

## Chapter 5- The Skeletal System

- I. The skeletal system
  - A. Parts of the skeletal system
    1. Bones (skeleton)
    2. Joints
    3. Ligaments
    4. Cartilage
  - B. Two subdivisions of the skeleton
    1. Axial skeleton
    2. Appendicular skeleton
  - C. Functions of bones
    1. Support the body
    2. Protect soft organs
    3. Allow movement due to attached skeletal muscles
    4. Store minerals and fats
    5. Blood cell formation
  - D. Bones of the human body
    1. The adult skeleton has 206 bones
    2. Two basic types of bone tissue
      - a. Compact bone
        - 1) Homogenous
      - b. Spongy bone
        - 1) Small needle-like pieces of bone
        - 2) Many open spaces
- II. Classification of bones on the basis of shape
  - A. Classification of bones
    1. Long bones
      - a. Typically longer than they are wide
      - b. Have a shaft with heads at both ends
      - c. Contain mostly compact bone
      - d. Example:
        - 1) Femur
        - 2) Humerus
    2. Short bones
      - a. Generally cube-shape
      - b. Contain mostly spongy bone
      - c. Example:
        - 1) Carpals
        - 2) Tarsals
    3. Flat bones
      - a. Thin, flattened, and usually curved
      - b. Two thin layers of compact bone surround a layer of spongy bone
      - c. Example:
        - 1) Skull
        - 2) Ribs
        - 3) Sternum
    4. Irregular bones

- a. Irregular shape
- b. Do not fit into other bone classification categories
- c. Example:
  - 1) Vertebrae
  - 2) Hip bones

### III. Anatomy of a long bone

- A. Diaphysis
  - 1. Shaft
  - 2. Composed of compact bone
- B. Epiphysis
  - 1. Ends of the bone
  - 2. Composed mostly of spongy bone
- C. Periosteum
  - 1. Outside coverings of the diaphysis
  - 2. Fibrous connective tissue membrane
- D. Sharpey's fibers
  - 1. Secure periosteum to underlying bone
- E. Arteries
  - 1. Supply bone cells with nutrients
- F. Articular cartilage
  - 1. Covers the external surface of the epiphyses
  - 2. Made of hyaline cartilage
  - 3. Decreases friction at joint surfaces
- G. Epiphyseal plate
  - 1. Flat plate of hyaline cartilage seen in young, growing bond
  - 2. Epiphyseal line
    - a. Remnant of the epiphyseal plate
    - b. Seen in adult bones
- H. Medullary cavity
  - 1. Cavity inside of the shaft
    - a. Contains yellow marrow (mostly fat) in adults
    - b. Contains red marrow (for blood cell formation) in infants

### IV. Bone markings

- A. Surface features of bones
  - 1. Sites of attachments for muscles, tendons, and ligaments
  - 2. Passages for nerves and blood vessels
- B. Categories of bone markings
  - 1. Projections or processes-grow out from bone surface
  - 2. Depressions or cavities- indentations

### V. Microscopic anatomy of bone

- A. Osteon (Haversian system)
  - 1. A unit of bone containing central canal and matrix rings
  - 2. Central (Haversian) canal
    - a. Opening in the center of an osteon
    - b. Carries blood vessels and nerves
  - 3. Perforating (Volkman's) canal
    - a. Canal perpendicular to the central canal
    - b. Carries blood vessels and nerves

4. Lacunae
    - a. Cavities containing bone cells (osteocytes)
    - b. Arranged in concentric rings
  5. Lamellae
    - a. Rings around the central canal
    - b. Sites of lacunae
  6. Canaliculi
    - a. Tiny canals
    - b. Radiate from the central canal to lacunae
    - c. Form a transport system connecting all bone cells to a nutrient supply
- VI. Formation of the human skeleton
- A. In embryos, the skeleton is primarily hyaline cartilage
  - B. During development, much of this cartilage is replaced by bone
  - C. Cartilage remains in isolated areas
    1. Bridge of nose
    2. Parts of ribs
    3. Joints
  - D. Bone growth (Ossification)
    1. Epiphyseal plates allow for lengthwise growth of long bones during childhood
    2. New cartilage is continuously formed
    3. Older cartilage becomes ossified
      - a. Cartilage is broken down
      - b. Enclosed cartilage is digested away, opening up a medullary cavity
      - c. Bone replaces cartilage through the action of osteoblasts
    4. Bones are remodeled and lengthened until growth stops
      - a. Bones are remodeled in response to two factors
        - 1) Blood calcium levels
        - 2) Pull of gravity and muscles on skeleton
    5. Bones grow in width (called appositional growth)
    6. Types of bone cells
      - a. Osteocyte- mature bone cells
      - b. Osteoblasts- bone-forming cells
      - c. Osteoclast- bone-destroying cells
        - 1) Break down bone matrix for remodeling and release of calcium in response to parathyroid hormone
        - 2) Bone remodeling is performed by both osteoblasts and osteoclasts
  - E. Bone fractures
    1. Fracture- break in bone
    2. Types of bone fracture
      - a. Closed (simple) fracture- break that does not penetrate the skin
      - b. Open (compound) fracture- broken bone penetrates through skin
    3. Bone fractures are treated by reduction and immobilization
    4. Repair of bone fractures
      - a. Hematoma (blood-filled swelling) is formed
      - b. Break is splinted by fibrocartilage to form a callus
      - c. Fibrocartilage callus is replaced by a bony callus
      - d. Bony callus is remodeled to form a permanent patch

## VII. The axial skeleton

- A. Forms the longitudinal axis of the body
- B. Divided into three parts
  - 1. Skull
  - 2. Vertebral column
  - 3. Bony thorax
- C. The skull
  - 1. Two sets of bones
    - a. Cranium
    - b. Facial bones
  - 2. Bones are joined by sutures
  - 3. Only the mandible is attached by a freely movable joint
  - 4. Human skull, lateral view
  - 5. Human skull, superior view
  - 6. Human skull, inferior view
  - 7. Human skull, anterior view
  - 8. Paranasal sinuses
    - a. Hollow portions of bones surrounding the nasal cavity
    - b. Functions of paranasal sinuses
    - c. Lighten the skull
    - d. Give resonance and amplification to voice
  - 9. The hyoid bone
    - a. The only bone that does not articulate with another bone
    - b. Serves as a moveable base for the tongue
    - c. Aids in swallowing and speech
  - 10. The fetal skull
    - a. The fetal skull is large compared to the infant's total body length
    - b. Fontanelles- fibrous membranes connecting the cranial bones
      - 1) Allow the brain to grow
      - 2) Convert to bone within 24 months after birth
- D. The vertebral column
  - 1. Each vertebrae is given a name according to its location
  - 2. There are 24 single vertebral bones separated by intervertebral discs
    - a. Seven cervical vertebrae are in the neck
    - b. Twelve thoracic vertebrae are in the chest region
    - c. Five lumbar vertebrae are associated with the lower back
    - d. Nine vertebrae fuse to form two composite bones
      - 1) Sacrum
      - 2) Coccyx
  - 3. The spine has a normal curvature
    - a. Primary curvatures are the spinal curvatures of the thoracic and sacral regions
      - 1) Present from birth
    - b. Secondary curvatures are the spinal curvatures of the cervical and lumbar regions
      - 1) Develop after birth
  - 4. A typical vertebrae, superior view
  - 5. Regional characteristics of vertebrae

6. Sacrum and coccyx
  - a. Sacrum
    - 1) Formed by the fusion of five vertebrae
  - b. Coccyx
    - 1) Formed from the fusion of three to five vertebrae
    - 2) "Tailbone" or remnant of a tail that other vertebrates have

E. The bony thorax

1. Forms a cage to protect major organs
2. Consists of three parts
  - a. Sternum
  - b. Ribs
    - 1) True ribs (pairs 1-7)
    - 2) False ribs (pairs 8-12)
    - 3) Floating ribs (pairs 11-12)
  - c. Thoracic vertebrae

VIII. The appendicular skeleton

A. Composed of 126 bones

1. Limbs (appendages)
2. Pectoral girdle
3. Pelvic girdle

B. The pectoral (shoulder) girdle

1. Composed of two bones
  - a. Clavicle- collarbone
  - b. Scapula- shoulder blade
  - c. These bones allow the upper limb to have exceptionally free movement

C. Bones of upper limbs

1. Humerus
  - a. Forms the arm
  - b. Single bone
2. The forearm has two bones
  - a. Ulna- medial bone in anatomical position
  - b. Radius- lateral bone in anatomical position
3. The hand
  - a. Carpals- wrist
  - b. Metacarpals- palm
  - c. Phalanges- fingers

D. Bones of the pelvic girdle

1. Formed by two coxal (ossa coxae) bones
2. Composed of three pairs of fused bones
  - a. Ilium
  - b. Ischium
  - c. Pubis
3. The total weight of the upper body rests on the pelvis
4. It protects several organs
  - a. Reproductive organs
  - b. Urinary bladder
  - c. Part of the large intestine
5. The pelvis

- a. The pelvis: right coxal bone
- b. Gender differences in the pelvis
  - 1) The female inlet is larger and more circular
  - 2) The female pelvis as a whole is shallower, and the bones are lighter and thinner
  - 3) The female ilia flare more laterally
  - 4) The female sacrum is shorter and less curved
  - 5) The female ischial spines are shorter and farther apart; thus the outlet is larger
  - 6) The female pubic arch is more rounded because the angle of the pubic arch is greater
- 6. Bones of the lower limbs
  - a. The thigh has one bone
    - 1) Femur
    - 2) The heaviest, strongest bone
  - b. The lower leg has two bones
    - 1) Tibia
      - a) Shinbone
      - b) Larger and medially oriented
    - 2) Fibula
      - a) Thin and sticklike
  - c. The foot
    - 1) Tarsals
      - a) Two largest tarsals
        - i. Calcaneus (heelbone)
        - ii. Talus
    - 2) Metatarsals- sole
    - 3) Phalanges- toes
    - 4) Arches of the foot
      - a) Bones of the foot are arranged to form three strong arches
      - b) Two longitudinal
      - c) One transverse

## IX. Joints

- A. Articulations of bones
- B. Functions of joints
  - 1. Hold bones together
  - 2. Allow for mobility
- C. Ways joints are classified
  - 1. Functionally
  - 2. Structurally
- D. Functional classification of joints
  - 1. Synarthroses- immovable joints
  - 2. Amphiarthroses- slightly moveable joints
  - 3. Diarthroses- freely moveable joints
- E. Structural classification of joints
  - 1. Fibrous joints- generally immovable
  - 2. Cartilaginous joints- immovable or slightly moveable

3. Synovial joints- freely moveable

F. Summary of joint classes

1. Fibrous joints

- a. Bones united by fibrous tissue
- b. Example:
  - 1) Sutures
    - a) Syndesmoses
    - b) Allows more movement than sutures
    - c) Example: Distal end of tibia and fibula

2. Cartilaginous joints

- a. Bones connected by cartilage
- b. Example:
  - 1) Pubic symphysis
  - 2) Intervertebral joints

3. Synovial joints

- a. Articulating bones are separated by a joint cavity
- b. Synovial fluid is found in the joint cavity
- c. Articular cartilage (hyaline cartilage) covers ends of bones
- d. A fibrous articular capsule encloses joint surfaces
- e. A joint cavity is filled with synovial fluid
- f. Ligaments reinforce the joint
- g. Structures associated with the synovial joint
  - 1) Bursae- flattened fibrous sacs
    - a) Lined with synovial membranes
    - b) Filled with synovial fluid
    - c) Not actually part of the joint
  - 2) Tendon sheath
    - a) Elongated bursa that wraps around a tendon
- h. Inflammatory conditions associated with joints
  - 1) Bursitis- inflammation of a bursa usually caused by a blow or friction
  - 2) Tendinitis- inflammation of tendon sheaths
  - 3) Arthritis- inflammatory or degenerative diseases of joints
    - a) Over 100 different types
    - b) The most widespread crippling disease in the US
    - c) Clinical forms of arthritis
      - i. Osteoarthritis- most common chronic arthritis, probably related to normal aging processes
      - ii. Rheumatoid arthritis- An autoimmune disease- the immune system attacks joints, begin with bilateral inflammation of certain joints, deformities occur
      - iii. Gouty arthritis- inflammation of joints is caused by a deposition of uric acid crystals from blood, can be controlled with diet

X. Developmental aspects of the skeletal system

- A. At birth, the skull bones are incomplete
- B. Bones are joined by fibrous membranes called fontanelles

- C. Fontanels are completely replaced with bone within two years after birth
- D. Ossification centers in a 12 week old fetus
- E. Skeletal changes throughout life
  - 1. Fetus
    - a. Long bones are formed of hyaline cartilage
    - b. Flat bones begin as fibrous membranes
    - c. Flat and long bone models are converted into bone
  - 2. Birth
    - a. Fontanels remain until around age 2
  - 3. Adolescence
    - a. Epiphyseal plates become ossified and long bone growth ends
    - b. Size of cranium in relationship to body
      - 1) 2 yrs old- skull is larger in proportion to body compared to that of an adult
      - 2) 8-9 yrs old- skull is near adult size and proportion
      - 3) Between 6-11 the face grows out from the skull
    - c. Curvatures of spine
      - 1) Primary curvatures are present at birth and are convex posteriorly
      - 2) Secondary curvatures are associated with a child's later development and are convex anteriorly
      - 3) Abnormal spinal curvatures (scoliosis and lordosis) are often congenital
  - 4. Old age
    - a. Osteoporosis
      - 1) Bone-thinning disease afflicting
        - a) 50% of women over age 65
        - b) 20% of men over age 70
      - 2) Disease makes bones fragile and bones can easily fracture
      - 3) Vertebral collapse results in kyphosis (also known as dowager's hump)
      - 4) Estrogen aids in health and normal density of a female skeleton