

Module 4 LO5

Bone Development

Dr. Lisa Brinn

lbrinn@fiu.edu

5. Bone Development

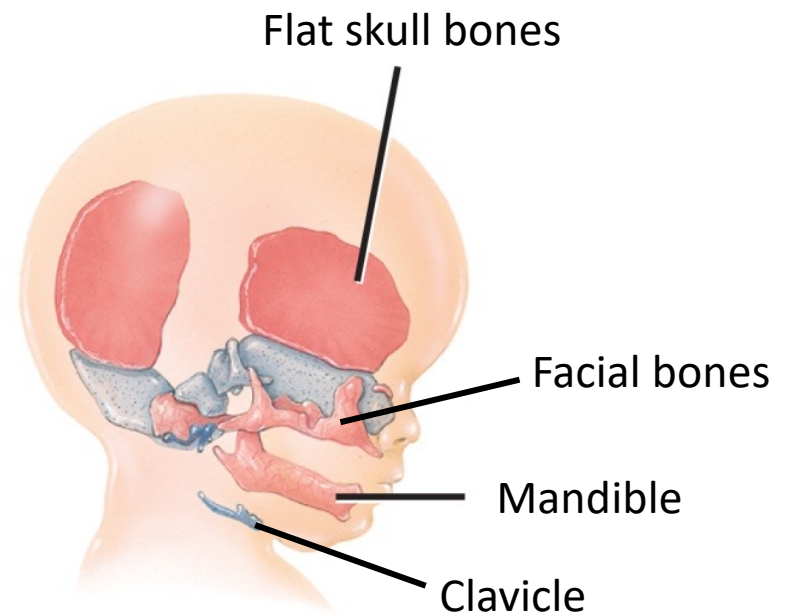
- Ossification (osteogenesis)
 - Process by which bone is formed
- Occurs in 4 principal situations
 - A. Embryo and fetus - initial bone formation
 - B. Infancy, childhood, adolescence – bone growth until adult
 - C. Remodeling of bone – replacing old for new throughout life
 - D. Repair fractures throughout life

Bone Formation

- Involves replacement of preexisting connective tissue (mesenchyme) with bone
- A. Intramembranous ossification
 - Bone forms directly within condensed mesenchymal cells
 - Mesenchymal cells
 - Arranged in sheet-like layers that resemble membranes
- B. Endochondral ossification
 - Bone forms within hyaline cartilage that develops from mesenchymal cells

A. Intramembranous Ossification

- Simpler process than endochondral ossification
- Examples:
 - flat bones of the skull
 - Most facial bones
 - Mandible
 - clavicle
- Involves a 4-step process



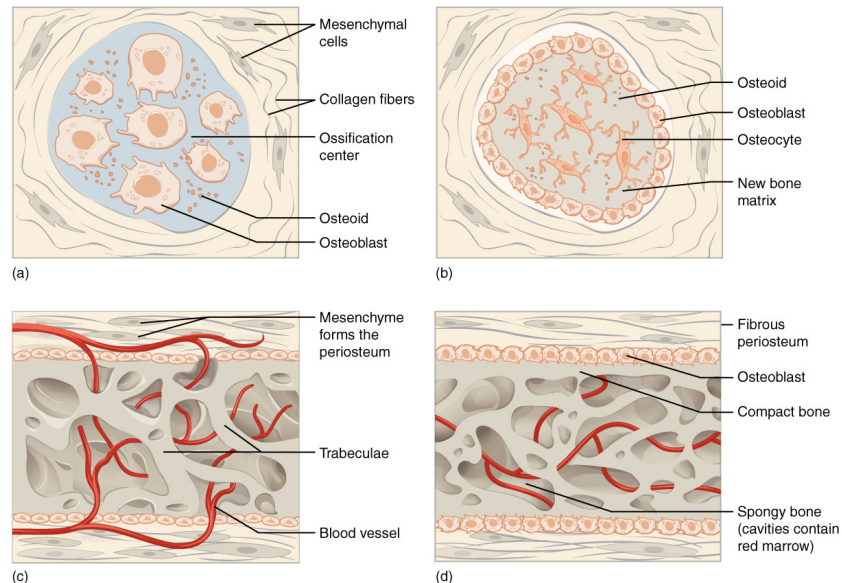
Steps of Intramembranous Ossification

Spongy Bone Formation

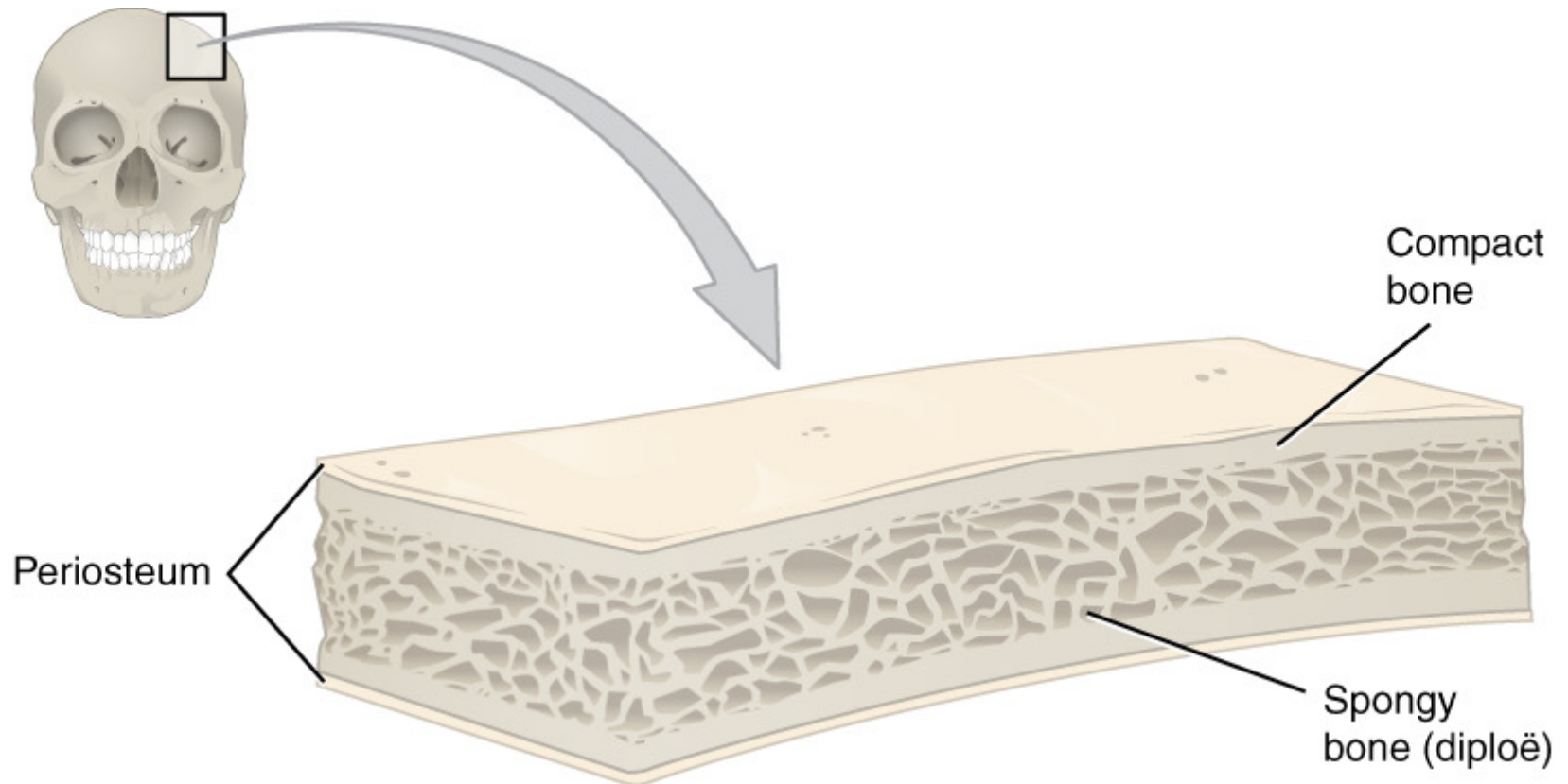
Mesenchymal cells ->
osteoprogenitor cells ->
Osteoblasts ->
Produce bone matrix ->
Surround collagen fibers ->
Osteocytes ->
Develop tiny trabeculae->
More and More: ->
Spongy bone

Compact Bone Formation

Mesenchymal cells ->
Periosteum ->
Osteoblasts ->
Bone matrix ->
Compact bone



Anatomy of Flat Bone

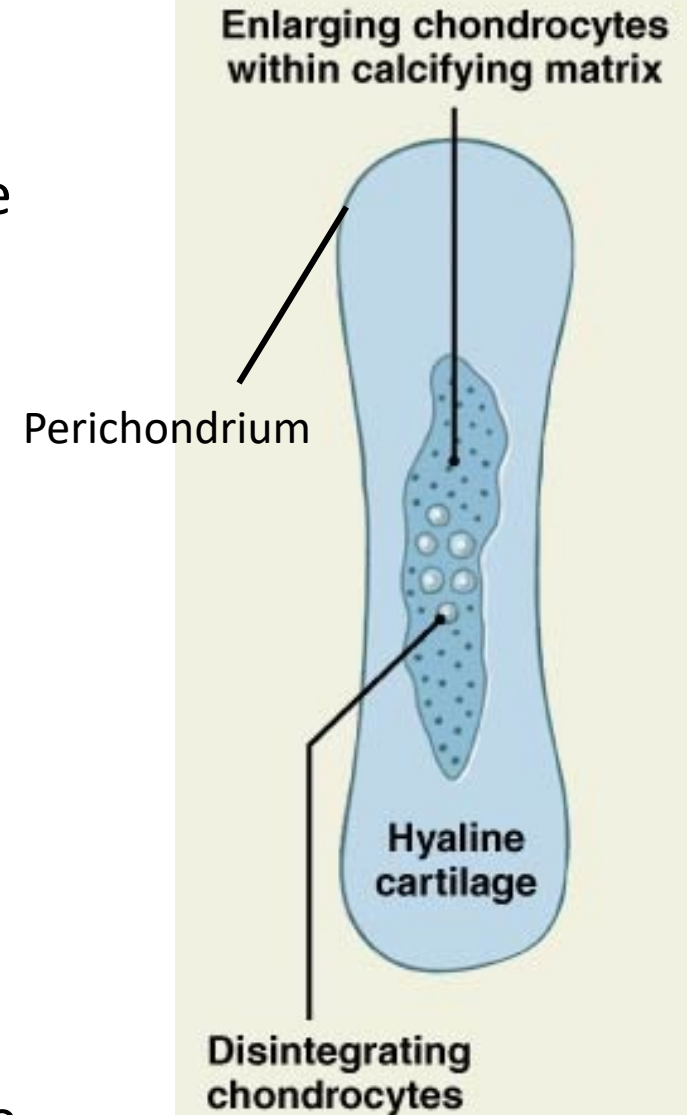


B. Endochondral Ossification

- 6-7 steps
- Step 1 – Formation of hyaline cartilage model
- Step 2 - Formation of collar bone
- Step 3 – Formation of primary ossification center
- Step 4 – osteoblasts invade metaphyses
- Step 5 – Formation of secondary ossification center
- Step 6 – Formation of epiphyseal cartilage (epiphyseal plate)
- Step 7 – Epiphyseal closure

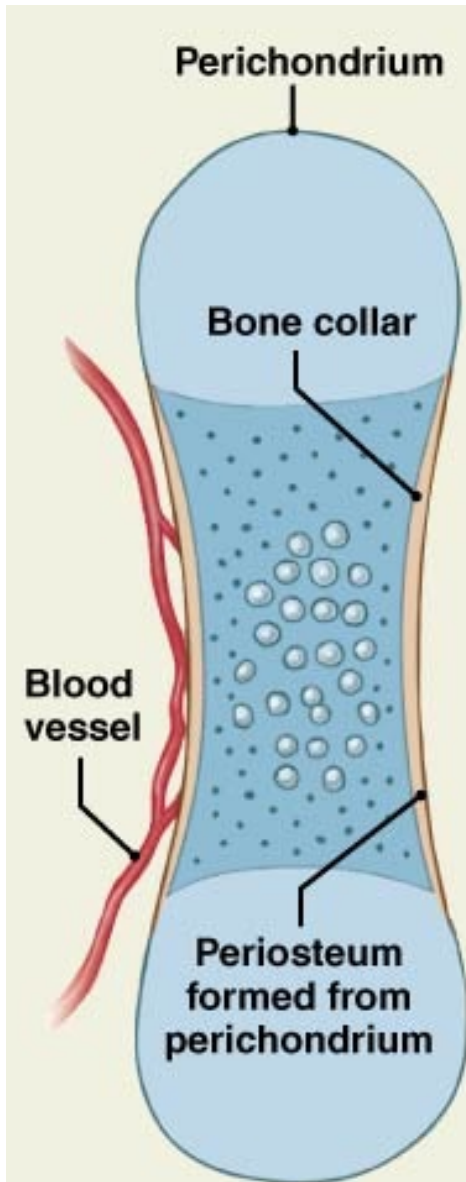
Step 1

- Mesenchymal cells concentrate in future bone region ->
- Differentiate into osteochondral progenitor cells ->
- Become chondroblasts ->
- Produce hyaline cartilage model with perichondrium surrounding it
- Chondrocytes near the center of the diaphysis increase in size
- Surrounding matrix begins to calcify
- Chondrocytes die and disintegrate due to lack of nutrients
- Formation of cavities within the cartilage



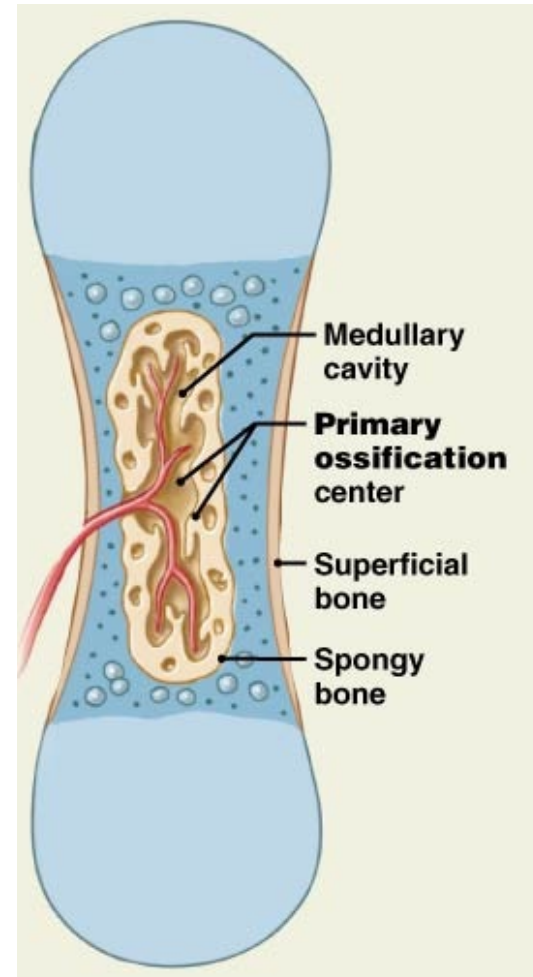
Step 2

- Blood vessels grow around the edges of the cartilage
- Cells of perichondrium differentiate into osteoblasts
- Perichondrium converts into periosteum
- Formation of bone collar
 - Thin layer of compact bone around the shaft of cartilage



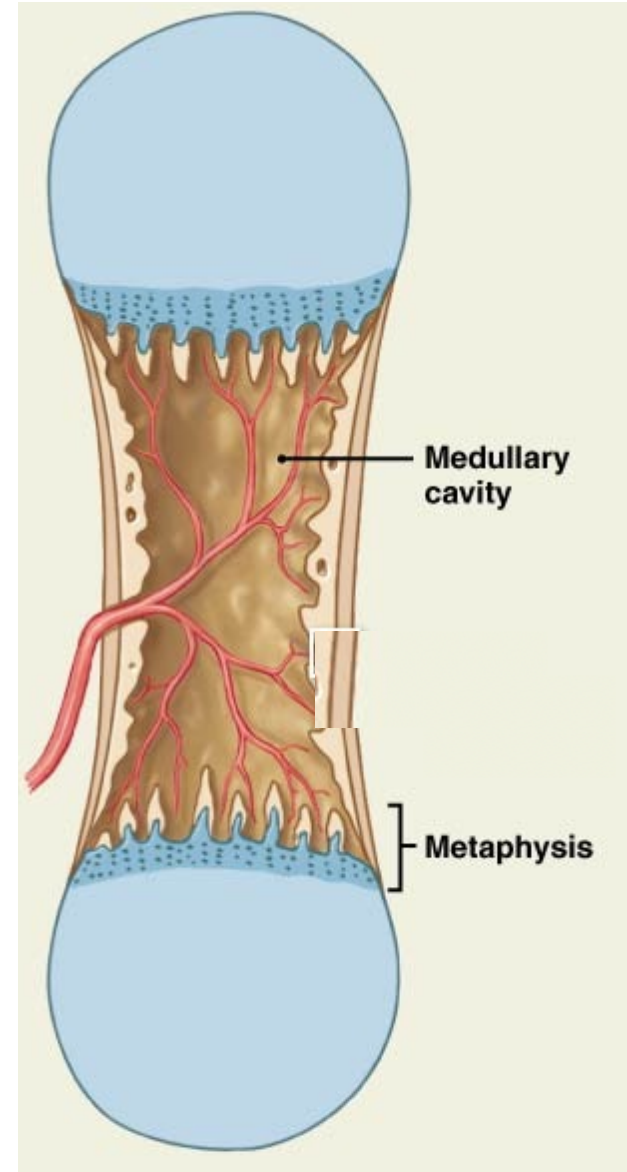
Step 3

- Increased blood supply
 - Capillaries and osteoblasts migrate into the heart of cartilage, invading spaces left by chondrocytes
- Primary ossification center
 - Cartilaginous matrix is replaced by spongy bone produced by osteoblasts
 - Localized medially and moves toward ends



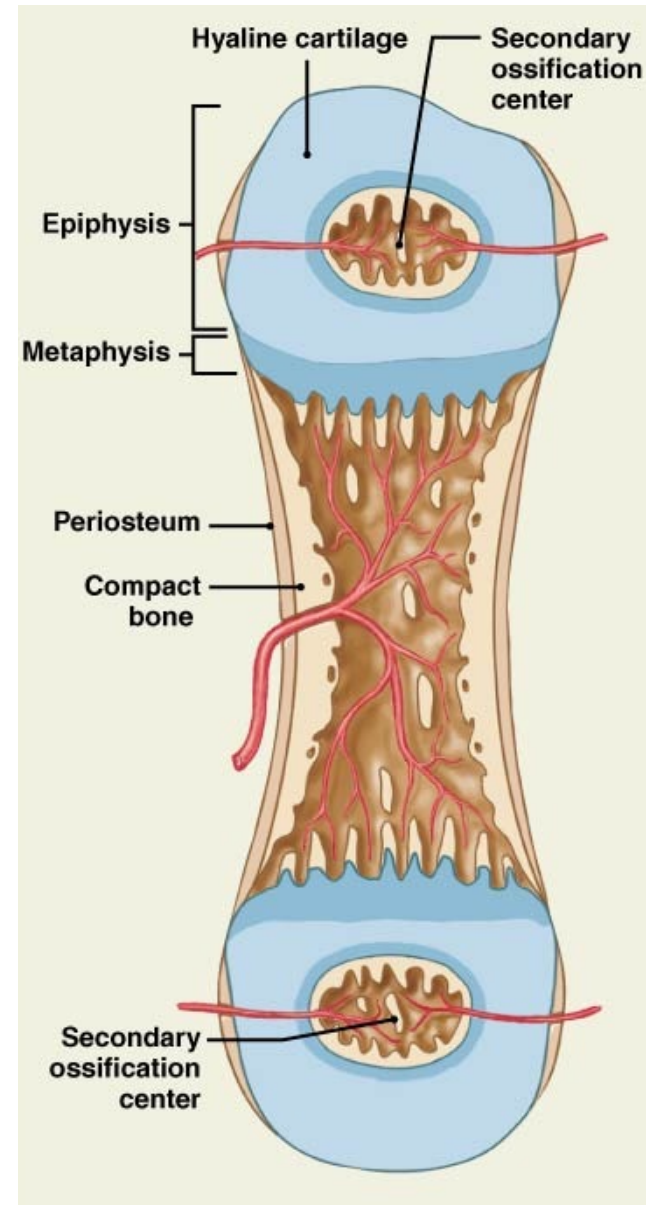
Step 4

- Shaft filled with spongy bone
- Osteoclasts create medullary cavity
- Shaft becomes thicker
- Cartilage of metaphysis invaded by osteoblasts
 - Production of bone columns
- Further growth:
 1. Increase in length
 2. Diameter enlargement



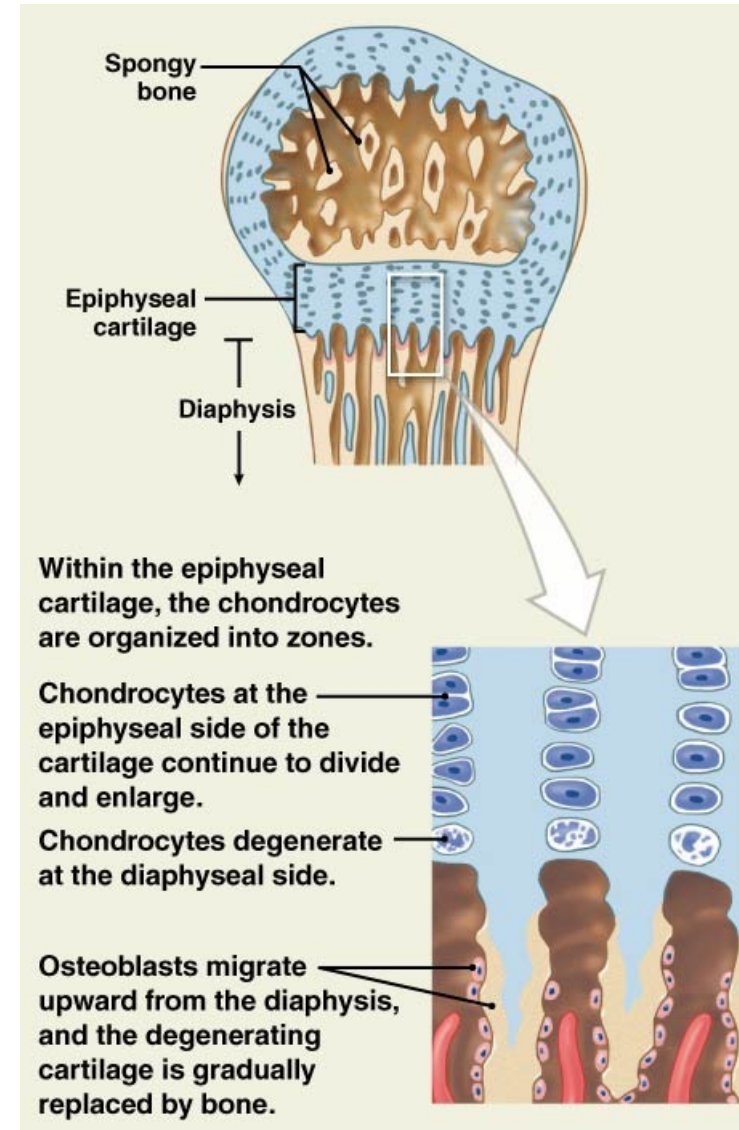
Step 5

- Formation of Secondary Ossification Center
 - Migration of capillaries and osteoblasts into epiphyses
- Present at birth
 - Femur
 - Tibia
 - Humerus



Step 6

- Epiphyses filled with spongy bone
- Formation of epiphyseal cartilage (epiphyseal plate)
 - Between epiphyses and diaphyses
- Osteoblasts invade shaft side of epiphyseal cartilage, replacing cartilage with bone at same rate that epiphyseal cartilage enlarges
 - Enlargement pushes epiphysis away from diaphysis – length of bone increases



Step 7

- ↓rate of epiphyseal plate enlargement
- ↑rate of osteoblast activity



- **Epiphyseal closure**

- Epiphyseal plate gets narrower and narrower; eventually disappears
- Epiphyseal plate → epiphyseal line
- Epiphyseal plate remains cartilaginous until skeletal maturity (depends on bone)
- Articular cartilage
 - Thin cap of original cartilage exposed to joint cavity
 - Prevents damaging bone-to-bone contact within joint

