Integumentary System - Learn and Understand

- Skin is an organ comprised of all four tissues
- Each layer of the skin contributes to one or more of its numerous functions
- Skin is both strong and flexible
- Keratinization results in an epidermis that is a protective barrier
- Darkly pigmented skin is an adaptation to ultraviolet light exposure
- Skin is flexibly attached to underlying tissues

Organ System:
Skin or Integumentary System

- Integumentary system consists of:
  - Skin
  - Hair
  - Nails
  - Sweat glands
  - Sebaceous (oil) glands
- About 7% of body weight but only 1.5-4.0 mm thick
- Skin = two distinct regions only:
  - Epidermis—superficial, mostly epithelial tissue
    - Stratified keratinized squamous epithelium
  - Dermis—deep to epidermis
    - Consisting mostly of irregular fibrous connective tissue
    - Highly vascularized

Hypodermis (or superficial fascia)

- Subcutaneous layer deep to skin
  - Not part of skin but shares some functions
- Consisting of loose fibrous CT
  - flexibly anchors skin to underlying structures:
    - Continuous with the outer coverings (fascia) of muscle and bone
- And significant amounts of adipose
  - absorbs shock & insulates
Micrograph of Skin

Epidermis
Keratinized stratified squamous epithelium
• Most epidermal cells are keratinocytes
  – Produce fibrous protein keratin through a continuous process called keratinization
  – Tightly connected by desmosomes which weaken and break in the upper epidermis (desquamation)
  – Epidermis is regenerated every 25-45 days ("tats" are dermal)
• Melanocytes
  – 10-25% of cells in deepest epidermis
  – Produce pigment melanin – packaged into melanosomes
    • More on this later
• Dendritic (Langerhans) cells – phagocytes process penetrating microbes to activating immune system
• Tactile (Merkel) cells – linked to nervous tissue, sensor of "light touch"
Layers of the Epidermis in ‘Thick Skin’

Thin skin lacks lucidum, other strata thinner.

**Stratum corneum**
- Protect from abrasion and penetration. Barrier against biological, chemical, and physical assaults.

**Stratum lucidum (only in thick skin)**

**Stratum granulosum**
- Typically five layers of flattened cells, organelles deteriorating; cytoplasm full of lamellar granules (releasable lipids) and keratohyaline granules. No living cells above this layer.

**Stratum spinosum**
- Several layers of keratinocytes unified by desmosomes (gives spiny appearance). Cells contain thick bundles of intermediate filaments made of pre-keratin.
- Melanosomes found here. Most abundant cells in epidermis.

**Stratum basale or germinativum**
- Deepest epidermal layer; one row of actively mitotic stem cells; some newly formed cells become part of the more superficial layers.
- See occasional melanocytes (10–25%) and dendritic cells.

Humans can shed ~50,000 cells every minute.

Keratinization Process
Skin Thickness is Defined Based on Thickness of Epidermis

- **Thick skin**
  - Has all 5 epithelial strata
  - Found in areas subject to pressure or friction – fingertip, palm, and plantar skin
  - No hair follicles in this skin but merocrine sweat glands are present
  - Ridges making our fingerprints and footprints = Papillae of underlying dermis arranged in parallel rows

- **Thin skin**
  - Missing the stratum lucidum and other strata are thinner
  - More flexible than thick skin
  - Has hair of various types and all three kinds of skin glands (depending on location)
  - Covers rest of body

- **Callus**
  - Increase in number of layers in stratum corneum
  - When this occurs over a bony prominence, a corn forms

- **Thickness of the dermis also varies**
  - Adds considerable 'thickness' to skin

**Dermis**

- Strong, flexible connective tissue
- **Cells**
  - Fibroblasts
  - Macrophages
  - Few mast cells
  - Few white blood cells
- **Fibers in matrix bind body together**
  - "Hide" used to make leather
- **Innervated and richly vascularized in some areas**
- **Lymphatic vessels**
- **Contains epidermal hair follicles; oil and sweat glands**
- **Two layers**
  - Papillary
  - Reticular

![Figure 5.3 Light micrograph of the dermis.](image-url)
Layers of the Dermis: Papillary Layer

- Areolar connective tissue
  - collagen and elastic fibers
  - small blood vessels (capillaries) nourish locally including epidermis

- Loose tissue
  - Phagocytes can patrol for microorganisms

- Dermal papillae
  - See next slide

Dermal Papillae

- Superficial peglike projections where capillary loops come close to the epidermal stratum basale
- Contain varying numbers of Meissner's corpuscles (touch receptors)
- Some contain free nerve endings (pain receptors)
- In thick skin, lie atop dermal ridges that cause epidermal ridges
  - Collectively ridges called friction ridges
    - Enhance gripping ability
    - Contribute to sense of touch
    - Pattern is fingerprints

Figure 5.4a  Dermal modifications result in characteristic skin markings.
Layers of the Dermis: Reticular Layer

- ~80% of dermal thickness
- Dense fibrous (collagen) connective tissue with epidermal ‘inclusions’
- Collagen fibers
  - Provide strength and resiliency
  - Bind water – skin is a ‘reservoir’
  - In general, collagen is irregularly arranged but,
    - Cleavage lines exist that provide more strength in one direction…
    - Adaptation to stress on skin caused by movement of body parts
      - Externally invisible
      - Important to surgeons - Incisions parallel to cleavage lines gap less and heal more readily

Dermal Modifications Result in Characteristic Skin Markings

- Cleavage lines
  - Represent separations between underlying collagen fiber bundles in the reticular dermis.
  - Run circularly around the trunk and longitudinally in the limbs.
  - Surgical incisions parallel to cleavage lines heal better than those made across them.

Functions of the Integumentary System

- Protection – see following slides
- Metabolic functions
  - Vitamin D production in the presence of bright light
- Excretion
  - Some nitrogenous wastes, water, salts are lost in sweat
    - Insignificant under normal circumstances, More important when sweating profusely
- Body temperature regulation
  - Covered during our discussion of negative feedback
- Cutaneous sensation
  - Skin exteroceptors will be discussed later
- Blood reservoir
  - one way to control blood flow
Protection Function: Chemical Barriers

- Skin secretions – the acid mantle
  - Low pH retards bacterial multiplication
  - Numerous bacteria remain but manageable
- Sebum/sweat and defensins kill bacteria
- Melanin located deep in the epidermis
  - Two forms: Reddish-yellow to brownish-black
  - Skin and hair color differences due to amount and form
  - Produced in melanocytes
    - Same relative number in all people, it’s the activity that differs genetically
  - Sun exposure stimulates melanin production
  - Defense against UV radiation damage
    - Dark skin is an adaptation to living in parts of the world where the amount of UV reaching the planet’s surface is greatest

Melanin and Melanocytes

Other pigments seen in the skin:
- Carotene
- Hemoglobin

Melanosomes migrate to keratinocytes to form “pigment shields” on superficial surface of nuclei.
Protection Function: Physical Barriers

- Flat, dead cells of stratum corneum surrounded by lipids
  - Keratin and glycolipids block most water and water-soluble substances
  - Keratin adds a resilience to the outer epidermis
    - "the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress"
  - Keratinocytes constantly lost and regenerated from below
- Limited penetration of skin by substances at its surface or from tissue below
  - Based on the chemical properties of substances

Protection Function

- Biological barriers
  - Dendritic cells of epidermis
  - Macrophages of dermis

Appendages of the Skin

- Derivatives of the epidermis
  - Hairs and hair follicles
    - Different types
  - Nails
  - Sweat glands
    - Merocrine (watery sweat) and apocrine (oily sweat of axillae and anogenital areas)
  - Sebaceous (oil) glands
    - Associated with hair