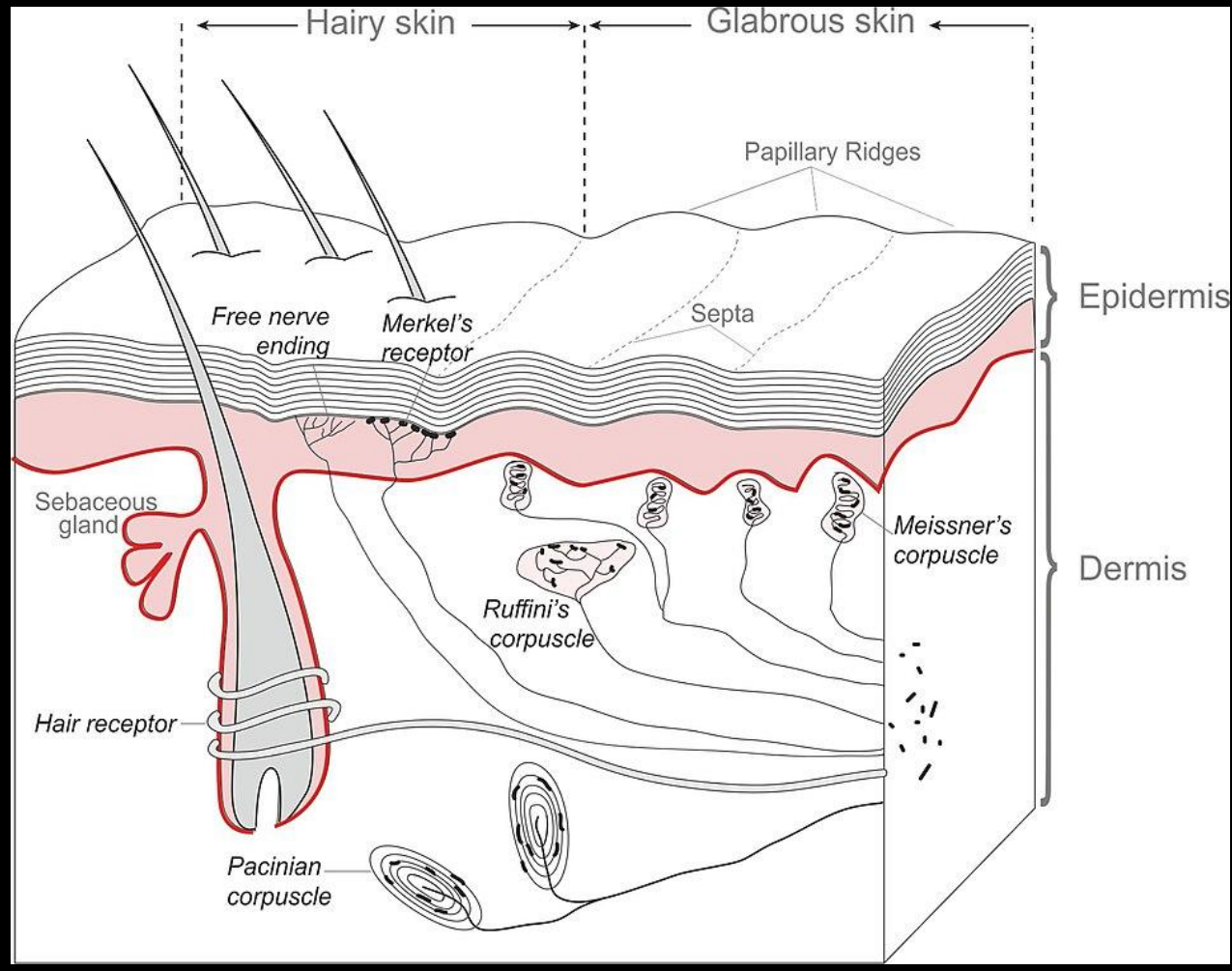
Touch Receptors

- **Encapsulated receptors**: specialized structures in dermis providing sensing of vibration deep pressure and precise touch
- **Structure:** Sensory nerve endings enclosed within a capsule of non-neuronal cells (e.g., Schwann cells)
- **Location:** Primarily located in the dermis (superficial or deep)
- **Function:** Specialized for specific mechanoreception: vibration, pressure, skin stretch, and fine touch



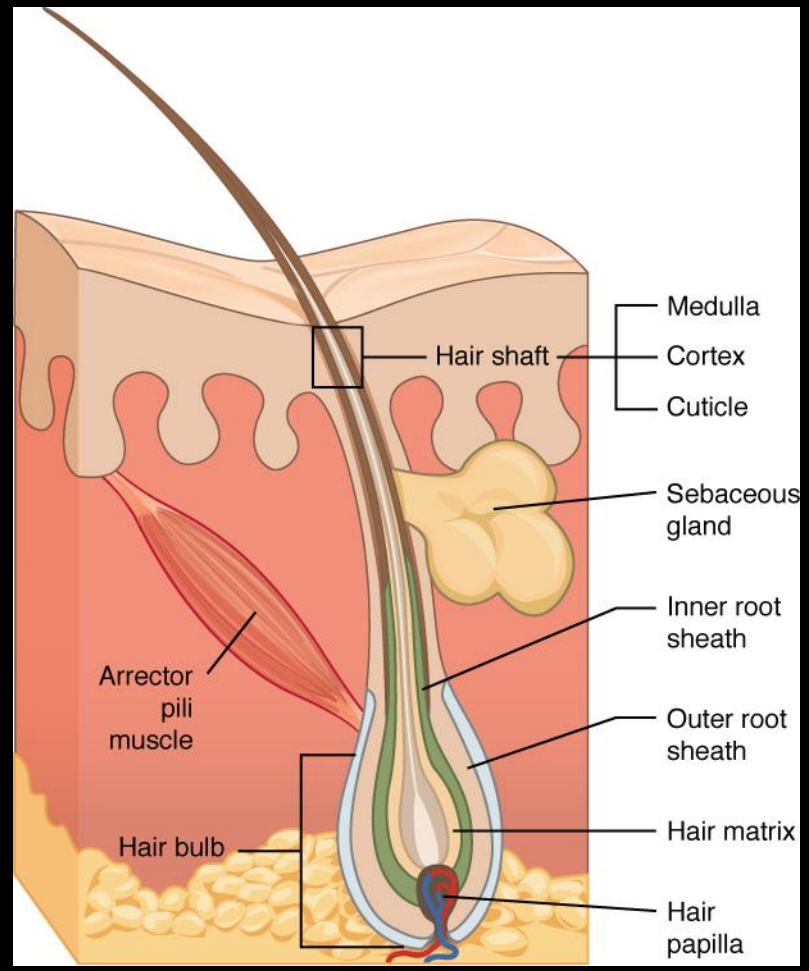
Hair receptors

- **Hair plexus**: Nerve endings wrapped around hair follicles
- Detect **hair movement**
- Sensitive to **light touch and air movement**
- Provide **early warning** of insects or objects on skin
- Important for protective reflexes



Motor Effectors

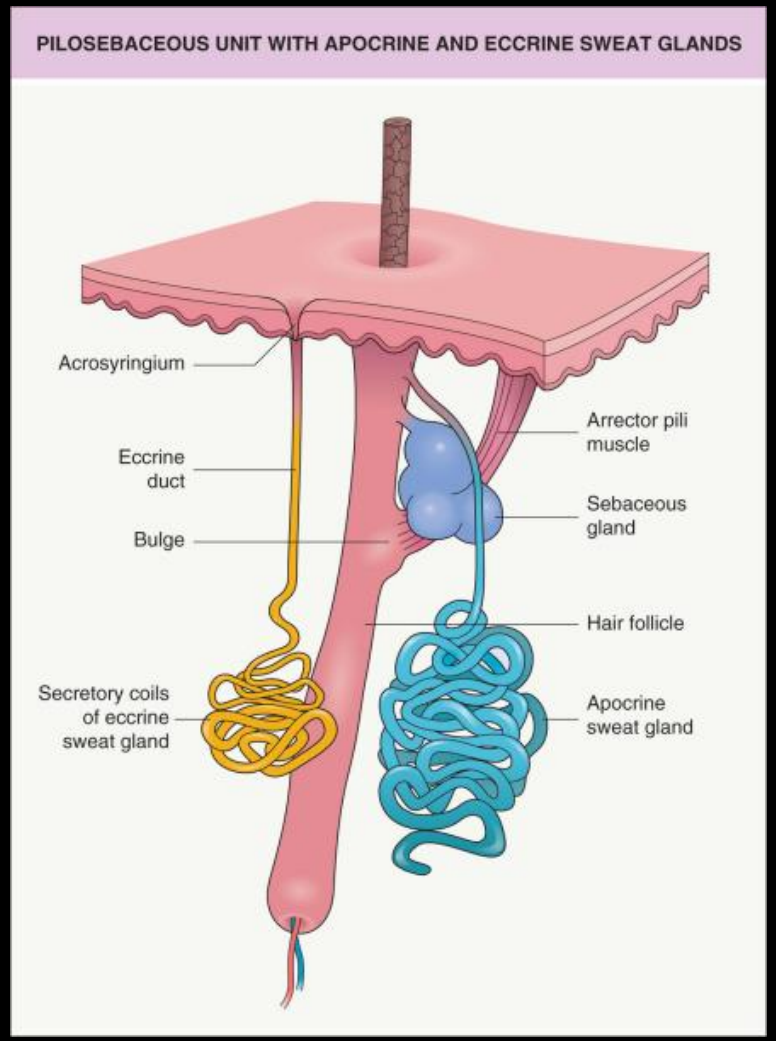
- **Arrector Pili Muscles**: small smooth muscles attached to hair follicles activated by cold, fear, or emotional stress
- Cause goosebumps
- Minor heat conservation
- Increase sensory awareness



Secretory effectors

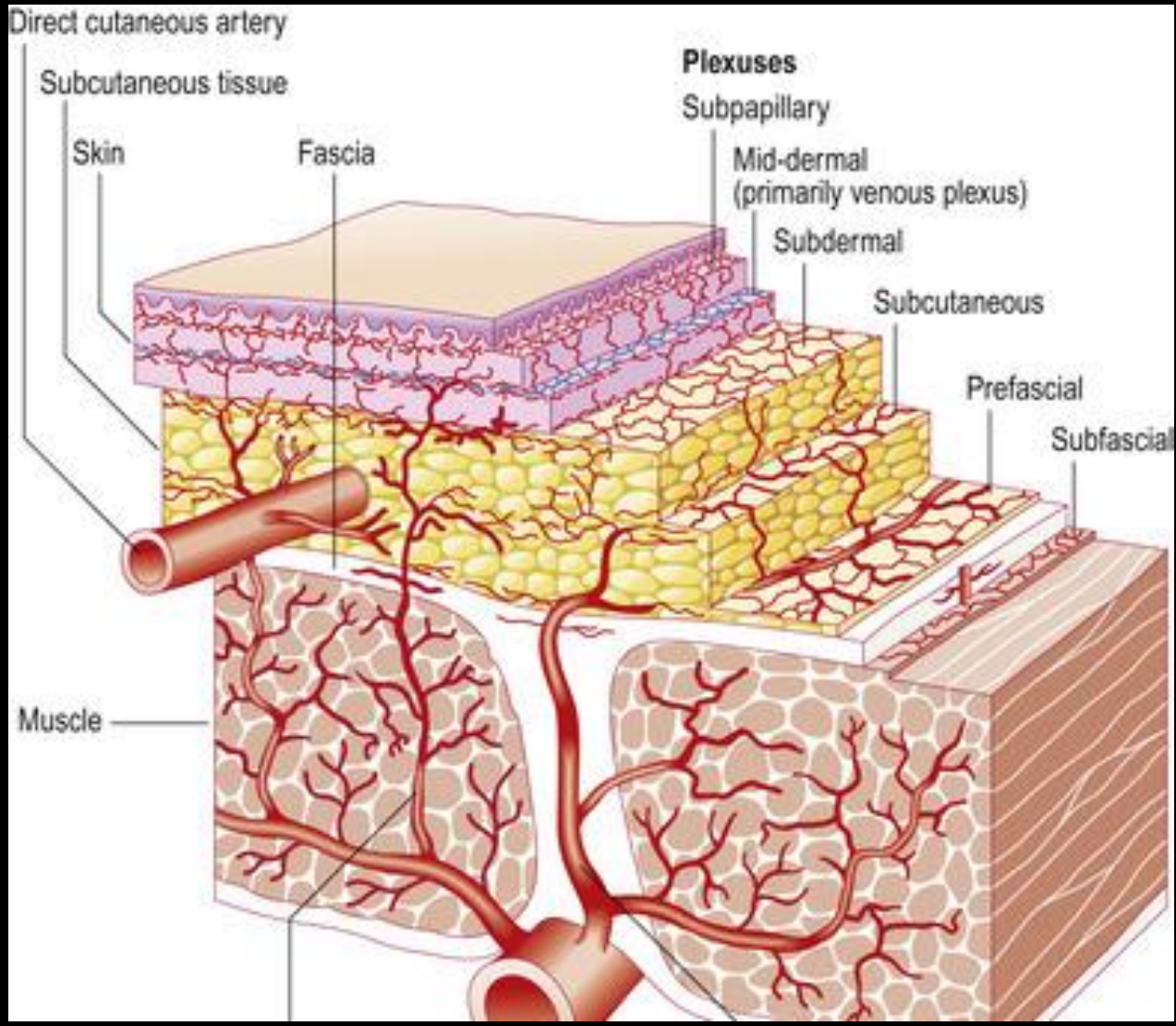
- **Sudoriferous glands**: produce sweat for cooling and waste removal
- Sweat removes:
  - Water
  - Salts
  - Small amounts of urea/ammonia

- **Sebaceous glands**: produce sebum (oil) to protect and waterproof skin



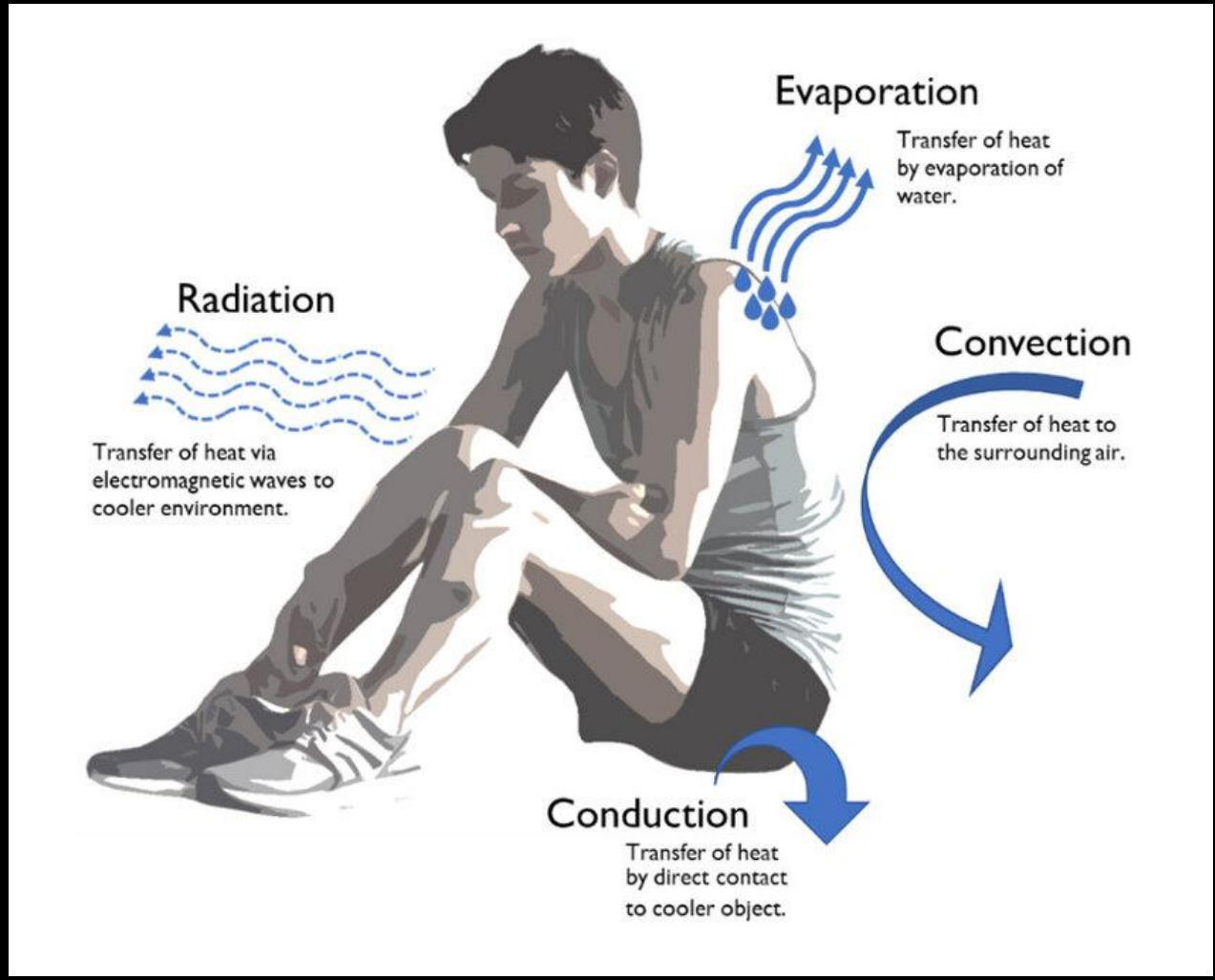
Blood Flow and Reservoir

- Skin can hold ~5–10% of blood volume
- Blood flow changes help regulate body temperature
- Supports heat loss and conservation.



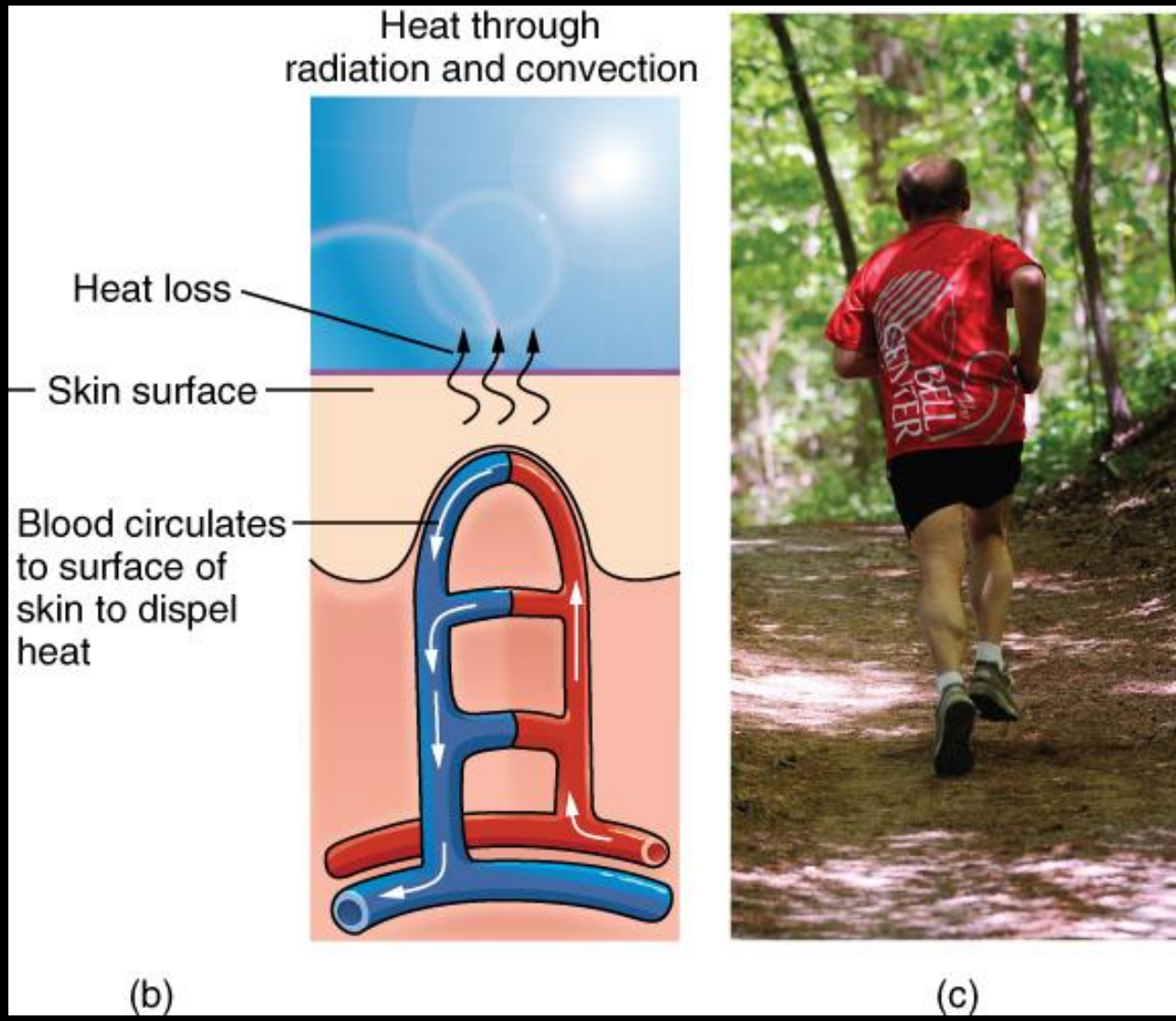
Thermoregulation

- **Thermoregulation**: homeostatic regulation of body temperature, skin with two primary controls:
  - Sweating
  - Blood flow



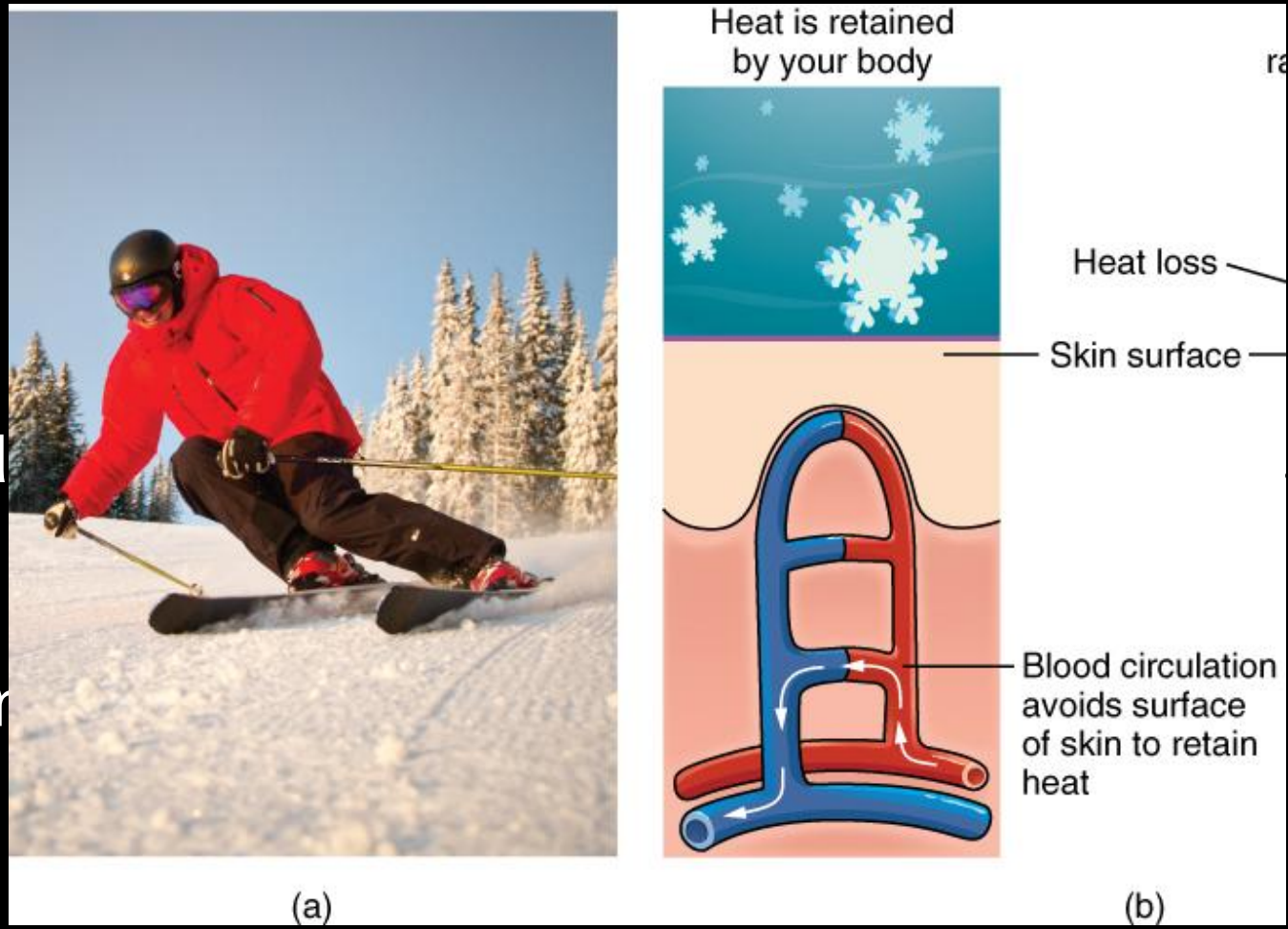
Heat Loss

- Sweating: secretion of water, salt, and other substances to cool the body through evaporation
  - Excessive body temp (external temp or exercise) can stimulate 0.7-1.5 L/h sweat
  - Insensible perspiration: not noticeable sweating, ~500mL per day
- Vasodilation: arterioles in the dermis dilate carrying excess heat to surface of skin, can cause flushing/redness of skin



Heat Conservation

- **Reduced sweating**: minimizes evaporative cooling
- **Vasoconstriction**: arterioles constrict to minimize heat loss, skin temp decreases, passive heat loss prevented, internal organs and structures maintain internal body temperature
  - Reduced circulation can result in whitish hue of skin



Thermoregulation Failure

- **Heat stroke**: severe heat illness with body temperature >40.0 °C (104.0 °F) presents with red skin, headache, dizziness, and confusion

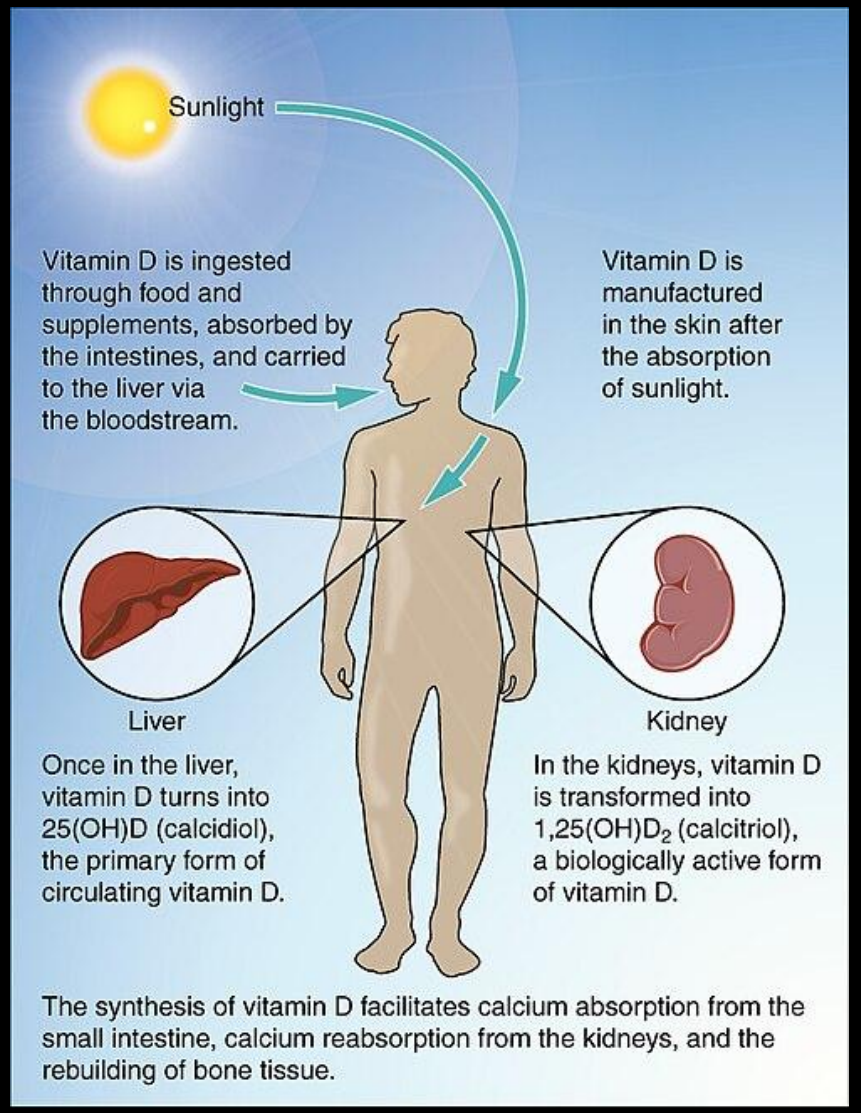
- **Frostbite**: injury to skin or other living tissue that is allowed to freeze, especially affecting the fingers, toes, nose, ears, cheeks and chin

Vitamin D

- Vitamin D: essential vitamin for bone health, general immunity, and possibly cancer prevention
  - Steroid-type molecule derived from cholesterol
  - Fat-soluble vitamin means overaccumulation is possible
  - Cholecalciferol: previtamin D3 form synthesized in skin

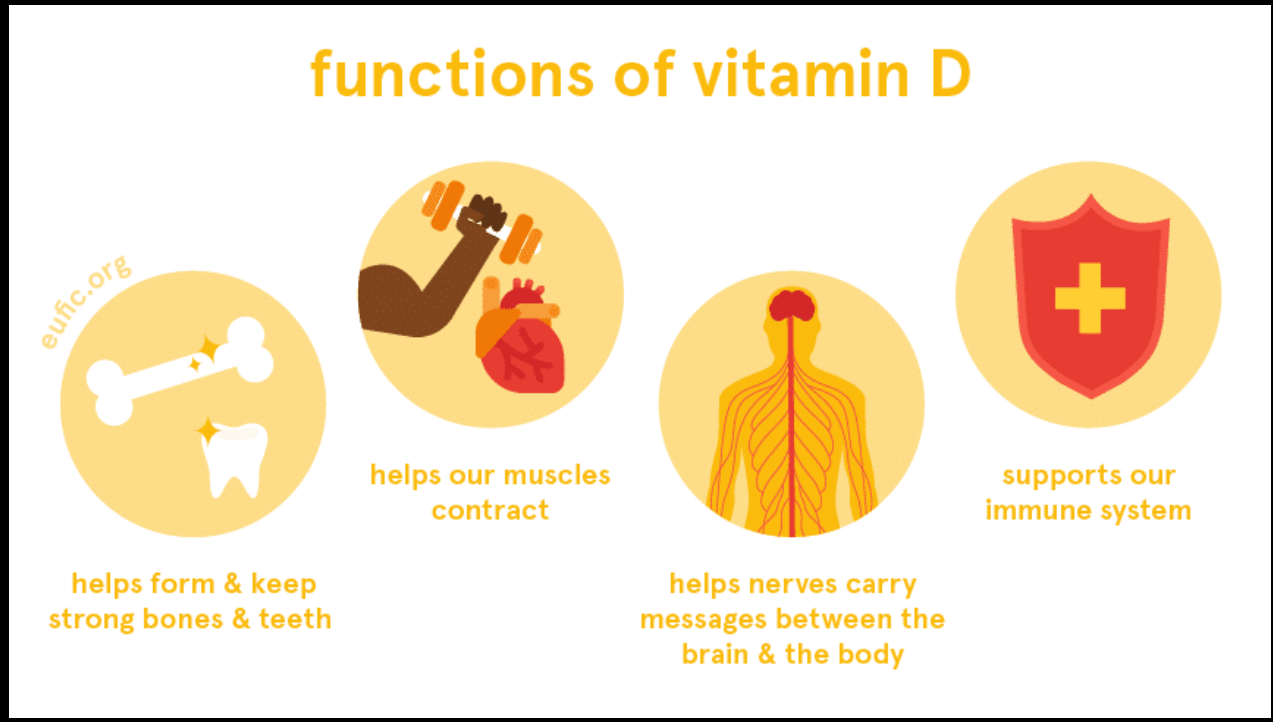
Vitamin D Synthesis

- **Vitamin D synthesis**: UV light converts precursor to previtamin D3 (cholecalciferol)
  - Occurs primarily in keratinocytes of epidermis
  - Liver and kidneys further converts previtamin D3 (cholecalciferol) into fully active vitamin D3



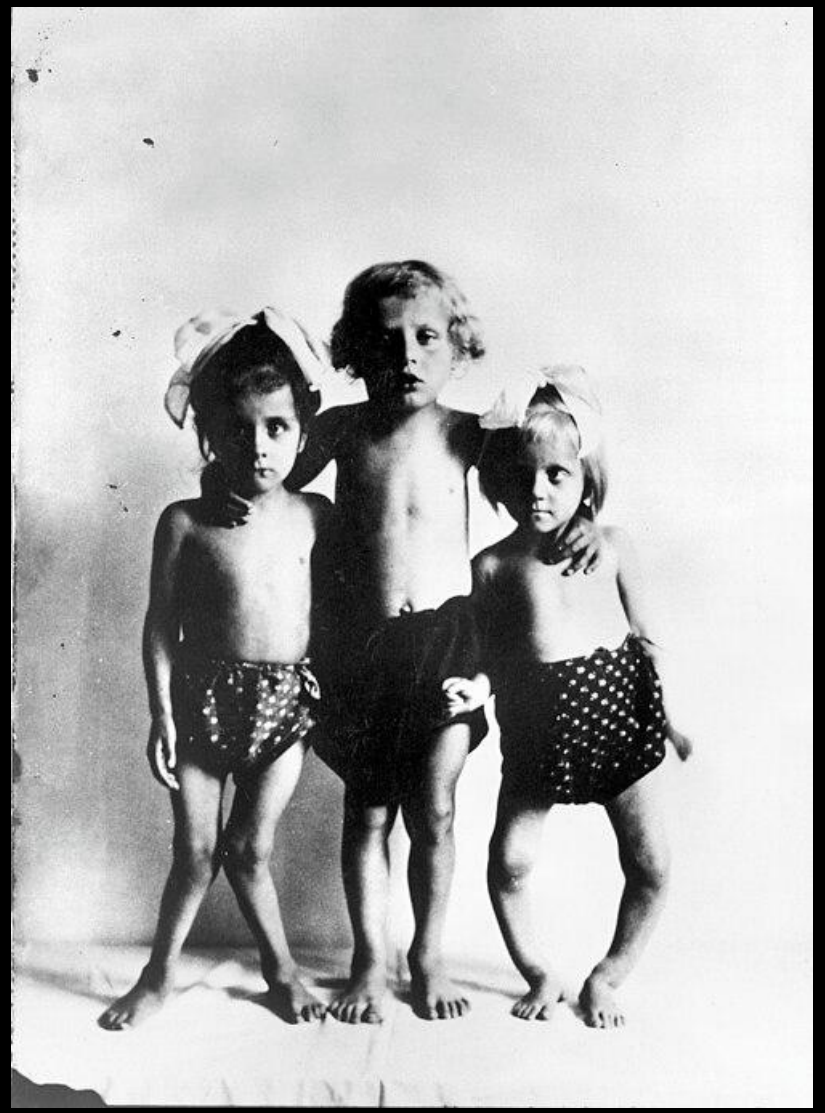
Vitamin D Importances

- Calcium absorption
- Bone mineralization
- Muscle function
- Immune support



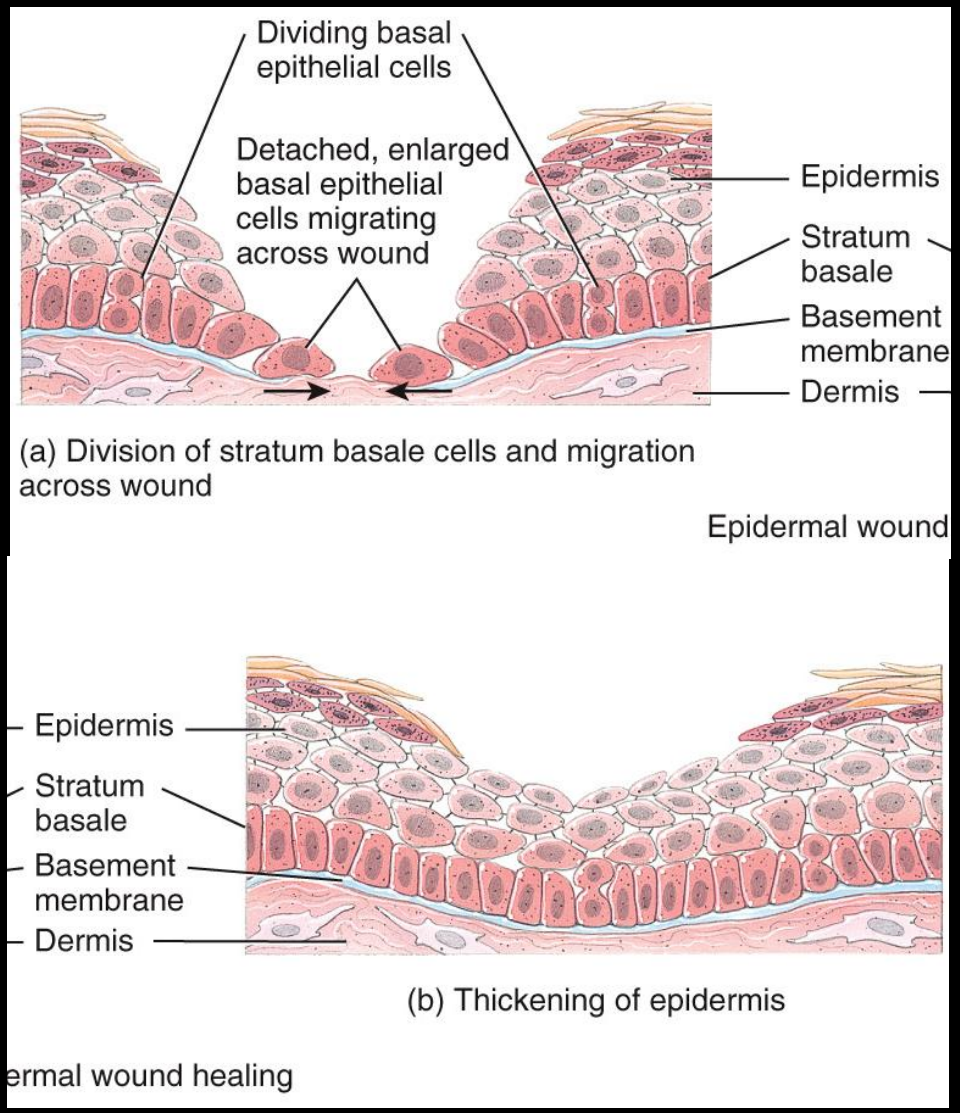
Vitamin D Deficiencies

- **Rickets**: painful condition in children with bowlegged bones due to a lack of calcium
- **Osteomalacia**: softening of bones in elerly with vitamin D deficiency



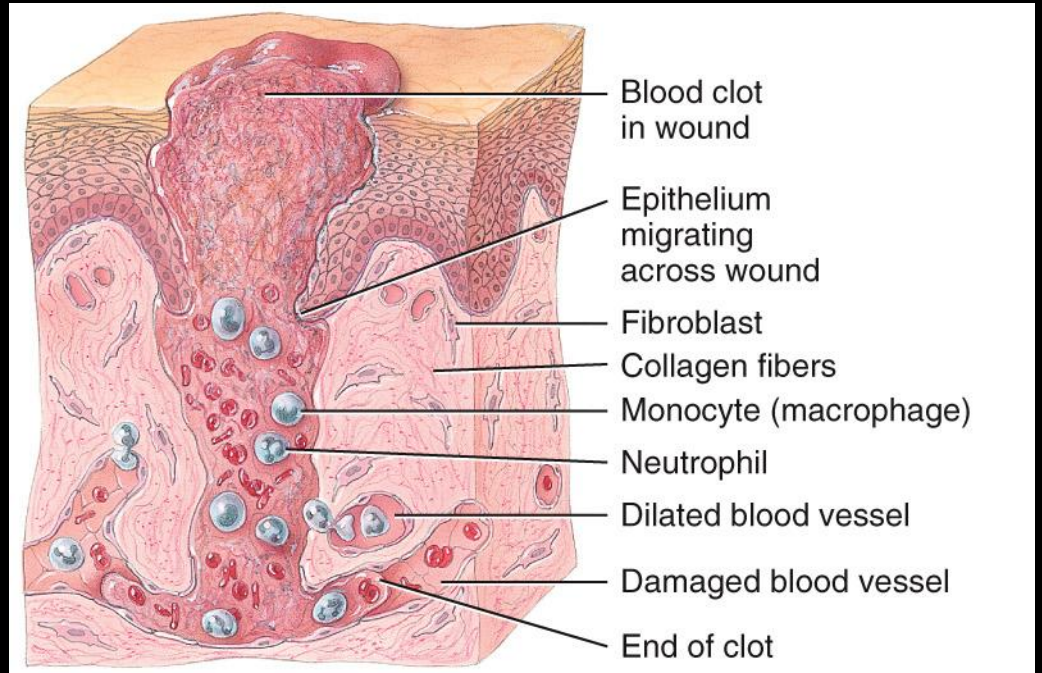
Superficial Wound Healing

- **Epidermal wound healing**: occurs when superficial wounds only affect the epidermis
  - Basal cells detach and migrate
  - Cells divide and spread
  - Contact inhibition stops migration



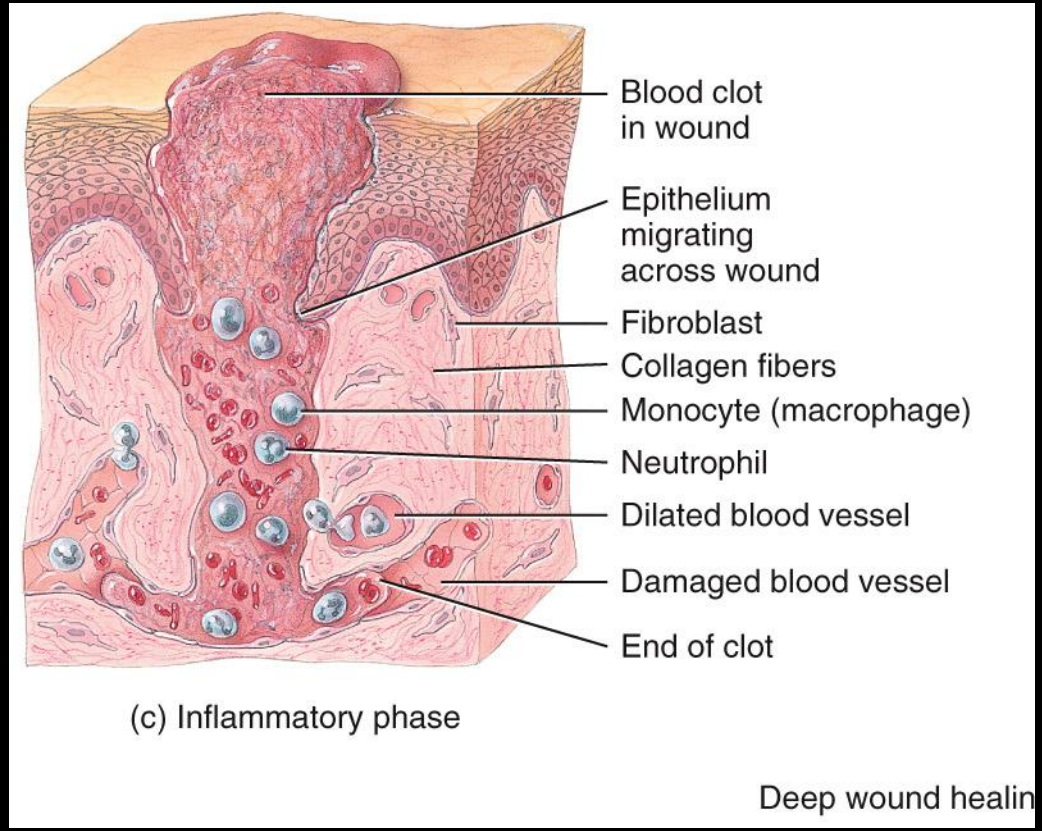
Deep Wound Healing

- Deep wound healing: Involves dermis and hypodermisMore complex repair process. Healed tissue may lose some function
- **Healing Phases**
  - Inflammatory
  - Migratory
  - Proliferative
  - Maturation



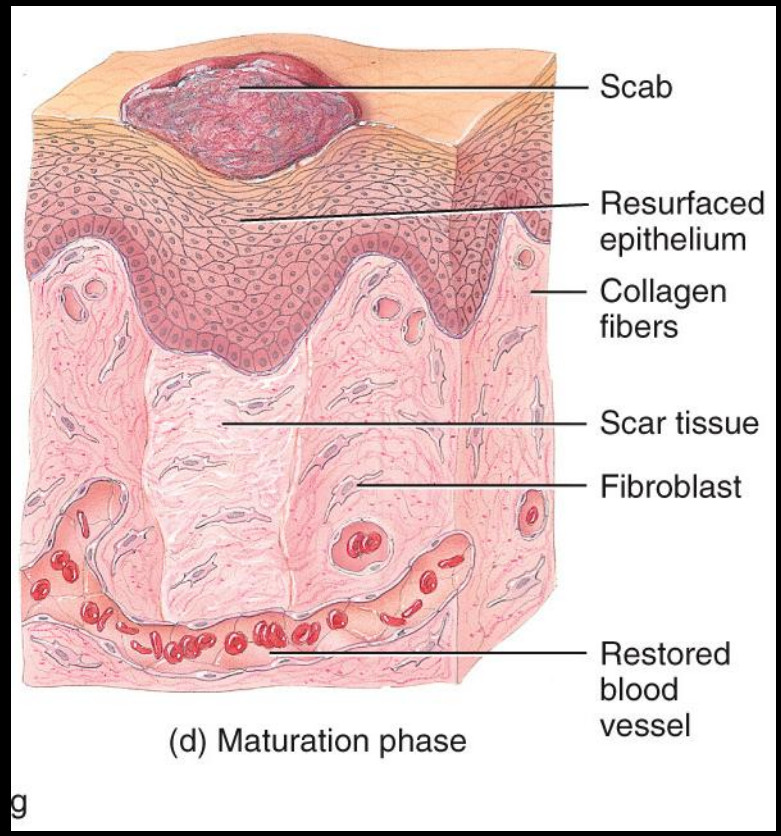
Deep Wound Healing: Initial Stages

- **[1] inflammatory phase**: a blood clot forms in the wound and loosely unites the wound edges
  - Vasodilation and increased blood vessel permeability brings macrophages and other immune cells
- **[2] migratory phase**: blood clot becomes a scab
  - fibroblasts of dermis begin to make scar tissue



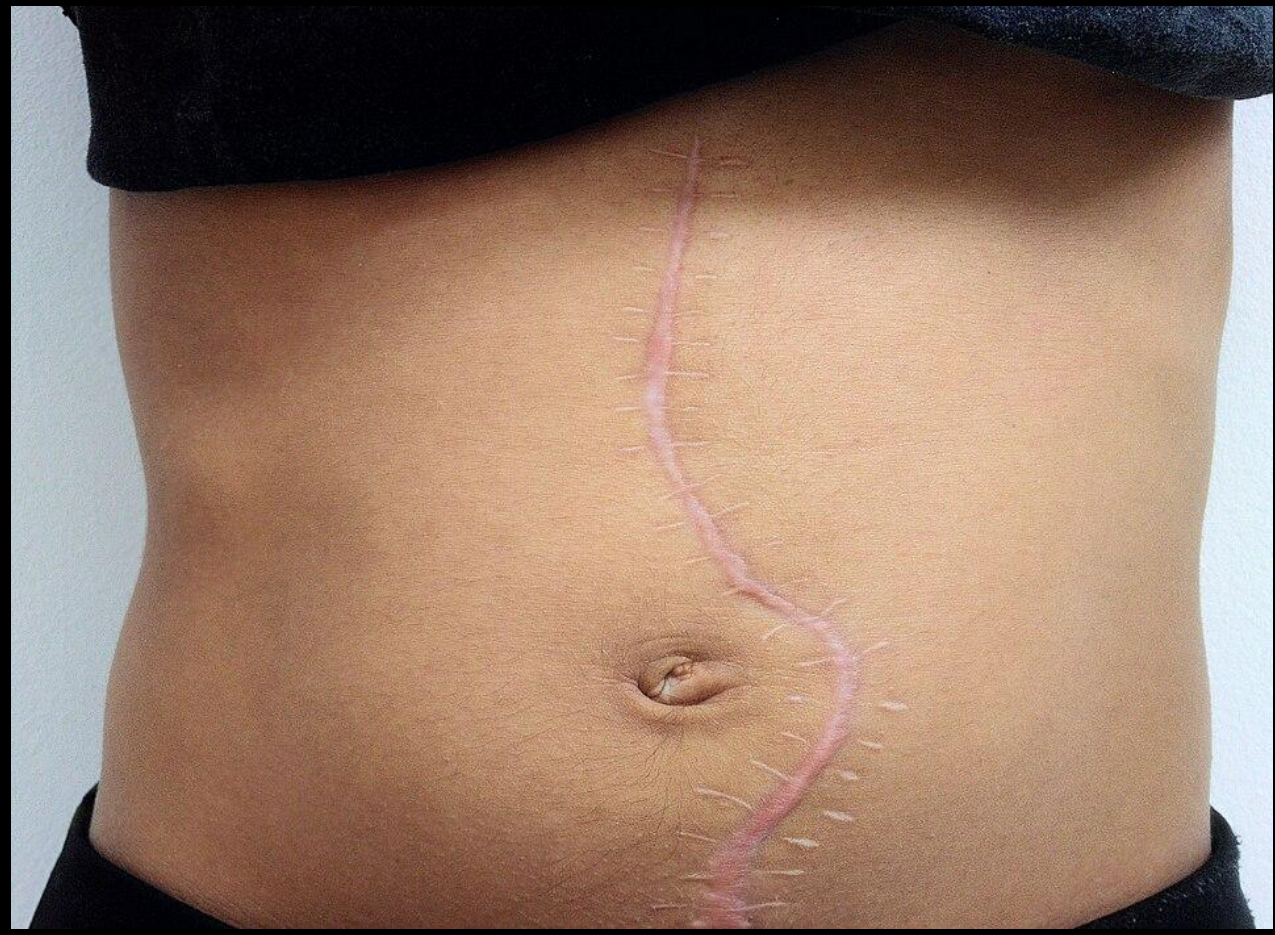
Deep Wound Healing: Final Stages

- **[3] proliferative phase**: extensive growth of epithelial cells beneath the scab
  - Fibroblasts continue to form scar tissue
  - Blood vessels are regrowing
- **[4] maturation phase**: the scab falls off once the epidermis is restored to its normal thickness
  - May leave a scar



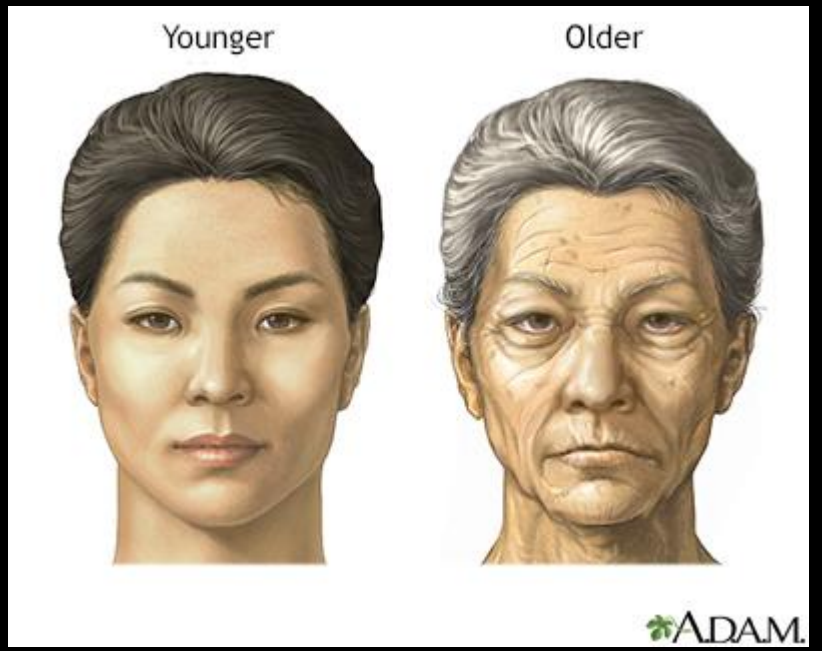
Scars

- **Fibrosis:** formation of a scar
- **Scar tissue**: contains more densely arranged collagen fibers andhas decreased elasticity
- Fewer blood vessels
- Reduced hair and gland function
- Often lighter in color



Aging and the Integumentary System

- ↓ epidermis thickness → ↓protection
- ↓ sweat/sebum → ↓thermoregulation
- ↓ collagen → ↓ wound healing
- ↓ vitamin D synthesis → ↑deficiency risk



Resources

- Dingess, Paige (2025)
- Grammarly. (2026). Grammarly (Version 14.1268.0) [Software]. https://www.grammarly.com/
- OpenAI. (2026). ChatGPT (GPT-5) [Large language model]. https://chat.openai.com/

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