Integumentary System

● What are the functions of skin?

- Protection: Shields underlying tissues (muscle, fat, nerves) from physical damage, microbes, and certain chemicals.
- Thermoregulation: Sweat glands help regulate body temperature by cooling through evaporation.
- Sensory Reception: Contains numerous nerve receptors providing detailed sensory information about the environment.
- Communication: Reflects age, health status (e.g., paleness, flushing, signs of infection), and emotions (e.g., blushing).
- Cultural Expression: Body modifications like tattoos, piercings, tanning, and makeup reflect personal or cultural identity.

● What are the two layers of the skin?

Epidermis/Dermis

Skin Structure and Layers

Layer	Description	Key Features
Epidermis	Outer layer; made of **keratinized stratified squamous epithelium**; avascular (no blood vessels).	Contains 5 distinct layers; protects against environmental damage; cells continuously renew.
Dermis	Inner layer beneath epidermis; contains blood vessels, nerves, glands, hair follicles, muscles.	Provides nutrients to epidermis via diffusion; supports skin structure and function.
Subcutaneous Layer	Located below dermis; mainly fat and connective tissue.	Not considered part of the skin scientifically; insulates and cushions the body.

● What are the 4 principal cells of the epidermis? What are their functions?

Keratinocytes: produce keratin

Melanocytes: produce melanin

Langerhans cells: immune cells

Merkel cells: sensory cells

Epidermal Cell Types

Cell Type	Function	Notes
Keratinocytes	Produce keratin, a tough protective protein; comprise ~90% of epidermal cells.	Provide chemical, microbial, and heat protection.
Melanocytes	Produce melanin pigment that determines skin color and absorbs UV radiation.	Melanin transferred to keratinocytes in the stratum spinosum layer.
Langerhans Cells	Immune cells that detect and destroy invading microbes on the skin surface.	Help maintain skin immunity.
Merkel Cells	Sensory cells involved in the sensation of touch.	Located in the basal layer; contribute to tactile sensation.

● What are the layers of the epidermis? Where on your body would you find the stratum lucidum?
Stratum Basale: single layer of mitotically active basal cells
Stratum Spinosum: Several Layers thick
Stratum Granulosum: 3-5 layhers, cell begin to die
Stratum Lucidum: Thin, clear layer found only in thick skin
Stratum Corneum: Outermost layer
Stratum Lucidum would be found only in thick skin (palms, soles, fingertips)

Epidermal Layers (from Deepest to Outermost)

Layer Name	Characteristics	Function/Notes
Stratum Basale	Single layer of mitotically active basal cells; attached to dermis by hemidesmosomes.	Contains stem cells producing keratinocytes; melanocytes and Merkel cells also present.
Stratum Spinosum	Several layers thick; named for "spiny" appearance due to cytoskeletal filaments.	Provides skin strength and flexibility; melanin is transferred here from melanocytes to keratinocytes.
Stratum Granulosum	3–5 layers; cells begin to die; contain granules that release lipid-rich secretions.	Transition zone between living and dead cells; lipid secretion contributes to waterproof barrier.
Stratum Lucidum	Thin, clear layer found only in **thick skin** (palms, soles, fingertips).	Provides additional protection in high-friction areas; cells are dead and flat.
Stratum Corneum	Outermost layer; consists of many layers of dead, keratin-filled cells surrounded by lipids.	Provides a tough, waterproof barrier; cells continuously shed (desquamation).

● What are the functions of epidermal ridges?

- Epidermal ridges are folds or ridges in the epidermis that:
- Increase surface area for better grip and friction (similar to gecko feet).
- Enhance contact area between the epidermis and dermis, improving nutrient delivery.

- Help anchor the epidermis to the dermis, preventing the layers from sliding apart (compared to interlocking egg cartons).
- Are especially prominent on fingers and toes, creating fingerprints.

● What are the two major regions of the dermis? What can be found in each?
• **Papillary Region** (top ~20%):

- Made of loose connective tissue.
- Contains **dermal papillae** which interlock with epidermal ridges.
- Houses **Meissner's corpuscles** (sensory receptors for light touch) and free nerve endings (detecting heat, cold, pain, tickle, itch).

• **Reticular Region** (remaining ~80%):

- Consists of dense irregular connective tissue with collagen and elastic fibers.
- Contains major structures such as **oil glands, sweat glands, hair follicles, and some fat**.
- Provides **extensibility** (ability to stretch) and **elasticity** (ability to return to original shape), crucial for skin flexibility and resilience.

● What is the function of the dermal papilla?
>Interlocks with epidermal ridges

● Into what layer is tattoo ink placed? Why is it permanent?
- Dermis, permanent since dermis is stable deep layer of skin that doesn't shed

● What are jaundice, cyanosis, and erythema? What causes each?
- Jaundice: Yellow skin and eye discoloration due to bilirubin accumulation from liver dysfunction
- Cyanosis: Bluish skin/nail discoloration from oxygen-deprived hemoglobin, indicates urgent oxygen need
- Urticaria: Skin redness/hives caused by various inflammatory or allergic reactions

● How and where is melanin produced?

- Melanin, the primary pigment responsible for skin color, is produced by specialized cells called melanocytes located in the epidermis.
- Melanocytes synthesize melanin within organelles called melanosomes, which are transferred to surrounding keratinocytes.
- Melanin production involves converting the amino acid tyrosine into melanin through the enzyme tyrosinase.
- UV radiation, specifically sunlight, stimulates melanocytes to increase melanin production as a protective response.

● Is there a difference in the number of melanocytes between individuals with darkly pigmented skin versus lightly pigmented skin? What accounts for the difference in pigmentation?

- The **number of melanocytes is roughly the same across all ethnic groups** (Africans, Asians, Europeans).
- Differences in skin pigmentation arise from the **amount and activity of melanin production**, not melanocyte quantity.
- Darkly pigmented individuals produce more melanin per melanocyte compared to lightly pigmented individuals.

● What causes freckles? Albinism? Vitiligo?
>Freckles or age-related “liver spots” result from localized overproduction of melanin in clusters of melanocytes.
>Albinism occurs due to a lack of tyrosinase enzyme, preventing melanin synthesis, resulting in no pigmentation.
>Vitiligo is an autoimmune condition where melanocytes are destroyed, causing depigmented patches on the skin.

● Other than melanin, what else contributes to the range of skin colors?
>Carotene (from orange/red foods like carrots) can impart a reddish-orange tint to skin.
>Hemoglobin in blood vessels near the skin surface contributes to rosy skin tones, often more prominent in women due to capillary distribution.

● What are the different types of melanin?
Eumelanin (dark pigment brown/black)
Pheomelanin (lighter pigment red/yellow)

>(not sure) Neuromelanin (responsible for color of neurons)

● What are the two main selection pressures for the evolution of skin pigmentation?
>Protect Folate from UVA
>Make Enough Vitamin D via UVB

● What causes the arrector pili muscle to contract?
>Smooth muscle in dermis contracts with cold or fear

● What are the three different types of hair?

Types of Hair

Hair Type	Description	Timing/Location	Characteristics
Lanugo Hair	Fine, non-pigmented hair on fetuses	In utero; some newborns retain it	Soft, silky
Vellus Hair	Fine, peach-fuzz hair	Post-birth, covers most of the body	Light, fine, non-coarse
Terminal Hair	Coarse, thick hair	Develops at puberty in certain regions	Found on scalp, eyebrows, armpits, groin

● What determines the length of hair?
>length of growth stage

● What causes the different colors of hair?
>amount and type of melanin

● What are the functions of hair?
- Prevents heat loss
- Decreases sunburn
- Eyelashes help protect eyes
- Touch receptors (hair root plexus) senses light touch

● What causes the different shapes of hair (ie. curly, wavy, straight)
>Shape of hair follicle (round: straight hair, oval: wavy hair, flattened: curly hair)

● What are the different types of skin glands? What do they do?
>sebaceous (oil) glands
>sudoriferous (Sweat) glands

● How does the skin synthesis Vitamin D? What is the active form? Why is this important?
>Through UVB, important in proper calcium absorption
>Active form dihydroxyvitamin D_3 (calcitriol)
>Lack can cause rickets

● What can photodamage do to skin?
- Acute overexposure causes sunburn
- DNA damage in epidermal cells can lead to skin cancer
- UVA produces oxygen free radicals that damage collagen and elastic fibers and lead to wrinkling of the skin

● What are the different types of skin cancer?
>Squamous Cell Carcinoma, Basal Cell Carcinoma, Melanoma

● What is the “rule of the 9s”?
>Method used to estimate the total body surface area affected by burns in adults
>Helps guide fluid resuscitation, treatment decisions, and burn severity

● What are first degree burn, second degree burn, third degree burn?
>First: affects epidermis only | Redness, pain, mild swelling, NO blisters | ex: Mild Sunburn
>Second: affects epidermis + part of dermis | redness, blisters, swelling, may be painful | ex: bad scald from hot water
>Third: Epidermis + entire dermis | skin may look white/brown/charred, little or no pain at first (nerves destroyed) | ex: severe flame or chemical burn

● Definitions:
○ Subcutaneous/hypodermis: The lowermost layer of the integumentary system, located directly beneath the dermis. It consists primarily of adipose (fat) and loose connective tissue. It serves as an energy reservoir, provides insulation, and anchors the skin to the underlying muscle or bone.
○ Avascular: tissue that does not contain blood vessels
○ Rickets: A skeletal disorder caused by a lack of Vitamin D, calcium, or phosphat

Bone Tissue

● What tissues is a bone made up of?
>bone tissue, cartilage, dense connective tissue, epithelial tissue, blood vessels, adipose tissue, nerve tissue

● What are the functions of bones?

- Support and Protection: Bones protect vital soft tissues such as the lungs, heart, and brain.
- Muscle Attachment: Bones serve as attachment points for muscles, enabling movement.
- Mineral Storage: Bones store essential minerals, mainly calcium and phosphate, critical for nerve conduction, muscle contraction, and blood clotting.
- Blood Cell Production: Red bone marrow within bones produces red and white blood cells through a process called hematopoiesis.
- Energy Storage: Yellow bone marrow stores fat, providing a limited energy reserve.

● Why does yellow bone marrow sometimes change to red bone marrow?
>Red marrow can revert from yellow marrow in response to physiological needs (e.g., illness, blood loss).

● What does articular cartilage do?
Covers joint surfaces to reduce friction and absorb shock.

● What are the 4 types of cells in bone tissue? What do they do?

Cell Type	Description	Function
Osteoprogenitor (Osteogenic)	Undifferentiated, dividing precursor cells	Differentiate into osteoblasts
Osteoblasts	Bone-building cells	Produce bone matrix
Osteocytes	Mature bone cells	Maintain bone tissue
Osteoclasts	Large, multinucleated cells derived from fused monocytes (white blood cells)	Break down bone matrix to release calcium and remodel bone

● What is bone matrix made of?
Inorganic Mineral Salts: Mainly hydroxyapatite (calcium phosphate, calcium hydroxide, and calcium carbonate), providing hardness and strength.
Organic Component: Collagen fibers confer flexibility and some elasticity, preventing brittleness.
Removing minerals (e.g., soaking a bone in vinegar/acetic acid) leaves behind collagen, making bones flexible and rubbery—a practical science experiment.

● What is compact bone?
>Dense, solid-appearing with small holes for blood vessels; contains osteons (Haversian systems) arranged along lines of stress

● Where would you find compact bone?
>Diaphysis and outer surface of bones

● Where is spongy bone located?
>Epiphyses of long bones, flat bones (hips, sternum, skull, ribs)

● What is are intramembranous and endochondral ossification? What bones are formed by each? Explain the steps to each.
1. Intramembranous ossification is the formation of bone directly from or within fibrous
connective tissue membranes.
- Flat bones of skull and the mandible

2. Endochondrial ossification is the formation of bone from hyaline cartilage models.
- All bones except some bones of skull and clavicles

● What is the epiphyseal plate?: layer of hyaline cartilage located in the metaphysis at each end of a long bone in children and adolescents

● What factors affect bone growth?
Nutrition, sufficient levels of specific hormones (insulinlike growth factor, sex steroids)

● What is meant by bone remodeling?
>Ongoing replacement of old bone tissue by new bone tissue
(Old bone - constantly destroyed by osteoclasts, new bone constructed by osteoblasts)

● What are the steps in the repair of a fracture?
- Formation of fracture hematoma
- Formation of fibrocartilagenous callus formation
- Formation of body callus
- Bone remodelling

● How does parathyroid hormone and calcitonin influence blood calcium levels? Why is calcium important?
- If calcium level falls, PTH is secreted - osteoclast activity increased - produces calcitriol
- If calcium level too high, calcitonin secreted - inhibits osteoclast activity, increases bone formation by osteoblasts

● How does exercise affect bone?
>Bone has ability to alter its strength in response to mechanical stgress by increasing deposition of mineral salts and production of collagen fibers
→ Weight bearing activities such as walking/moderate weightlifting, help build and retain bone mass

● Definitions:
○ Diaphysis: The long, central part of the bone.
○ Epiphysis: Proximal (nearer to the body center) and distal (far end) parts.
○ Endosteum: Lines the inner medullary cavity.
○ Periosteum: A membrane covering the outer surface of bone, containing connective and epithelial tissues.
○ Articular cartilage: Covers joint surfaces to reduce friction and absorb shock.
○ Medullary cavity: Central cavity filled with marrow; contains red marrow in youth and yellow marrow (fat) in adults, which can revert to red marrow during illness or blood loss.

○ Trabeculae: bone plates
○ Osteon: Cylindrical units with concentric lamellae (rings) around a central canal (Haversian canal) housing blood vessels.
○ Osteocyte: Mature bone cells, maintain bone tissue
○ Osteoblast: Bone building cells, produce bone matrix
○ Osteoclast: Large, multinucleated cells derived from fused monocytes (white blood cells), break down bone matrix to release calcium and remodel bone
○ Cavitation: Cartilage deteriorates forming a cavity
○ Canaliculi: filled with extracellular fluid that connect one cell to the next cell
○ Lacunae: spaces where osteocytes can be found
○ Haversian canal: run longitudinally through the center of osteons in compact bone, carrying blood vessels and nerves to nourish bone cells
○ Perforating canal: run transversely or perpendicular to the osteons, connecting Haversian canals to each other, the periosteum, and the medullary cavity for nutrient supply
○ Appositional growth: growth in width, occurs at bone's surface
○ Acromegaly: caused by oversecretion of hGH, hormonal abnormality
Fractures: Named for shape or position of fracture line
– greenstick -- partial fracture
– impacted -- one side of fracture driven into the interior of other side
– closed -- no break in skin
– open fracture --skin broken
– comminuted -- broken ends of bones are fragmented
– Pott's -- distal fibular fracture
– Colles's -- distal radial fracture
– stress fracture -- microscopic fissures from repeated strenuous activities

Skeleton

● You will get some questions where an injury is described and you will need to identify the broken bone.

● What skull bones have sinuses?
    ● frontal, ethmoid, sphenoid, and maxillary bones.

● How many of the following are there: cervical vertebrae, thoracic vertebra, lumbar vertebra, sacral vertebra, coccygeal vertebra
> 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 3-5 coccygeal

● What are intervertebral discs made of? What is their function?
Cushion-like pads between vertebrae, absorb shock, and allow flexibility. Worn discs cause bone-on-bone contact, resulting in pain.

● When are primary curves of the vertebral column formed? When are secondary curves formed?
Primary: Thoracic and sacral, present at birth, resembling fetal position
Secondary: Cervical and lumbar, develop postnatally with head lifting and walking

● What are the differences between male and female pelvic? Be able to identify them in an image.
Male: larger and heavier, larger articular surfaces, larger muscle attachments
Female: wider & shallower, larger pelvic inlet & outlet, pubic arch > 90 degrees

● Definitions
○ Foramen: Opening/hole
○ Fossa: Shallow depression
○ Sulcus: Groove, longer than fossa
○ Meatus: Tube-like passage
○ Condyle: Smooth, rounded joint surface
○ Facet: Flat articular surface
○ Trochanter: Large projection
○ Tuberosity: Roughened projection

Joints

● What is the difference between a fibrous, cartilaginous and synovial joint? Explain in detail (give specific subtypes, etc). Give examples.

Structural Type	Characteristics	Movement Type	Examples
Fibrous Joints	No synovial cavity; bones held by connective tissue	Mostly immovable or slightly movable (synarthrosis or amphiarthrosis)	Sutures (skull), Syndesmosis (tibia-fibula), Gomphosis (tooth socket), Interosseous membranes
Cartilaginous Joints	No synovial cavity; bones connected by cartilage (fibrocartilage or hyaline)	Slightly movable (amphiarthrosis)	Synchondrosis (epiphyseal plates, ribs-sternum), Symphysis (pubic symphysis, intervertebral discs)
Synovial Joints	Synovial cavity present filled with fluid; articular cartilage covering bone ends	Freely movable (diarthrosis)	Most limb joints (knee, shoulder, hip)

● What are extracapsular and intracapsular ligaments? Give examples.
Extracapsular ligaments: Outside the capsule (e.g., fibular and tibial collateral ligaments).
Intracapsular ligaments: Inside the capsule (e.g., ACL and PCL in the knee).

● What is the function of the meniscus?
Crescent-shaped fibrocartilage structures in joints like the knee.
Provide cushioning and enhance joint stability by forming a “cup” for rounded bone ends.

● What is the difference between a strain versus a sprain?
Sprain: Injury to ligaments, often with swelling and bruising due to damaged blood vessels.
Strain: Injury involving muscles or tendons, sometimes occurring alongside ligament damage.

● What is the difference between a bursa and a tendon sheath?
Bursa: Fluid-filled sacs that cushion tendons/ligaments to reduce friction.
Tendon Sheaths: Tube-like bursae surrounding tendons in confined spaces (e.g., wrist, ankle).

● Explain the following movements and give examples:

Movement Type	Definition	Examples	Joint Types Involved
Gliding	Sliding of bones over each other	Carpals in wrist, tarsals in ankle	Plane joints
Flexion	Decrease angle between bones	Bicep curl, thigh moving forward	Hinge, ball-and-socket
Extension	Increase angle, return to anatomical position	Straightening arm or leg	Hinge, ball-and-socket
Hyperextension	Extension beyond anatomical position	Moving arm/leg behind the body	Hinge joints (limited)
Abduction	Movement away from midline	Raising arms/legs to the side	Ball-and-socket, condyloid
Adduction	Movement toward midline	Lowering arms/legs back to the body	Ball-and-socket, condyloid
Circumduction	Circular movement combining flexion, extension, abduction, adduction	Arm circles (pitching)	Ball-and-socket
Rotation	Bone turns around longitudinal axis	Forearm twisting	Ball-and-socket, pivot
Elevation/Depression	Raising/lowering mandible or scapula	Shrugging shoulders, opening mouth	Special joint movements
Protraction/Retraction	Moving mandible or scapula forward/backward	Underbite, scapula movement	Special joint movements
Inversion/Eversion	Turning sole inward/outward	Ankle movements	Subtalar joint
Dorsiflexion/Plantar flexion	Bending foot upward/downward	Foot movement on gas pedal analogy	Ankle joint
Pronation/Supination	Rotating forearm so palm faces down/up	Turning hands palm down or up	Radioulnar joint
Opposition	Thumb touches fingertips across palm	Grasping objects	Carpometacarpal joint of thumb

● Know the following types of synovial joints, give examples, what types of movement are possible:

Joint Type	Description & Structure	Locations in Body	Movements Allowed
Planar (Gliding)	Flat or slightly curved bone surfaces that glide past each other	Intercarpal (wrist), Intertarsal (ankle), Sternoclavicular, Vertebrocostal joints	Side-to-side gliding, limited movement
Hinge	Like a door hinge, allows flexion and extension	Elbow (humerus-ulna), Knee, Interphalangeal joints	Flexion, extension, sometimes hyperextension
Pivot	Rounded bone rotates around a ring or notch	Proximal radioulnar joint, Atlantoaxial joint (C1-C2 vertebrae)	Rotation (supination/pronation, head turning)
Ellipsoidal (Condylar)	Oval-shaped projection fits into oval depression	Wrist, Metacarpophalangeal (fingers 2-5)	Flexion, extension, abduction, adduction, circumduction
Saddle	Resembles a saddle for a rider; allows opposition	Carpometacarpal joint of the thumb	Flexion, extension, abduction, adduction, opposition
Ball and Socket	Spherical head fits into a rounded socket	Shoulder (humerus-glenoid cavity), Hip (femur-acetabulum)	Flexion, extension, abduction, adduction, rotation, circumduction

- What are the factors that affect the range of motion at synovial joints?
    - Structure and shape of articulating bone
    - Strength and tautness of joint ligaments
    - Arrangement and tension of muscles
    - Contact of soft parts
    - Hormones
    - Disuse

- What happens to joints with age?
    - Decreased production of synovial fluid
    - Thinning of articular cartilage
    - Loss of ligament length and flexibility

- Know the differences between osteoarthritis, rheumatoid arthritis and gouty arthritis.

Disorder	Cause/Mechanism	Primary Symptoms & Features	Typical Affected Areas
Rheumatoid arthritis	Autoimmune attack on cartilage	Inflammation, swelling, bone overgrowth (joint fusion), deformities	Small joints first (fingers, feet), may progress to larger joints
Osteoarthritis	Degenerative wear and tear	Cartilage breakdown, bone spurs, pain especially after rest, stiffness improves with movement	Weight-bearing joints (knees, hips, shoulders)
Gouty arthritis	Uric acid crystal deposition in joints	Severe pain, inflammation, bone growth, especially at base of big toe	Big toe base (hallmark), other joints possible