

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

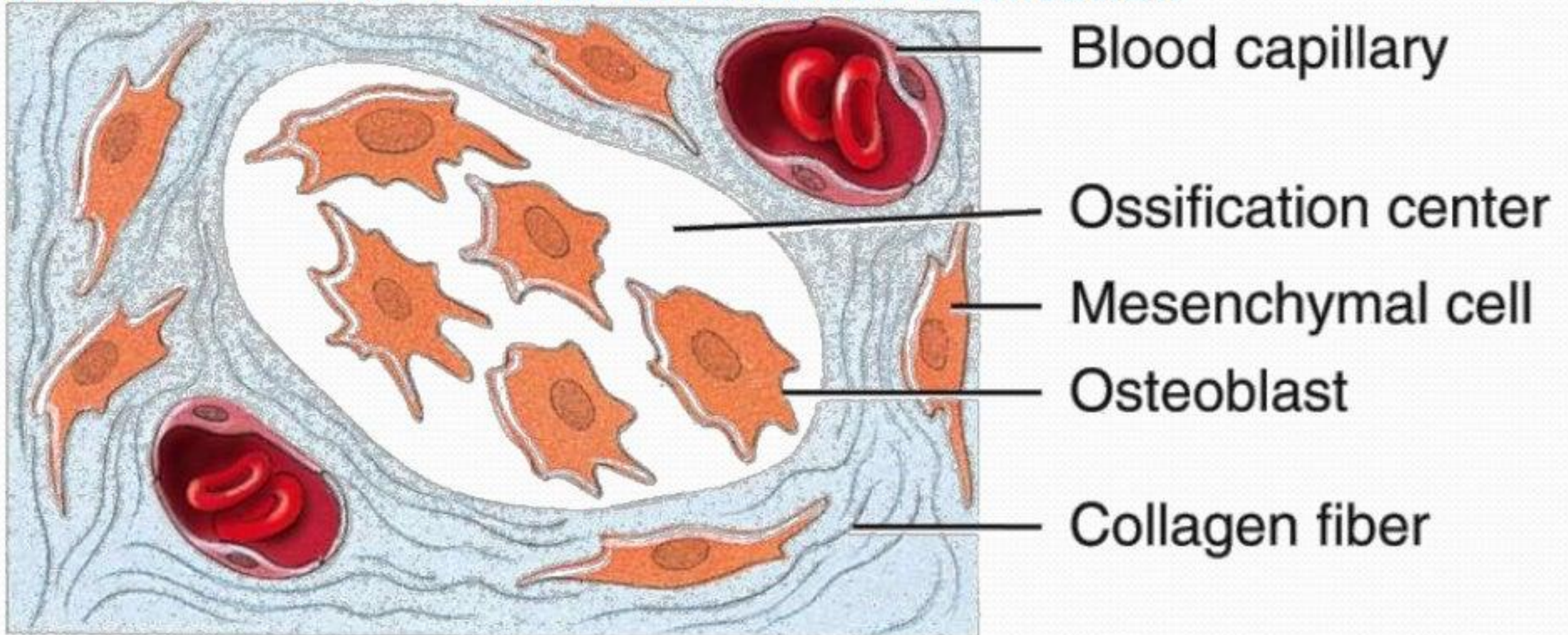
FORMATION OF BONE

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

INTRAMEMBRANOUS OSSIFICATION

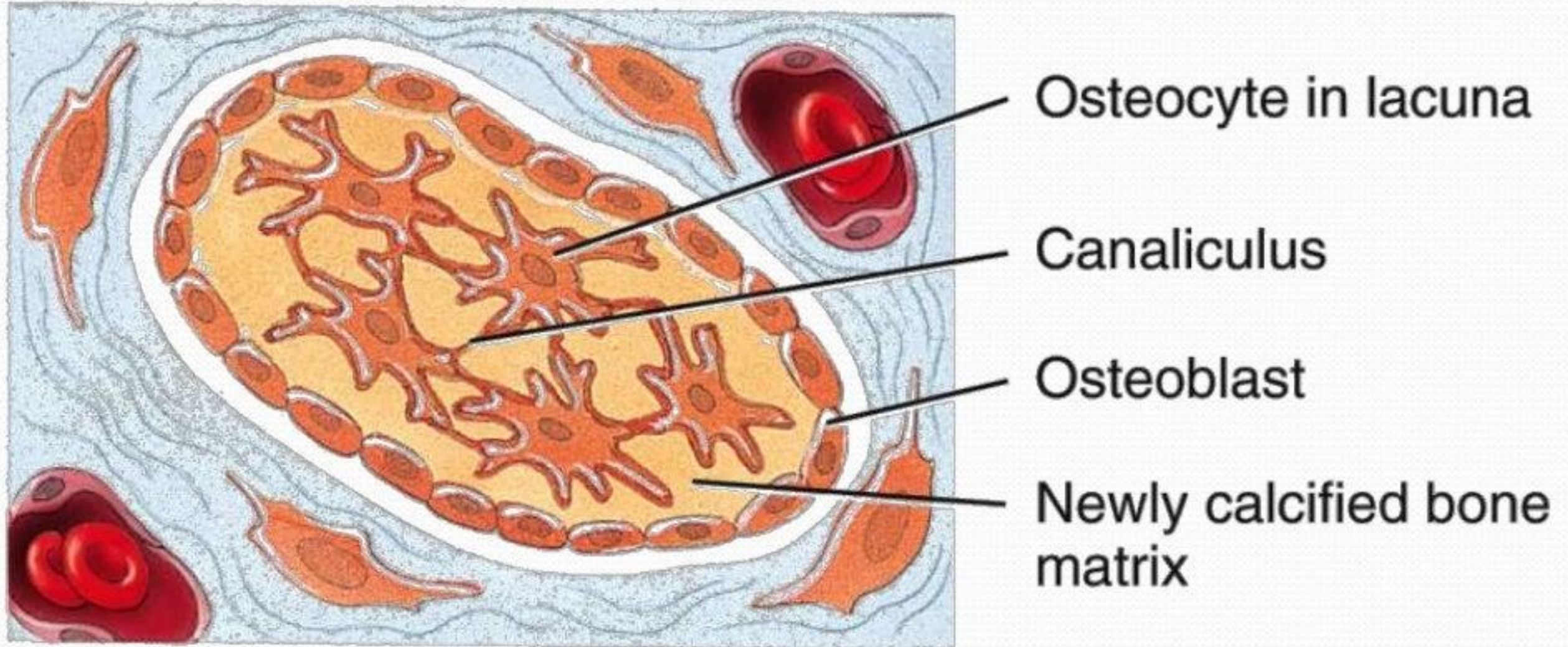
- Mesenchymal condensation
- Highly vascular
- Laying down of bundles of collagen fibres in the mesenchymal condensation
- Osteoblast formation – OSTEOID
- Calcium salts deposition – lamellus of bone

BONE FORMATION- Intramembranous ossification



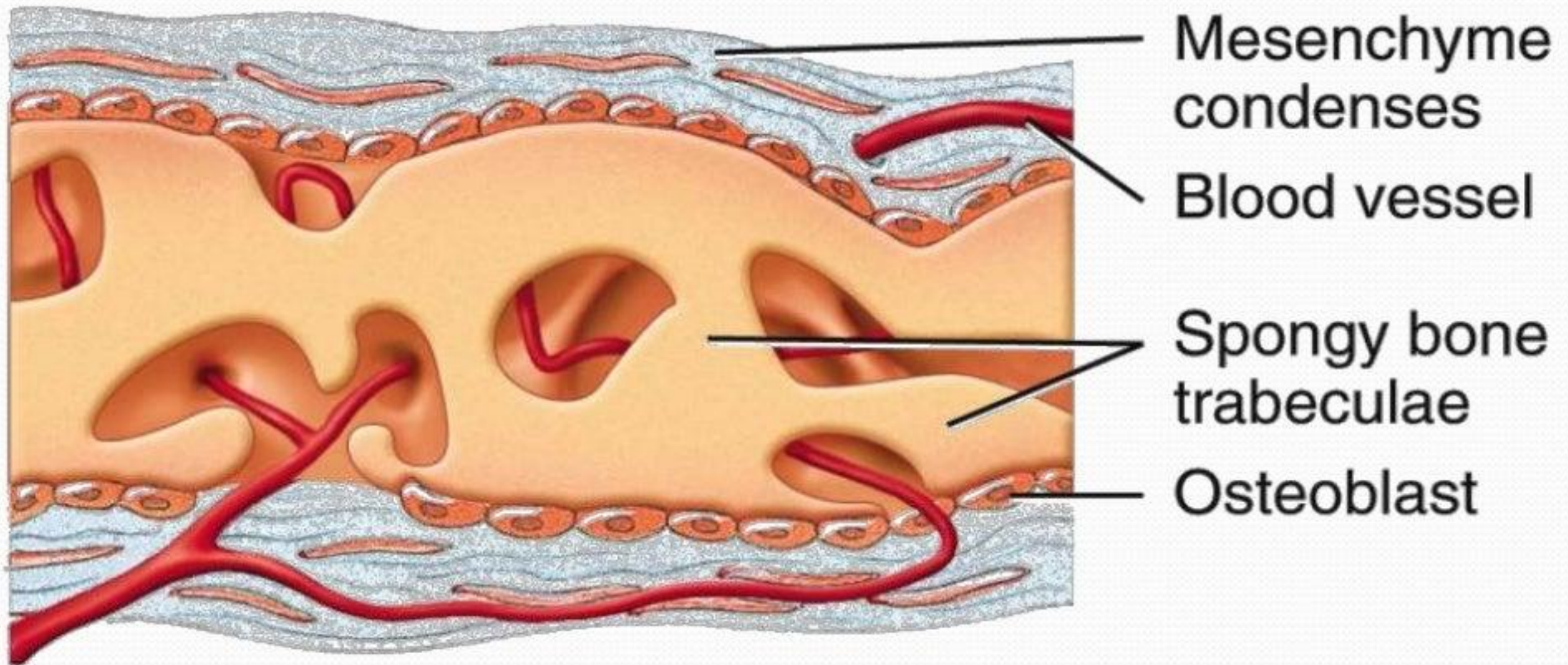
- 1** Development of ossification center: osteoblasts secrete organic extracellular matrix

BONE FORMATION - Intramembranous ossification



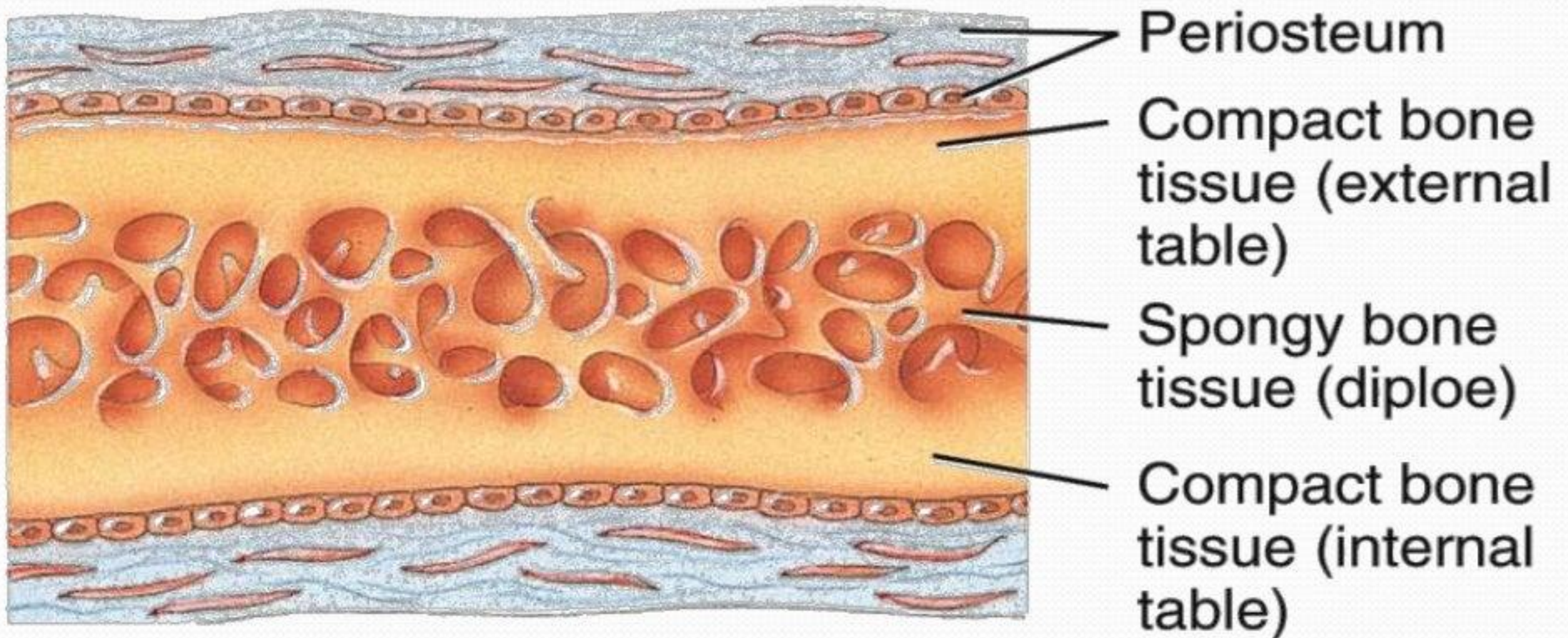
- 2 Calcification: calcium and other mineral salts are deposited and extracellular matrix calcifies (hardens)

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

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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

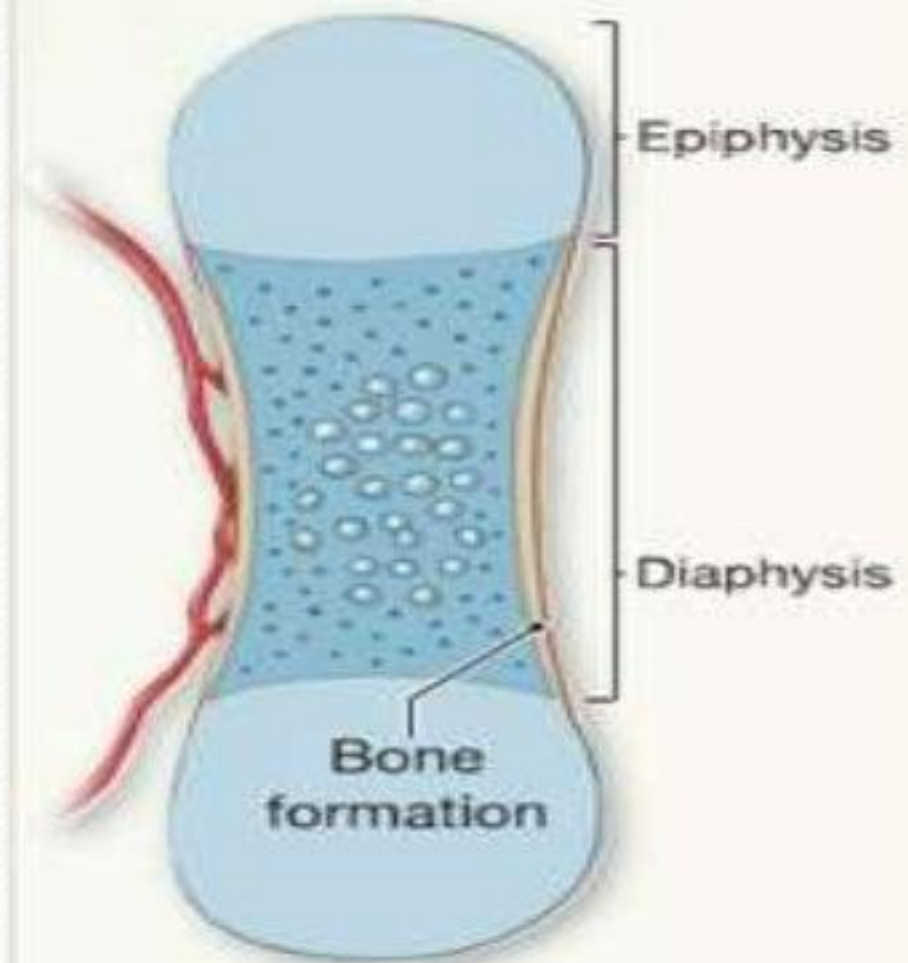


Hyaline cartilage

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 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)

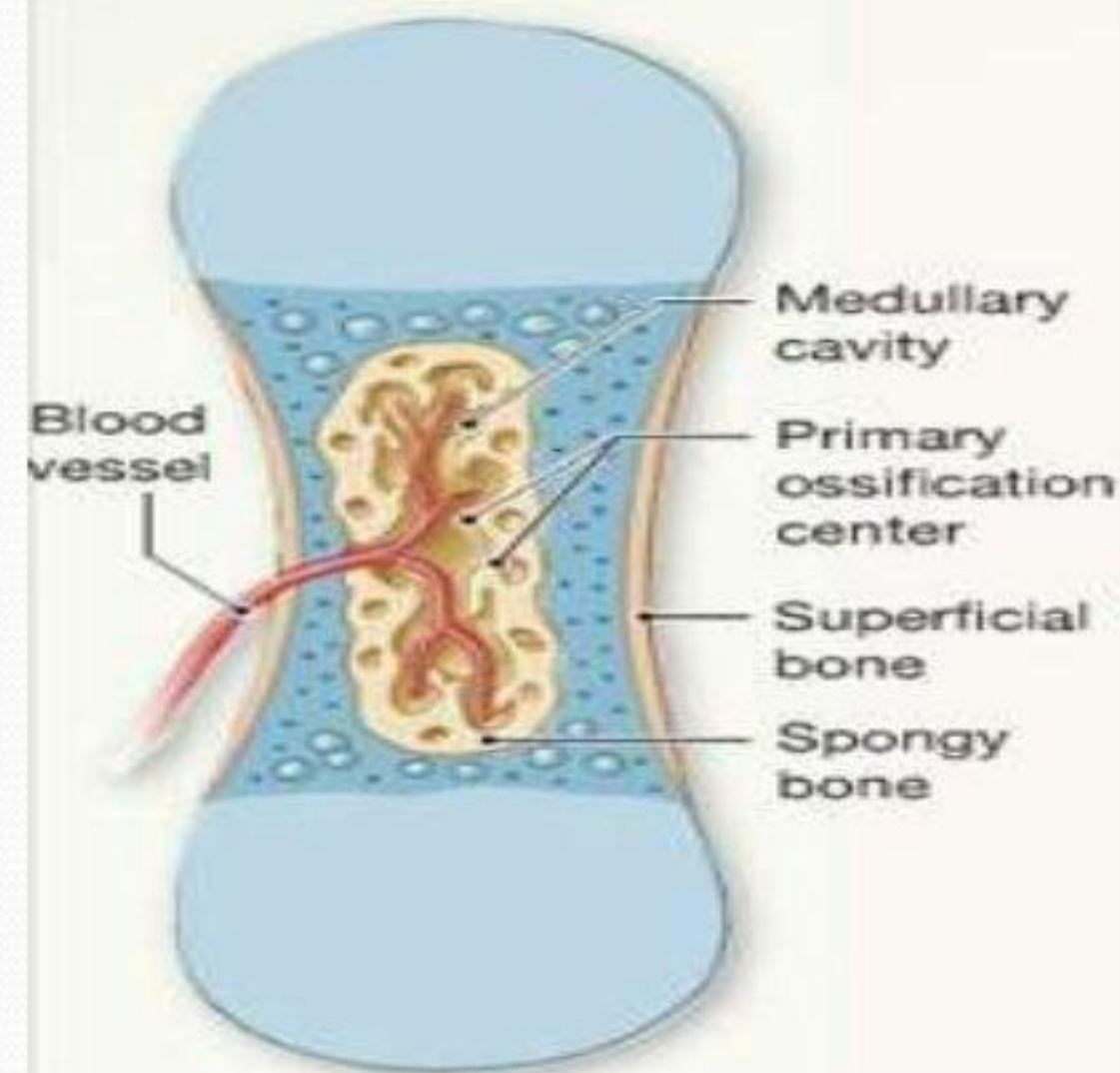


STEP 3

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

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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.



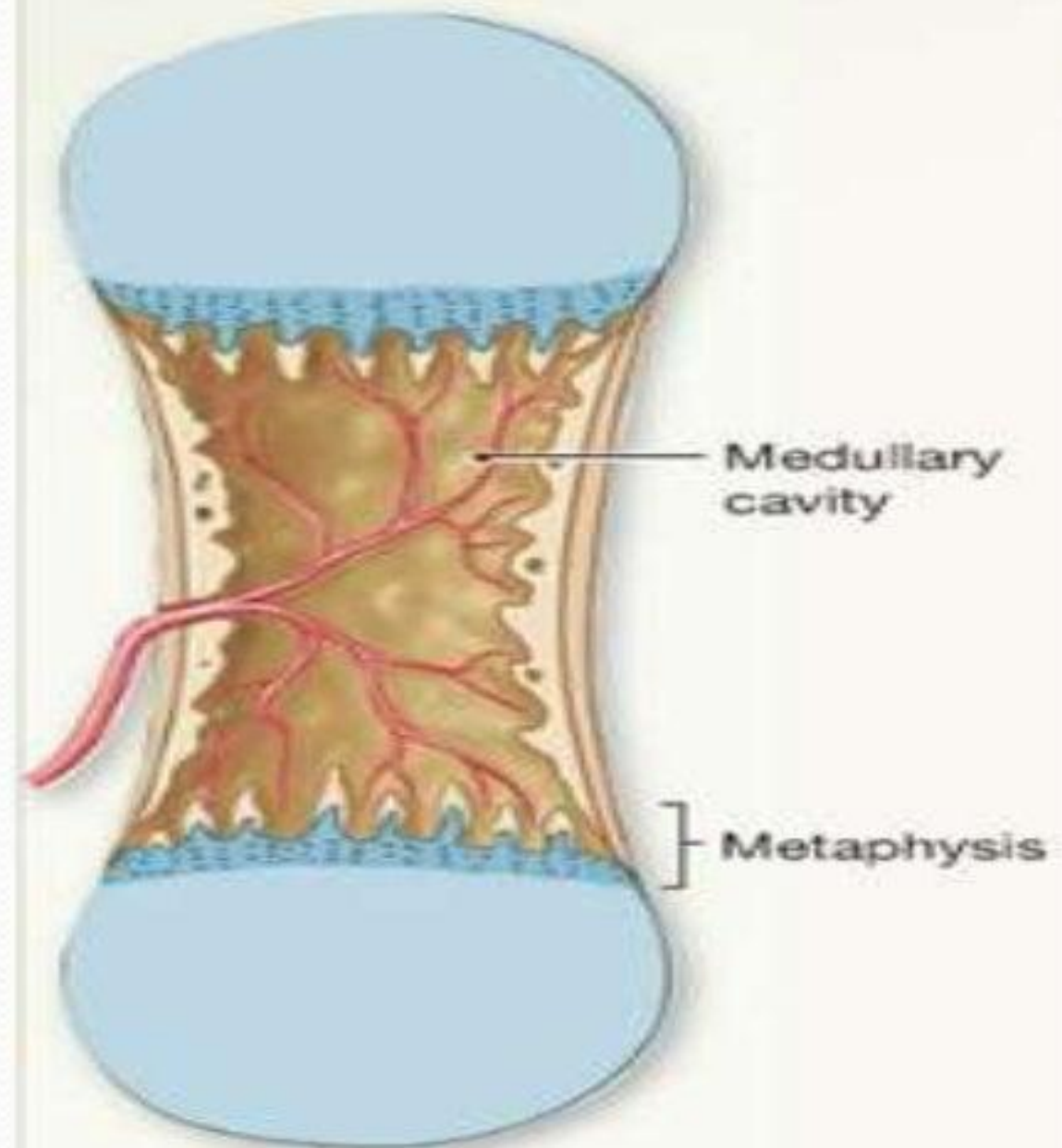
STEP 4

- 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.

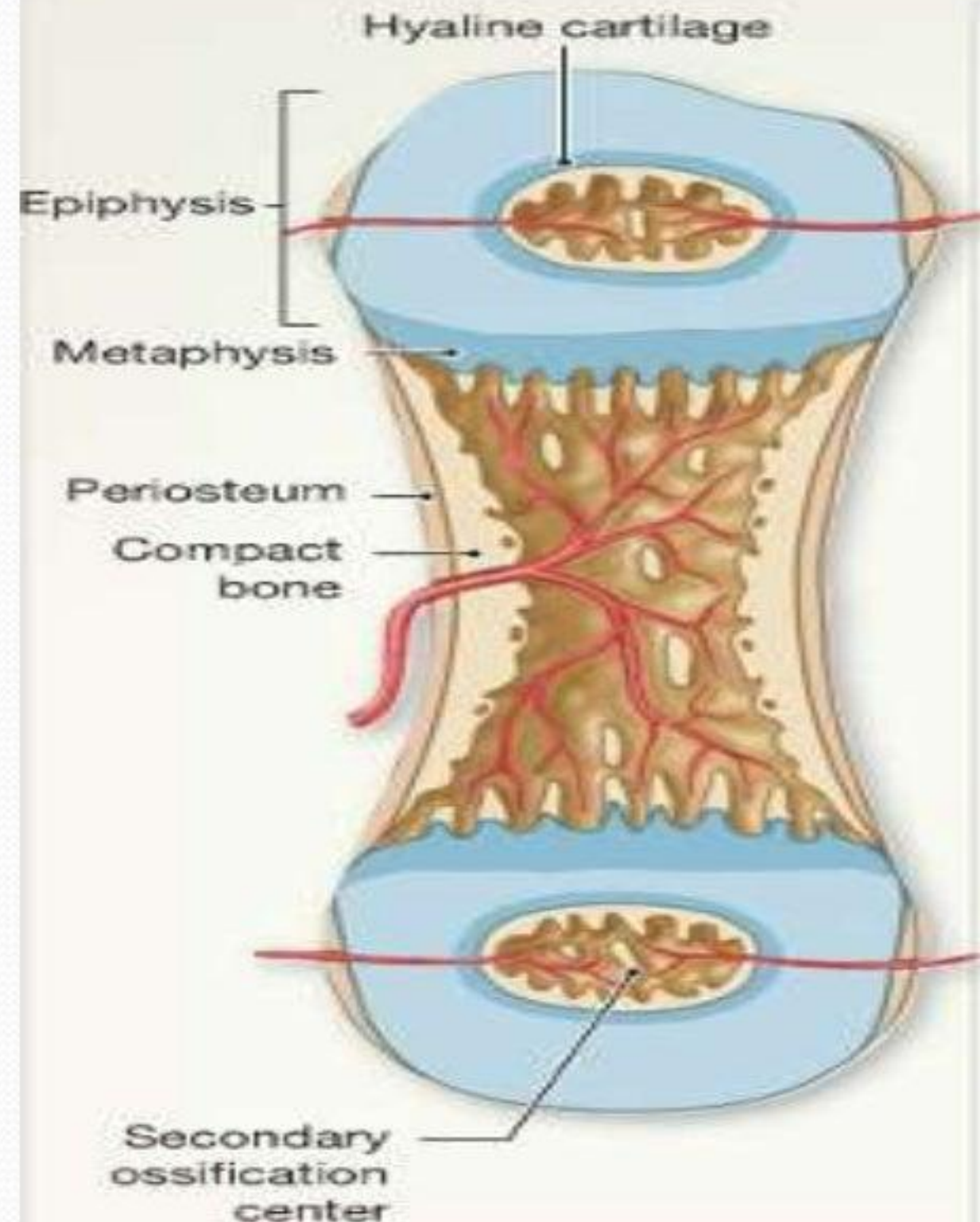


STEP 5

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

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

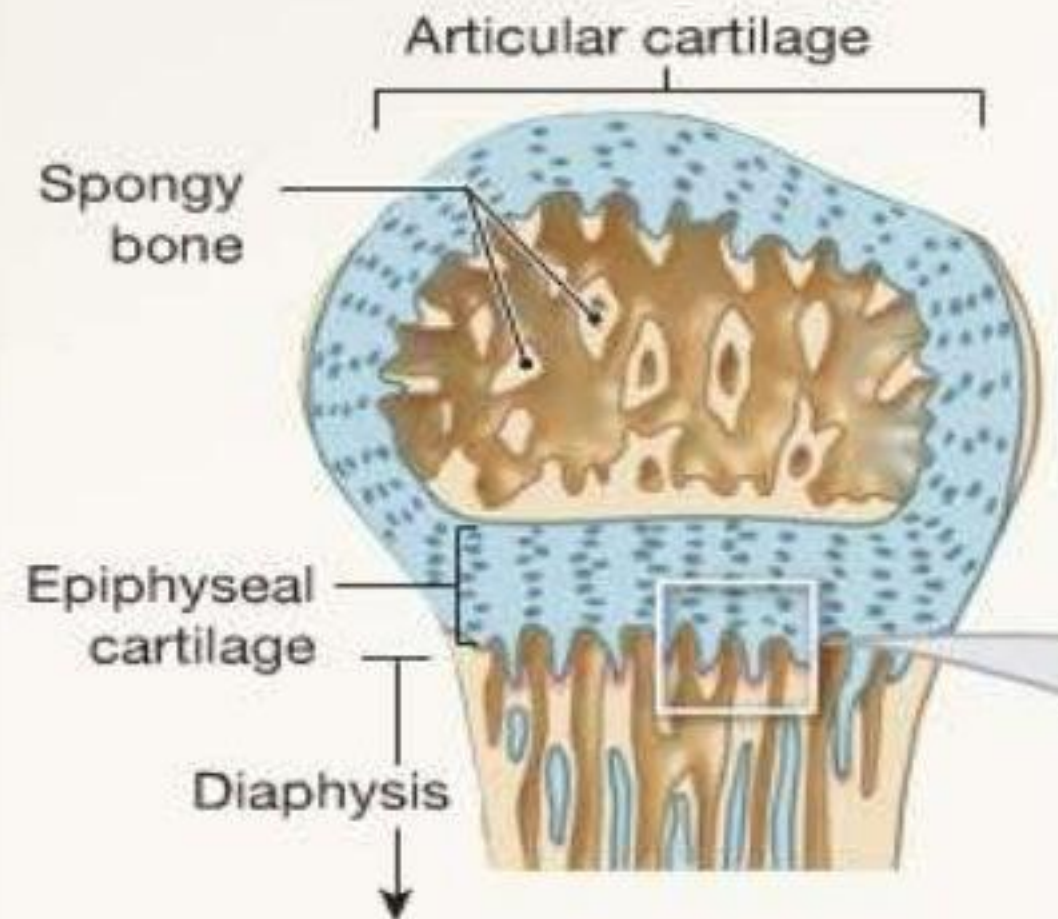


STEP 6

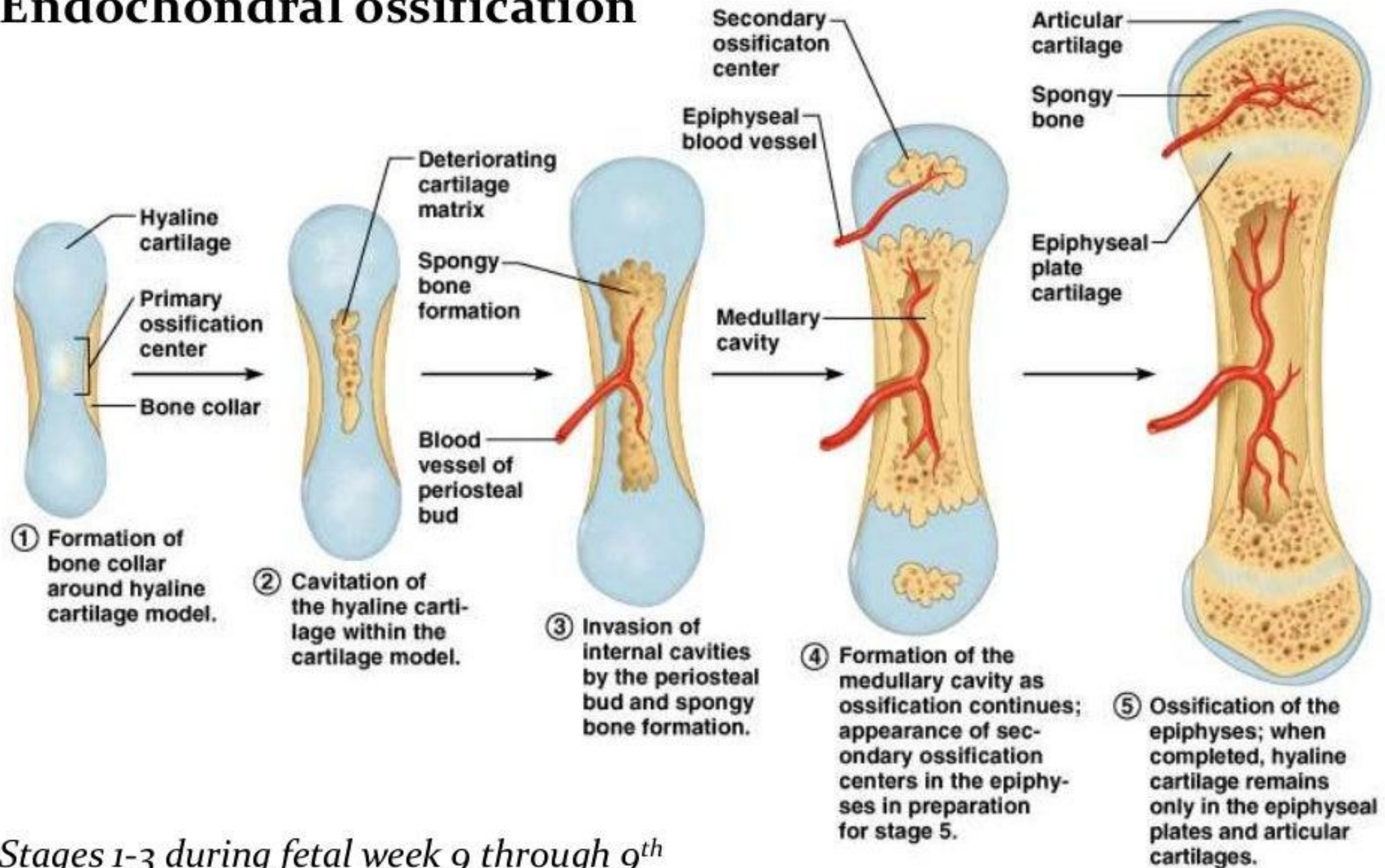
- Epiphyses fill with spongy bone:
 - cartilage within the joint cavity is articulation cartilage
 - cartilage at the metaphysis is epiphyseal cartilage

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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 9th month

Stage 4 is just before birth

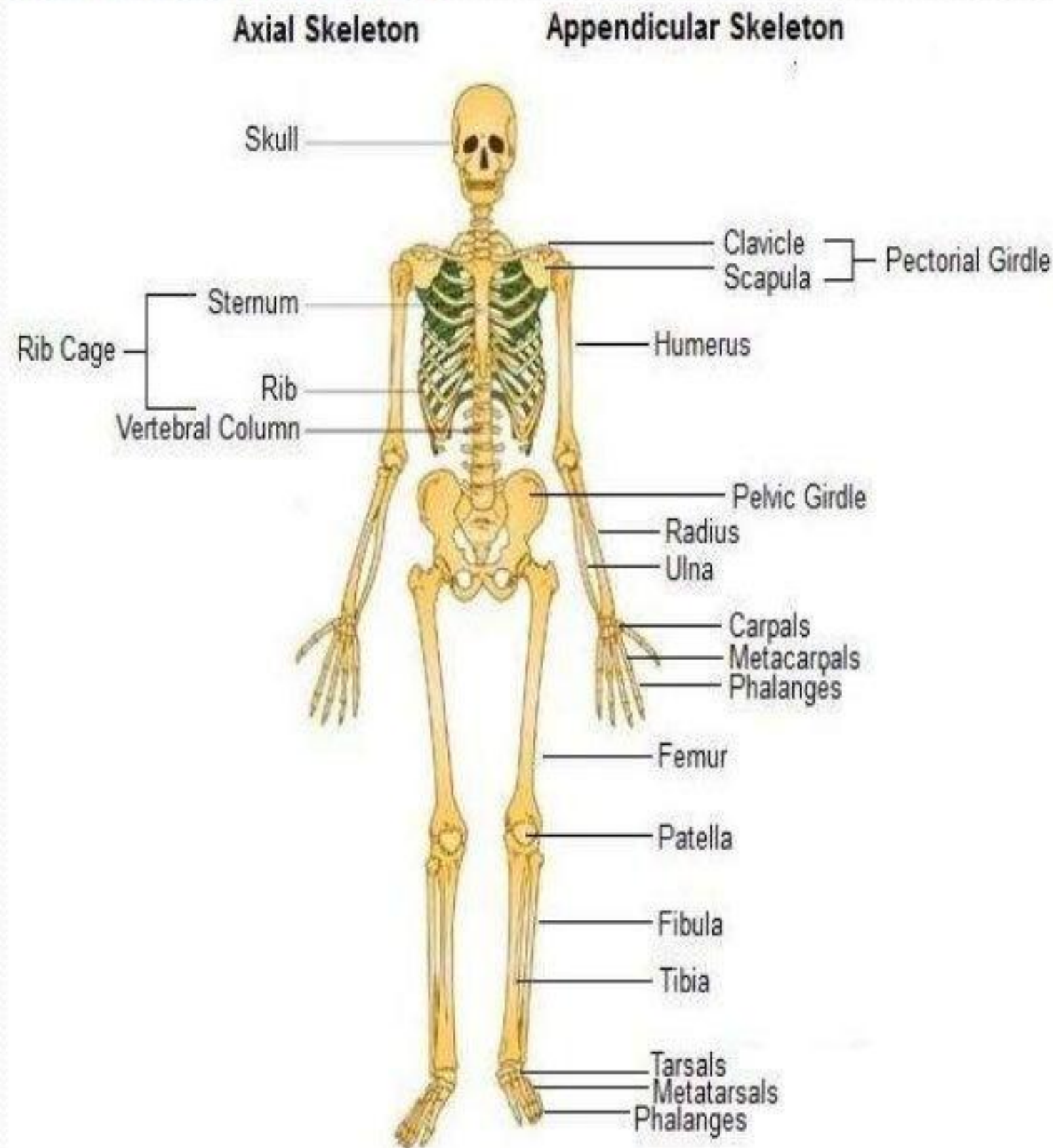
Stage 5 is process of long bone growth during childhood & adolescence

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

