The Integumentary System

Skin (Integument)

- Consists of two major regions
  1. Epidermis—superficial region
  2. Dermis—middle region

Hypodermis

- (superficial fascia)—deepest region
- Subcutaneous layer deep to skin
- Not one of the layers of the skin
- Mostly adipose tissue

Epidermis

Layers of the Epidermis: Stratum Basale (Basal Layer)

- Deepest epidermal layer firmly attached to the dermis
- Single row of stem cells
- Also called stratum germinativum: cells undergo rapid division
- 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 and dendritic cells

Layers of the Epidermis: Stratum Granulosum (Granular Layer)

- Thin; three to five cell layers in which the cells flatten
- Keratohyaline and lamellated granules accumulate

Layers of the Epidermis: Stratum Lucidum (Clear Layer)

- In thick skin
- 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, keratinized membranous sacs
- Three-quarters of the epidermal thickness
- Functions
  - Protects from abrasion and penetration
  - Waterproofs
  - Barrier against biological, chemical, and physical assaults

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

Layers of the Dermis: Papillary Layer
- Papillary layer
  - Areolar connective tissue with collagen and elastic fibers and blood vessels
  - Dermal papillae contain:
    - Capillary loops
    - Meissner's corpuscles
    - Free nerve endings

Layers of the Dermis: Reticular Layer
- Reticular layer
  - ~80% of the thickness of dermis
  - Collagen fibers provide strength and resiliency
  - Elastic fibers provide stretch-recoil properties

Skin Markings: Friction Ridges
- Epidermal ridges lie atop deeper dermal papillary ridges to form friction ridges of fingerprints

Skin Markings: Cleavage Lines
- Collagen fibers arranged in bundles form cleavage (tension) lines
- Incisions made parallel to cleavage lines heal more readily

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
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

- 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

Sweat Glands

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

- Widely distributed

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

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
- Hair pigments: melanins (yellow, rust brown, black)
  - Gray/white hair: decreased melanin production, increased air bubbles in shaft

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”

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)

Hair Thinning and Baldness
- Alopecia—hair thinning in both sexes after age 40
- True (frank) 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

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