

Human Biology

The Skeletal System

Introduction:

Individual bones are the organs of the skeletal system. A bone contains very active tissues.

Bone Structure:

Bone structure reflects its function.

1. Classification of bones - Bones are grouped according to their shapes - long, short, flat, irregular or sesamoid.
2. Parts of a long bone
 - a. Epiphyses at each end are covered with articular cartilage and articulate with other bones.
 - b. The shaft of a bone is called the diaphysis.
 - c. Except for the articular cartilage, a bone is covered by a periosteum.
 - d. Compact bone provides strength and resistance to bending.
 - e. Spongy bone provides strength where needed and reduces the weight of bone.
 - f. The diaphysis contains a medullary cavity filled with marrow.
3. Microscopic structure
 - a. Compact bone contains osteons cemented together.
 - b. Osteonic canals contain blood vessels that nourish the cells of osteons.
 - c. Communicating canals connect osteonic canals transversely and communicate with the bone's surface and the medullary canal.
 - d. Cells of spongy bone are nourished by diffusion from the surface of the thin bony plates.

Bone Development and Growth

1. Intramembranous bones
 - a. Certain flat bones of the skull are intramembranous bones.
 - b. They develop from layers of connective tissues.
 - c. Bone tissue is formed by osteoblasts within the membranous layers.
 - d. Mature bone cells are called osteocytes.
 - e. Primitive connective tissues give rise to the periosteum.
2. Endochondral bones
 - a. Most of the bones of the skeletal system are endochondral bones.
 - b. They develop first as hyaline cartilage that is later replaced by bone tissue.
3. Growth of an endochondral bone
 - a. Primary ossification center appears in the diaphysis, while secondary ossification centers appear in the epiphyses.

- b. An epiphyseal disk remains between the primary and secondary ossification centers.
- c. An epiphyseal disk consists of layers of cells: resting cells, young reproducing cells, older enlarging cells, and dying cells.
- d. The epiphyseal disk is responsible for growth in length.
- e. Long bones continue to grow in length until the epiphyseal disks are ossified.
- f. Growth in thickness is due to intramembranous ossification occurring beneath the periosteum.

Functions of Bone

- 1. Support and protection
 - a. Skeletal parts provide shape and form of body structures.
 - b. They support and protect softer, underlying tissues
- 2. Body movement
 - a. Bones & muscles function together as levers
 - b. A lever consists of a rod, pivot (fulcrum), weight that is moved, and a force that supplies energy.
- 3. Blood cell formation
 - a. At different ages, hematopoiesis occurs in the yolk sac, liver and spleen, and red bone marrow.
 - b. Red marrow functions in the production of red blood cells, white blood cells, and blood platelets; yellow bone marrow stores fat.
- 4. Storage of inorganic salts
 - a. The intercellular material of bone tissue contains large quantities of calcium phosphate.
 - b. When blood calcium is low, osteoclasts break down bone; when blood calcium is high, osteoclasts build bone.
 - c. Bone also stores lesser amounts of magnesium, sodium, potassium, and carbonate ions.

Organization of the Skeleton

- 1. The skeleton can be divided into axial and appendicular skeletons.
- 2. The axial skeleton consists of the skull, hyoid bone, vertebral column, and thoracic (rib) cage.
- 3. The appendicular skeleton consists of the pectoral girdle, upper limbs, pelvic girdle and lower limbs.

Skull

The skull consists of 22 bones, which include 8 cranial bones, 13 facial bones, and 1 mandible.

1. Cranium
 - a. The cranium encloses and protects the brain.
 - b. Some cranial bones contain air-filled sinuses.
 - c. Cranial bones include the frontal bone, parietal bones, occipital bone, temporal bones, sphenoid bone, and ethmoid bone.
2. Facial skeleton
 - a. Facial bones form the basic shape of the face and provide attachments for muscles.
 - b. Facial bones include the maxillary bones, palatine bones, zygomatic bones, lacrimal bones, nasal bones, vomer, inferior nasal conchae, and mandible.
3. Infantile skull
 - a. Incompletely developed bones are separated by fontanelles.
 - b. Proportions of the infantile skull are different from those of the adult skull.

Vertebral Column

The vertebral column extends from the skull to the pelvis and protects the spinal cord. It is composed of vertebrae, separated by intervertebral disks. It has four (4) curvatures, which give it resiliency.

1. Typical vertebra
 - a. A typical vertebra consists of a body and a bony arch, which surrounds the spinal cord.
 - b. Notches on the lower surfaces provide intervertebral foramina, through which spinal nerves pass.
2. Cervical vertebrae
 - a. Transverse processes bear transverse foramina.
 - b. The atlas (first vertebra) supports and balances the head.
 - c. The odontoid process of the axis (second vertebra), provides a pivot point for the atlas.
3. Thoracic vertebrae
 - a. Thoracic vertebrae are larger than cervical vertebrae.
 - b. Facets on the sides articulate with the ribs.
4. Lumbar vertebrae
 - a. Vertebral bodies are large and strong.
 - b. They support more body weight than other vertebrae.
5. Sacrum
 - a. The sacrum is a triangular structure formed of five fused vertebrae.
 - b. Vertebral foramina form the sacral canal.
6. Coccyx

- a. The coccyx forms the lowest part of the vertebral column.
- b. It is composed of four (4) fused vertebrae.

Thoracic cage

The thoracic cage includes the ribs, thoracic vertebrae, sternum, and costal cartilages. It supports the shoulder girdle and arms, protects visceral organs, and functions in breathing.

1. Ribs
 - a. The ribs are attached to the thoracic vertebrae.
 - b. The costal cartilages of the true ribs join the sternum directly; those of the false ribs join it indirectly.
 - c. A typical rib bears a shaft, a head, and tubercles, which articulate with the vertebrae.
2. Sternum
 - a. The sternum consists of the manubrium, body, and xiphoid process.
 - b. It articulates with the clavicles.

Pectoral Girdle

The pectoral girdle is composed of two clavicles and two scapulae. It forms an incomplete ring that supports the arms and provides attachment for muscles.

1. Clavicles
 - a. The clavicles are located between the manubrium and scapulae.
 - b. They function to hold the shoulders in place and provide attachment for muscles.
2. Scapulae
 - a. The scapulae are broad, triangular bones.
 - b. They articulate with the humerus and provide attachments for muscles.

Upper Limb

Bones of the upper limb provide frameworks of arms, wrists, palms, and fingers. They also provide attachments for muscles and function in levers that move the limb and its parts.

1. Humerus
 - a. The humerus extends from the glenoid cavity of the scapula to the elbow.
 - b. It articulates with the radius and ulna at the elbow.
2. Radius
 - a. The radius extends from the elbow to the wrist.
 - b. It articulates with the humerus, ulna, and wrist.
3. Ulna
 - a. The ulna overlaps the humerus posteriorly.

- b. It articulates with the radius laterally and with a disk of fibrocartilage inferiorly.
- 4. Hand
 - a. The hand is composed of a wrist, palm, and five (5) fingers.
 - b. It includes 8 carpals that form a carpus, 5 metacarpals, and 14 phalanges.

Pelvic Girdle

The pelvic girdle consists of two coxal bones that articulate with each other anteriorly and with the sacrum posteriorly. The sacrum, coccyx, and pelvic girdle form the pelvis.

Coxal bones

Each coxal bone consists of three bones, which are fused in the region of the acetabulum.

1. The Ilium
 - a. The ilium is the largest portion of the coxal bone.
 - b. It joins the sacrum at the sacroiliac joint.
2. The Ischium
 - a. The ischium is the lowest portion of the coxal bone.
 - b. It supports the body weight when sitting.
3. The Pubis
 - a. The pubis is the anterior portion of the coxal bone.
 - b. The pubic bones are fused anteriorly at the symphysis pubis.

Lower Limb

Bones of the lower limb provide frameworks of the leg, ankle, instep, and toes.

1. Femur
 - a. The femur extends from the knee to the hip.
 - b. The patella articulates with its anterior surface.
2. Tibia
 - a. The tibia is located on the medial side of the lower leg.
 - b. It articulates with the talus of the ankle
3. Fibula
 - a. The fibula is located on the lateral side of the tibia.
 - b. It articulates with the ankle, but does not bear body weight.
4. Foot
 - a. The foot consists of the ankle, instep, and five (5) toes.
 - b. It includes 7 tarsals that form the tarsus, 5 metatarsals, and 14 phalanges.

Joints

Joints can be classified on the basis of the amount of movement they make possible.

1. Immovable joints
 - a. The bones of immovable joints are in close contact, separated by a thin layer of fibrous tissue or cartilage, as in a suture.
 - b. No active movements are possible at these joints.
2. Slightly movable joints
 - a. The bones of slightly movable joints are connected by disks of fibrocartilage or by ligaments, as in the vertebrae.
 - b. Such a joint allows a limited amount of movement.
3. Freely movable joints
 - a. The bones of freely movable joints are covered with hyaline cartilage and held together by a fibrous capsule.
 - b. The joint capsule consists of an outer layer of ligaments and an inner lining of synovial membrane.
 - c. Bursae are often located between the skin and underlying bony prominences.
 - d. Freely movable joints include several types: ball-and-socket, condyloid, gliding, hinge, pivot, and saddle.
4. Types of movable joints
 - a. The movements of synovial joints are produced by muscles that are fastened on either side of the joint.
 - b. The movements include flexion, extension, dorsiflexion, plantar flexion, hyperextension, abduction, adduction, rotation, circumduction, pronation, supination, eversion, inversion, retraction, protraction, elevation, and depression.