2. The Skeletal System – Lecture Outline

1. **Functions**
   A. Support: muscles and other soft tissues
   B. Protection: important organs
   C. Movement: works with muscles
   D. Mineral Storage: Ca and P deposited
   E. Blood Cell Formation (Hematopoiesis): in the marrow
      - Erythrocytes – red blood cells
      - Leukocytes – white blood cells
      - Thrombocytes – platelets

2. **Classification**:
      - based on size (long, short) and shape (regular, irregular, round, flat)
      - made up of compact and spongy parts
      - types: appendicular and axial skeleton

Regular Bones:
   A. Long Bones: rectangular, e.g., arm and leg bones
   B. Short Bones: square, e.g., carpal (hand), tarsal (feet) bones
   C. Flat Bones: flat, e.g., skull, collar bone (clavicle), breastbone (sternum), ribs

Irregular Bones: made up of thin, compact bones and deep spongy bones, e.g., shoulder blade (scapula), vertebrae, and pelvis.

Round or Seseamoid Bones: e.g., kneecap (Patella)

3. **Parts of a long Bone**

A. Tissues, called osteons
   1. Compact Bone Tissue: found on the outer surface, are columnar, no space between cells
   2. Spongy Bone Tissue: found inside, osteons loosely arranged, osseous tissue called trabeculae, lots of air spaces

B. Structure
   1. **Diaphysis** – the shaft: made up of compact bone, spongy bone and cavity, called medullary cavity, which is filled with marrow
   2. **Epiphysis** – wider ends of a shaft, same composition as the shaft
      a. **Articular cartilage** – makes up the ends of the bone
      b. **Epiphyseal plate** – cite of bone growth (mitosis) between diaphysis and epiphysis
   3. **Membranes** – two parts,
      a. **Periosteum** – covers the outside
      b. **Endosteum** – inner tissue covering the trabeculae
   4. **Marrow** – hematopoiesis, 2 types recognized
      a. **Red marrow** – in children, develops red blood cells

b. **Yellow marrow** – in adults, red blood cells plus adipose tissue

4. **The Axial Skeleton**
   - the skull (cranial and facial bones), vertebral column, and rib cage.

A. **Skull** – the cranial bones

1. **Frontal Bone** – one, curved, flat bone; includes forehead, eye sockets (superior orbital bones)
2. **Parietal Bones** – two, slightly curved, flat bones; include the superior, lateral portion of the skull
3. **Temporal Bones** – two, slightly curved, flat bones; include the lateral and inferior (base) of the skull
   a. **External Auditory Meatus** – tube forming the ear canal
   b. **Styloid Process** – needle-like bone at the base of the temporal bone, anchors a ligament that is attached to the hyoid bone which attaches to the tongue
   c. **Mastoid Process** – a large round projection on the inferior, lateral aspect of the temporal bone
4. **Occipital Bone** – one, slightly curved, flat bone; makes up the posterior and inferior base of the skull; is made up of:
   a. **Occipital Condyles** – two, flattened projections on the lateral aspect of the foramen magnum; forms an articulation with the first cervical vertebrae; nodding bones
   b. **Foramen Magnum** – is the large hole in the occipital bone; the spinal cord goes through this
5. **Sphenoid Bone** – butterfly-shaped bone at the anterior, inferior cranial floor
   a. **Sella turcica** – Turkish saddle, located in the center of the sphenoid bone, protects the pituitary gland
6. **Ethmoid Bone** – cuboidal, anterior to the sphenoid bone and posterior to the nasal bones; forms a small portion of the inferior cranial floor, the medial orbits of the eye and the superior nasal cavity
   a. **Crista Galli** – is the superior projection of the ethmoid bone, attaches to the meninges, protects the brain from sloshing around in the cranial cavity
   b. **Cribriform Plate** – located laterally to the crista galli, is a series of small foramina allowing branches of the olfactory nerve (cranial nerve I) from the nasal cavity to enter the brain

B. **Skull** – **Facial Bones**: anchor muscles, protect organs

1. **Maxillae** – a pair of bones fused together in the center of the face; include the inferior orbits of the eye, hard palate of the roof of the mouth, and sockets for the upper teeth; all bones except the mandible connect with it.
2. **Palatine Bones** – a pair of bones forming the posterior hard palate in the roof of the mouth, arch superiorly to form the posterior nasal cavity
3. **Zygomatic Bones** – a pair of bones that make up the cheek and the lateral aspect of the eye orbits

4. **Nasal Bones** – a pair of bones that form the bridge of the nose
5. **Mandible** – jaw bones, only moveable bone of the skull, joined to the temporal bone, called temporomandibular joint, contains sockets holding the lower teeth
6. **Hyoid Bone** – a small U-shaped bone in the fleshy area between the mandible, does not articulate with other bones in the skull; a long ligament connects the styloid process to the hyloid bone which anchors the tongue

C. **Vertebral Column**

- made up of irregular bones called vertebrae
- protects the spinal cord
- divided into 5 parts each having differently shaped vertebrae and curvatures
- each vertebra has three parts: body (anterior part), vertebral arch (extends posteriorly from the body), and vertebral foramen (a hole formed by the body and vertebral arch)
    1. **Cervical vertebrae** – 7, superior, located in the neck
        a. **Atlas** (C –1) – connects with the occipital condyles; the nodding or yes movement due to this
        b. **Axis** (C – 2) – connects with the atlas, brings about rotation of head and neck, the no movement due to this
            i. **odontoid process** – connects C- 1 with C-2
    2. **Thoracic vertebrae** – 12, form a posterior, concave curve, each connected with the 12 pairs of ribs
    3. **Lumbar vertebrae** – 5, thick, anterior, convex curve in the posterior lower back or loin region, form the posterior wall of the abdominal cavity, support the weight of the entire upper body
    4. **Sacrum** – 5, fused, posterior, concave curve, form the posterior wall of the pelvic cavity
    5. **Coccyx or tailbone** – 3-4, fused, anterior, convex curve

D. **Bony Thorax or Rib Cage** – protect the heart, lungs, and major blood vessels

1. **Sternum or breastbone** –flat, anterior, forms the medial thoracic wall; connected to the clavicle (collarbone) and the ribs
    a. **Manubrium** – most superior portion, together with the paired clavicle forms the thoracic inlet that is the path of the trachea, esophagus, carotid arteries, jugular viens and vagus nerves
    b. **Body** – middle, long portion
    c. **Xiphoid process** – pointed, anterior portion
2. **Ribs** – 12 pairs, curved, flat bones; 10 pairs connected to the sternum, 2 floating
    a. **True ribs** – 7 pairs, directly connected to the sternum
    b. **False ribs** – 5 pairs, indirectly connected to the sternum or not
    c. **Floating ribs** – 2 pairs (11 and 12), connected posteriorly to the thoracic vertebrae

5. **The Appendicular Skeleton** – shoulder, arm, hip, leg

A. **Pectoral Girdle** (shoulder joint) **and Upper Limb:** – made up of clavicle and scapula

1. **Clavicle or collar bone** – widely S-shaped, flat bone, connects medially with the sternum and laterally with the acromion process of the scapula
2. **Scapula** – irregular, triangular, flat bone, posterior to the rib cage, includes several structures:
    a. **Acromion process** – superior, lateral process connecting to the clavicle
    b. **Coracoid process** – anterior projection just inferior and medial to the acromion process, serves as insertions for the tendons of the biceps brachii and pectoralis minor muscles.
    c. **Glenoid Cavity** – a smooth, convex surface between two bony processes.
3. **Humerus** – single, large, long bone of the upper arm
    a. **Trochlea** – forms the elbow joint
4. **Radius** – lateral, long bone of the forearm
5. **Ulna** – the medial, long bone of the forearm
    a. **Olecranon process** – a bony projection of the ulna
6. **Carpals** – 8 per hand, short, round bones, arranged in 2 rows
7. **Metacarpals** – 5 per hand, long bones making up the fleshy part of the hand; knuckles are the distal ends of the metacarpal's bones
8. **Phalanges** – 14 per hand, long bones of the fingers or digits; 3 phalanges per finger except for the thumb (2)

B. **Pelvic Girdle and Lower Limb**:

- pelvic girdle is the hip joint,
- made up of coxal bones (paired os coxae) of the pelvis and the sacrum,
- supports the entire weight of the body in a standing position

1. **Ilium** – the large, flared, superior bone of the ox coxae, supports organs of the abdominopelvic cavity
    a. iliac crest – ridge or spine of the ilium; feel it by putting your hands on your hips
    b. greater sciatic notch – a hole through which the sciatic nerve traverses
2. **Ischium** – the inferior portion of the ox coxae comprising of the the laeral portion of the pelvic inlet (large space through which a baby passes during childbirth)
    a. **ischial tuberosity** – inferior projection of bone from each ischium; feel it when sitting
    b. **obturator foramen** – a large, round opening covered by a fibrous membrane, a few nerves and blood vessels go through it
3. **Pubis** – anterior portion of the ox coxae comprising the anterior portion of the pelvic inlet
    a. **acetabulum** – the socket of the hip joint
    b. **pubic symphysis** – the joint where both pubic bones connect with each other
4. **Femur** – a single, large, long bone of the thigh, heads fits into the acetabulum

a. greater trochanter – superior, lateral projection of the proximal femur, origin of several muscles of the thigh.

5. **Tibia** (shin bone) – the medial, large, long bone of the lower leg, proximal head of the tibia connects with the femur to form the knee joint
    a. **tibia tuberosity** – point of insertion of the patellar ligament
    b. **medial malleolus** – distal tibia that helps stabilize the ankle by providing attachments for ligaments
6. **Fibula** – lateral, thin, long bone
    a. Lateral malleolus – helps stabilize the ankle joint
7. **Tarsals** – 7 per foot, short, round bones
    a. **calcaneus** – largest tarsal bone, the heel; the largest tendon in the body, the Achilles tendon originates from the calf muscle and inserts into the calcaneus
8. **Metatarsals** – 5 per foot, long bones
9. **Phalanges** – 14 per foot, long bones of the toes; 3 phalanges per toe except the big toe

6. **Types of Articulations (Joints)**

– joints are the weakest parts of the skeletal system,
– connect bone to bone,
– 3 types recognized:

A. **Synarthroses** – immoveable joints in the axial skeleton, fibrous connective tissue, e.g., sutures between cranial bones, interosseous ligament joining the tibia and fibula, the periodontal ligament anchoring the teeth into the skull

B. **Amphiarthroses** – slightly moveable joints in the axial skeleton, cartilage, e.g., ribs to sternum, the inter-vertebral disks, pubic symphysis

C. **Diarthroses** (Synovial Joints) – freely moveable joints in the appendicular skeleton, complex fibrous connective tissue and cartilage, e.g., shoulder, elbow, wrist, hand, finger, hip, knee, ankle, foot and toes.

1. **Ligaments** – connect bone to bone
2. **Tendons** – connect bone to muscle
3. **Synovial membrane** – lines joint capsule
    a. synovial fluid – lubricates joints during movement
4. **Bursae** – fluid sac reducing friction between tendon and bone

7. **Types of Movements at Synovial Joints**

– muscles cause movement to occur,
– movements are grouped in pairs:

1. **Flexion** – bending a joint to decrease the angle between two articulating bones, occurs along a sagittal plane, e.g., hamstring muscles flexing the lower leg, thigh, elbow, wrist, fingers, trunk, and head

2. **Extension** – bending a joint to increase the angle between tow articulating bones, e.g., quadriceps muscle extends the lower leg at the knee joint

3. **Adduction** – moving a part toward the midline of the body, e.g., the serratus anterior relaxes the deltoid muscle and lowers the arm

4. **Abduction** – moving a part away from the midline of the body, occurs along a frontal plane, e.g., deltoid muscle raising the arm at the shoulder joint, spreading the fingers and toes

5. **Circumduction** – twisting a part along a central axis to inscribe a cone, e.g., moving the arm about the shoulder joint to draw a circle on a chalkboard, head, wrist, trunk, hip, and ankle, can be clockwise or anticlockwise.

6. **Rotation** – turning a part on its won long axis along a single point, e.g., saying no by shaking a head

7. **Supination** – is rotating the forearm laterally with the palms facing up; the rounded head of the radius rotating about the ulna
8. **Pronation** – is rotating the forearm medially with the palms facing down

9. **Inversion** – the sole facing inward toward the midline

10. **Eversion** – the sole facing outward away from the midline

11. **Elevation** – lifting a part superiorly along the frontal plane, e.g., shrugging your shoulder, closing your mouth

12. **Depression** – dropping a part inferiorly along the frontal plane, e.g., dropping your shoulders, opening your mouth

8. **Connective Tissues Covering Skeletal Muscles**
    A. **Endomysium** – an elastic cover for each individual muscle cell or fiber
    B. **Perimysium** – a cover around groups of muscle cells
        a. Fascicle – a group of muscle cells
    C. **Epimysium** – a cover for the entire muscle, connects with other tissues, e.g., skin, is called the fascia
        1. **Tendon** – the end of all the 3 coverings (Endo-, Peri- and Epimysium), coming together as a sheet or cord anchoring muscle to bone; tendons attach muscle to the periosteum to bone.