Chapter 6: Bones and Skeletal Development

- Histology of cartilage and bone
- Function of the skeletal system
- Bone terminology
- Bone development and growth
Skeleton = A bunch of bones with the person scraped off.
The skeletal system (like others) is multifunctional

- Support
- Storage of minerals and lipid
- Blood cell proliferation (red marrow)
- Protection (heart, brain, etc.)
- Leverage, Movement
- Metabolic role recently discovered
  - Osteocalcin increases insulin secretion
    - Produced by osteoblasts
Cartilage: Connective tissue

- Chondroblasts lay down the matrix,
- become chondrocytes when surrounded by EC matrix
- **Chondrocytes** do not mitose
- Poor healing
- No nerves, avascular
- On aging, cartilage becomes calcified
- Less flexible
- Not bone
Cartilage, cont’d

- **Elastic**: More flexible, e.g., ear, epiglottis

Hyaline
  Especially **articular**

Fibrocartilage
Resists compression—IV Disk, menisci
Typical (Long) Bone Structure
Types of Osseous Tissue

1. **Compact Bone**
   1. Dense, found in the walls, or cortex

2. **Spongy or Cancellous Bone**
   1. Network of struts and thin plates (trabeculae)

3. **Marrow**
   1. Red and Yellow
1. Compact Bone

- Osteon = functional unit of bone
- The mineral matrix is hydroxyapatite
- **Osteoblasts** lay down the matrix in layers (lamellae)
  - Become **osteocytes** when surrounded by EC matrix
  - **Lacunae**
- **Osteoclasts** break down bone
  - Often multinucleated
2. Spongy Bone

- No osteons
- Lacy network of struts called trabeculae reinforce the bone
- Covered by endosteum
3. Marrow

- Red Marrow
  - Active
  - Blood Precursors
- Yellow Marrow
  - Inactive
  - Mostly fat
Internal Organization of a Typical Bone

Osteon = Functional unit of bone
Types (shapes) of Bones

- **Long**
  - Femur

- **Short**
  - Carpal

- **Sesamoid**
  - Patella

- **Flat**
  - Scapula

- **Sutural**
  - Skull

- **Irregular**
  - Vertebra
Bone markings

Table 6.1, p 131

- Projection and Process
  - Tuberosity, tubercle
  - Trochanter
  - Lines and spines
  - Epicondyles
- Surfaces for Joints
  - Head, facet, condyle
- Depressions and holes
  - Foramen
  - Fossa

- Mostly a lab exercise
Bone Development

- Osteoblasts produce hydroxyapatite
- Osteoclasts break down the hydroxyapatite
- **Intramembranous Ossification**
  - Spongy bone
  - Plates of Bone e.g. skull
- **Endochondral Ossification**
  - Long Bones
Intramembranous Ossification

**Step 1:** Mesenchymal cells aggregate, differentiate into osteoblasts, and begin the ossification process. The bone expands as a series of spicules that spread into surrounding tissues. (LM × 32)

**Step 2:** As the spicules interconnect, they trap blood vessels within the bone. (LM × 32)

**Step 3:** Over time, the bone assumes the structure of spongy bone. Areas of spongy bone may later be removed, creating marrow cavities. Through remodeling, spongy bone formed in this way can be converted to compact bone.
Endochondral Ossification

**Step 1:** As the cartilage enlarges through appositional and interstitial growth, chondrocytes near the center of the shaft increase greatly in size. The matrix is reduced to a series of small struts that soon begin to calcify. The enlarged chondrocytes then die and disintegrate, leaving cavities within the cartilage.

**Step 2:** Blood vessels grow around the edges of the cartilage, and the cells of the perichondrium convert to osteoblasts. The shaft of the cartilage then becomes ensheathed in a superficial layer of bone.

**Step 3:** Blood vessels penetrate the cartilage and invade the central region. Fibroblasts migrating with the blood vessels differentiate into osteoblasts and begin producing spongy bone at a primary ossification center. Bone formation then spreads along the shaft toward both ends.

**Step 4:** Remodeling occurs as growth continues, creating a marrow cavity. The bone of the shaft becomes thicker, and the cartilage near each epiphysis is replaced by shafts of bone. Further growth involves increases in both length (Steps 5-6) and diameter (Fig. 5.9).

(a) Steps in endochondral ossification
Endochondral Ossification

**Step 5:** Capillaries and osteoblasts migrate into the epiphyses to create secondary ossification centers.

**Step 6:** Soon each epiphysis is filled with spongy bone. An articular cartilage remains exposed to the joint cavity; over time it will be reduced to a thin superficial layer. At each metaphysis, an epiphyseal cartilage separates the epiphysis from the diaphysis.

**(b) Light micrograph of an epiphyseal cartilage**

- Epiphyseal cartilage matrix
- Cartilage cells undergoing division
- Zone of proliferation
- Zone of hypertrophy
- Marrow cavity
- Osteoblasts
- Osteoid
Bone Circulation

Nutrient artery
Metaphyseal arteries (2)
Bone Remodeling

- Bones are metabolically very active
- Osteoid becomes hydroxyapatite
- Site for calcium, phosphorus storage
- Structure and strength are altered by need
Fractures

- Young vs. old patients
- Simple vs. open (compound) fractures
- Healing:
  - Reduction and stabilization
  - Formation of hematoma
  - Callus—
    - fibrocartilagenous and
    - bony
  - Remodeling—months later
Osteoporosis (p 141)

- Loss of bone mass weakness
- Both compact and spongy bone
- Post-menopausal women, some men
  - Estrogen replacement??
  - Other newer modalities
Osteoporosis (p 141)