The Skeletal System

Chapter 6

Composition of the Skeletal System

- **Cartilage**: embryonic forerunner of most bones and covers many joint surfaces
- **Ligaments**: hold bone to bone at joint
- **Tendons**: attach muscles to bone

Functions of the Skeleton

- **Support**
- **Protection**
- **Movement**
- **Storage areas**
  - Minerals
  - Lipids
- **Hemopoiesis**
  - Red marrow

Histology of Bones

- **Bone = osseous tissue** (connective tissue)
  - Cells
    - Osteoblasts
    - Osteocytes
    - Osteoclasts
  - **Matrix**
    - 2/3 inorganic
      - hydroxyapatite crystals
      - Calcium carbonate
      - Other minerals
    - 1/3 organic
      - Mostly collagen fibers
Shape of Bones

- Long
- Short
- Flat
- Irregular

General Features of Bones

- **Compact (dense) bone**
  - Dense
  - White tissue that acts as outer shell
  - ¾ of skeleton
- **Spongy (cancellous) bone**
  - Loosely organized
  - Spaces between bone tissue
  - ¼ of skeleton

Anatomy of a Long Bone

- Diaphysis – shaft
- Epiphysis – extremity of bone
- Articular cartilage – covers epiphysis
- Periosteum – covering around surface of bone
- Nutrient Foramina
  - Blood vessels penetrate into bone
- Medullary cavity – marrow cavity in diaphysis
- Endosteum – lines medullary cavity

The Periosteum

- Two layers
  - Fibrous layer
  - Osteogenic layer
  - Osteoblasts

The Endosteum

- Single layer
  - Osteoclasts
  - Osteoblasts

General Features of Bones

- Pores
  - Living cells
  - Channels for blood vessels
  - Decrease weight of bone
- Degree of porosity
  - **Spongy (cancellous) bone**
    - Loosely organized
    - 25% of skeleton
  - **Compact bone**
    - Dense
    - 75% of skeleton
Compact Bone

- **Haversian system (Osteon)**
  - Volkmann’s canals
  - Haversian (central) canals
  - Lamellae
  - Lacunae
  - Canaliculi

Spongy Bone

- Composed of **trabeculae**
  - Spaces filled with bone marrow
  - Penetrated by blood vessels from periosteum

Bone Marrow

- Soft tissue
  - Medullary cavity
  - Spaces in trabeculae
  - Large central canals
- Two types
  - Red marrow
    - Hemopoietic
  - Yellow Marrow
    - Replaces red as we age
    - Turns to mainly fat

Ossification

- Embryo skeleton
  - Begins as cartilage & membrane
  - Bone formation begins about 6 weeks after fertilization
- 2 types
  - Intramembranous ossification
  - Endochondral ossification

Ossification

- 1st stage – embryonic mesenchyme cells migrate into future bone sites
  - Become chondroblasts or
  - Become osteoblasts

Intramembranous Ossification

- Mostly in flat bones
- Osteoblasts in the fibrous membrane secrete intercellular substances (matrix)
- Matrix becomes mineralized
- Formation of spongy bone
- Original layer of connective tissue remains as periosteum
**Intramembranous Bone Development**

- Occurs within a hyaline cartilage model
- Occurs in most bones of the body
- Periosteum forms at about week 8
- Calcification begins in center of diaphysis
  - **Primary ossification center**
  - **Secondary ossification centers** at epiphyses
  - Medullary cavity forms

**Endochondral Ossification**

- Occurs within a hyaline cartilage model
- Occurs in most bones of the body
- Periosteum forms at about week 8
- Calcification begins in center of diaphysis
  - **Primary ossification center**
  - **Secondary ossification centers** at epiphyses
  - Medullary cavity forms

**Fetus. 10 weeks**

- Cartilage bone of the skull
- Intramembranous ossification produces the roofing bones of the skull
- Primary ossification center of the lower limb (embryonic development of the hip bone)

**Remaining Cartilage**

- Articular cartilage
- **Epiphyseal plate**
  - Bone grows in length

(a) (b)
Homeostasis

- **Remodeling**
  - Different rates in body
  - Balance between osteoclasts and osteoblasts
  - Wolff’s law of bone
- **Factors affecting bone growth**
  - Calcium & phosphorus in diet
  - Vitamins A, C, & D
  - Hormones
    - Growth hormone, thyroxine
    - Calcitonin
    - Parathyroid hormone
    - Sex hormones

Disorders

- **Rickets**
  - Defective mineralization in children
    - insufficient sunlight
    - insufficient vitamin D
    - dietary deficiency of calcium or phosphate
    - liver or kidney diseases

- **Osteoporosis**
  - “Porous bones”
    - lack of estrogen
    - postmenopausal white women are at greatest risk
    - By age 70, average white woman has lost 30 – 50% of bone mass

Fractures

- **Stress fracture**
  - Caused by abnormal trauma to bone
- **Pathological fracture**
  - Due to weakening of the bone caused by disease or osteoporosis
- **Can be classified according to direction of fracture line or whether or not skin is broken**
- **Closed reduction**
  - Bone fragments in place
  - No surgery
- **Open reduction**
  - Surgery
  - Plates, screws or pins
- **Traction**
  - Aligns bone fragments
  - Children not adults
- **Heals in 8-12 weeks typically**

Bone Fractures
Fracture Repair

- **Hematoma** formation
- Formation of **fibrocartilagenous callus**
- Formation of **bony callus**
- Remodeling of bony callus