Human Anatomy
Unit 1

OSTEOLOGY: BONE DEVELOPMENT
In Anatomy Today
General Anatomy of Long and Flat Bones

• Composition
  – Compact (Dense) outside
  – Spongy inside
    • Flat bones = diploe

• Regions of long bone
  – Diaphysis
  – Epiphysis
  – Marrow (medullary) cavity
  – Epiphyseal plate vs. epiphyseal line (18-25 years)
  – Periosteum
    • Fibrous layer
    • Osteogenic layer (cellular layer)
    • Sharpey’s fibers
  – Nutrient foramina
  – Endosteum
  – Articular cartilage
(a) The peristeam contains outer (fibrous) and inner (cellular) layers. Collagen fibers of the peristeam are continuous with those of the bone, adjacent joint capsules, and attached tendons and ligaments.

(b) The endosteum is an incomplete cellular layer containing osteoblasts, osteoprogenitor cells, and osteoclasts.

(c) A tendon–bone junction

LM × 100
Gross Anatomy of a Long Bone

- Articular surface of head of femur
- Epiphysis
- Metaphysis
- Diaphysis (shaft)
- Compact bone
- Medullary cavity

(a) Femur

- Spongy bone
- Branches of nutrient artery and vein
- Periosteum
- Connections to superficial osteons
- Nutrient artery and vein
- Metaphyseal artery and vein
- Epiphyseal cartilage
- Articular cartilage
- Epiphyseal artery and vein
- Periosteum
- Compact bone
- Medullary cavity
- Nutrient foramen
- Metaphysis
Development of Bones

• Ossification = osteogenesis
  – deposition of bone tissue
  – begins at approx 4 weeks gestation
  – apparent at approx 10 weeks
  – bone tissue arises as connective tissue from embryonic mesenchyme

– Two types
  • Endochondral
  • Intramembranous
Intramembranous bones forming

Endochondral bones forming

16 weeks of development
Endochondral Bone Formation

• Built from a hyaline cartilage model
  – Perichondrium present
• Ossification results in spongy bone first then the bone is remodeled and an outer layer of compact bone forms
• 1º center of ossification in diaphysis
• 2º centers of ossification in epiphysis
Endochondral Bone Formation
Endochondral Bone Formation

**STEP 5**
Capillaries and osteoblasts migrate into the epiphyses, creating secondary ossification centers.

- Hyaline cartilage
- Epiphysis
- Metaphysis
- Periosteum
- Compact bone
- Secondary ossification center

**STEP 6**
Soon the epiphyses are 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.

- Articular cartilage
- Spongy bone
- Epiphyseal cartilage
- Diaphysis

Image: (b) Zone of proliferation
- Epiphyseal cartilage matrix
- Cartilage cells undergoing division
- Medullary cavity
- Osteoblasts
- Osteoid
- LM × 250

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Increasing the Length of a Developing Bone

• Growth in both directions at the metaphyses or growth plates
  – On the shaft side:
    • Osteoblasts are continuously replacing cartilage with bone
  – On the Epiphysis side:
    • New cartilage is being produced at the same rate of cartilage replacement on the shaft side

• Growth in opposite directions causes the bone to lengthen
Increasing the Diameter of a Developing Bone

- Appositional growth on the outer surface
- Osteoprogenitor cells of the inner layer of the endosteum differentiate into osteoblasts
- Matrix is deposited to the outer (periosteal) surface
  - Adds layers of circumferential lamellae
- Marrow cavity enlarges as bone diameter enlarges
Intramembranous Bone Formation

Dermal Bone Formation

• Ossification occurs in the deeper layers of the dermis
• Forms
  – Roofing bones of the skull, mandible, clavicle
• Bone tissue deposited within embryonic or fibrous connective tissue
• Mesenchymal cells differentiate into osteoblasts
• Spongy bone may be remodeled to form medullary cavities or compact bone
  – Diploe: spongy bone between 2 layers of compact bone
• Process of bone repair due to fractures
Bone Repair
Intramembranous Bone Formation

1. Embryonic mesenchyme condenses into a soft sheet permeated with blood capillaries. The mesenchymal cells in this sheet soon differentiate into osteogenic cells, which further differentiate into osteoblasts.

2. Osteoblasts form rows on the surface of a mesenchymal sheet, secrete a layer of osteoid tissue, and then calcify it to form bony plates, or trabeculae. Osteoblasts that become trapped in the matrix become osteocytes. A fibrous peristeum forms external to the osteoblast layer.

3. Continued bone deposition forms a honeycomb of bony trabeculae enclosing marrow spaces with blood vessels.

4. Further ossification at the surface of the bone fills in the spaces and produces surface plates of compact bone. Spongy bone remains in the center of the plate, forming the typical sandwichlike arrangement of a flat bone. In the skull, this middle layer of spongy bone is called the diploe.
(b) Right lateral view

- Parietal bone
- Anterior (frontal) fontanel
- Coronal suture
- Frontal bone
- Anterolateral (sphenoid) fontanel
- Sphenoid bone
- Temporal bone
- Occipital bone
- Posterior (mastoid) fontanel
- Squamous suture
- Lambdoid suture
- Frontal suture