The most amazing story of bone histology!
Functions of Bone

- Supports soft tissue
- Protects vital organs (cranium, thoracic cavity)
- Contains bone marrow
- Reservoir of Ca++, PO4 to maintain constant concentrations in body fluids
- Allows body to move
Specialized CT

- Cells
  - Osteoblasts
  - Osteocytes
  - Osteoclasts
- Bone matrix
  - Calcified material, lacunae
- And more…. 
  - Canaliculi
  - Periosteum
  - Endosteum
Anatomy of a Long Bone
Osteoblasts

- Synthesize organic components of matrix (collagen type I, proteoglycans, glycoproteins.)
- Collagen forms osteoids: strands of spiral fibers that form matrix
- Influence deposit of Ca++, PO4.
- Active vs inactive osteoblasts
- Estrogen, PTH stimulate activity
Osteoblasts
Osteocytes

- Mature bone cells that sit in lacunae
- Gap junctions between osteocytes provide nutrition (15 cells in a row)
- Maintain bony matrix; long lived cells
- Stimulated by calcitonin; inhibited by PTH
Osteocyte with Cytoplasmic Extensions
Osteocytes with Canaliculi

Photomicrograph of dried bone ground very thin. The lacunae and canaliculi filled with air deflect the light and appear dark, showing the communication between these structures through which nutrients derived from blood vessels flow. Medium magnification.
Osteoclasts

- Derived from monocytes; engulf bony material
- Active osteoblasts stimulate osteoclast activity
- Large, branched, motile cells
- Secrete enzymes that digest matrix
Bone-Resorbing Osteoclast

Developing medullary cavity

Osteoclast
Osteoclasts
Bone Resorption

- Osteoclast
- Nucleus
- Golgi
- Lysosomes
  - \( \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{HCO}_3^- \)
- Ruffled border
- Bone matrix
- Section of circumferential clear zone
- Blood capillary
- Microenvironment of low pH and lysosomal enzymes
On this image, the deepest red color is bone while pink represents either fibrocartilage (i.e., collagen within cartilage) or mineralized cartilage. The central clearing represents the invasion of bone into calcified cartilage. **Osteoblasts** are laying down new bone toward the left of the upper boundary of this cavity. **Osteoclasts** are removing previously-formed bone.
Remodeling
Bone Replacing Cartilage

- fibrocartilage
- osteoblasts
- bone
- osteocytes
- chondrocytes
- osteoclasts
- calcified cartilage
Remodeling Bone

- Osteoblasts
- Osteocytes
- Osteoclasts
- Bone matrix
Bone Remodeling

- http://www.siumed.edu/~dking2/ssb/skeleton.htm#bone
Endochondral Ossification
Photomicrograph of endochondral ossification. In the upper region is a row of osteoblasts with intense cytoplasmic basophilia, a feature to be expected in cells synthesizing a glycoprotein (collagen). Note an osteoblast being captured in the bone matrix (arrow). Between the layer of osteoblasts and the calcified bone matrix is a pale region made of noncalcified bone matrix called osteoid. PT stain. Medium magnification.
Periosteum

Mesenchyme
Fibroblasts
Osteoprogenitor cells
Compact Bone

Compact bone

Yellow marrow in medullary cavity

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Epiphyses of the Femur

(b) Remnant of epiphyseal disk  Spongy bone  Compact bone

Courtesy of John W. Hole Jr.
Osteon

- Long cylinder parallel to long axis of diaphysis
- Consists of:
  - Haversian canal with nerves, blood vessels; lamellae with osteocytes
- Haversian canals communicate with marrow cavity, periosteum, other canals through Volkmann’s canals
Compact Bone
OSTEONS  (wow!)
Canaliculi between Osteocytes
Endochondral Bone Development

- Cartilaginous model
  - Calcified cartilage

- Developing periosteum

- Compact bone developing
  - Blood vessel
  - Secondary ossification center
  - Primary ossification center

- Remnants of epiphyseal disk
  - Articular cartilage

- Compact bone
  - Epiphyseal disk
  - Medullary cavity
  - Remnant of epiphyseal disk

- Spongy bone
  - Articular cartilage