

<u>Lecture Date</u>	<u>Topic</u>	<u>Reading in Marieb, Mallatt, and Wilhelm</u>
L5	Tues 1/27	Cartilage and bone tissues I
		Ch. 6, pp. 125-143

**Cartilages**

*avascular*  
*not innervated*  
*60-80% water*

**Location and basic structure (see Figure 6.1)**

1. *cartilages in the external ear*
  2. *cartilages in the nose*
  3. *articular cartilages*
  4. *costal cartilages*
  5. *cartilages in the larynx*
  6. *cartilages that hold open the air tubes of the respiratory system*
  7. *cartilages in the discs between the vertebrae*
  8. *cartilage in the pubic symphysis*
  9. *cartilages that form the articular discs within certain movable joints, e.g. the meniscus in the knee*
- perichondrium*

**Types of cartilage**

*hyaline cartilage*

*structure: thin collagen fibers; chondrocytes*  
*function: support through flexibility and resilience*  
*location: see Fig. 6.1*  
*lacuna*

*elastic cartilage*

*structure: elastic fibers and delicate collagen fibers; chondrocytes*  
*function: bendable, tolerates repeated bending*  
*location: epiglottis, outer ear*

*fibrocartilage*

*structure: rows of thick collagen fibers; chondrocytes*  
*function: resists both strong compression and strong tension (pulling) forces*  
*location: annulus fibrosis of vertebral discs, pubic symphysis, articular discs of some joints (e.g. menisci of knee)*

**Growth of cartilage**

*appositional growth*  
*interstitial growth*

**Bones**

*bones are organs, why?*

**Functions**

- 1) support
- 2) movement
- 3) protection
- 4) mineral storage (calcium and phosphate)
- 5) blood-cell formation and energy storage
  - red bone marrow
  - yellow bone marrow

## **Classification of bones**

### **Bone shapes**

- long bones
- short bones
  - sesamoid bones
- flat bones
- irregular bones

## **Gross anatomy of bones**

- compact bone
- spongy bone (trabecular bone)
  - trabeculae

### **Structure of long bones**

- diaphysis (shaft)
- epiphyses (bone ends)
- articular cartilage
- epiphyseal line
- epiphysial plate
- nutrient artery
- nutrient vein
- nutrient foramen
- epiphyseal artery
- epiphyseal vein
- medullary cavity (marrow cavity; yellow bone marrow)
- periosteum
  - dense irregular connective tissue (superficial)
  - osteogenic layer (deep)
    - osteogenic cells
    - osteoblasts
    - osteoclasts
  - perforating fibers (Sharpey's fibers)
  - collagen fibers
- endosteum
  - trabeculae
  - central canals of osteons
  - osteoblasts
  - osteoclasts

## **Bone design and stress**

*bone markings*

1) *projections that are attachment sites for muscles and ligaments*

*tuberosity*

*crest*

*trochanter*

*line*

*tubercle*

*epicondyle*

*spine*

*process*

2) *surfaces that form joints*

*head*

*facet*

*condyle*

3) *depressions and openings*

*for passage of vessels and nerves*

*foramen*

*groove*

*fissure*

*notch*

*others*

*fossa*

*meatus*

*sinus*

## **Microscopic anatomy of bones**

### **Compact bone**

*osteon (Haversian system)*

*lamella*

*central canal (Haversian canal)*

*perforating canals (Volkmann's canals)*

*osteocytes*

*lacunae*

*canaliculi*

*gap junctions*

*interstitial lamellae*

*circumferential lamellae*

### **Chemical composition of bone tissue**

*organic components*

*cells, fibers, ground substance*

*inorganic components*

*hydroxyapatites (mineral salts)*

*calcium phosphate*

### **Bone development**

*osteogenesis (ossification)*

*membrane bones*

*intramembranous ossification (from mesenchyme)*

*skull bones and clavicles (collarbones)*

*osteoid*

*woven bone tissue*

*Stage 1: an ossification center appears in the fibrous connective tissue*

*Stage 2: bone matrix (osteoid) is secreted within the fibrous membrane*

*Stage 3: woven bone and periosteum form*

*Stage 4: bone collar of compact bone forms and red marrow appears*

*endochondral bones (cartilage replacement bones)*

*endochondral ossification (from hyaline cartilage)*

*Stage 1: a bone collar forms around the diaphysis*

*hyaline cartilage model*

*perichondrium*

*periosteum*

*Stage 2: cartilage calcifies in the center of the diaphysis*

*Stage 3: the periosteal bud invades the diaphysis, and the first bone trabeculae form*

*periosteal bud*

*nutrient artery and vein*

*precursor cells of bone marrow*

*pre-osteoblasts and osteoclasts*

*primary ossification center*

*Stage 4: secondary ossification centers form in the epiphyses*

*epiphyseal plates (epiphyseal discs or growth plates)*

*Stage 5: ossification of the epiphyses (during childhood and adolescence)*

### **Anatomy of the epiphyseal growth areas**

*resting (quiescent) zone*

*growth (proliferation) zone*

*hypertrophic zone*

*calcification zone*

*ossification (osteogenic) zone*

*achondroplasia*

### **Postnatal growth of endochondral bones**

*closure of the epiphyseal plates*

*18 years, females*

*21 years, males*

### **Bone remodeling**

*remodeling units*

*bone resorption*

*osteoclasts (multinucleated; derived from immature blood cells, hematopoietic stem cells), may be related to macrophages*

*hydrochloric acid*

*lysosomal enzymes*

*calcium ions ( $Ca^{2+}$ )*

*phosphate ions ( $PO_4^{3-}$ )*  
*bone deposition*  
*osteoblasts (derived from mesenchyme-like stem cells)*  
*osteocytes*  
*parathyroid hormone*

### **Repair of bone fractures**

*fractures*

*simple fractures*

*compound fractures*

*reduction*

*closed reduction*

*open reduction*

*Stages of healing*

*Stage 1: hematoma formation*

*Stage 2: fibrocartilaginous callus formation*

*soft callus (fibrous granulation tissue)*

*fibrocartilaginous callus (fibrocartilage and hyaline cartilage)*

*Stage 3: bony callus formation*

*hard callus*

*Stage 4: bone remodeling*

### **Disorders of bones**

*osteoporosis (“bone-porous-condition”)*

*osteomalacia (adults; “soft bones”)*

*rickets (children)*

*vitamin D*

*calcium phosphate*

*Paget’s disease*

*Pagetic bone*

*osteosarcoma*