Bone Ossification

Practical part

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Bone Development

- Osteogenesis (ossification)—bone tissue formation

- Stages:
  - Bone formation—begins around 8th week of development
  - Postnatal bone growth—until early adulthood
  - Bone remodeling and repair—lifelong

Postnatal Bone Growth

- Interstitial growth:
  - ↑ length of long bones
- Appositional growth:
  - ↑ thickness and remodeling of all bones by osteoblasts and osteoclasts on bone surfaces

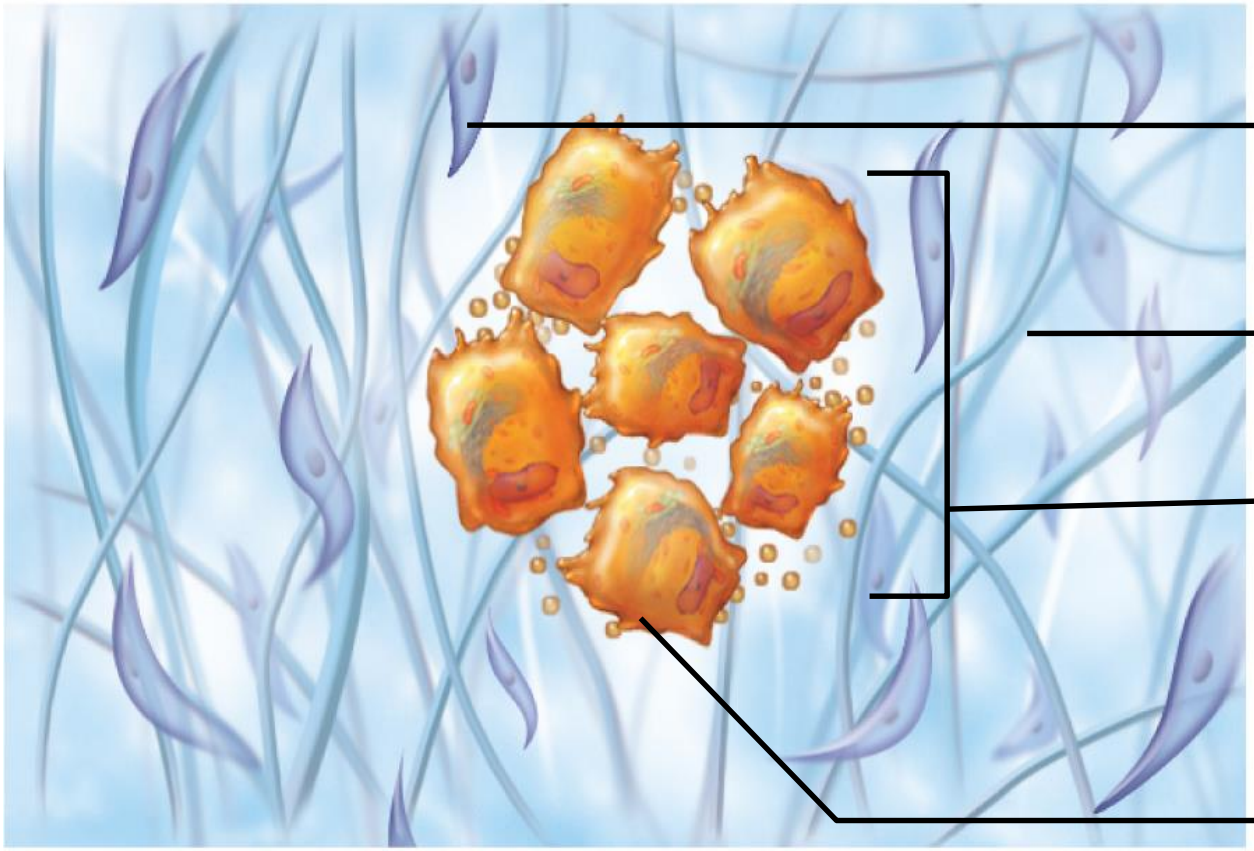
Ossification

The process by which bone forms.

Different methods of development in which both replace preexisting connective tissue with bone, both methods lead to the same structure in mature bone

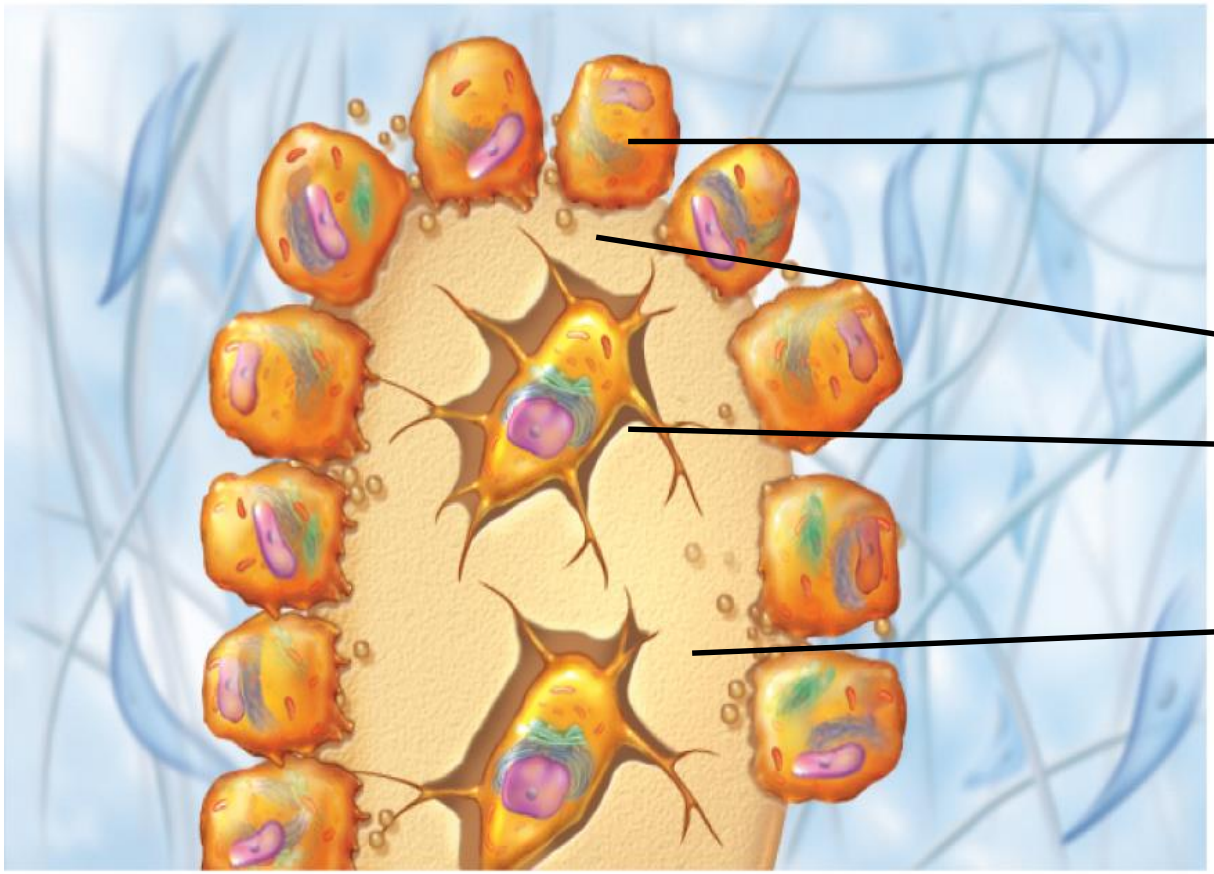
Intramembranous Ossification

(prenatal)



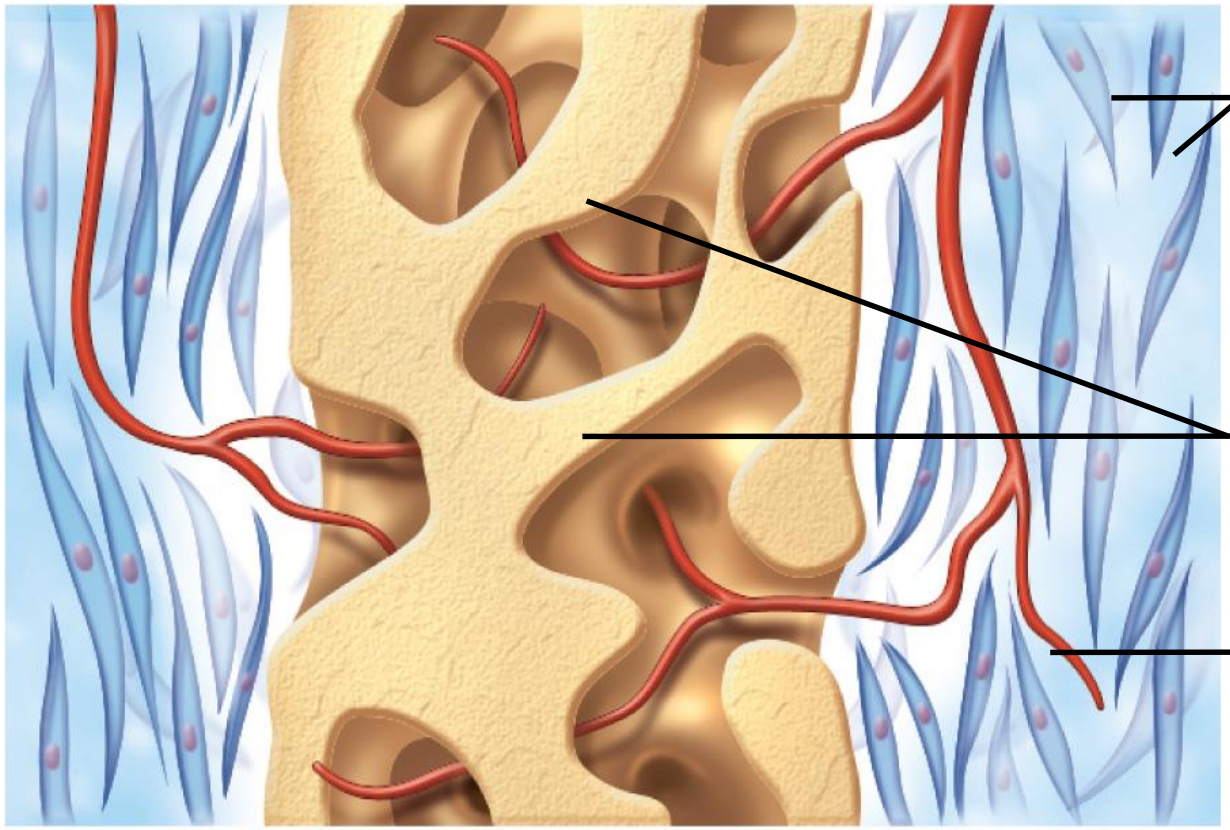
1 Ossification centers appear in the fibrous connective tissue membrane.

- Selected centrally located mesenchymal cells cluster and differentiate into osteoblasts, forming an ossification center.



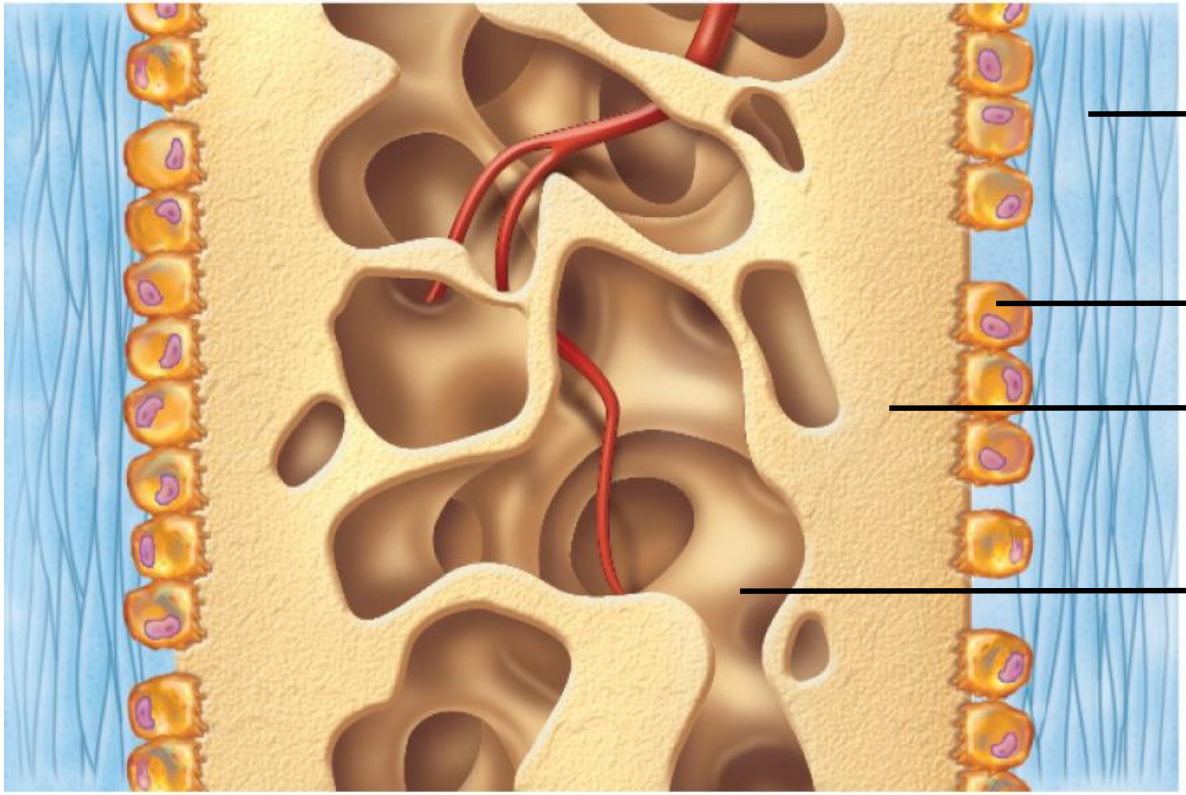
2 Bone matrix (osteoid) is secreted within the fibrous membrane and calcifies.

- Osteoblasts begin to secrete osteoid, which is calcified within a few days.
- Trapped osteoblasts become osteocytes.



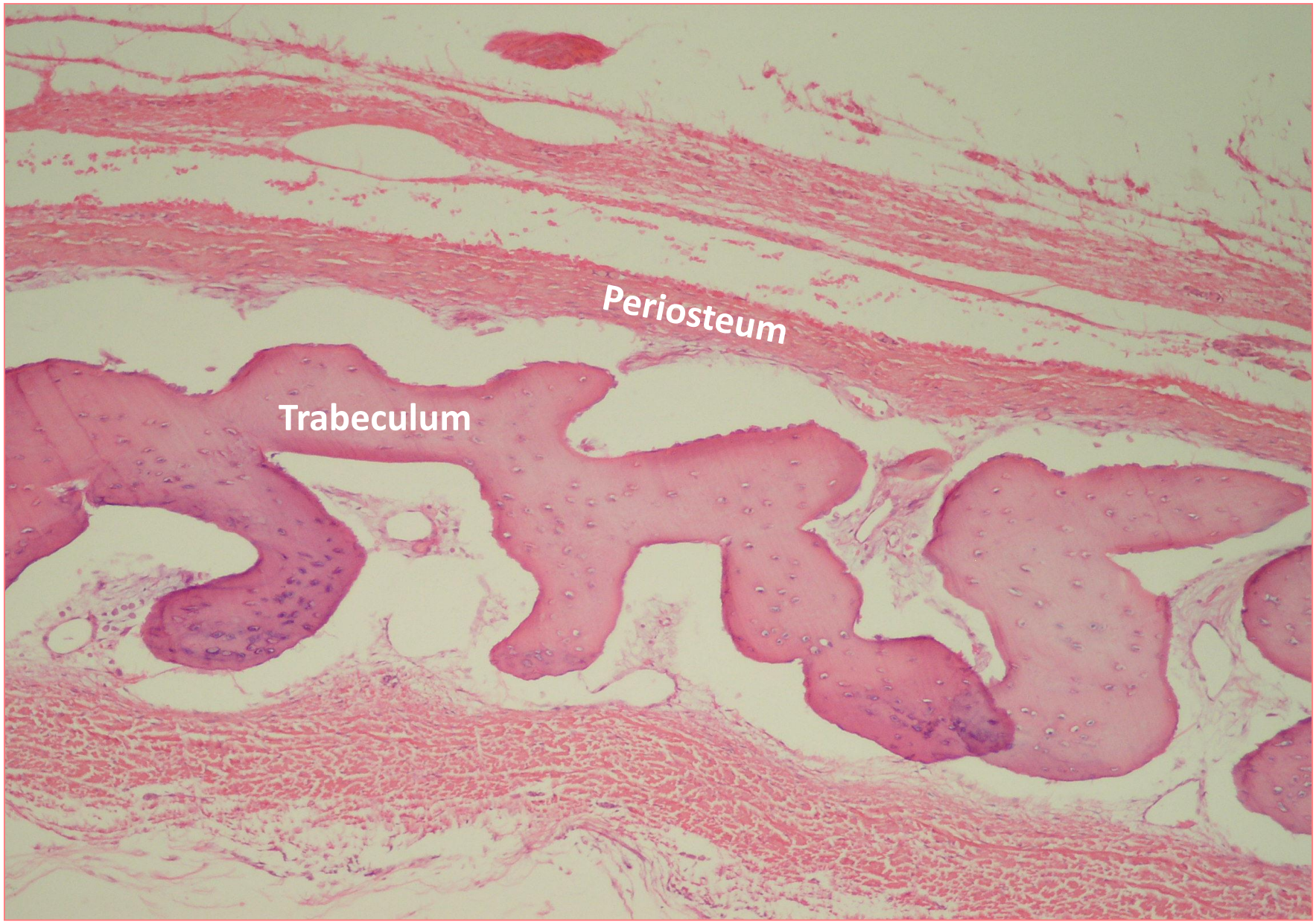
3 **Woven bone and periosteum form.**

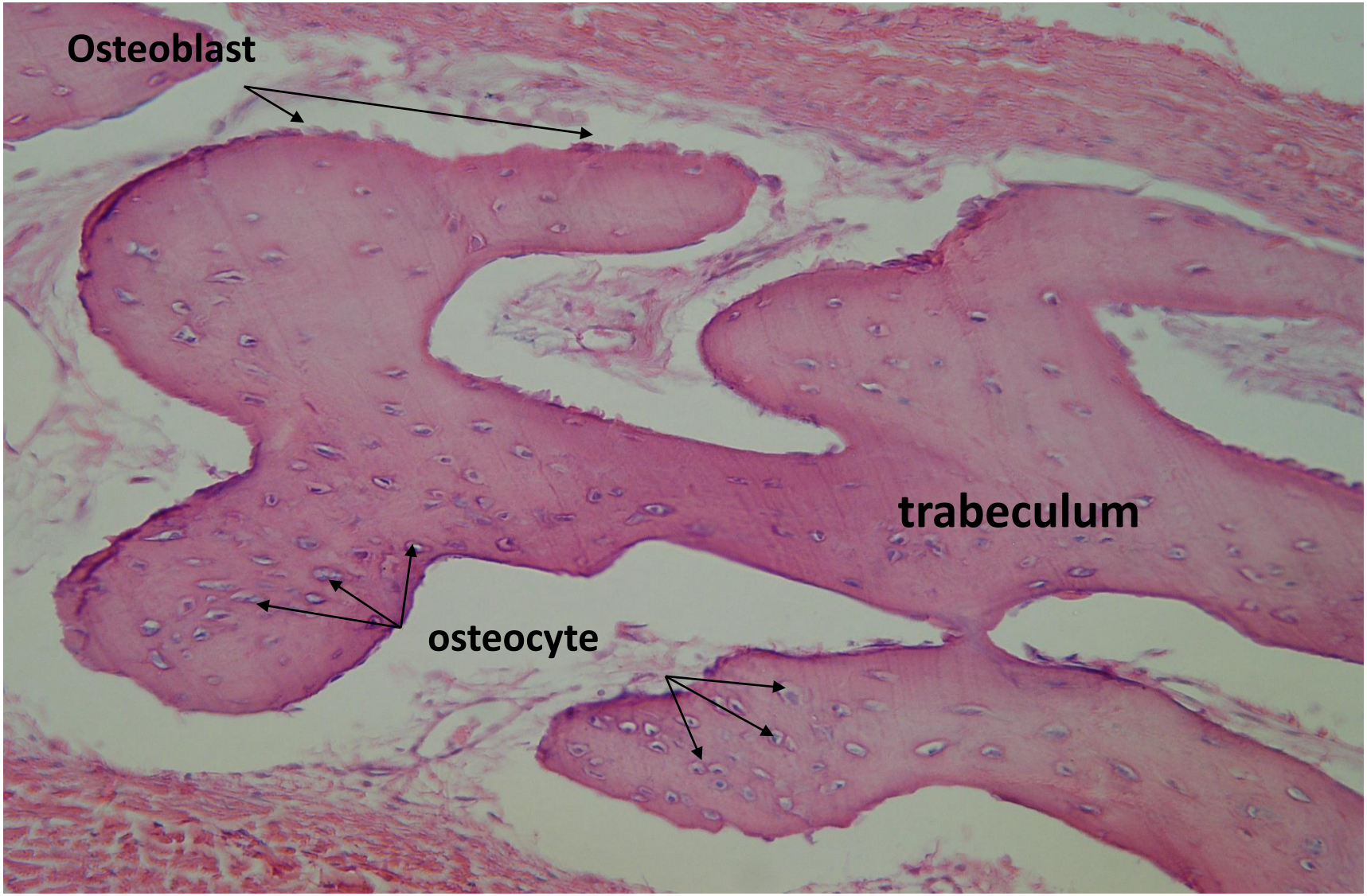
- Accumulating osteoid is laid down between embryonic blood vessels in a random manner. The result is a network (instead of lamellae) of trabeculae called woven bone.
- Vascularized mesenchyme condenses on the external face of the woven bone and becomes the periosteum.



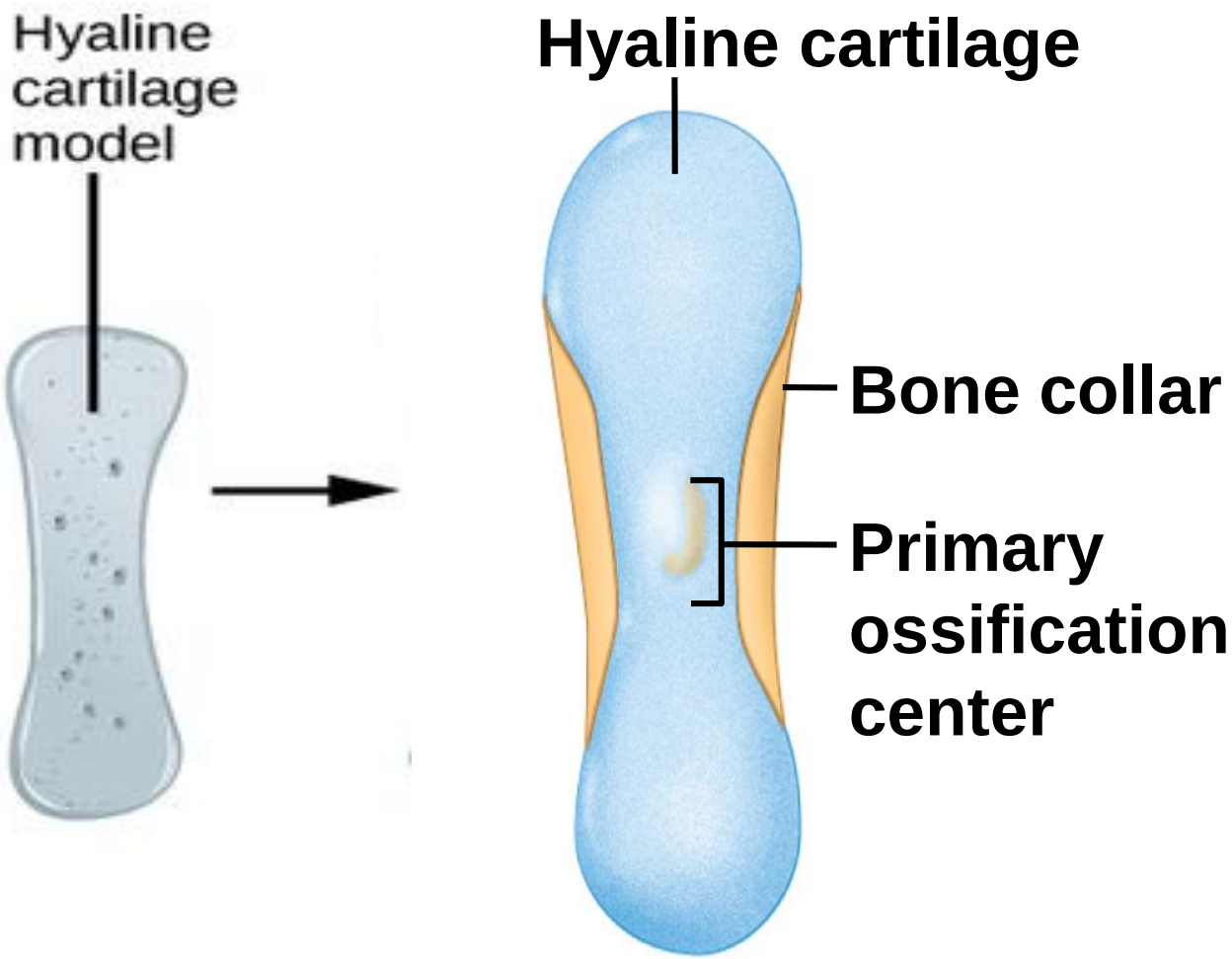
4 Lamellar bone replaces woven bone, just deep to the periosteum. Red marrow appears.

- Trabeculae just deep to the periosteum thicken, and are later replaced with mature lamellar bone, forming compact bone plates.
- Spongy bone (diploë), consisting of distinct trabeculae, persists internally and its vascular tissue becomes red marrow.

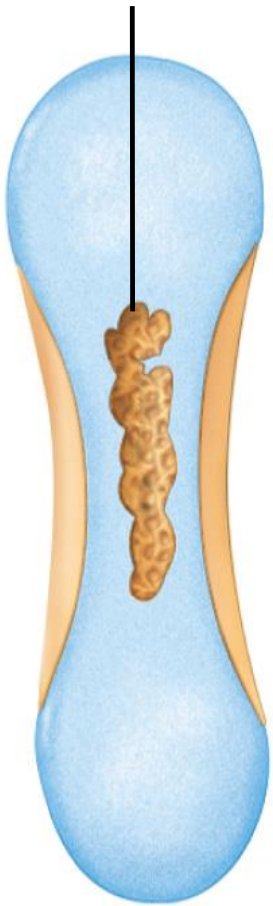

Periosteum
Trabeculum


Osteoblast
trabeculum
osteocyte

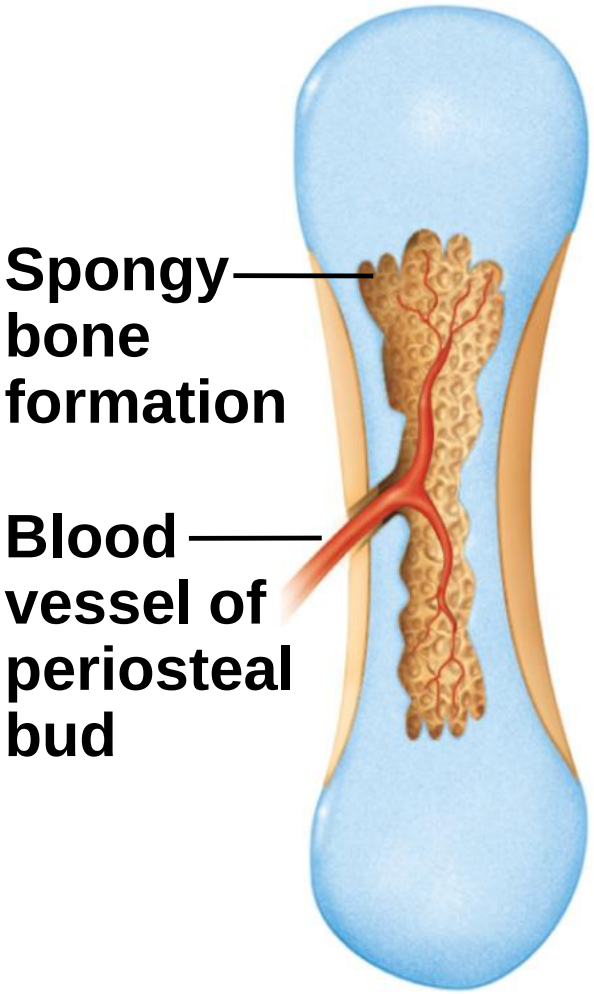
Endochondral Ossification



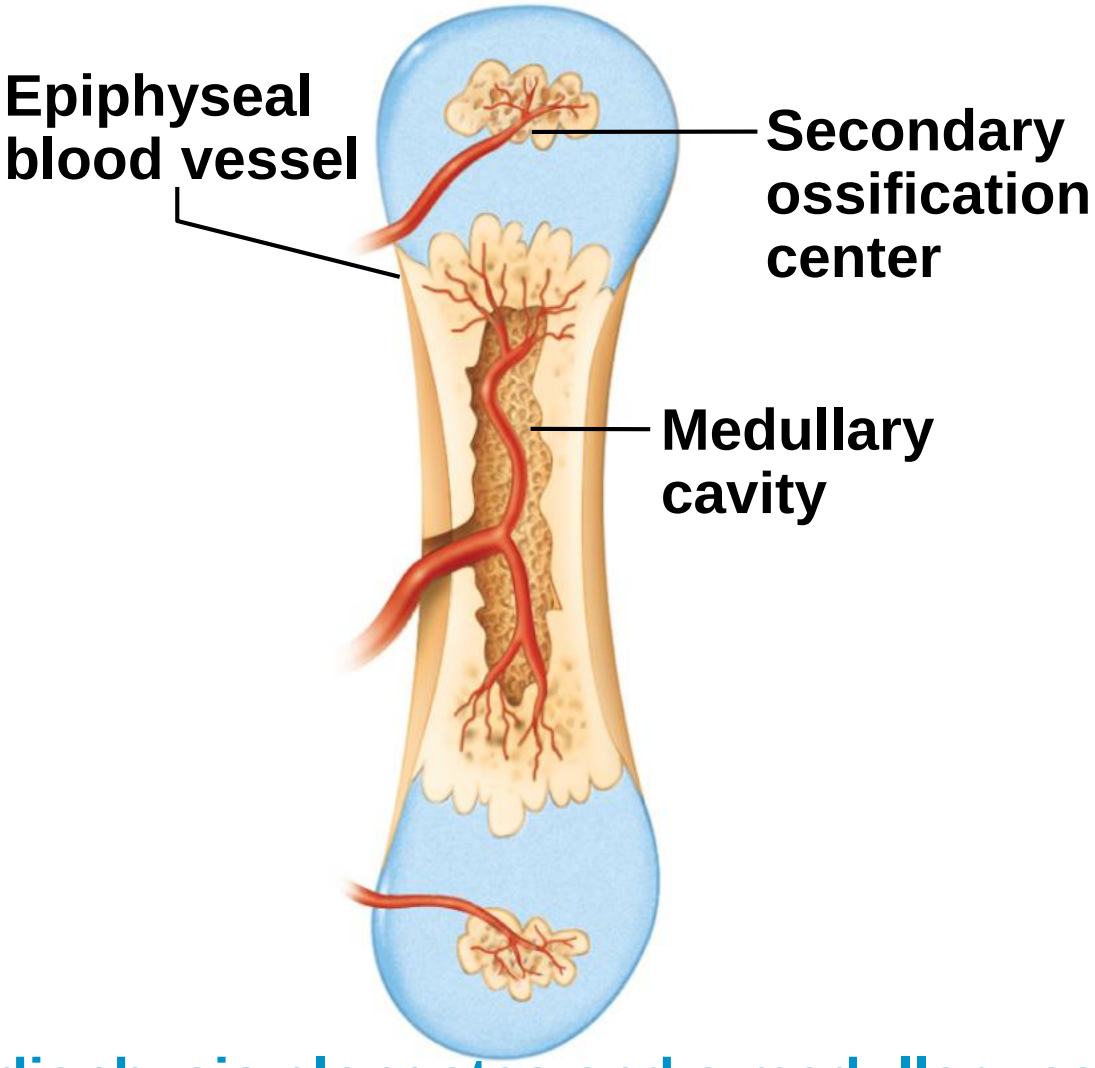
1 **Bone collar forms around hyaline cartilage model.**



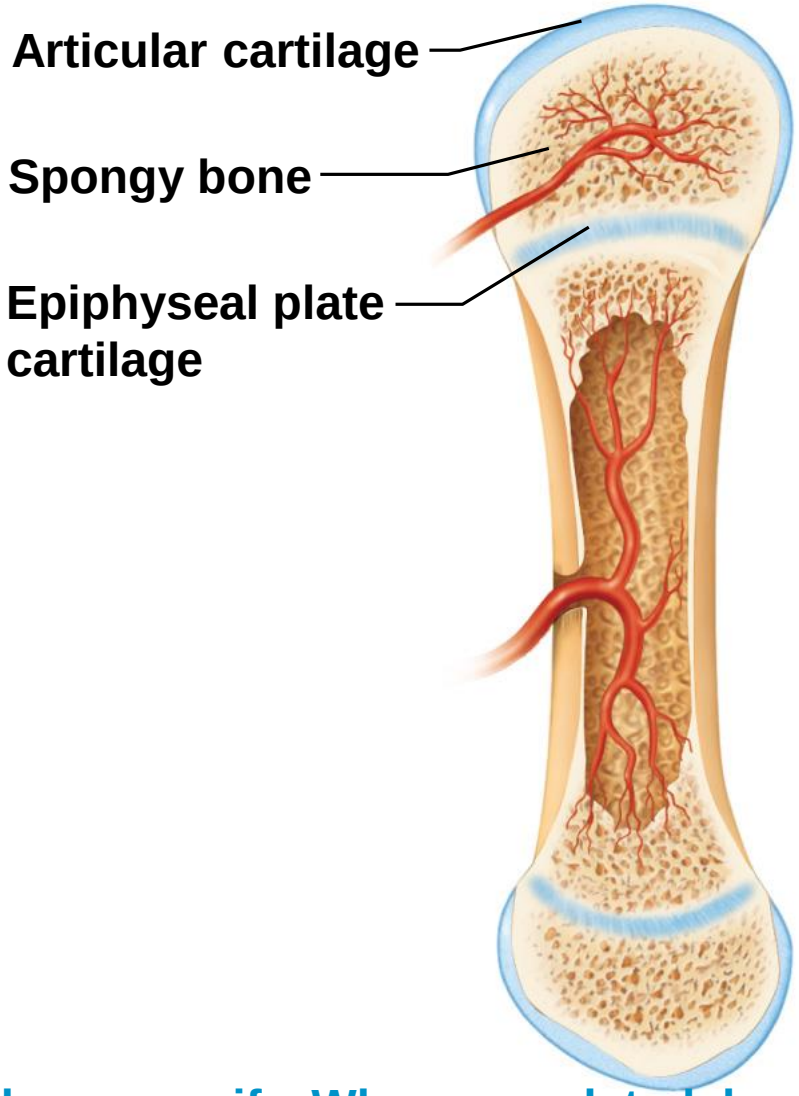
② Cartilage in the center of the diaphysis calcifies and then develops cavities.



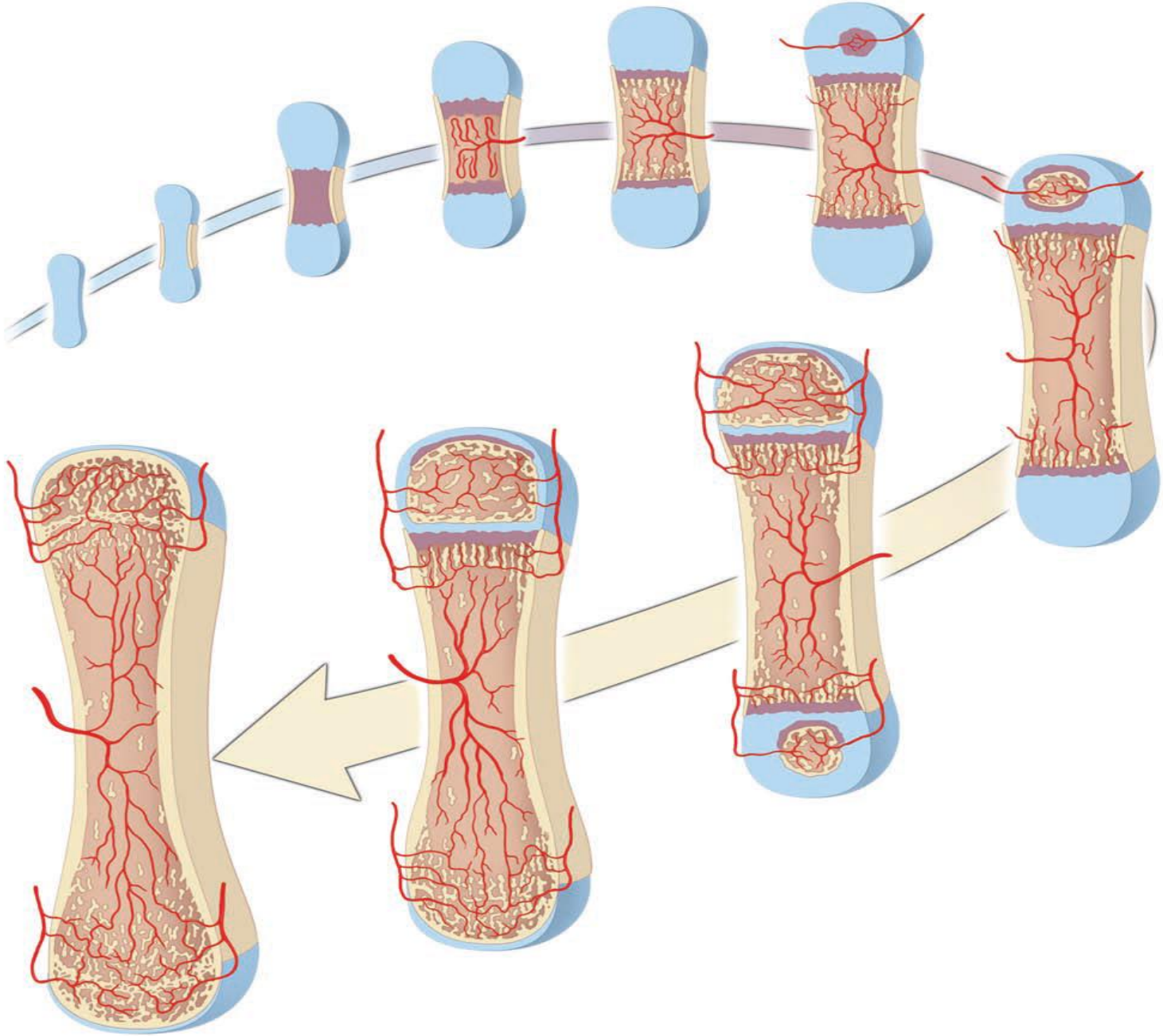
③ The periosteal bud invades the internal cavities and spongy bone begins to form.

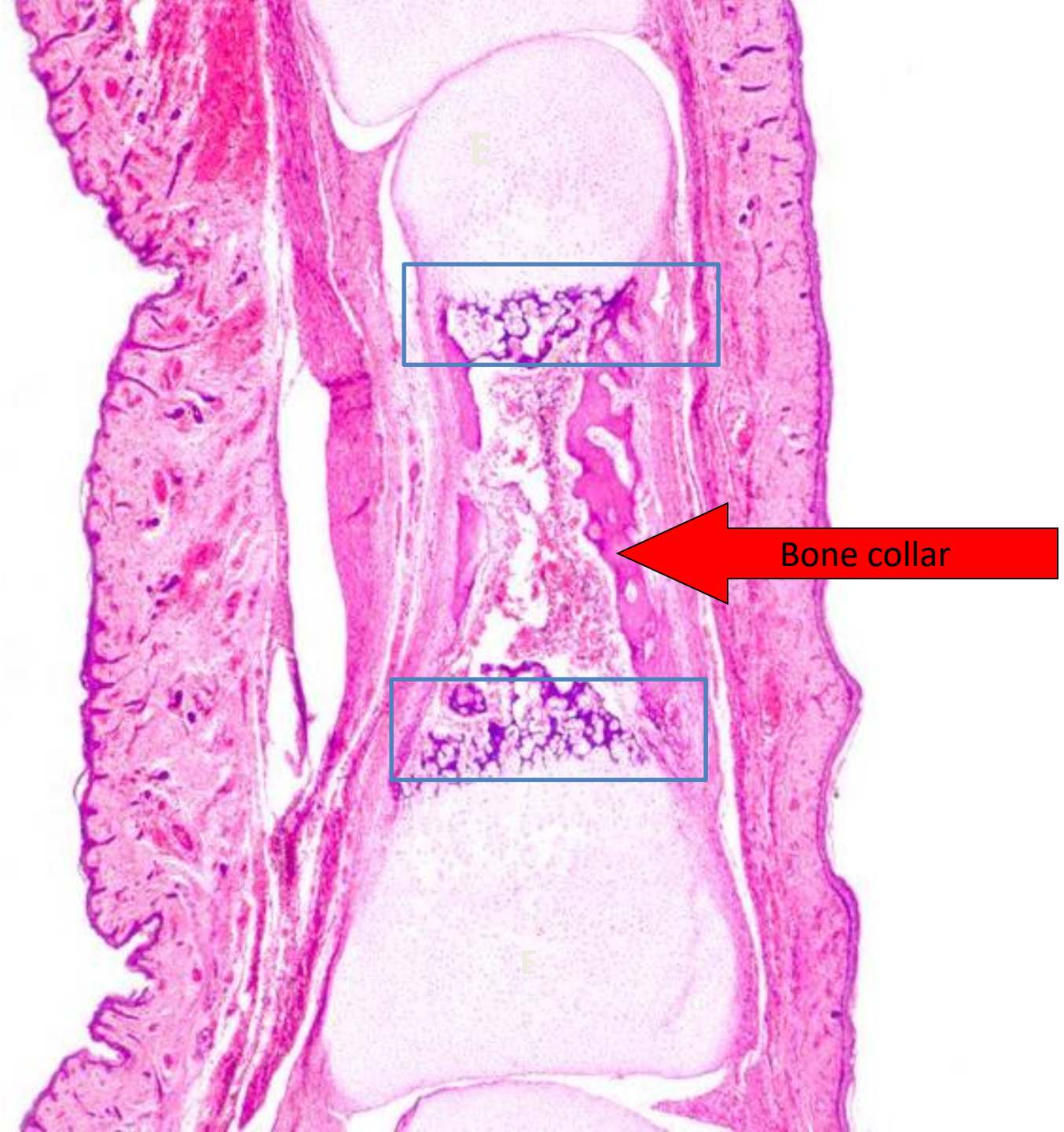


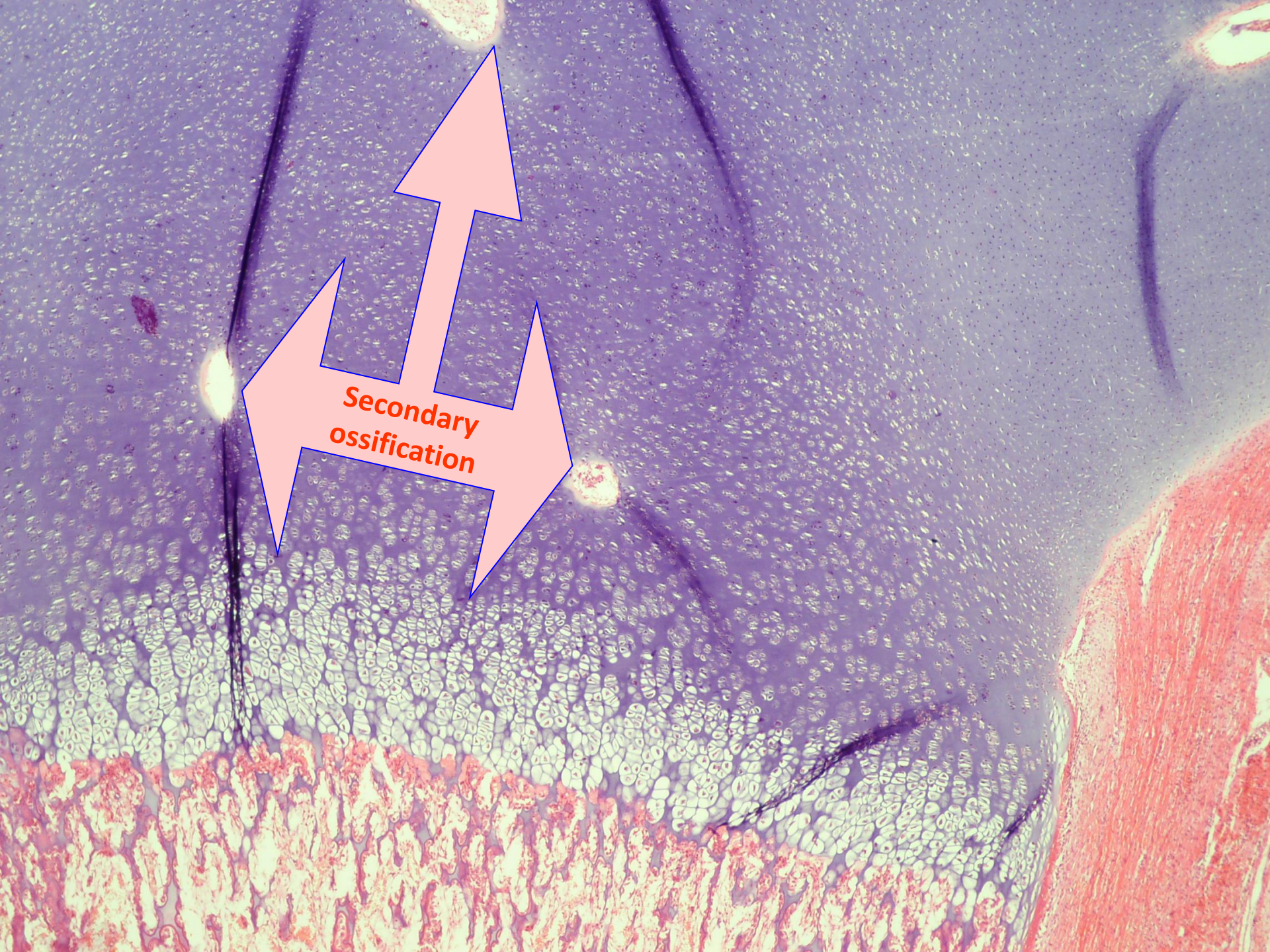
④ The diaphysis elongates and a medullary cavity forms as ossification continues. Secondary ossification centers appear in the epiphyses.



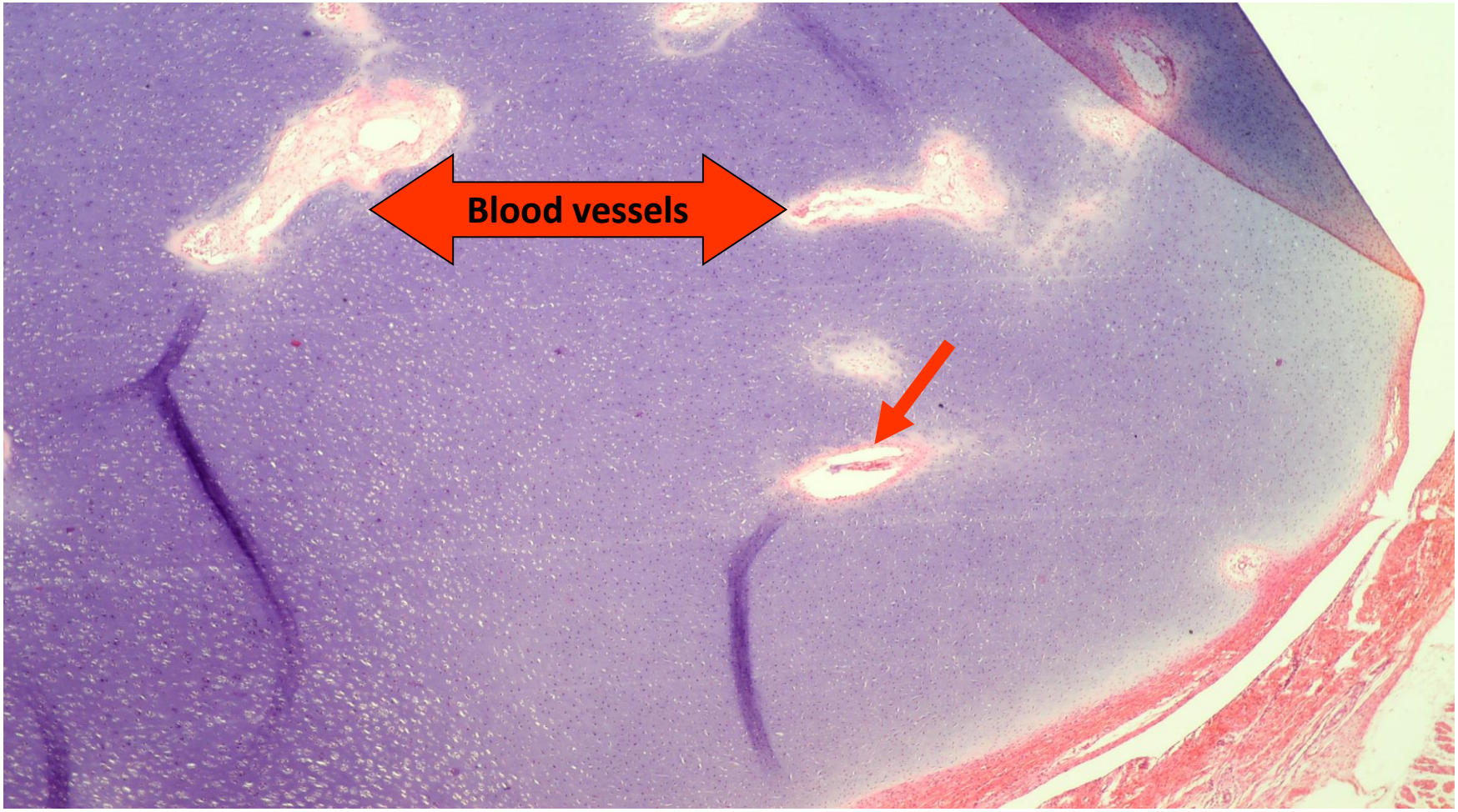
⑤ The epiphyses ossify. When completed, hyaline cartilage remains only in the epiphyseal plates and articular cartilages.

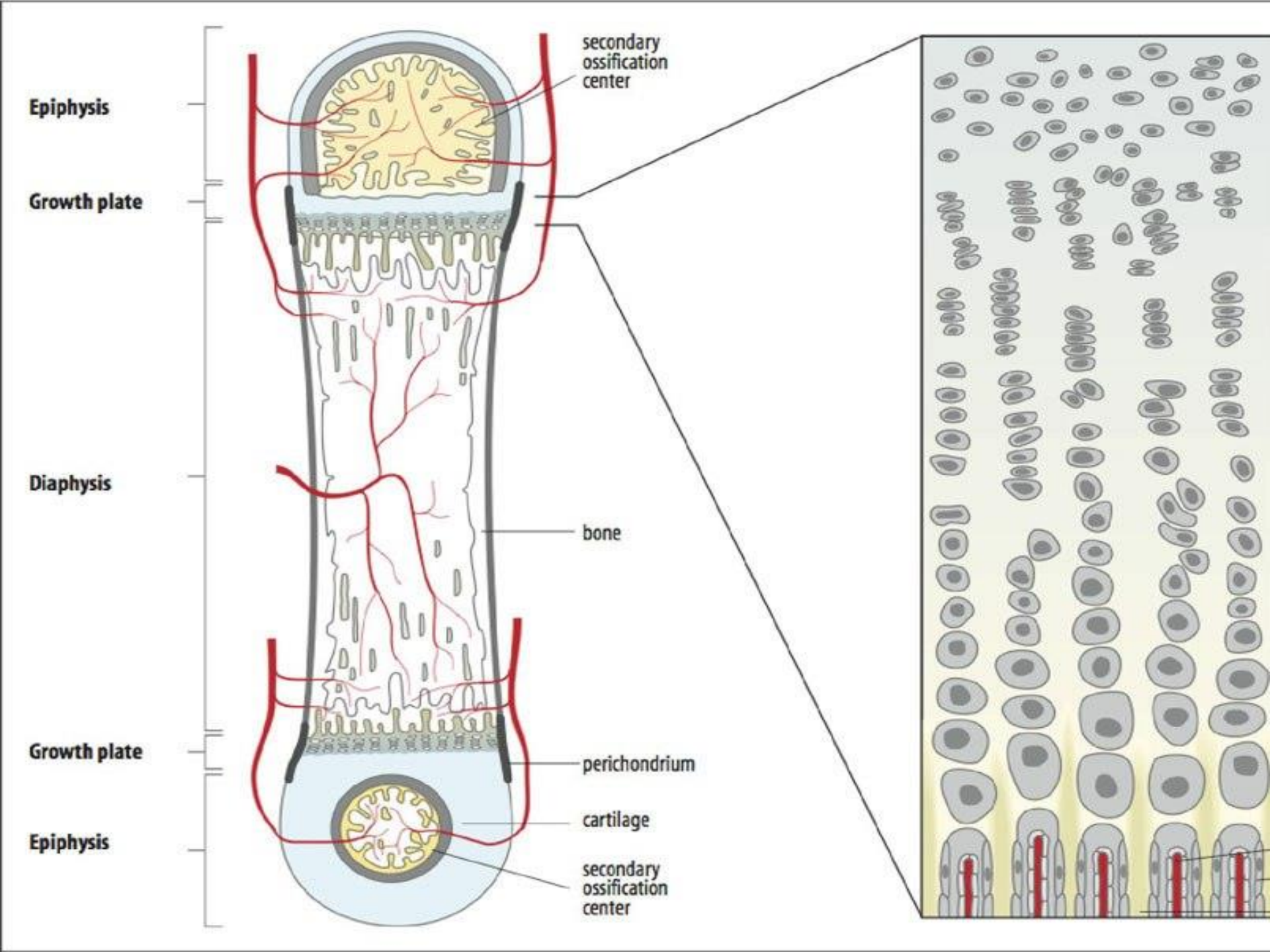



Bone collar

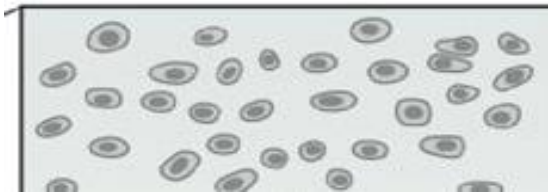

Secondary
ossification

Secondary ossification center

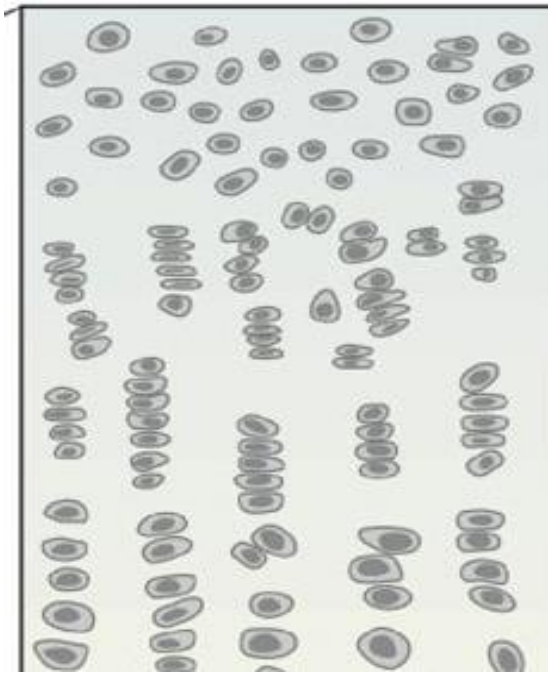



Epiphysis
Growth plate
Diaphysis
Growth plate
Epiphysis
secondary ossification center
bone
perichondrium
cartilage
secondary ossification center

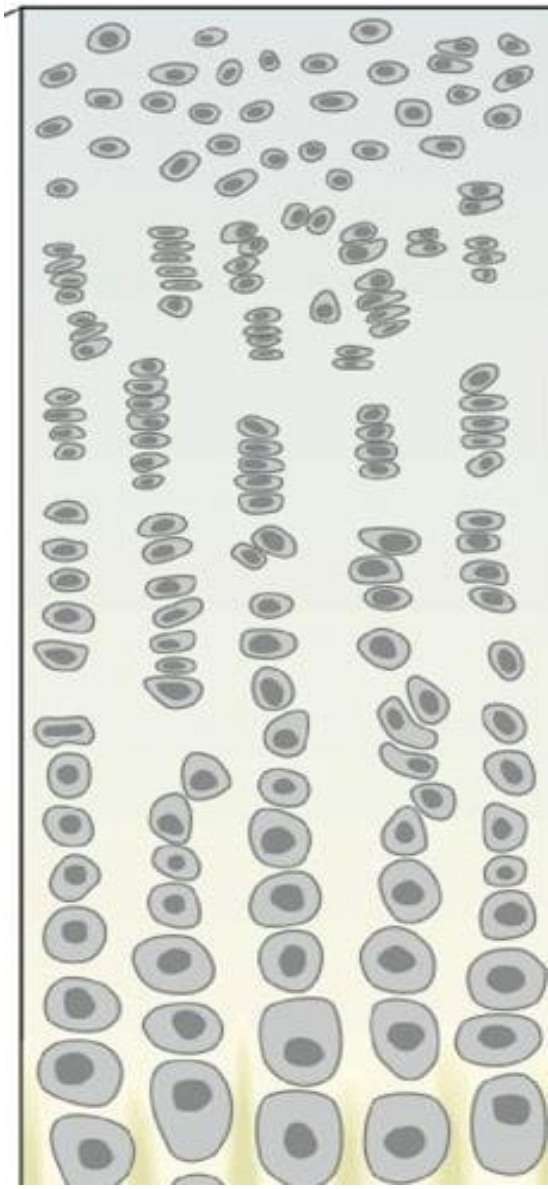
Zone of reserve cartilage (resting cartilage)

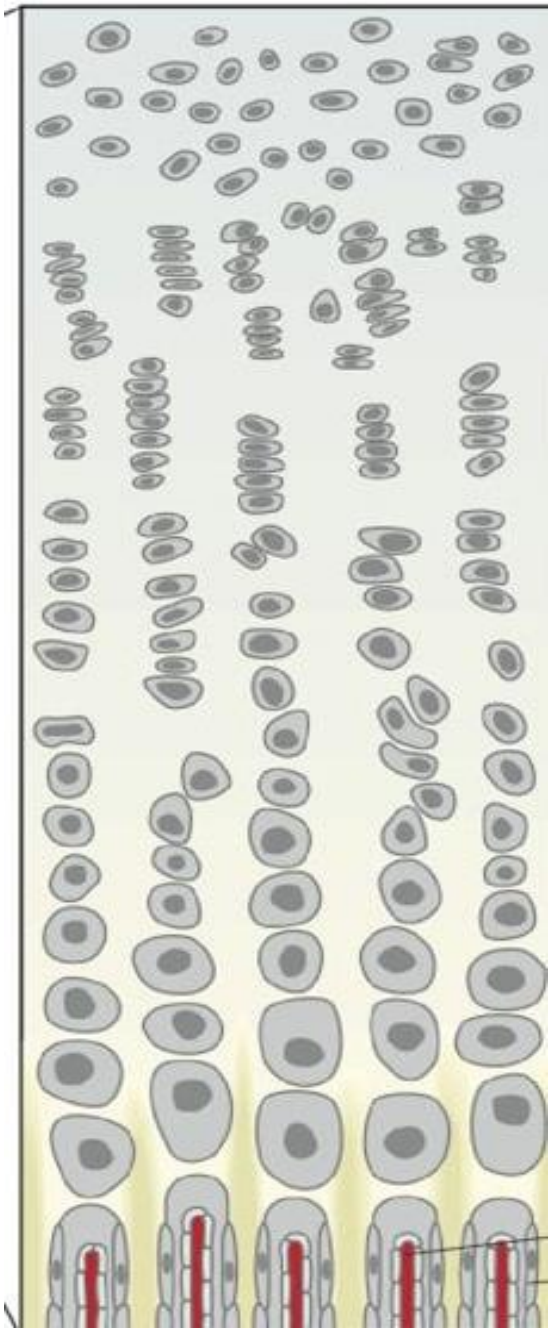


Zone of proliferation

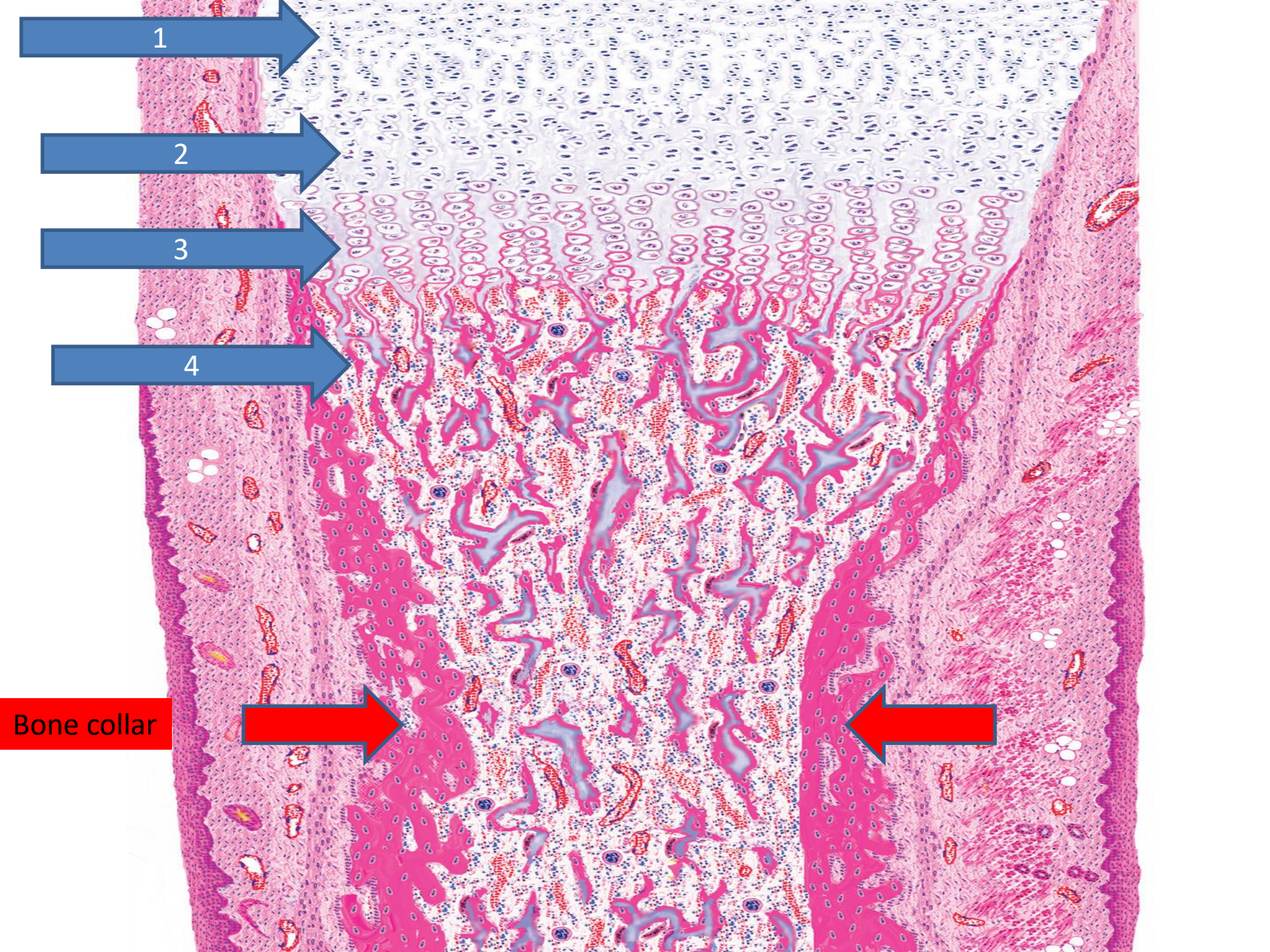


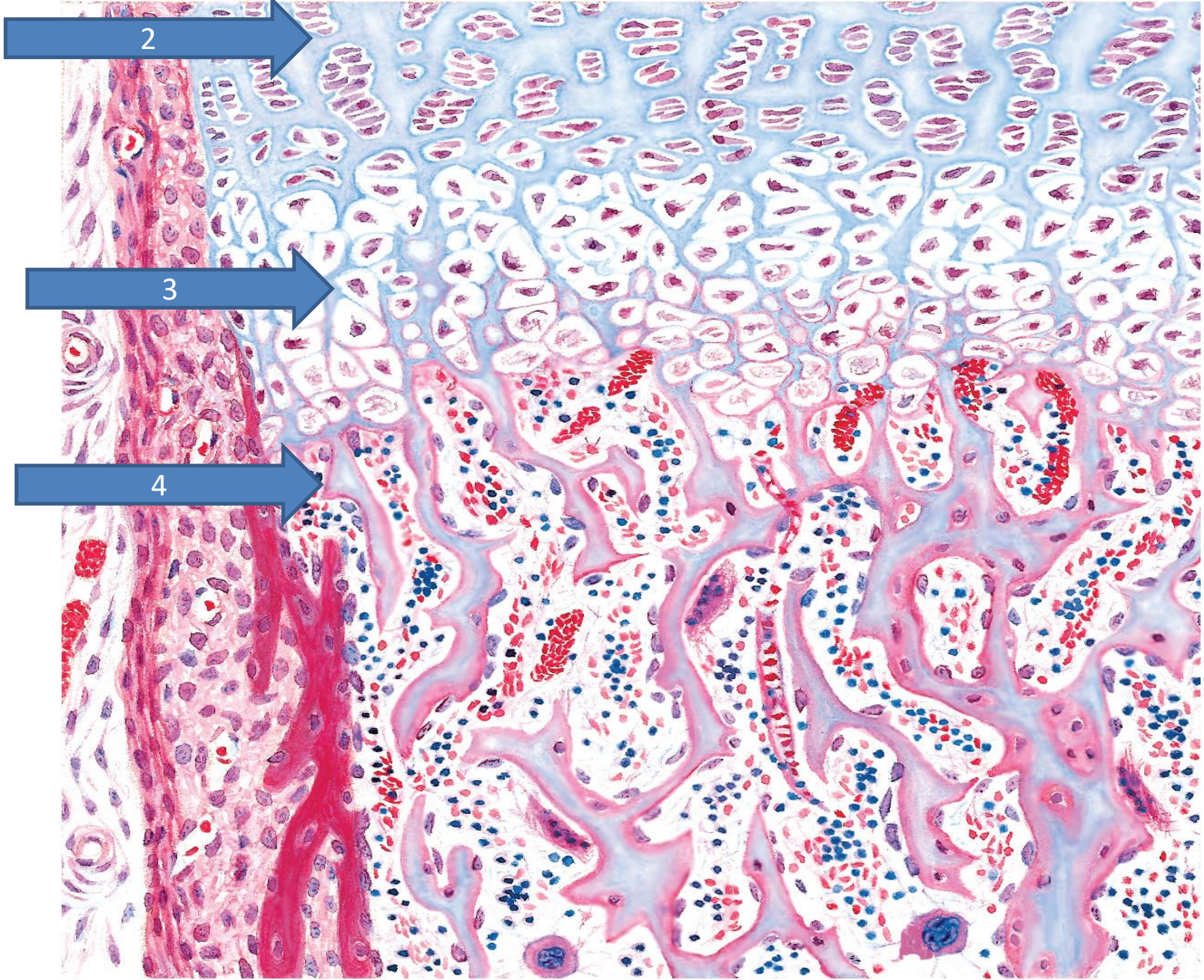
Zone of hypertrophy and calcification

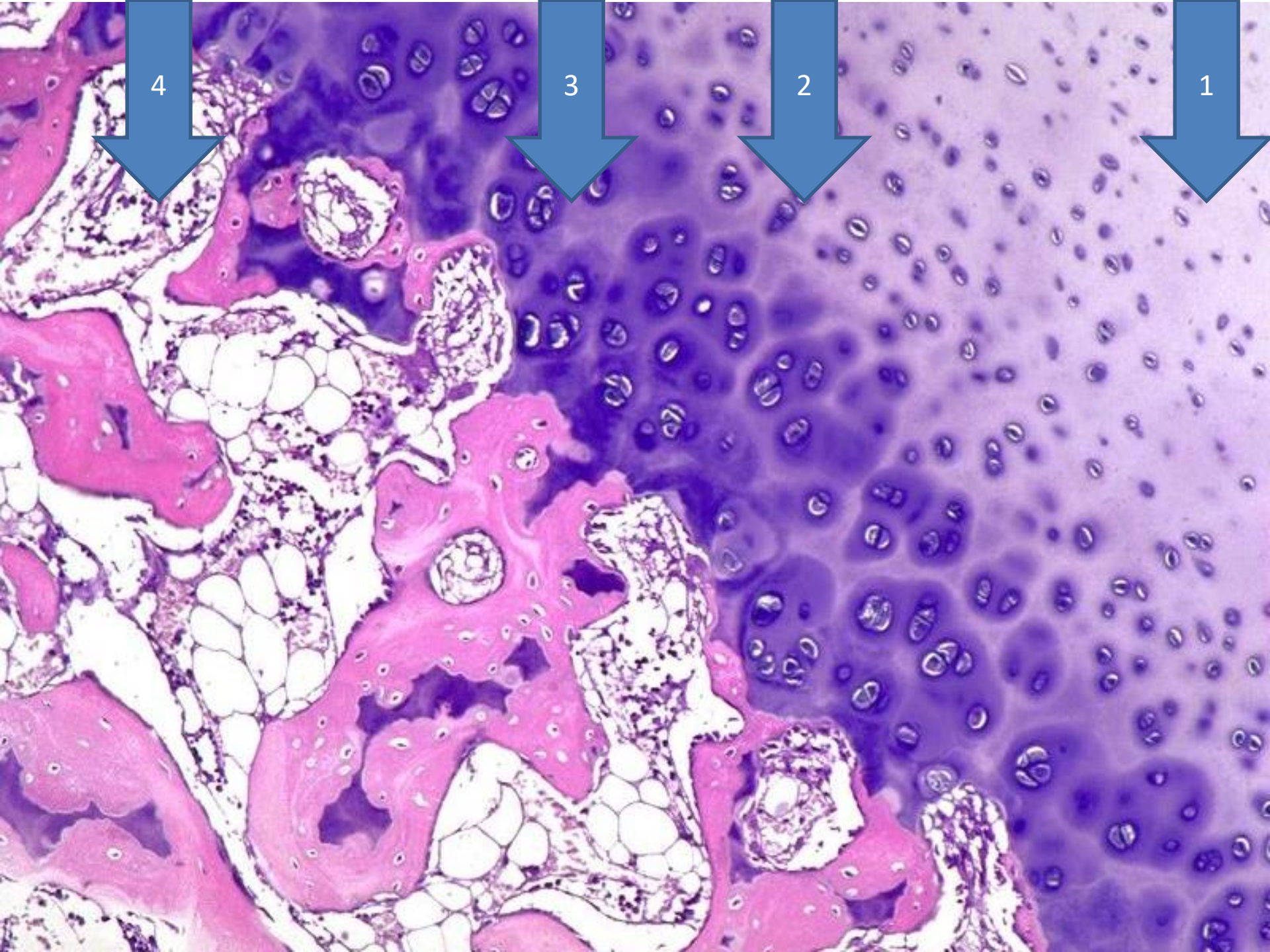


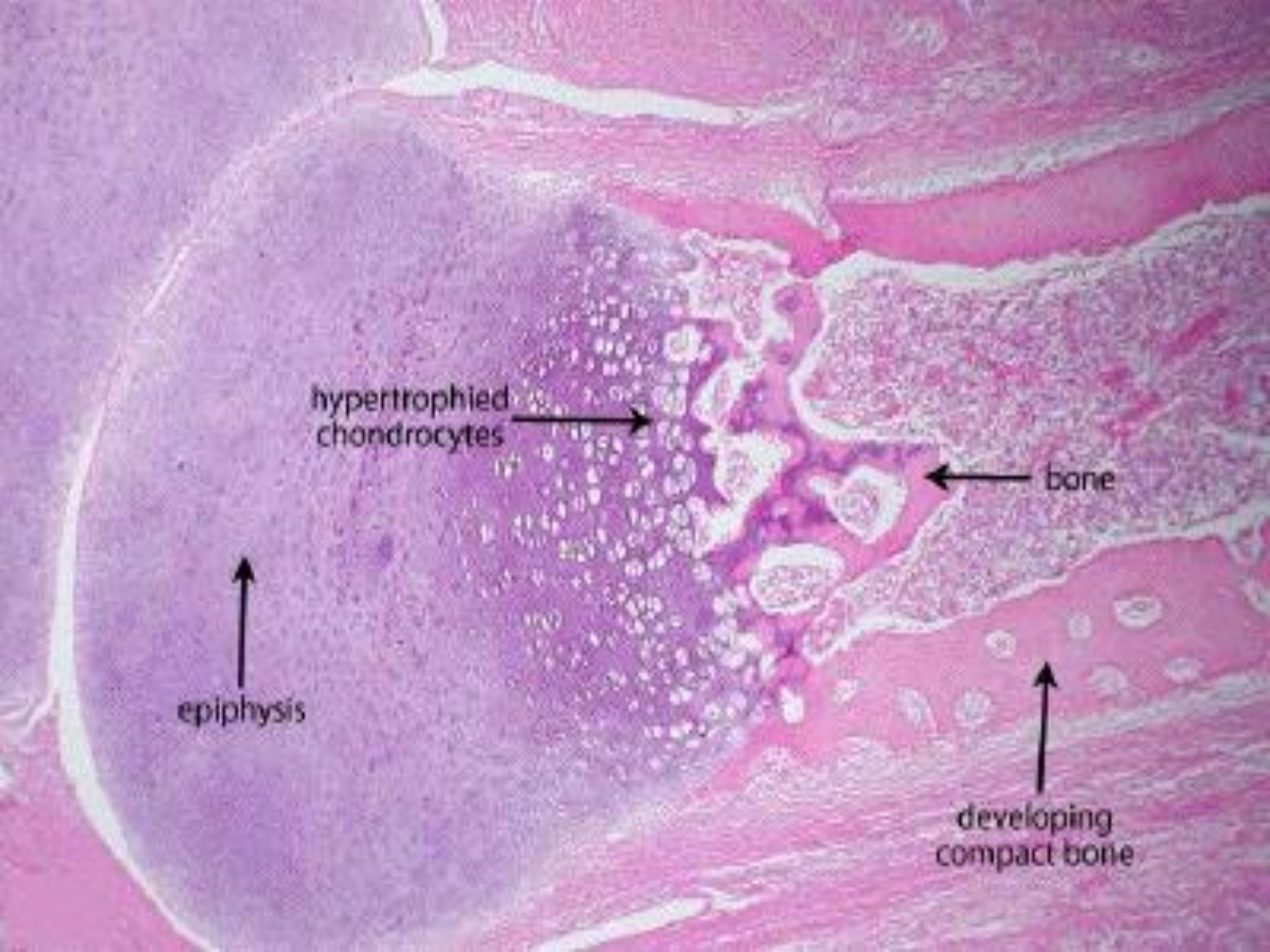


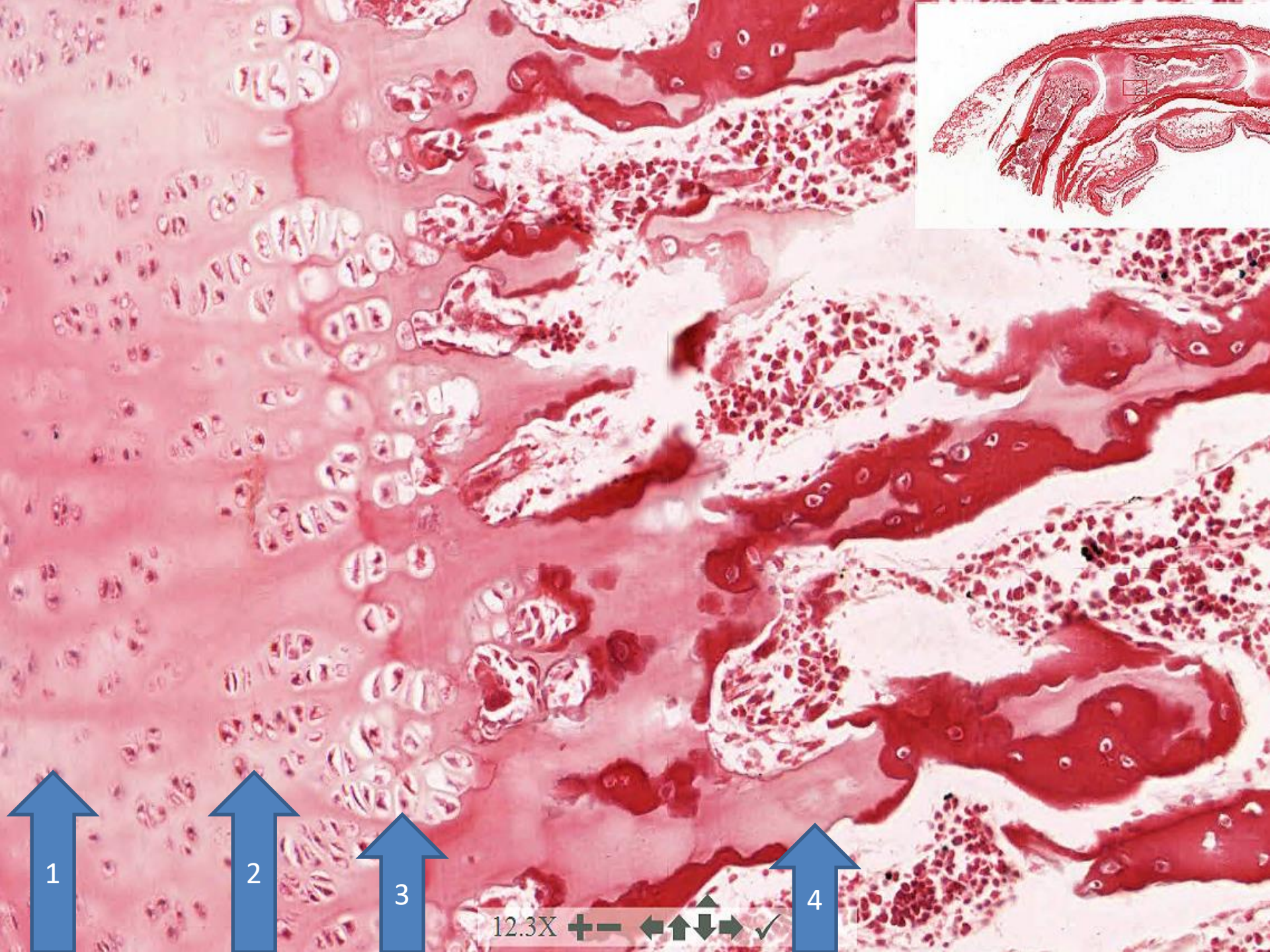
Zone of ossification


1
2
3
4
Bone collar

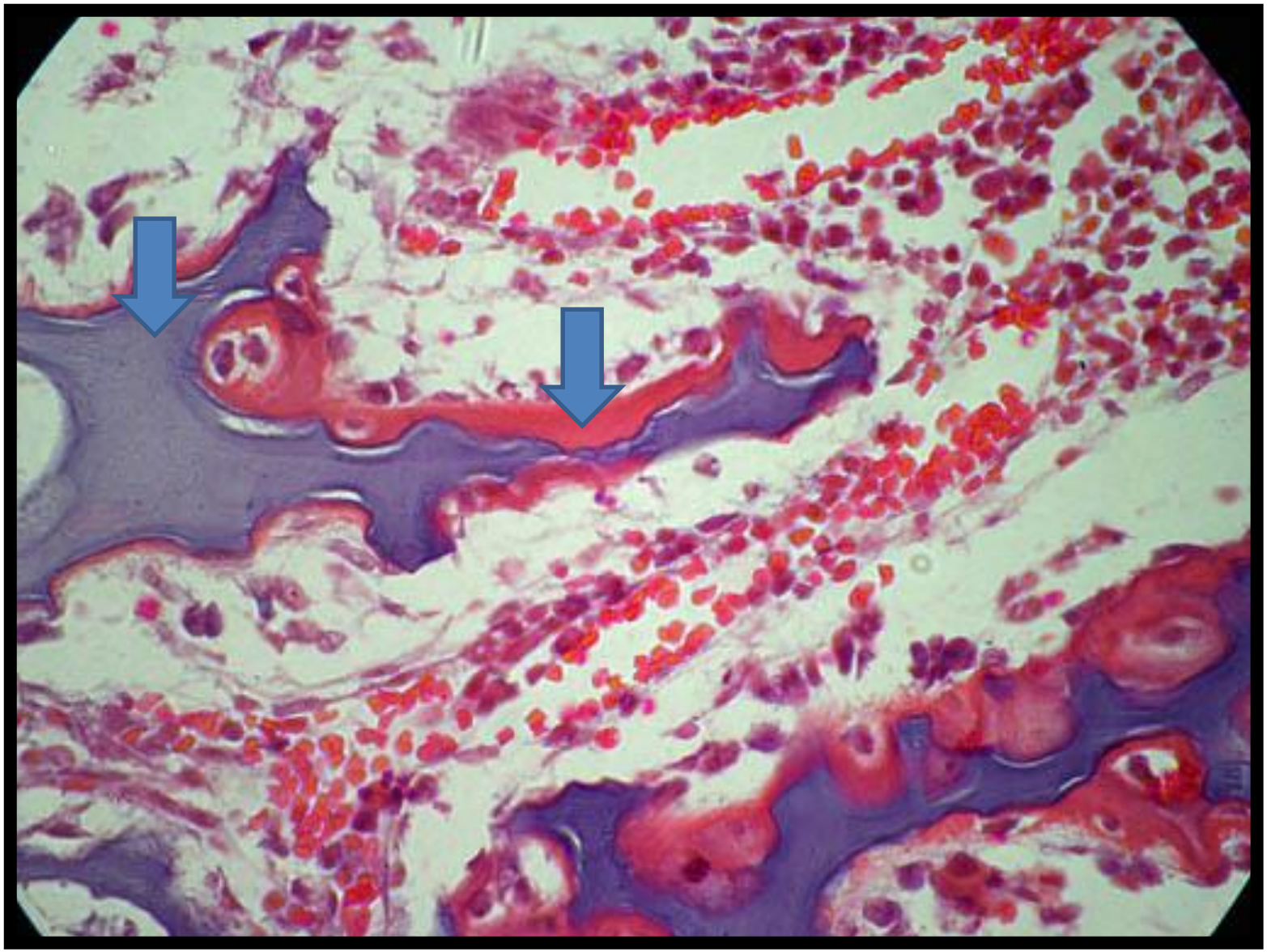

2
3
4


4
3
2
1

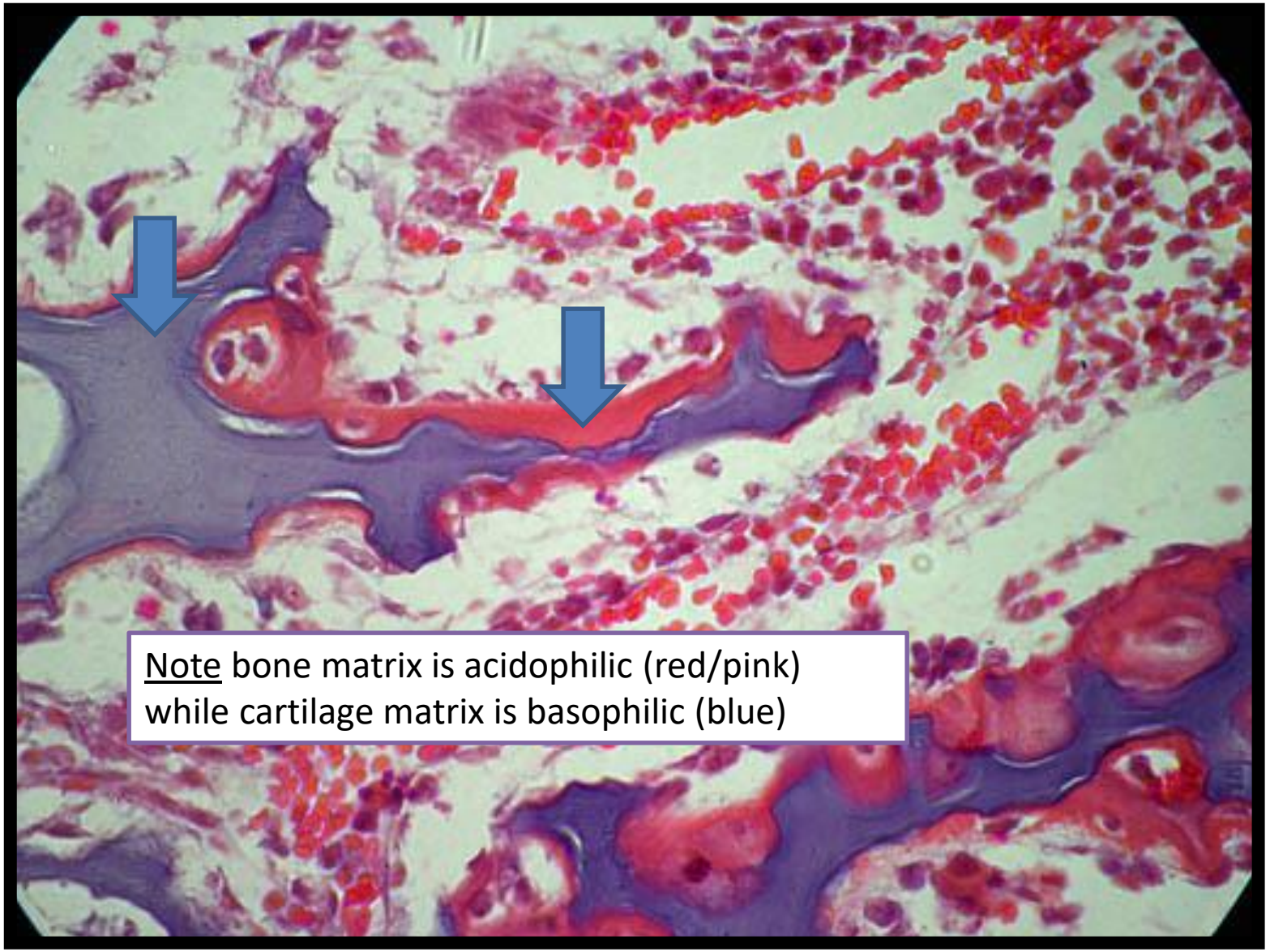

hypertrophied chondrocytes
bone
epiphysis
developing compact bone


1
2
3
4
12.3X

Ossification zone

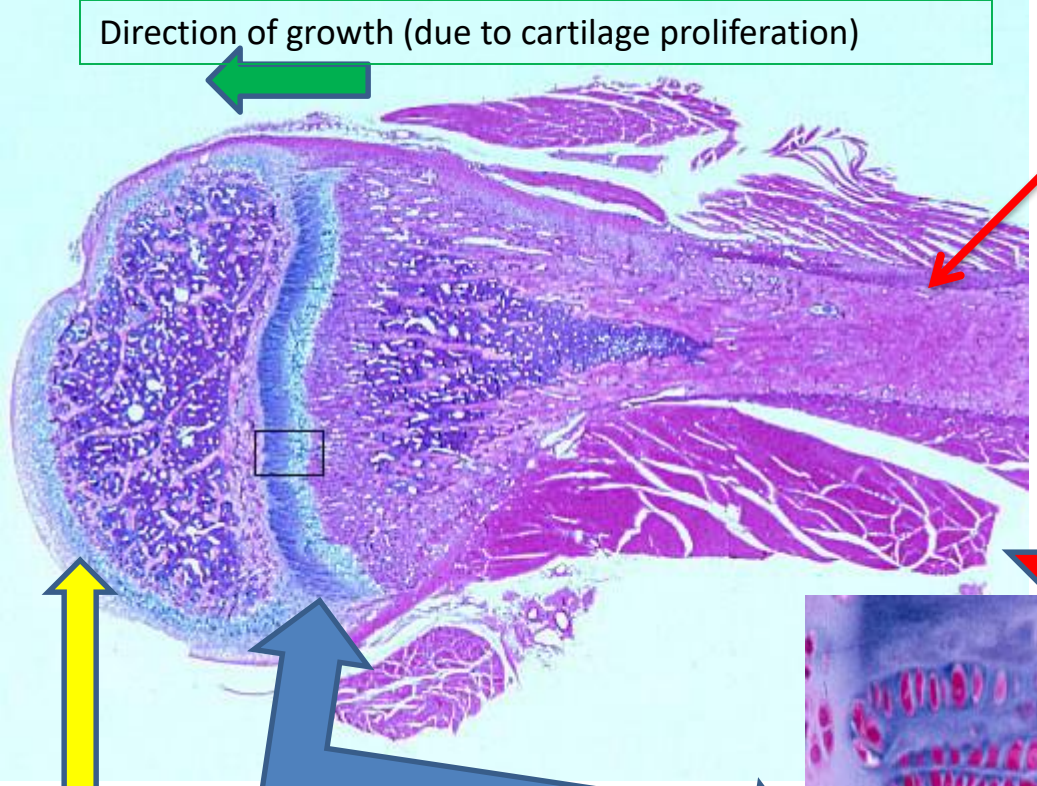


Ossification zone



Direction of growth (due to cartilage proliferation)

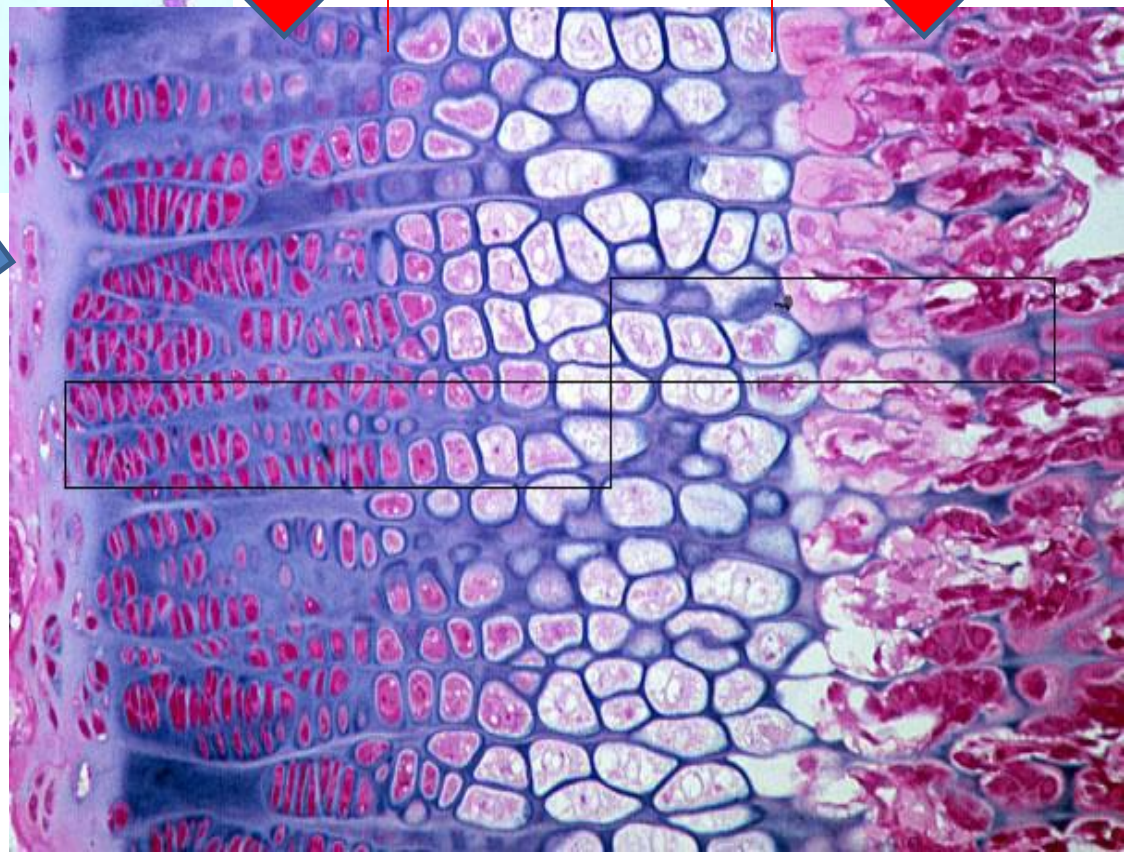
Shaft (diaphysis) becomes **compact bone**



2

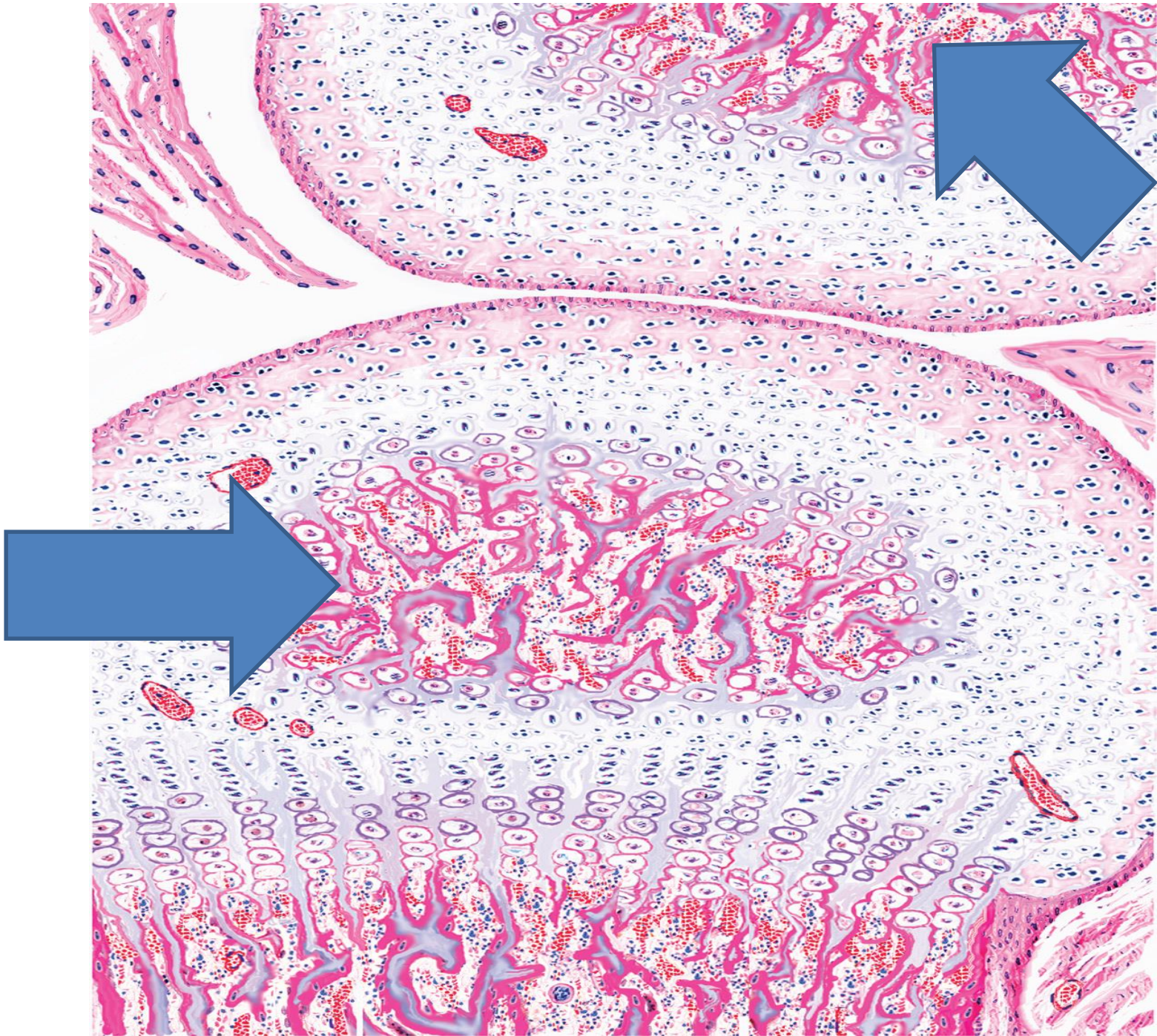
3

4



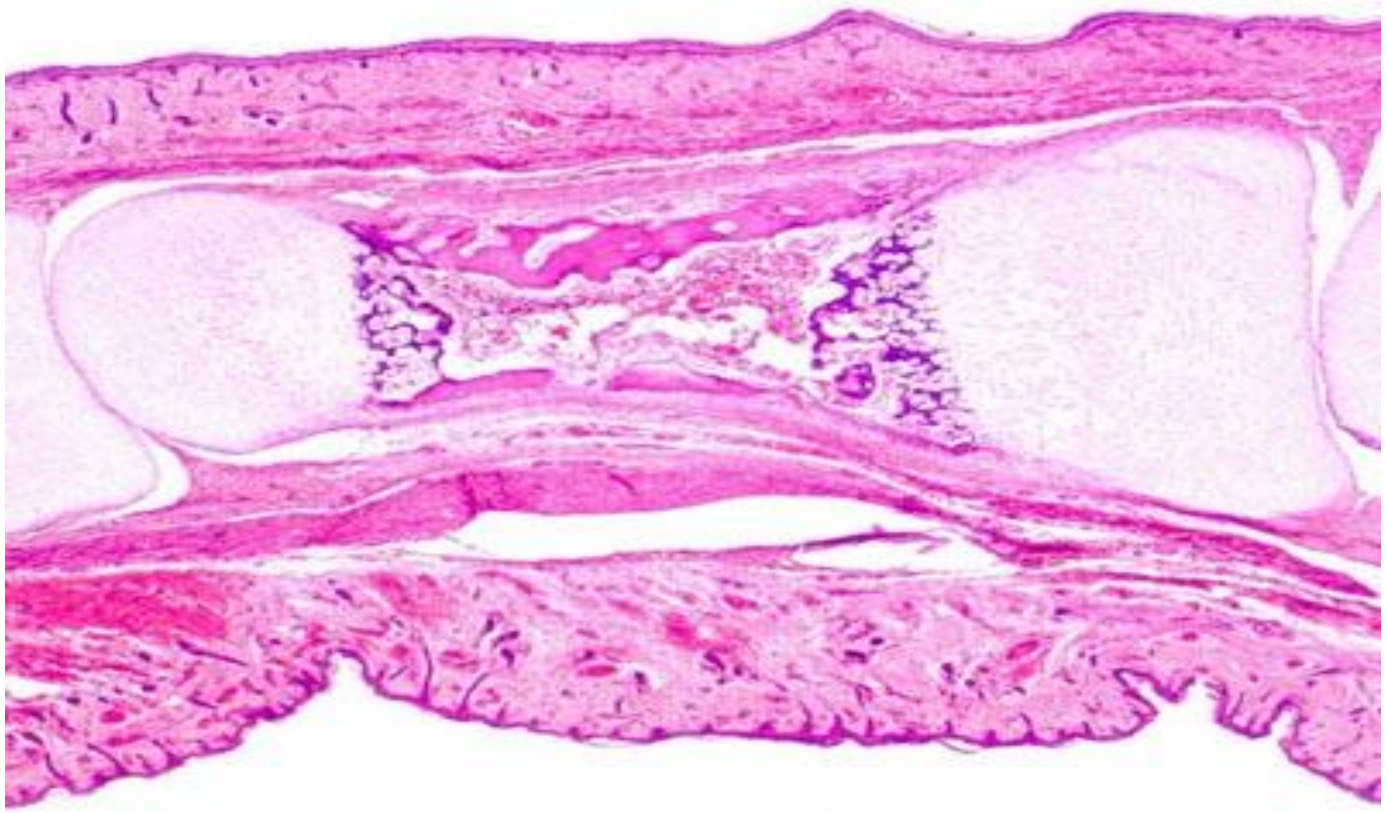
Cartilage at the head of the bone remains – this is the **articular cartilage (no perichondrium!)**

Secondary center of ossification



Growth in the Epiphyseal Plate

What type of bone formation is taking place?



Clinical Application

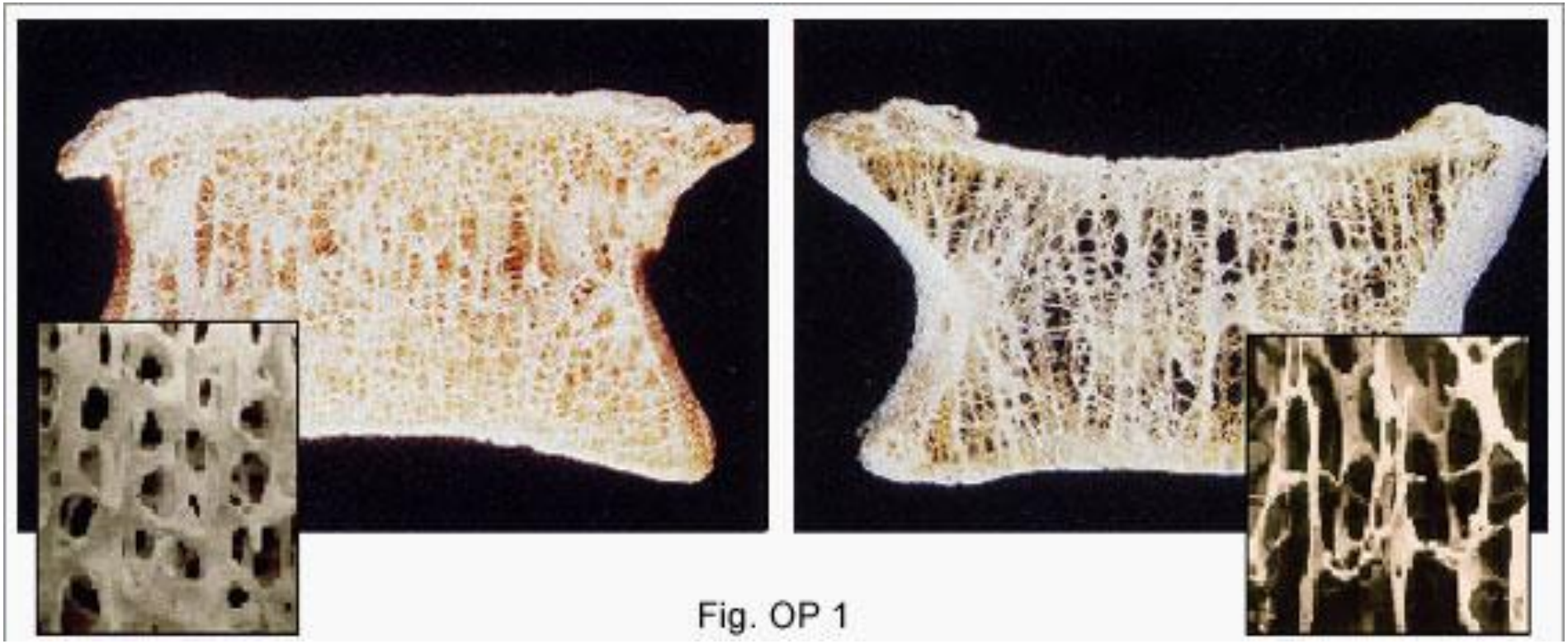


Fig. OP 1

Osteoporosis