Unit 3 – The Integumentary System
The Integumentary System

- Integument is skin
- Skin and its appendages make up the integumentary system
  - Skin, hairs, nails, vessels, nerves, and glands
- A fatty layer (hypodermis) lies deep to it
The Integumentary System

- Two major components:
  1. Cutaneous Membrane
     - Epidermis/Superficial Epithelium
     - Dermis/Underlying Connective Tissue
  2. Accessory Structures
     - Located in dermis
     - Hair, nails, exocrine glands, blood vessels
     - Sensory receptors for touch, pressure, temperature and pain

- Deep to the dermis, the loose connective tissue of the subcutaneous layer/superficial fascia/hypodermis separates the integument from the deep fascia around other organs
Functions of the Skin

- **Protection**
  - Covering to protect deeper tissues from dehydration, trauma, and germ invasion

- **Regulate Body Temperature**
  - Controls heat loss
  - Evaporation of water from the skin, in the form of perspiration
  - Helps rid the body of excess heat

- **Helps manufacture Vitamin D**
  - The sunshine vitamin
  - Ultraviolet light on the skin is necessary for the first stages of vitamin D
Functions of the Skin

- Storage
  - Fat, glucose, water, and salt

- Absorption
  - Can absorb certain medications and chemicals

- Screens out harmful ultraviolet radiation and eliminates wastes

- Site of many receptors and nerve endings for sensory information
  - Touch, pressure, pain, and temperature
Layers of Skin

- Epidermis
- Dermis
- Subcutaneous Membrane
  - Hypodermis
Epidermis

- Outer layer of the skin
- Renews itself ~ every 45 days
Epidermis – Cell Types

- Keratinocytes
  - Produce keratin → waterproofing protein
  - Originate in deeper layers & get pushed to surface
  - Connected to each other by desmosomes & tight junctions
  - Cell production & keratinization are accelerated in areas of friction
    - Think callus → thickened skin
Epidermis – Cell Types

- Melanocytes
  - Produce melanin
  - Prevents DNA mutation from UV radiation
  - UV increases melanin production
  - Same number in everyone but different amount of pigment produced
  - Accumulation of melanin results in freckles and moles
5 Layers of the Epidermis

- In order from deep to superficial
  1. Stratum germinative (basale)
  2. Stratum spinosum
  3. Stratum granulosum
  4. Stratum lucidum
  5. Stratum corneum

- Takes 15-30 days for a cell to move through all five levels
Stratum Germinative/Basale

- Highly mitotic (goes through mitosis quickly)
  - Produces new skin layer
  - ~25% melanocytes
Stratum Spinosum

- Slightly mitotic – one of the daughter cells from the stratum germinativum is pushed into the stratum spinosum
- Consists of 8-10 layers of cells
- Contains Langerhans macrophages
  - Stimulate a defense against:
    - Microorganisms that manage to penetrate the superficial layers of the epidermis
    - Superficial skin cancers
Stratum Granulosum

- Not mitotic but begin making keratin and keratohyalin
  - Keratin = tough fibrous protein component of hair and nails
  - Keratohyalin = forms dense granules that dehydrate the cell and aggregate cross-linking of the keratin fibers
- Also contains Langerhans cells
- Nuclei and other organelles disintegrate = Cell Death
Stratum Lucidum

- ONLY found in thicker epidermis – palms, soles, callus
- Completely keratinized (and dead!)
- Contains closely packed, clear cells that contain gel-like substance eleiden
Stratum Corneum

- Outermost layer – Exposed Skin
- Also completely keratinized
- Dead cells
  - Remain in this layer for two weeks before they are shed
- Tough, waterproofing protection
Dermis

- Middle layer of skin – your “hide” – like leather
- Contains hair follicles, glands, nerves, vessels, and muscle
Layers of the Dermis

- Mainly strong, flexible connective tissue – 2 layers
  1. Papillary Layer
     - Upper region
     - Uneven and has fingerlike projections called dermal papillae that create fingerprints and are important for grip
     - Contain capillaries, pain receptors (free nerve endings), and touch receptors called Meissner’s corpuscles
  2. Reticular Layer
     - Deepest skin layer
     - Contains blood vessels, adipose (fat) sweat and oil glands, and deep pressure receptors
Hypodermis

- Not usually part of the skin
- Also called subcutaneous layer
  - Site of subcutaneous injections – absorbed directly into the blood stream
- Anchors skin to underlying organs, bones, and muscles
- Shock absorption and insulation
- Composed mostly of adipose tissue
- Very vascular
Skin Color

Skin color is determined by 3 factors:

1. 3 Types of pigments present
   1. Melanin
      - Brown, black, or yellow
   2. Carotene
      - Orange-yellow pigment from some vegetables
      - Vitamin A precursor – vitamin A forms retinal which is needed for sight
      - Accumulates in adipose and stratum corneum cells
   3. Hemoglobin
      - Red, oxygen-carrying pigment in erythrocytes
      - More obviously detected in fair skin

2. Blood circulation
3. Stratum corneum thickness
Skin Color

- People who produce a lot of melanin have brown-toned skin.
- The crimson color of oxygen-rich hemoglobin gives the skin a rosy color.
- When hemoglobin is poorly oxygenated, the skin appears blue – a condition called cyanosis.
  - Common during heart failure and severe breathing disorders.
Skin Color Signals Disease States

- Rubor
  - Redness or erythema
    - Embarrassment (Blushing)
    - Fever
    - Hypertension
    - Inflammation
    - Allergy

Skin Color Signals Disease States

- Pallor or Blanching
  - Emotional stress (fear, anger, and others)
  - Pale skin may also signify anemia, low blood pressure, or impaired blood flow into the area
- Jaundice
  - A yellow-case
  - Liver disorder in which excess bile pigments is in the blood
- Bruises
  - Sites where blood has escaped and has clotted in the tissue spaces
    - Called hematomas
  - Unusual bruising may signify a deficiency of vitamin C or hemophilia
Hair

- Millions of hairs all over the body
  - Guards head
  - Shields eyes (eyelashes)
  - Keeps foreign particles out of the respiratory tract (nose hairs)
Hair

- A hair is produced by a hair follicle
- **Structure of Hair**
  - Shaft – protects skin
  - Follicle – extends into dermis
  - Root – lies within the follicle
  - Bulb – growth zone at the inferior end of the follicle
  - Sebaceous Gland – lubricates hair
  - Arrector Pili Muscle – attached to follicle and contracts to move hair (growth or goosebumps)
Hair Growth

- Influenced by (in this order)
  - Nutrition – main influence
  - Hormones
  - Blood flow
- Baldness (alopecia)
  - Male pattern baldness – sex-linked recessive genetic trait
  - Thinning – can be caused by medications, nutrition, stress
Hair Pigment

- Caused by proportions of 3 melanin types:
  1. Dark Hair = true melanin
  2. Blonde & Red Hair = melanin with iron and sulfur
  3. Gray/White Hair = melanin replaced by air bubbles in shaft
Nails

- Scale-like modification of the epidermis
- Heavily keratinized
- Stratum basale extends beneath the nail bed to form the nail matrix
  - Responsible for growth (matrix region)
- Lack of pigment makes them colorless
- Lunula “little moon” – area of cell growth (white semicircle at base of nail)
- Cuticle – area of skin that covers base of nail
Figure 4.7  **Structure of a nail.** Surface view (left) and longitudinal section of the distal part of a finger (right), showing nail parts and the nail matrix that forms the nail.
Glands of the Body

- Cutaneous Glands
  - All are exocrine glands

- Exocrine Glands
  - Release secretions to surface via ducts

- 2 Groups:
  1. Sweat Glands
  2. Sebaceous Glands

- Both formed by stratum basale and push into dermis
Sweat Glands

- More than 2.5 million per person
- 2 Primary Types
  - Eccrine Glands
    - Widely distributed in skin; abundant on palms, soles, and forehead
    - Sweat composition: mostly water with a slightly acidic 4-6 pH
    - Function: thermoregulation
Sweat Glands

- Apocrine Glands
  - Ducts empty into hair follicles
  - Found mainly in anogenital and axillary region
  - Begin to function at puberty due to hormones/pheromones
  - Organic contents: fatty acids and proteins – can have a yellowish color that stains clothes
  - Odor is from associated bacteria

- Cerminous Glands
  - Modified apocrine gland
  - Found in outer 1/3 of ear canal
  - Produce ear wax to trap “invaders”
Sebaceous (Oil) Glands

- All over except palms and soles of feet
- Produce oil for waterproofing
- Lubricant for skin and kills bacteria
- Most with ducts that empty into hair follicles
  - Some open onto skin surface in lips, eyelids, genitalia
- Sebum (seb = grease)
  - Mixture of oily substances and fragmented cells
- Glands are activated at puberty ➞ stimulated by hormones
Sebaceous (Oil) Glands

- Acne
  - Active infection of sebaceous glands
  - Can be mild or extremely severe
- Whitehead
  - A sebaceous gland’s duct becomes blocked by sebum
- Blackhead
  - Accumulated material oxidized, dries, and darkens
The most common skin disorders result from allergies or bacterial, viral, or fungal infections.

Homeostatic imbalances of the skin
Common Skin Disorders

- Acne = disease of sebaceous glands
- Alopecia = hair loss
- Tinea pedis = athletes foot
- Carbuncle = bacterial infection like a boil but subcutaneous
- Cyst = liquid filled sac
- Dermatitis = inflammation
- Eczema = non-contagious skin rash
- Impetigo = contagious bacterial infection causes eruption
- Moles = (nevi) tumors that are pigmented
- Pediculosis = lice
- Pruritis = itching without eruption
- Scabies = mites
- Shingles = (Herpes Zoster) virus causes blisters at nerve path
Contact Dermatitis

- Itching, redness, and swelling of the skin, & blistering.
- Caused by exposure of the skin to chemicals
  - Ex: poison ivy
    - Provokes an allergic response
Psoriasis

- Chronic condition
- Reddened epidermal lesion-covered with dry, silvery scales
- When severe, may be disfiguring
- Cause unknown; may be hereditary in some cases
- Attacks often triggered by trauma, infection hormonal changes, and stress.
Athlete's Foot

- *tinea pedis*
- Itchy, red, peeling skin between the toes, resulting from a fungal infection

**Athlete's Foot Tips From The APMA**
- Avoid walking barefoot; use shower shoes
- Reduce perspiration by using talcum powder
- Wear light and airy shoes
- Wear socks that keep your feet dry, and change them frequently if you perspire heavily
Boils and Carbuncles

- Inflammation of hair follicles and sebaceous glands,
- Common on the dorsal neck
- Carbuncles are composite boils
- Typically caused by the bacterial infection (Staphylococcus aureus)
Cold Sores

- Fever blisters
- Small fluid-filled blisters that itch and sting
- Caused by herpes simplex virus
  - Virus localizes in a cutaneous nerve
- Remains dormant until activated by emotional upset, fever, or UV radiation
- Cold sores usually occur around the lips and in the oral mucosa of the mouth
Impetigo

- Pink, water-filled, raised lesions
- Common around the mouth and nose
- Develop a yellow crust and eventually rupture
- Caused by a highly contagious staphylococcus infection
- Common in elementary school-aged children
Necrotizing Fasciitis

- Severe type infection that involves the skin, subcutaneous fat, and muscle fascia
- Caused by several bacteria both aerobic and anaerobic
- The most severe kind is caused by a virulent *streptococcus* species
- Infection usually enters through the skin and releases toxins that:
  1. Directly kill tissue
  2. Interfere with blood flow to tissue
  3. Digest materials in tissue and allows bacteria to spread rapidly
  4. Cause widespread effects, i.e. shock
Necrotizing Fasciitis Symptoms

- Infection begins as a small reddish painful spot or bump on the skin
- It quickly changes to a brown or purplish patch, the center of the wound will begin to turn black (dead cells)
- The wound will visibly expand in less than 1 hour
- Symptoms include sweating, chills, nausea, dizziness, profound weakness, and finally shock. Without treatment death occurs rapidly
- Many times the patient requires a surgeon to diagnose by culture of wound drainage
Necrotizing Fasciitis Treatment

- Powerful, broad spectrum anti-biotic administered IV immediately and immediate surgery required to open and drain infection and debride dead material
- Skin grafts are required after infection is cleared
- Infection in a limb and is not containable = amputation
- Prognosis
  - Outcomes vary, depending on organism, rate of spread, susceptibility to antibiotics and how early infection is diagnosed
- Complications
  - Sepsis, scarring and disfigurement, loss of limb, and death
- The disease untreated has 100% mortality
Basal Cell Carcinoma

- Least malignant
- Most common skin cancer
- Cells of the stratum basale are altered so that they cannot form keratin & no longer honor the boundary between epidermis and dermis
  - They proliferate, invading the dermis and subcutaneous tissue.
- Lesions occur most often on sun-exposed areas of the face
- Appear as shiny, dome-shaped nodules that later develop a central ulcer with a "pearly" beaded edge
- Relatively slow-growing
- Metastasis seldom occurs before it is noticed
- Full cure is the rule in 99 percent of cases where the lesion is removed surgically
Squamous Cell Carcinoma

- Arises from the cells of the stratum spinosum
- The lesion appears as a scaly, reddened papule (small, rounded elevation) that gradually forms a shallow ulcer with a firm, raised border
- Scalp, ears, dorsum of the hands, and lower lip
- Grows rapidly
- Metastasizes to adjacent lymph nodes if not removed
- Believed to be sun-induced
- If it is caught early and removed surgically or by radiation therapy, the chance of complete cure is good
Malignant Melanoma

- Cancer of melanocytes
- Accounts for 5 percent of skin cancers
- Incidence is increasing
- It is often deadly
- Melanoma can begin wherever there is pigment
- Appear spontaneously, but some develop from pigmented moles
- Appears as a spreading brown to black patch that metastasizes rapidly to surrounding lymph and blood vessels
- Chance for survival is about 50 percent
- Early detection helps – the American Cancer Society suggests that sun worshippers periodically examine their skin for new moles or pigmented spots
Apply the **ABCD rule** for recognizing melanoma:

- **Asymmetry**: the two sides of the pigmented spot or mole do not match.
- **Border irregularity**: the borders of the lesion are not smooth but exhibit indentations.
- **Color**: the pigmented spot contains areas of different colors (blacks, browns, tans, and sometimes blues and reds).
- **Diameter**: the spot is larger than 6 mm in diameter (the size of a pencil eraser)

The usual therapy for malignant melanoma is wide surgical excision along with immunotherapy.
Burns

- Protein denaturation and cell death caused by heat, electricity, UV radiation (sunburn), or chemicals

- 2 main dangers:
  1. Dehydration
     - Loss of fluids and electrolytes lead to
       - Renal shutdown
       - Circulatory shock
  2. Infection
     - Skin (mechanical) barrier lost
     - Immune system depresses
Rules of Nines

- Way to determine extent of burns
  - Primary importance is to estimate fluids needed for rehydration
- Body is divided into 11 areas for quick estimation
  - Each area represents about 9%
- This along with cause of burn helps determine the severity
First Degree Burns (Superficial Burns)

- Only epidermis is damaged
- Local redness, swelling, and pain
- Usually heal in 2-3 days (short time period) with NO scarring
Second Degree Burns (Partial Thickness Burns)

- Epidermis, dermis, and structures within dermis are damaged
- Appearance of blisters of any size
- Skin regeneration in 3-4 weeks with some scarring
- There is a danger of infection
- Very painful
Third Degree Burns (Full Thickness Burns)

- Epidermis, dermis, hypodermis, and all structures within are completely destroyed.
- Usually painless at site of burn due to destruction of sense receptors.
- Burn is gray-white, tan, brown, black, or deep cherry red.
- Surrounded by areas of 1\textsuperscript{st} & 2\textsuperscript{nd} degree burns that are painful.
- Treatments are numerous but will involve skin grafting of some sort, fluid replacement, and debridement.
Emergent Care

- Burning process stopped with removal of clothing & jewelry and covering affected area with cool water
- Increase blood volume with IV inserted in intact skin area
- Urinary catheter to monitor fluid output, indicates dehydration
- Intubation to secure an airway
- Vitals: BP, HR, BPM, Temp
Complications of Major Burns

- Pulmonary injury; Stridor (whistling) with breathing
- Hypovolaemia – loss of plasma and decreased BP
- Hypothermia – with skin gone there is no thermoregulation
- Cardiac Arrhythmia – irregular heart beat
- Kidney Failure
- Death
When Burns Are Critical...

- Any burn greater than 25% BSA
- Full or deep-partial-thickness burns greater than 10% BSA
- Burns complicated by a respiratory or airway injury
- Most burns involving the face, hands, feet, or genitals
- Burns complicated by a fracture or major soft-tissue injury
- Electrical or deep-chemical burns
- Burns occurring in patients with serious pre-existing medical conditions