~22 square feet
Weighs ~9 - 11 pounds
Accounts for about ~16\% of total body weight
LECTURE OUTLINE

- Overview
- Basic Structure
- Types of Skin
- Skin Color
- Accessory Organs
- Wound Healing
- Homeostasis
INTEGUMENTARY SYSTEM OVERVIEW

- **Skin**: cutaneous membrane
  - Cutaneous membrane: epithelial tissue and connective tissue
    - Epidermis
    - Dermis

- **Accessory organs**
  - Hair
  - Nails
  - Multicellular exocrine glands

- **Subcutaneous layer**
  - Hypodermis, superficial fascia
  - Loose connective tissue (primarily adipose tissue)
  - NOT part of integumentary system
INTEGUMENTARY SYSTEM OVERVIEW

- Functions
  - Resistance to trauma and infection
  - Barrier
  - Excretion: ~400 mL of water evaporates from it daily
  - Thermoregulation
  - Vitamin D3 (Cholecalciferol)
    - Precursor to calcitriol: essential for absorption of calcium and phosphorus by the small intestine
  - Storage
    - Lipids
    - Blood: ~5% body’s entire volume
  - Nonverbal communication
  - Sensation
Rickets
Vitamin D deficiency
BASIC STRUCTURE

- Epidermis
- Dermis
- Hypodermis
EPIDERMIS

- Keratinized Stratified Squamous Epithelium
- Cells
  + Stem cells (basal cells)
  + Keratinocytes
  + Melanocytes
  + Langerhans cells (dendritic cells)
  + Merkel cells
- Layers
  + Stratum basale
  + Stratum spinosum
  + Stratum granulosum
  + Stratum lucidum
  + Stratum corneum
EPIDERMIS

Basal Cells (Germinative cells)

- Stem cells
  - “baby keratinocytes”
  - Divide and replace keratinocytes
- Dominate stratum basale
- Rounded and stain dark
Keratinocytes

- Produce keratin and kera-tohylin - fibrous proteins that help give epidermis its protective properties
  - Intermediate filaments
- Tightly connected to one another by desmosomes
- Arise from stratum basale
EPIDERMIS

Melanocytes

- Spider shaped epithelial cells
- produces melanin pigment
  + Melanosomes - membrane bound granules of accumulated melanin
- melanin transferred to other cells with long cell processes
Langerhans’ Cells

- Arise from bone marrow
  + Macrophages
- provide immunity
Merkel cells

- form touch receptor with sensory neuron
  - Merkel disc
- Present at epidermal-dermal junction
EPIDERMIS

Stratum Basale

- Basal layer
- Firmly attached to underlying dermis
  + wavy borderline like corrugated cardboard
- Stem cells
- Some melanocytes
- UV triggers production of vitamin D$_3$
Stratum Spinosum

- Spiny layer
- 8-10 layers thick
- Flattening Keratinocytes
- Langerhans’ cells
- UV triggers production of vitamin D$_3$
Stratum Granulosum

- Granular layer
- 3-5 layers
- Keratinocytes
  - continue to flatten,
  - nuclei and organelles begin to disintegrate
- Keratin and keratohyaline
Stratum Lucidum

- Thick skin
- 3-5 layers
- Clear, flat, dead cells
- Full of keratin and eleidin
  - Eleidin: clear protein
Stratum Corneum

- 20 to 30 layers
- flat dead cells
  - filled with keratin and surrounded by lipids
- Continuously shed
- Barrier to light, heat, water, chemicals & bacteria

Average person sheds ~ 40 pounds of these flakes in a lifetime
EPIDERMOLYSIS BULBOSA

Keratinocyte

Intermediate filament (keratin)

Keratinocyte
EPIDERMIS

Life History of a Keratinocyte

- Stem cells divide to produce keratinocytes
- As keratinocytes are pushed up towards the surface
  - They produce keratin filaments
  - They produce lipid-filled lamellar granules
  - They die and nuclei and organelles degenerate
- 30-40 days unless outer layers removed in abrasion
  - Psoriasis = chronic skin disorder
    - cells shed in 7 to 10 days as flaky silvery scales
    - abnormal keratin produced
**DERMIS**

- **Accessory structures**
- **Layers**
  - Papillary layer
    - Areolar connective tissue
    - Dermal papillae
      - Epidermal ridges
  - Reticular layer
    - Dense irregular connective tissue
Dermis

Papillary Layer

- Areolar connective tissue
  - collagen
  - elastic fibers
- Dermal papillae
  - Contain capillary loops, nerve endings, touch receptors
  - Epidermal ridges
  - Friction ridges
DERMIS

Reticular Layer

- Dense irregular connective tissue
  - collagen and elastic fibers
  - Adipose tissue
- Flexure lines (flexion creases)
- Lines of cleavage
  - Separations or less dense regions of collagen
DERMIS

Dermal Blood Supply

- **Papillary plexus**: network of arteries in papillary layer of dermis
  - Follow contours of epidermis
- **Cutaneous plexus**: networks of arteries in subcutaneous layer
  - Supply reticular layer of dermis
**Stretch Marks:** tears in dermis

**Blister:** separation of epidermal and dermal layers by fluid filled pocket

**Dermatitis:** inflammation primarily involving papillary layer
HYPODERMIS

Aka Subcutaneous Layer or Superficial fascia

- No clear boundary between this layer and reticular dermis
- Adipose plus some areolar connective tissue
- Not part of skin - shares protective functions
- Anchors the skin to the underlying structures
- Acts as a shock absorber and an insulator that prevents heat loss due to fatty composition
- Blood reservoir
TYPES OF SKIN

- Thin skin
  - covers most of body
  - thin epidermis (0.1 to 0.15 mm) that lacks stratum lucidum
  - lacks epidermal ridges, has fewer sweat glands and sensory receptors

- Thick skin
  - only on palms and soles
  - thick epidermis (0.6 to 4.5 mm) with distinct stratum lucidum & thick stratum corneum
  - lacks hair follicles and sebaceous glands
SKIN COLOR

- The wide variety of colors in skin is due to three pigments
  - melanin
  - carotene
  - hemoglobin
- Diagnostic clues
  - Cyanosis, jaundice, erythema, pallor, hematoma
SKIN COLOR

Pigments

- Melanin produced in epidermis by melanocytes
  - same number of melanocytes in everyone, but differing amounts of pigment produced
  - results vary from yellow to tan to black color
  - melanocytes convert tyrosine to melanin
    - UV in sunlight increases melanin production

- Clinical observations
  - Freckles / liver spots = melanocytes in a patch
  - Mole = elevated patch of melanocytes
  - Albinism = inherited lack of tyrosinase; no pigment
SKIN COLOR

Pigments

- **Carotene**
  + yellow-orange pigment (precursor of vitamin A)
  + Normally found in stratum corneum & dermis
  + Can accumulate in dermis and subcutaneous layers

- **Hemoglobin**
  + red, oxygen-carrying pigment in blood cells
  + if other pigments are not present, epidermis is translucent so pinkness will be evident
SKIN COLOR

Diagnostic Clues

- Jaundice
  + yellowish color to skin and whites of eyes
  + buildup of yellow bilirubin in blood from liver disease

- Cyanotic
  + bluish color to nail beds and skin
  + hemoglobin depleted of oxygen looks purple-blue
SKIN COLOR

Diagnostic Clues

- Erythema
  + redness of skin due to capillary enlargement in dermis
  + inflammation, exercise, allergy or burns, emotion

- Pallor
  + Pale color due to decreased blood flow through skin
  + White color of collagen showing through
  + Fever, shock, cold

- Hematoma (bruising)
  + Blood clotting in skin
ACCESSORY ORGANS OF SKIN

- Epidermal derivatives
- Cells sink inward during development to form:
  - Hair
  - Oil glands
  - Sweat glands
  - Nails
Hair (pilus): non living structures that project above the surface of the skin

Hair follicles: organs shaped like tubes that produce hair

Function
- Protection from UV
- Cushion from light blows
- Insulation
- Prevents entry of foreign particles
- Sensory receptors
- Nonverbal communication and maturity
HAIR

Structure of the Hair and Follicle

- Keratinized epithelial cells
- Zones
  - Bulb (only region with living cells)
  - Root
  - Shaft
- Dermal papilla: bud of vascular connective tissue
- Arrector pili (piloerector muscle, pilomotor muscle)
- Hair root plexus (hair receptors)
HAIR

Hair Growth and Loss

- Hair cycle
  - Anagen - Growth stage (6-8 years)
    - matrix cells at base of hair root producing length
  - Catagen – Degeneration stage (2-3 weeks)
    - Mitosis stops & follicle atrophies
    - Club hair
  - Telogen – Resting stage (1-3 months)
- Club hair falls out as growth stage begins again
  - normal hair loss is 50 to 100 hairs per day
  - Increased hair loss with drugs, diet, excess vit A, fever, stress, hormones
Hair Color

- Result of melanin produced in melanocytes in hair bulb
- Dark hair contains melanin (eumelanin)
- Blond and red hair contain melanin with iron and sulfur added (pheomelanin)
- Graying hair is result of decline in melanin production
- White hair has air bubbles in the medulla (middle) of shaft
CUTANEOUS GLANDS

Specialized exocrine glands found in dermis

- Sebaceous glands: oil
- Sudoriferous glands: sweat
  - Apocrine
  - Eccrine (merocrine)
- Ceruminous glands: wax
- Mammary glands: milk
GLANDS

Sebaceous Glands - Oil

- Holocrine glands
- Located in dermis
- Most open onto hair follicles
- Sebum
  + Triglycerides, cholesterol, proteins, electrolytes
  + keeps hair and skin from soft & pliable
  + inhibits growth of bacteria & fungi (ringworm)
- Acne
  + bacterial inflammation of glands
  + secretions stimulated by hormones at puberty
GLANDS

Sudoriferous Glands - Sweat

- Eccrine (sweat) glands
  + most areas of skin
  + secretory portion in dermis with duct to surface
  + regulate body temperature with perspiration

- Apocrine (sweat) glands
  + armpit and pubic region
  + secretory portion in dermis with duct that opens onto hair follicle
  + secretions more viscous
Modified Sudoriferous Glands

- Ceruminous Glands
  - Waxy secretion in ear canal
  - Cerumen contains secretions of oil and wax glands
  - Helps form barrier for entrance of foreign bodies
  - Impacted cerumen may reduce hearing

- Mammary glands
  - Secrete milk
NAILS

- Tightly packed keratinized cells
  + Derivatives from stratum corneum
- Functions
  + Grasping and manipulating
  + Protections against trauma
- Structures
  + Nail body (nail plate)
  + Free edge
  + Nail fold
  + Nail bed
  + Eponychium
  + Nail root
WOUND HEALING

- Bleeding
- Scab formation and macrophage activity
- Granulation tissue
- Epithelial regeneration and dermal fibrosis

See chpt 5 fig 5.34
Burns
Cancer
Pressure sores
Age related changes

HOMEOSTASIS
Burn: tissue damage from excessive heat, electricity, radioactivity, or corrosive chemicals that destroys (denatures) proteins in the exposed cells

- Fluid replacement, infection control, electrolyte balance
- Methods for determining the extent of a burn
  - Rule of nines
  - Lund-Browder
- Classification of burns
  - first-degree: partial-thickness
  - second-degree: partial-thickness
  - third-degree: full-thickness
When a burn area exceeds 70%, over half of the victims die.
Most tumors that arise in the skin are benign and do not metastasize.

Skin cancer can be caused by excessive exposure to sunlight.

Forms:
- basal cell carcinoma
- squamous cell carcinoma
- malignant melanoma

Among the risk factors for skin cancer are skin type, sun exposure, family history, age, and immunologic status.
<table>
<thead>
<tr>
<th>Normal Mole</th>
<th>Melanoma</th>
<th>Sign</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Normal Mole Image" /></td>
<td><img src="image2.png" alt="Melanoma Image" /></td>
<td>Asymmetry</td>
<td>when half of the mole does not match the other half</td>
</tr>
<tr>
<td><img src="image3.png" alt="Normal Mole Image" /></td>
<td><img src="image4.png" alt="Melanoma Image" /></td>
<td>Border</td>
<td>when the border (edges) of the mole are ragged or irregular</td>
</tr>
<tr>
<td><img src="image5.png" alt="Normal Mole Image" /></td>
<td><img src="image6.png" alt="Melanoma Image" /></td>
<td>Color</td>
<td>when the color of the mole varies throughout</td>
</tr>
<tr>
<td><img src="image7.png" alt="Normal Mole Image" /></td>
<td><img src="image8.png" alt="Melanoma Image" /></td>
<td>Diameter</td>
<td>if the mole’s diameter is larger than a pencil’s eraser</td>
</tr>
</tbody>
</table>

*Photographs Used By Permission: National Cancer Institute*
PRESSURE SORES

- Decubitus ulcers
- Caused by constant deficiency of blood flow to tissue
- Areas affected is skin over bony prominence in bedridden patients
- Preventable with proper care
- Epidemis thins as basal cells slow
  - More prone to injury and infection
- Number of langerhans cells decrease
  - More prone to skin damage and infection
- Vitamin D\textsubscript{3} production declines
  - Muscle weakness, decreased bone strength and density
- Melanocyte activity decreases
  - More sensitive to sunburn and UV damage
- Glandular activity declines
  + Skin becomes dry and scaly
  + Higher risk of overheating
- Blood supply reduced
  + Lessens ability to decrease body temperature
- Hair follicles stop functioning
- Dermis thins and elastic network decreases
  + Sagging wrinkling skin
- Repair slows – higher risk of infection

AGE RELATED CHANGES