Cartilage and Bone

- Cartilage--function, types, location
- Bone Tissue--structure, types
- Long Bone Structure and Development
- Most common bone problems
  - Fractures
  - Osteoporosis

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What is cartilage?

- **Skeletal tissue**—maintains certain shape and form
- **Very resilient** (bouncy or rubbery), mostly water
- **Grows fast**—forms embryonic skeleton
Kinds of cartilage

- Hyaline cartilage--most common, found in joints
- Elastic cartilage--epiglottis, ear
- Fibrocartilage--annular fibrosis of intervertebral disk, menisci of knee
Figure 6.1
Bones provide:

- Support and movement (limbs, axial skeleton)
- Protection (skull bones)
- Mineral storage
- Blood cell development (long bone marrow)

Bone is made up of:

- 35% collagen, ground substance and cells
- 65% inorganic calcium (hydroxyapatite)
Bone is alive!! Bone cell types:

- **Osteoblasts**: Make and deposit components of bone extracellular matrix
- **Osteoclasts**: Degrade and resorb bone for remodeling
- **Osteocytes**: “watcher cells” Sit in bone and monitor its current status
Types of bony tissue

- Compact Bone
  - Dense tissue at surface of bones
  - Haversian canals
  - Osteocytes in lacunae
  - Highly vascularized
  - Fig. 6.6, p. 138
Types of bony tissue

- **Spongy bone**
  - Trabeculae (oriented to give mechanical strength)
  - Interior of long bones, skull bones
  - Epiphyses of long bones
  - Intramembranous ossification (osteoblasts lay down bone around blood vessels in connective tissues of dermis (after 8 weeks of development)
Structure of a long bone

- Diaphysis (shaft)
- Epiphysis
  - Proximal
  - Distal
- Compact bone
- Spongy bone
- Periosteum
- Medullary cavity
- Articular/hyaline cartilage
- Nutrient V/A/N
- Epyphyseal (growth) plates

Fig. 6.3, p. 135
Bone Tissue within a Bone
Why do bones need to “remodel?”

**Growth**

Bone grows in length because:

1. Cartilage grows here
2. Cartilage replaced by bone here
3. Cartilage grows here
4. Cartilage replaced by bone here

**Remodeling**

Growing shaft is remodeled by:

1. Bone resorbed here
2. Bone added by appositional growth here
3. Bone resorbed here
Endochondral Ossification

1. Cartilage model
2. Bone collar forms in diaphysis (dense bone)
   - Cartilage chondrocytes in center of diaphysis die and cartilage disintegrates
3. Periosteal bud enters diaphysis
   - Makes spongy bone at ends of diaphysis (primary ossification center)
4. Epiphysis begins to ossify (secondary ossification center)
5. Hyaline cartilage remains only at
   - Epiphyseal surfaces (articular surfaces of joints)
   - Epiphyseal growth plates between diaphysis and epiphysis (primary and secondary centers)
1. Formation of bone collar around hyaline cartilage model.
2. Cavitation of the hyaline cartilage within the cartilage model.
3. Invasion of internal cavities by the periosteal bud and spongy bone formation.
4. Formation of the medullary cavity as ossification continues; appearance of secondary ossification centers in the epiphyses in preparation for stage 5.
5. Ossification of the epiphyses; when completed, hyaline cartilage remains only in the epiphyseal plates and articular cartilages.
Endochondral ossification centers—newly formed bone within cartilage shown is stained red.
<table>
<thead>
<tr>
<th>Osteoclasts</th>
<th>Osteoblasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Dig holes” with hydrochloric acid</td>
<td>Line tubes (Haversian canals) left by osteoclasts</td>
</tr>
<tr>
<td>Degrades calcium</td>
<td>Lay down new bone in circular concentric lamellae</td>
</tr>
</tbody>
</table>
| Phagocytize collagen fibers and dead osteocytes | Unique to warm-blooded animals—dinosaurs???
Bone Fractures

- Treatment is reduction
  - Closed--set in place by physical manipulation from outside body
  - Open--surgical placement of pins or screws

- Healing
  - Hematoma
  - Fibrocartilaginous callus
  - Bony callus
  - Remodeling by osteoclasts/osteoblasts

- Types of Fractures
Comminuted: Bone fragments into three or more pieces. Particularly common in the aged, whose bones are more brittle.

Compression: Bone is crushed. Common in porous bones (i.e., osteoporotic bones) subjected to extreme trauma, as in a fall.

Spiral: Ragged break occurs when excessive twisting forces are applied to a bone. Common sports fracture.

Epiphyseal: Epiphysis separates from the diaphysis along the epiphyseal plate. Tends to occur where cartilage cells are dying and calcification of the matrix is occurring.
TABLE 6.2  
Common Types of Fractures (continued)

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Description and Comments</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Depressed</td>
<td>Broken bone portion is pressed inward</td>
<td>Greenstick</td>
<td>Bone breaks incompletely, much in the way a green twig breaks. Only one side of the shaft breaks; the other side bends</td>
</tr>
<tr>
<td></td>
<td>Typical of skull fracture</td>
<td></td>
<td>Common in children, whose bones have relatively more organic matrix and are more flexible than those of adults</td>
</tr>
</tbody>
</table>

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Fracture repair

1. Hematoma formation
2. Fibrocartilaginous callus formation
3. Bony callus formation
4. Bone remodeling

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Calcium regulation is negative feedback mechanism.
- Affects elderly, especially women
- Bone resorption proceeds faster than deposition
- Low estrogen levels implicated but estrogen replacement now considered risky
- Importance of calcium in diet???
- Leads to fractures
  - Compression fractures of vertebrae
  - Neck of femur
Bone grafts and artificial bone

- Widely used cutting-edge technologies
- Bone cells highly regenerative and move into any suitable matrix
  - Use bone pieces from same body—fibula
  - Use crushed bone from cadavers
  - Use bone substitutes—coral, synthetics—“nanotechnology”
- Applications are numerous
  - Jaw bone filler for dental work
  - Birth defects
  - Osteoporosis
  - Bone repair