

UNIT 4 - SKELETAL SYSTEM

LECTURE NOTES

4.01 FUNCTIONS OF THE SKELETAL SYSTEM

A. Support

1. Provides a framework for the body.
2. Supports soft tissue.
3. Serves as a point of attachment for ligaments, tendons, fascia, and muscles.

B. Protection

1. Skull protects the brain.
2. Vertebral column protects the spinal cord.
3. Ribs protect the organs of the heart and lungs.
4. Pelvic bones protect the internal reproductive organs.

C. Movement Facilitation

Bones serve as levers to convert muscular contraction to movement.

D. Mineral Storage

Bones store calcium and phosphorus in the bone matrix.

E. Storage of Energy

Yellow bone marrow serves as an important reservoir of lipids.

F. Hematopoiesis (Hemopoiesis)

The process of producing blood cells in the red bone marrow.

1. Erythrocytes – red blood cells.
2. Leukocytes – white blood cells.
3. Thrombocytes – platelets.

4.02 BONE CELLS, BONE GROWTH AND OSSIFICATION

A. Bone Cells

1. Osteoblasts

Osteoblasts are responsible for bone formation by secreting a matrix of organic compounds and mineral salts.

2. Osteocytes

Osteocytes are mature bone cells -- the principle cells of bone tissue.

- a. Are osteoblasts that have become isolated within lacunae found within the bony intercellular matrix.
- b. Maintain daily cellular activities of bone tissue.
- c. No mitotic potential.

3. Osteoclasts

Osteoclasts are cells that break down bone tissue.

- a. Are important in the development, growth, maintenance, and repair of bone tissue.
- b. Help to maintain the blood calcium levels.

B. Bone Growth

Bone growth occurs as existing connective tissues are replaced. This happens in one of two ways – intramembranous bone growth or endochondral bone growth.

1. Intramembranous Bone Growth

- a. Occurs in the skull bones.
- b. The model of the skull is formed by membrane-like layers of connective tissue. It contains primitive cells which form osteoblasts.
- c. Osteoblasts are surrounded by the mineral matrix and form the osteocytes.

2. Endochondral Bone Growth

- a. Occurs in most of the skeletal bones.
- b. Development occurs from masses of hyaline cartilage which form the skeletal model.
- c. The cartilage cells enlarge and destroy the cartilage matrix.
- d. Some of the invading cells form osteoblasts which deposit the bony matrix around them forming osteoblasts.
- e. Endochondral bone growth also occurs at the epiphyseal plate (growth plate) of long bones.

C. Ossification

The process by which bones form in the body by replacing pre-existing connective tissue with bone. Ossification occurs during bone growth.

4.03 FEATURES OF A LONG BONE

A. Periosteum

A dense, white fibrous covering surrounding the surface of bone. Periosteum is not covered by articular (hyaline) cartilage.

1. Essential for bone growth, repair, and nutrition.
2. Serves as a point of attachment for ligaments and tendons.

B. Diaphysis

The shaft or long, main, portion of the long bone.

C. Epiphysis

The expanded ends of the long bone.

D. Medullary Cavity

The medullary cavity is the space or hollow chamber within the diaphysis. It is continuous with the spaces of the spongy bone and is filled with a specialized type of soft connective tissue called marrow.

E. Red Marrow

Red marrow is blood cell forming tissue located within the spaces or the spongy bone of the long bones. Red marrow forms all blood cells types including erythrocytes, leukocytes, and thrombocytes.

F. Yellow Marrow

Yellow marrow is the fat storing tissue found within the medullary cavities of long bones.

G. Articular Cartilage

Articular cartilage is a thin layer of hyaline cartilage covering the epiphysis in order to reduce friction during the movement of the joint.

H. Endosteum

Endosteum is a thin layer of squamous cells which line the medullary cavity.

I. Compact Bone

1. Contains little space between the solid components of bone.
2. Has a concentric ring structure.
3. Blood vessels and nerves perforate the concentric rings through lateral canals called Volkmann's Canals or Perforating Canals.
4. Blood vessels and nerves run the length of the bone and are contained in Osteonic (Haversian) Canals. These canals are found in the center of the concentric ring structure of compact bone.
5. Osteocytes (bone cells) are embedded in the fluid-filled spaces called lacunae.
6. Canaliculi or small canals are found radiating in all directions from the lacunae, which connect to other lacunae and eventually with the central osteonic canals.
7. The entire network is called an Osteon (Haversian System). It contains a central canal with its surrounding lamellae, lacunae, osteocytes, and canaliculi.
8. Provides the strength of the bone.

J. Spongy Bone

1. Composed of irregular networks of thin plates of bone with many intercellular spaces called trabeculae.
2. The spaces between the trabeculae are usually filled with red bone marrow which is responsible for producing blood cells.
3. Helps to reduce the weight of the bone while reducing shock associated with movement.

4.04 SHAPES OF BONES

A. Long

1. Longer than they are wide.
2. Have a distinct diaphysis (shaft).
3. Slightly curved for strength.
4. Examples: humerus, ulna, radius, metacarpals, phalanges, femur, tibia, fibula, metatarsals.

B. Short

1. Cube-shaped.
2. Nearly equal in length and width.
3. Spongy texture on the inside of the bone.
4. Examples: Some of the carpals and tarsals.

C. Flat

1. Generally thin and flat.
2. Composed of two layers of compact bone on the outside with a layer of spongy bone on the inside.
3. Provide protection for underlying organs.
4. Provide surface area for muscle attachment.
5. Examples: cranial bones, sternum, ribs, and scapulae.

D. Irregular

1. Various shaped bones which cannot be classified into any of the other three groups.
2. Vary in the amount of spongy and compact bone
3. Examples: facial bones, vertebrae.

4.05 BONE MARKINGS

A. Foramen

1. An opening or hole through a bone which serves as a passageway for nerves or blood vessels.
2. Examples: mental foramen on the chin, infraorbital foramen on the maxillae.

B. Meatus

1. A tube-like passageway within a bone.
2. Example: external auditory meatus which conducts sound waves through the temporal bone.

C. Sinus

1. A space within a bone lined with a mucus membrane to reduce the weight of the bone.
2. Examples: frontal, maxillary, ethmoidal, sinuses.

D. Fossa

1. A fairly deep pit or depression.
2. Examples: olecranon fossa of the humerus, mandibular fossa of the temporal bone.

E. Condyle

1. A large rounded prominence which articulates with another bone.
2. Examples: occipital condyles where the skull meets the cervical vertebrae, medial and lateral condyles of the femur which articulate with the tibia.

F. Tuberosity

1. An elevated, rounded, (knob-like) usually roughened area on a bone. Generally bigger than a tubercle and is used for muscle attachment.
2. Examples: tibial tuberosity for the attachment of the quadriceps tendon, radial tuberosity for the attachment of the biceps.

G. Trochanter

1. A very large, blunt process used for muscle attachment.
2. Examples: Only found on the femur – the greater and lesser trochanters.

H. Tubercle

1. A small rounded process used for muscle attachment.
2. Examples: greater and lesser tubercles of the humerus.

I. Process

1. Any projection from the surface of a bone used in muscle attachment.
2. Examples: mastoid process of the temporal bone, styloid process of the temporal bone.

4.06 SUTURES AND FONTANELS

A. Sutures "Seam or Stitch"

1. An immovable joint found only between skull bones.
2. Contains very little connective tissue between the bones of a suture.
3. Examples: sagittal suture located between the parietal bones.

B. Fontanel

1. Membrane-filled spaces between cranial bones which are more commonly known as the soft spots of a baby's skull.
2. Functions of Fontanel
 - a. Enables the fetal skull to compress as it passes through the birth canal.
 - b. Permits rapid growth of the brain during infancy.
 - c. Assists in the determination of the fetal head position prior to birth.

4.07 AXIAL AND APPENDICULAR SKELETONS

A. Axial Skeleton

The axial skeleton consists of bones that lie along the axis of the body.

1. Skull
2. Vertebral column
3. Ribs
4. Sternum
5. Hyoid bone

B. Appendicular Skeleton

The appendicular skeleton contains the bones of the free appendages.

1. Upper Extremities

- a. Clavicle
- b. Scapula
- c. Humerus
- d. Ulna
- e. Radius
- f. Carpals
- g. Metacarpals
- h. Phalanges

2. Lower Extremities

- a. Pelvis
- b. Femur
- c. Tibia
- d. Fibula
- e. Patella
- f. Tarsals
- g. Metatarsals
- h. Phalanges

4.08 LOCATION OF SKULL BONES

A. Cranium

The cranium or the skull encloses and protects the brain.

1. Specific bones of the cranium and their locations

- a. Mandible (1)
The lower jaw bone; the only moveable bone in the skull.
- b. Maxilla (1)
The upper jaw bone.
- c. Zygomatic (2)
The cheek bones.

- d. Frontal (1)
Forms the forehead (anterior part of the cranium), the roofs of the orbits (eye sockets), and most of the anterior part of the cranial floor.
- e. Parietal (2)
Form the greater portion of the sides and roof of the cranial cavity.
- f. Occipital
Forms the posterior part and the prominent portion of the base of the cranium.
- g. Sphenoid
Bone situated in the middle part of the base of the skull. Forms the sides of the skull and part of the eye orbit.
- h. Ethmoid
A light, spongy bone located in the anterior part of the floor of the cranium between the orbits.
- i. Hyoid bone
 - (1) U-shaped bone suspended from the styloid process of the temporal bone by ligaments.
 - (2) Does NOT articulate with any other bone in the body.
 - (3) Located in the neck between the mandible and the larynx.
 - (4) Supports the tongue and provides a point of attachment for some of the tongue muscles.
 - (5) Provides a point of attachment for muscles of the neck and pharynx.
- j. Temporal (2)
Form the inferior sides of the cranium and part of the cranial floor.
- k. Mastoid Process (2)
The bony extensions from the temporal bone which are posterior to the ears. Used for muscle attachment.

4.09 THE VERTEBRAL COLUMN

- A. Cervical Vertebrae (7)
Vertebrae of the neck
- B. Thoracic Vertebrae (12)
Vertebrae to which ribs attach
- C. Lumbar Vertebrae (5)
Large, weight-bearing vertebrae of the lower back
- D. Sacral Vertebrae (5)
Fused vertebrae which articulate with the pelvic bones
- E. Coccygeal Vertebrae (Coccyx) (4)
Four vertebrae usually fused into two separate bones called the coccyx or tailbone.

4.10 STRUCTURAL CLASSIFICATION OF JOINTS

A. Fibrous Joints

1. Lack a synovial cavity.
2. Articulating bones are held very closely together by fibrous connective tissue.
3. Permit little or no movement.
4. Examples include the distal ends of the tibia and fibula, sutures between the cranial bones, and teeth in the alveolar sockets.

B. Synovial Joints

1. Joints which contain a synovial cavity between the articulating bones.
2. The ends of the articulating bones are covered with articular (hyaline) cartilage.
3. The joint is surrounded by a sleeve like layer of connective tissue called a Synovial (articular) Capsule.
 - a. Fibrous Capsule
 - (1) Outer layer of the synovial capsule.
 - (2) Attaches to the periosteum of the bone.
 - b. Synovial Membrane
 - (1) Inner layer of the synovial capsule.
 - (2) Secretes a lubricating fluid called synovial fluid.
4. Menisci are pads of fibrocartilage found between the articular surfaces.
 - a. Allow two bones of different shapes to fit together tightly (modify the shape of the articulating bone surfaces).
 - b. Help maintain the stability of the joint.
 - c. Help absorb shock.
 - d. Direct the flow of synovial fluid to areas in the joint of greatest friction.
5. Bursae are sac-like structures that resemble joint capsules situated within body tissues.
 - a. Reduces friction between soft tissue and bones.
 - b. Reduces friction between the skin and bones.
6. Examples include the knee, shoulder, wrists, ankles, elbows, and hips.

C. Cartilaginous Joints

1. Lack a synovial cavity.
2. Articulating bones are held tightly together by cartilage.
3. Examples include the articulation between the first rib and the sternum and the symphysis pubis in the pelvis.

4.11 LIGAMENTS AND TENDONS

A. LIGAMENTS

A band or cord of dense fibrous connective tissue extending from one bone to another bone to provide a joint with structural stability.

B. TENDONS

A band or cord of dense fibrous connective tissue extending from one bone to a muscle for attachment.

4.12 DISEASES AND DISORDERS OF THE SKELETAL SYSTEM

A. **Herniated Disk**

The intervertebral disks are soft pads of cartilage located between each of the vertebrae to absorb shock and provide some flexibility for movement. Within each of these disks is a gelatinous center called the nucleus pulposus. A herniated disk, also known as a ruptured, slipped, or bulging disk, occurs when the nucleus pulposus spills out into the spinal canal and presses on the spinal nerves in that region. The most common location is the lumbosacral area which causes pressure and pain on the sciatic nerve. The patient then experiences numbness, weakness, and/or pain down the affected leg. Treatment may include bedrest, analgesics, hot or cold applications, and may require surgery at some later point.

B. **Osteoarthritis**

Osteoarthritis is a type of arthritis caused by the destruction of cartilage from the joints. This is the most common form of arthritis. It develops from normal wear and tear on the joints. The first symptoms of arthritis are vague and include joint soreness, aching, stiffness, and swelling. Eventually, nodes are noted at the affected site as well as a loss of the range of motion. Treatment involves the use of analgesics to relieve pain, use of steroids to reduce inflammation, and possibly surgical replacement of the joint.

C. **Osteoporosis**

Osteoporosis is a loss of bone mass and bone density which leads to porous bones making them more susceptible to fracture. Although there are no overt symptoms, the bones may now be scanned for density. Women who are small boned, from European or Asian backgrounds, and have a family history should be screened as well as those who have not eaten a calcium rich diet. There are now bone-building drugs available. A calcium rich diet as well as weight bearing exercises to improve muscle mass and bone density are also encouraged.

D. **Scoliosis**

Scoliosis is the abnormal lateral curvature of the spine (vertebral column) resulting in a S-shaped appearance. It is more common in women than men. It causes one hip or one shoulder to be higher than the other. Treatment plans vary with the degree of the severity from a brace to surgical placement of a rod to help keep the spine straight.

E. Spina Bifida

Spina bifida occurs when the posterior part of the vertebrae fails to form properly and does not enclose the spinal cord. The neural deficits seen in the patient will vary with where the impairment occurred. For example, some people are able to walk while other people are confined to wheelchairs. The intake of folic acid (folate) before and during pregnancy seems to reduce the incidence by fifty percent. Surgery may be required to fix the herniation. Experimental surgeries have included surgery on the fetus while he/she is still in utero.

F. Fractures

Fractures or broken bones are caused by the stress on bones placed upon them by trauma or disease conditions. They can occur in any bone of the body and are classified by the fracture -- either by specific names or locations of the bone break.

G. Sprains

Sprains are tears of the ligaments which are holding two bones together.