

# ANATOMY OF BONE AND CARTILAGE

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# BONE (syn – Os; Osteon)

- Osseous tissue, a specialised form of dense connective tissue consisting of bone cells (osteocytes)
- Embedded in a matrix of calcified intercellular substance
- Bone matrix contains collagen fibres and the minerals calcium phosphate and calcium carbonate

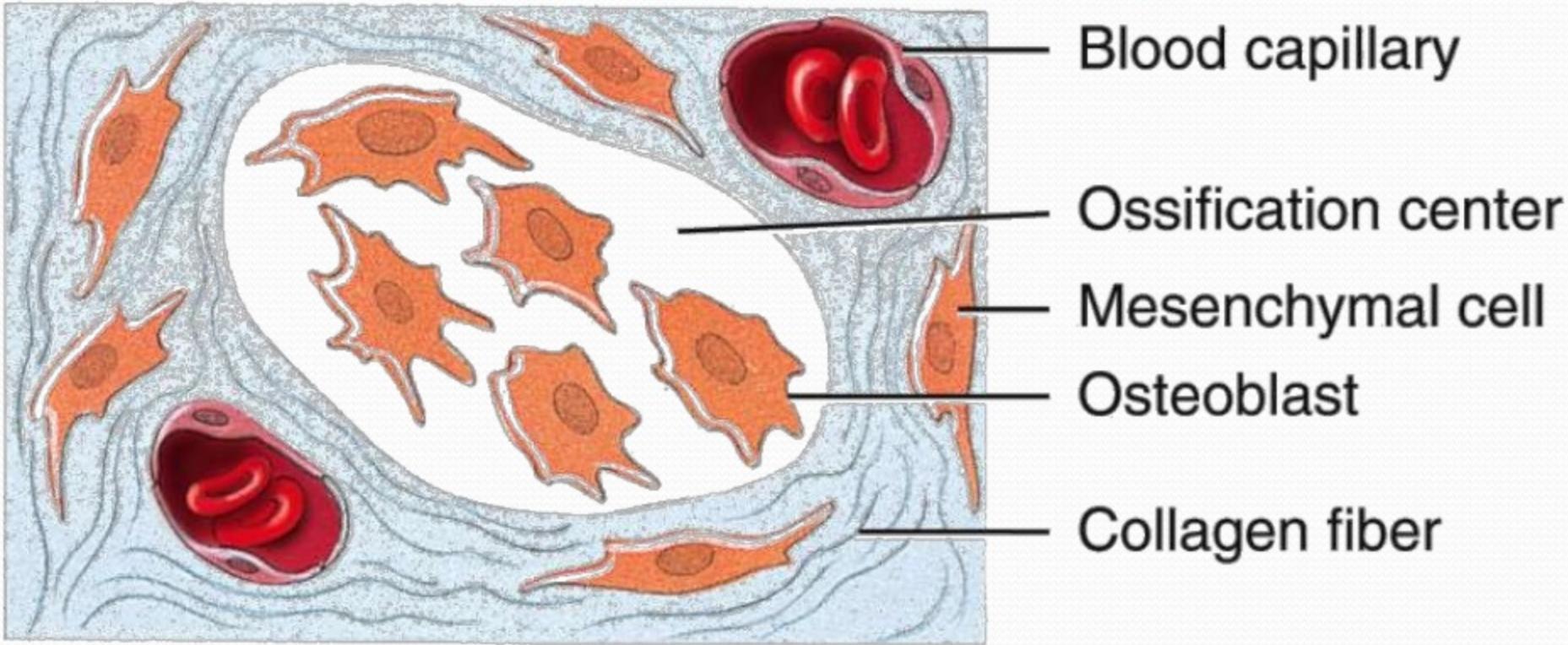
# FORMATION OF BONE

- The process of bone formation - ossification
- All bone is of mesodermal origin
- Two types of ossification
  1. Intramembranous ossification
  2. Endochondral ossification

# INTRAMEMBRANOUS OSSIFICATION

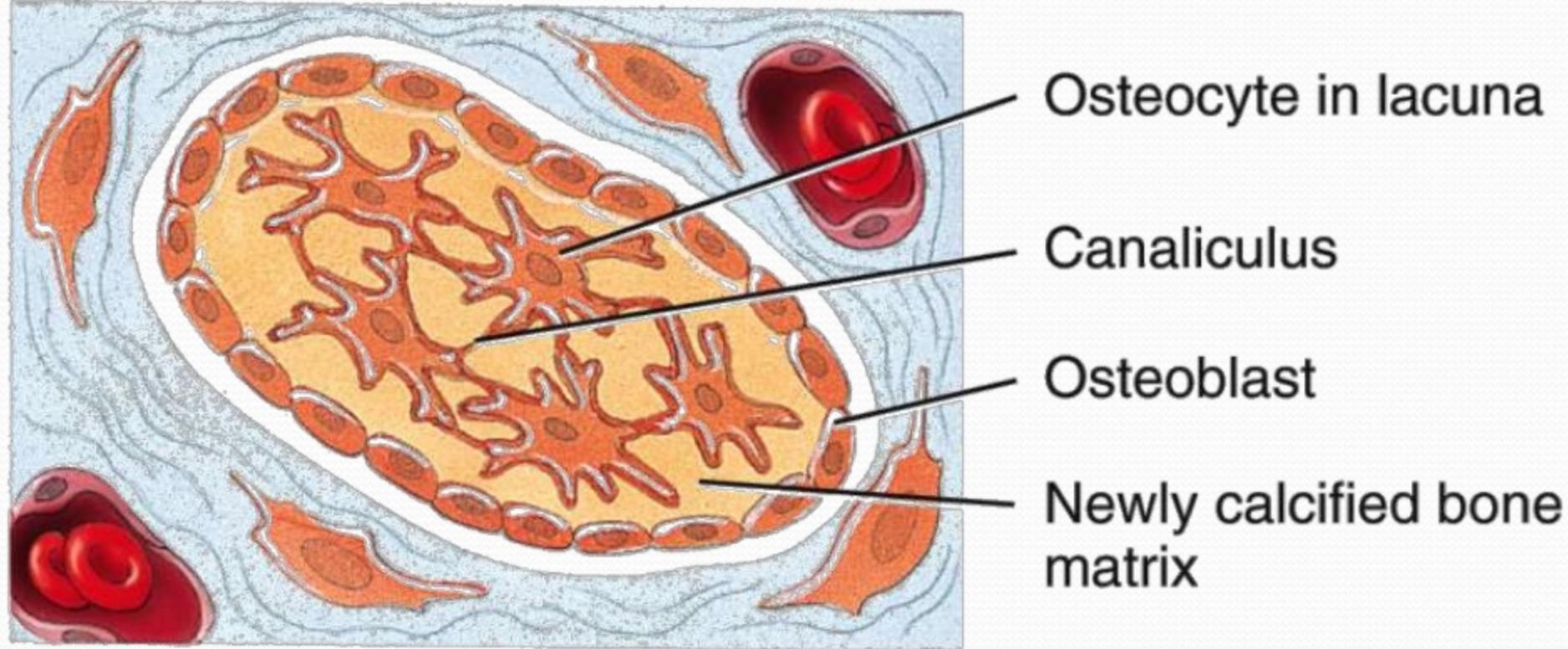
- Mesenchymal condensation
- Highly vascular
- Laying down of bundles of collagen fibres in the mesenchymal condensation
- Osteoblast formation – OSTEOID
- Calcium salts deposition – lamellus of bone

## BONE FORMATION- Intramembranous ossification



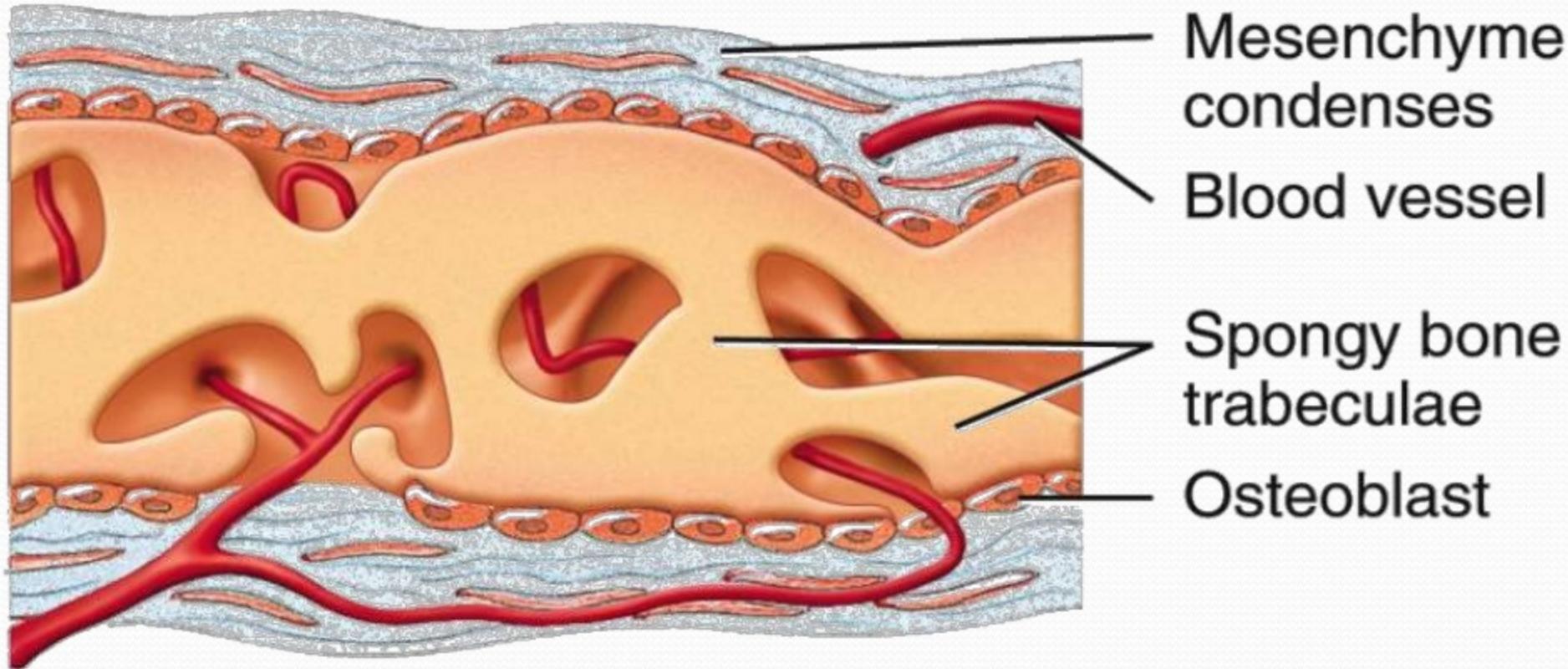
- 1 Development of ossification center:  
osteoblasts secrete organic  
extracellular matrix

## BONE FORMATION - Intramembranous ossification



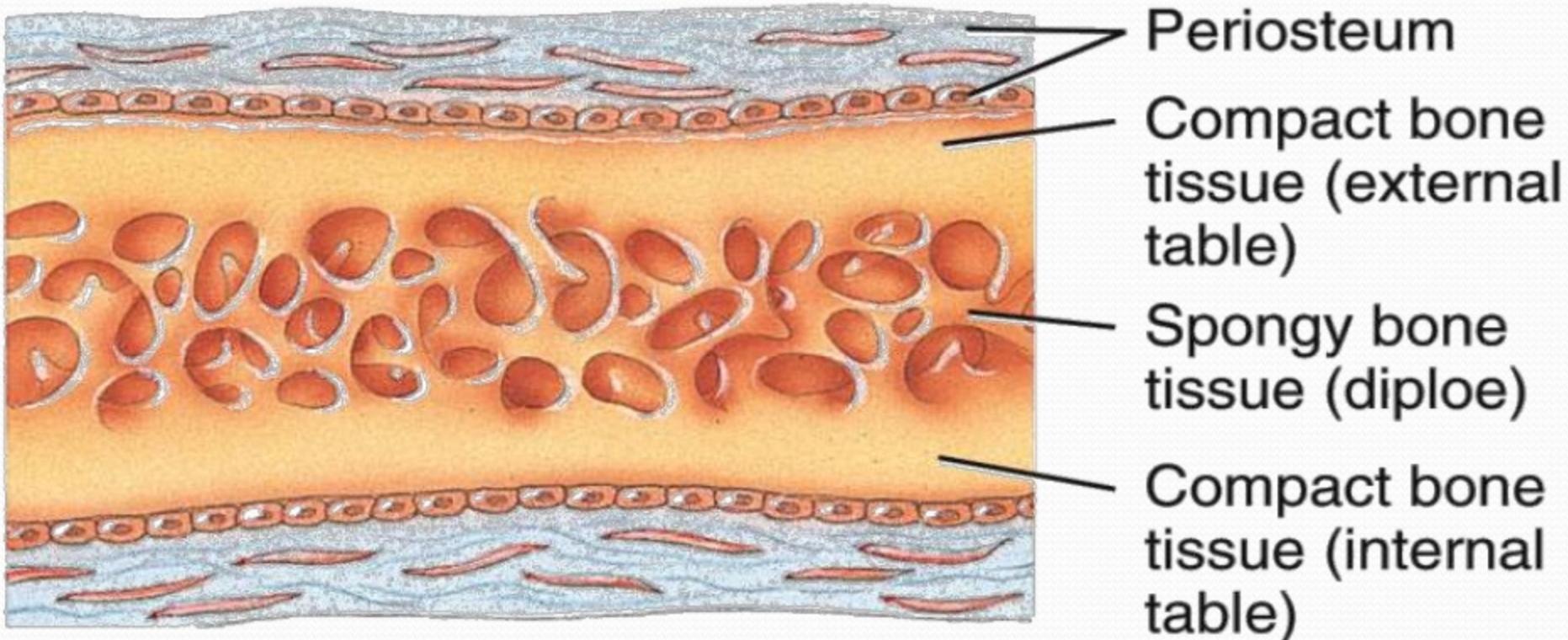
- 2 Calcification: calcium and other mineral salts are deposited and extracellular matrix calcifies (hardens)

## BONE FORMATION - Intramembranous ossification



- 3 Formation of trabeculae: extracellular matrix develops into trabeculae that fuse to form spongy bone

## BONE FORMATION - Intramembranous ossification



- 4 Development of the periosteum:  
mesenchyme at the periphery of the  
bone develops into the periosteum

# ENCHONDRAL OSSIFICATION

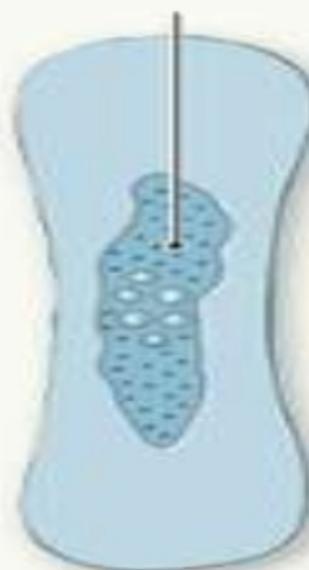
- Ossifies bones that originate as hyaline cartilage
- Most bones originate as hyaline cartilage
- Growth and ossification of long bones occurs in 6 steps

# STEP 1

- Chondrocytes in the center of hyaline cartilage:
  - enlarge
  - form struts and calcify
  - die, leaving cavities in cartilage

As the cartilage enlarges, chondrocytes near the center of the shaft increase greatly in size. The matrix is reduced to a series of small struts that soon begin to calcify. The enlarged chondrocytes then die and disintegrate, leaving cavities within the cartilage.

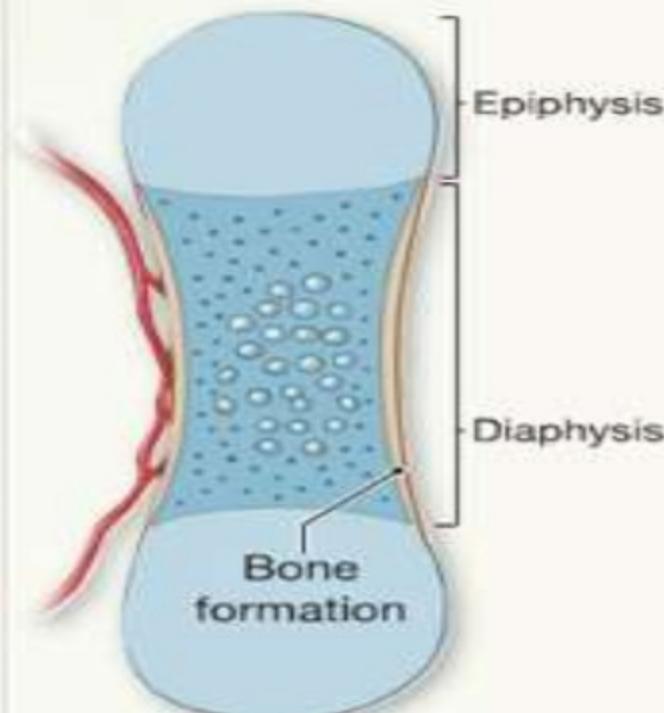
Enlarging chondrocytes within calcifying matrix



Hyaline cartilage

## STEP 2

- Blood vessels grow around the edges of the cartilage
  - Cells in the perichondrium change to osteoblasts:
    - producing a layer of superficial bone around the shaft which will continue to grow and become compact bone (appositional growth)



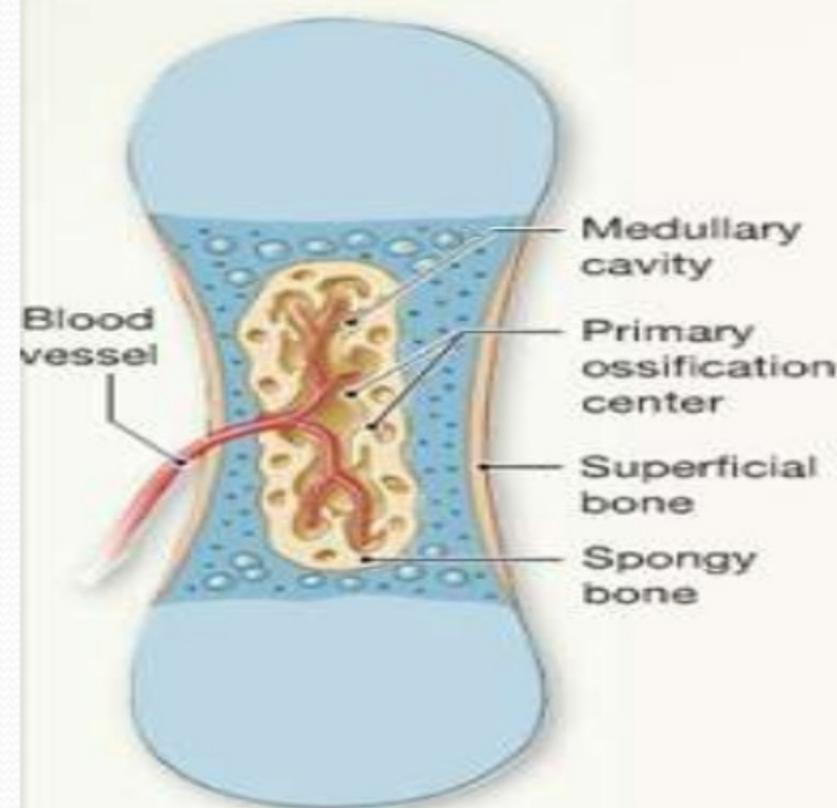
Blood vessels grow around the edges of the cartilage, and the cells of the perichondrium convert to osteoblasts. The shaft of the cartilage then becomes ensheathed in a superficial layer of bone.

## STEP 3

- Blood vessels enter the cartilage:
  - bringing fibroblasts that become osteoblasts
  - spongy bone develops at the primary ossification center

3

Blood vessels penetrate the cartilage and invade the central region. Fibroblasts migrating with the blood vessels differentiate into osteoblasts and begin producing spongy bone at a primary ossification center. Bone formation then spreads along the shaft toward both ends.



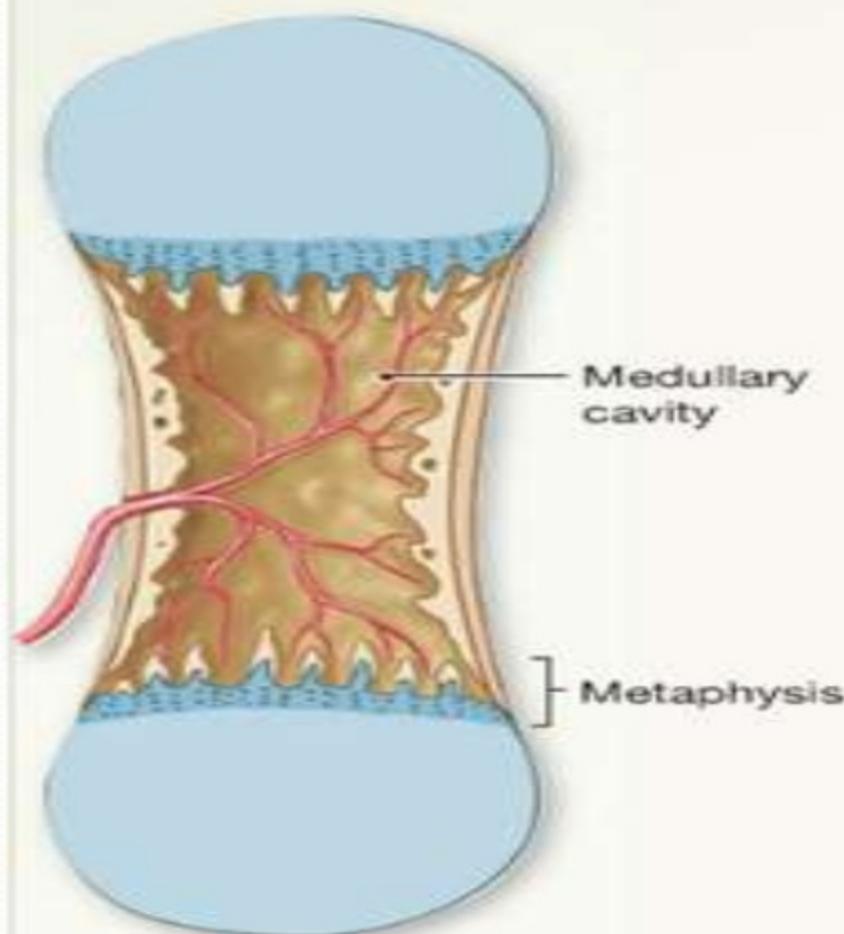
# STEP 4

- Remodeling creates a marrow cavity:
  - bone replaces cartilage at the metaphyses

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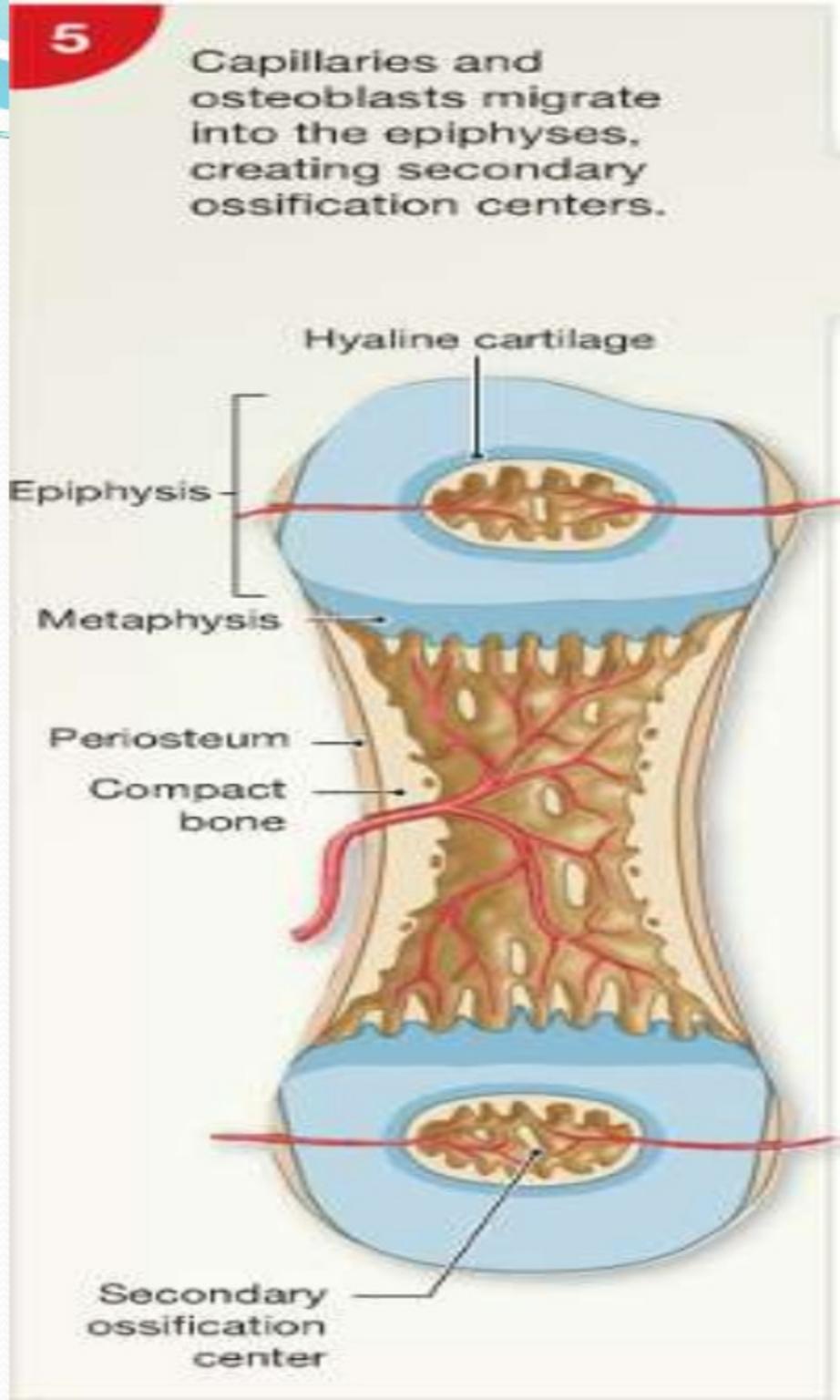
Remodeling occurs as growth continues, creating a medullary cavity.

The osseous tissue of the shaft becomes thicker, and the cartilage near each epiphysis is replaced by shafts of bone. Further growth involves increases in length and diameter.



# STEP 5

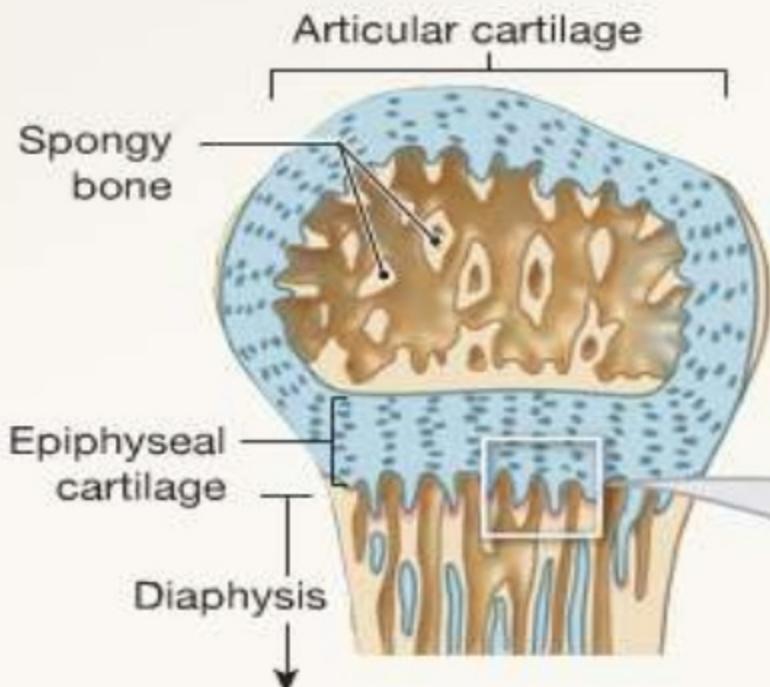
- Capillaries and osteoblasts enter the epiphyses:
  - creating secondary ossification centers



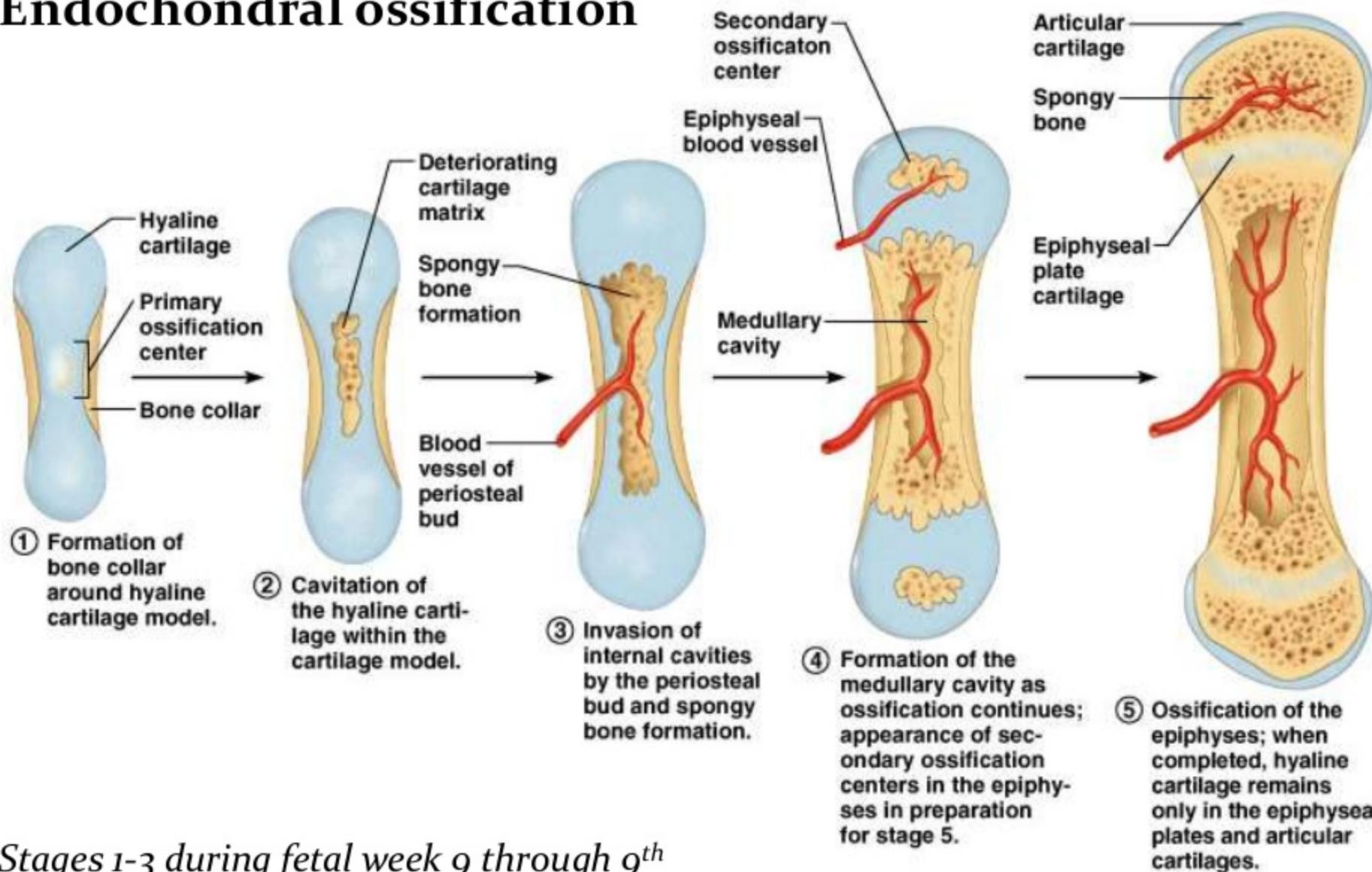
## STEP 6

- Epiphyses fill with spongy bone:
  - cartilage within the joint cavity is articulation cartilage
  - cartilage at the metaphysis is epiphyseal cartilage

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.



# Endochondral ossification



*Stages 1-3 during fetal week 9 through 9<sup>th</sup> month*

*Stage 4 is just before birth*

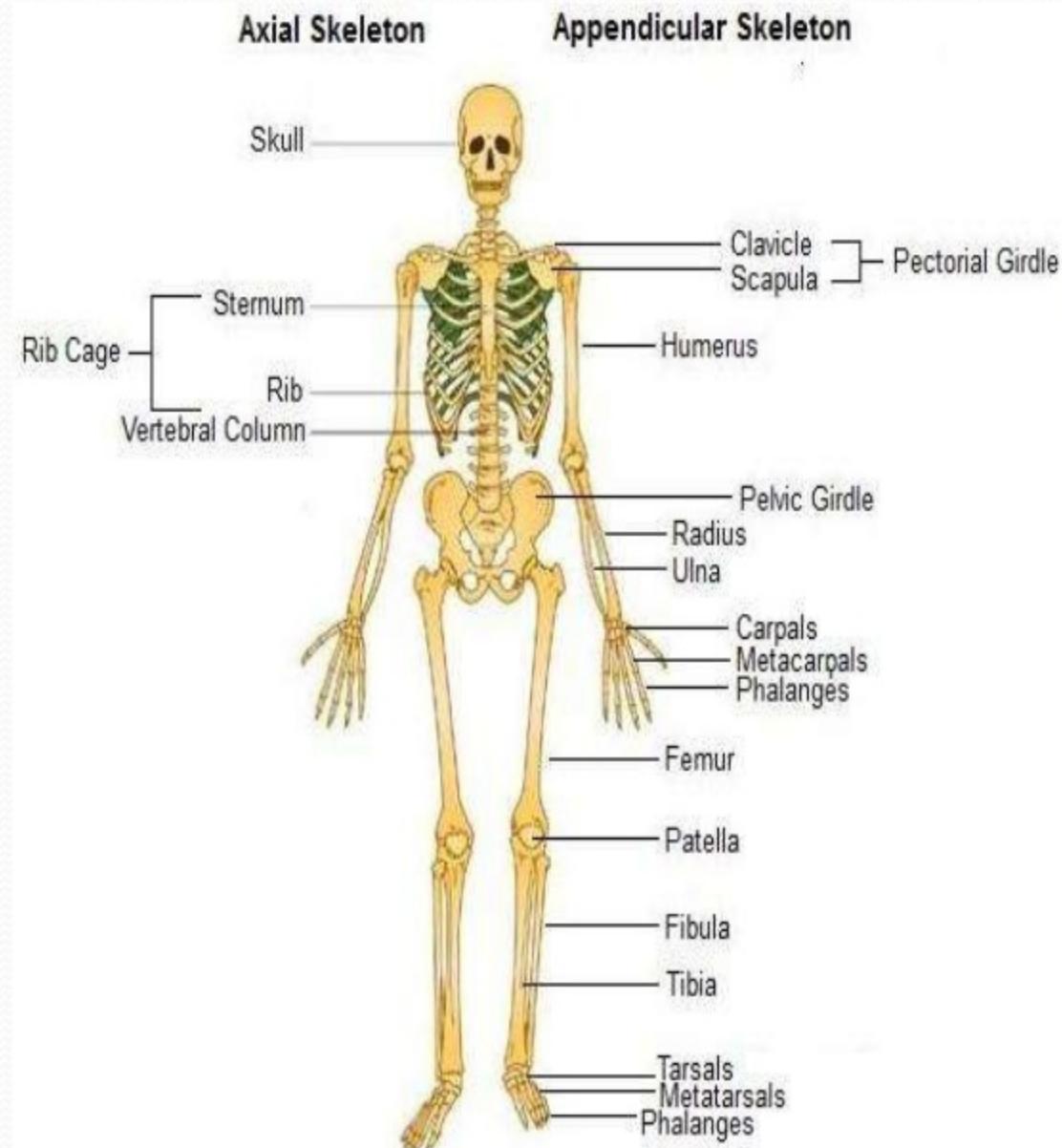
*Stage 5 is process of long bone growth during childhood & adolescence*

# SKELETAL ORGANIZATION

- The actual number of bones in the human skeleton varies from person to person
- Typically there are about 206 bones
- For convenience the skeleton is divided into the:
  - Axial skeleton
  - Appendicular skeleton

# DIVISION OF SKELETON

- **Axial Skeleton**
  - Skull
  - Spine
  - Rib cage
- **Appendicular Skeleton**
  - Upper limbs
  - Lower limbs
  - Shoulder girdle
  - Pelvic girdle



# CLASSIFICATION OF BONES BY SHAPE

- Long bones
- Short bones
- Flat bones
- Irregular bones
- Pneumatized bones
- Sesamoid bones

