Chapter 4

Cartilage and Bone

Li Shu-Lei instructor

Dept. Histology and Embryology, School of Basic Medical Sciences , Jilin University

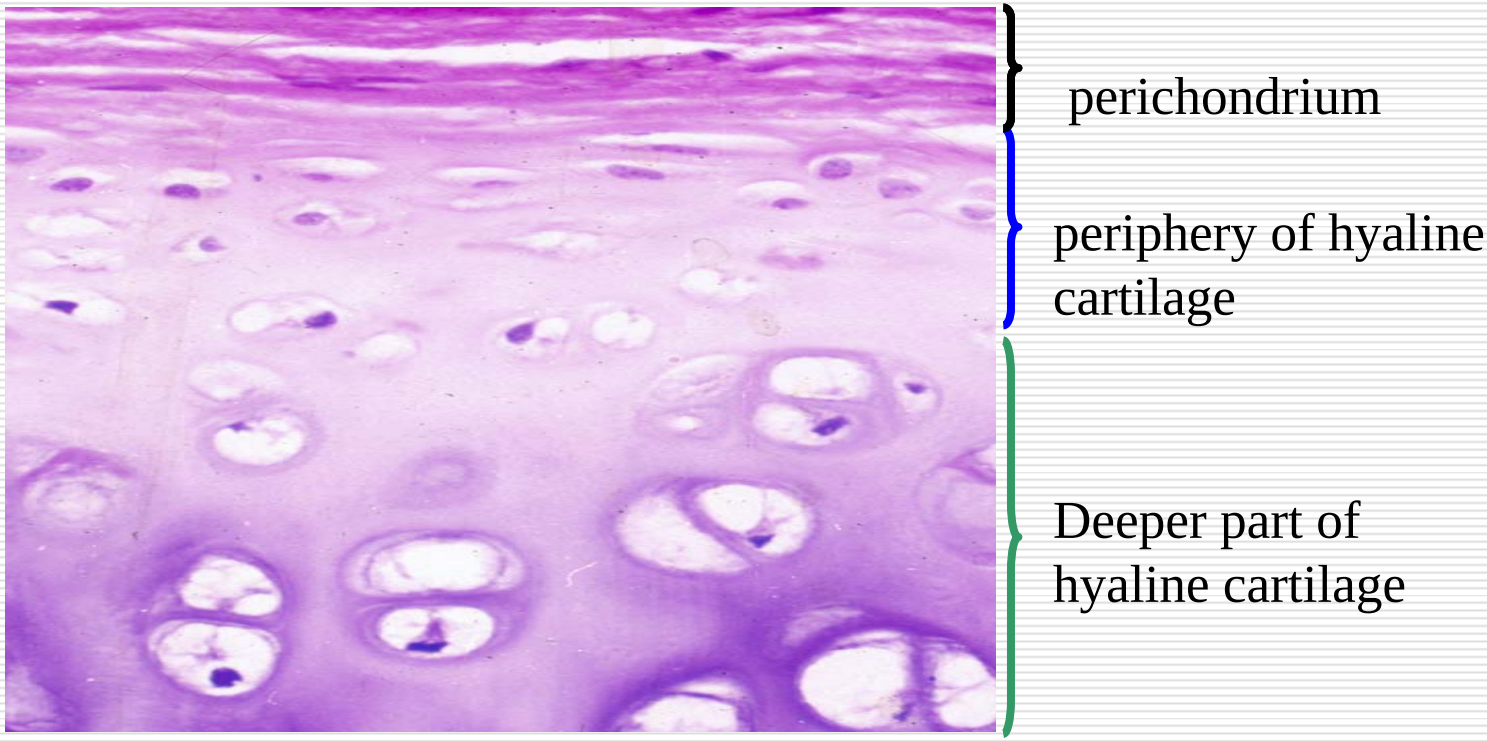
I Cartilage

- a specialized connective tissue
- Characterizers:
  - Cartilage cells (chondrocytes)
  - ground substance is semi-rigid. chondromucoprotein
  - no blood vessels, lymphatic vessels or nerves
- Types:
  - hyaline cartilage,
  - elastic cartilage,
  - fibrocartilage

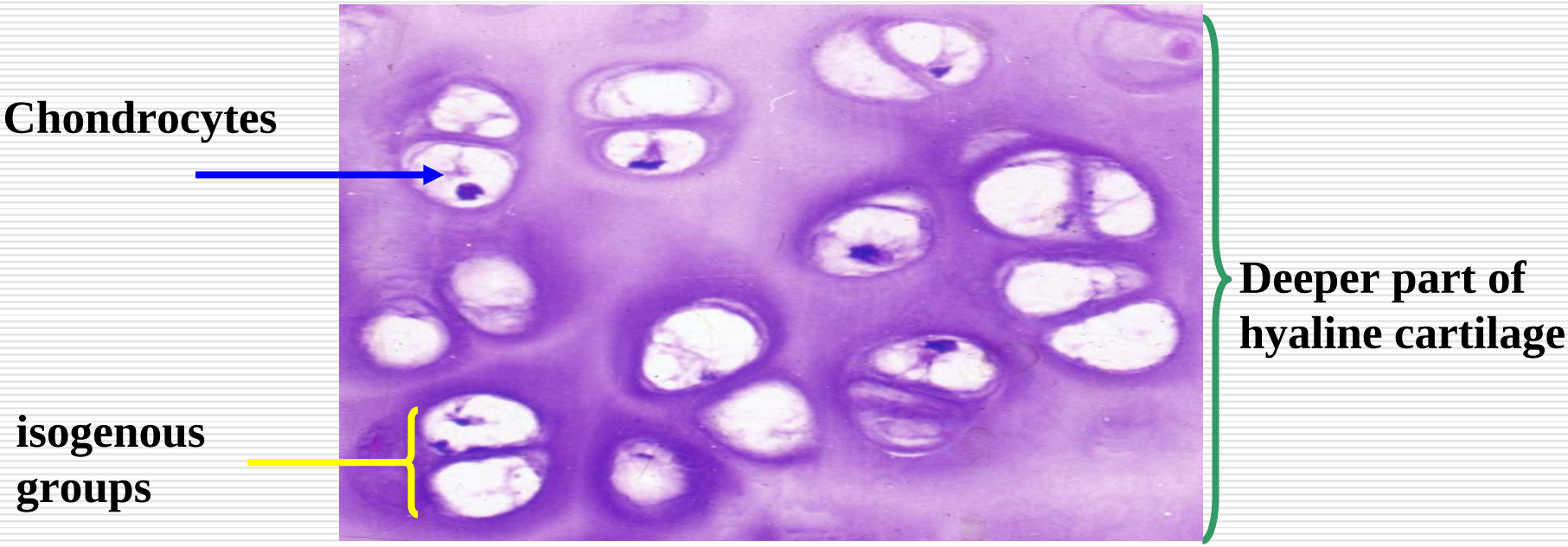
Hyaline cartilage

- Distribution
  - Bluish-white
  - Articular surface, rib cartilage, trachea & bronchus
- Components
  - **Chondrocytes**
  - **Extracellular matrix**
  - **Perichondrium**

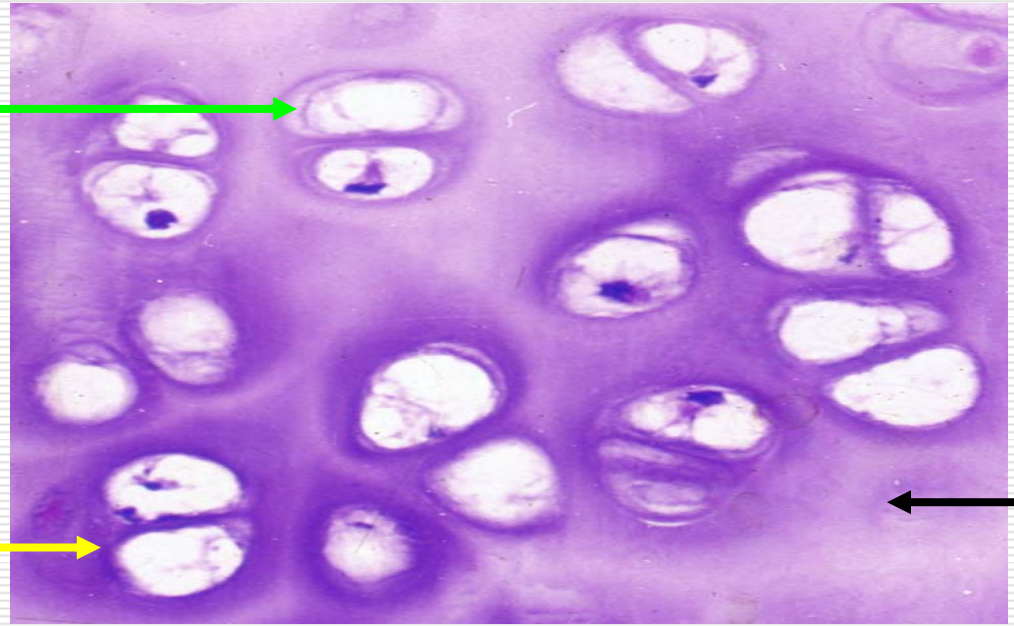
- **peripheral cells:**
  - **immature, small,single , elliptic, flattened**



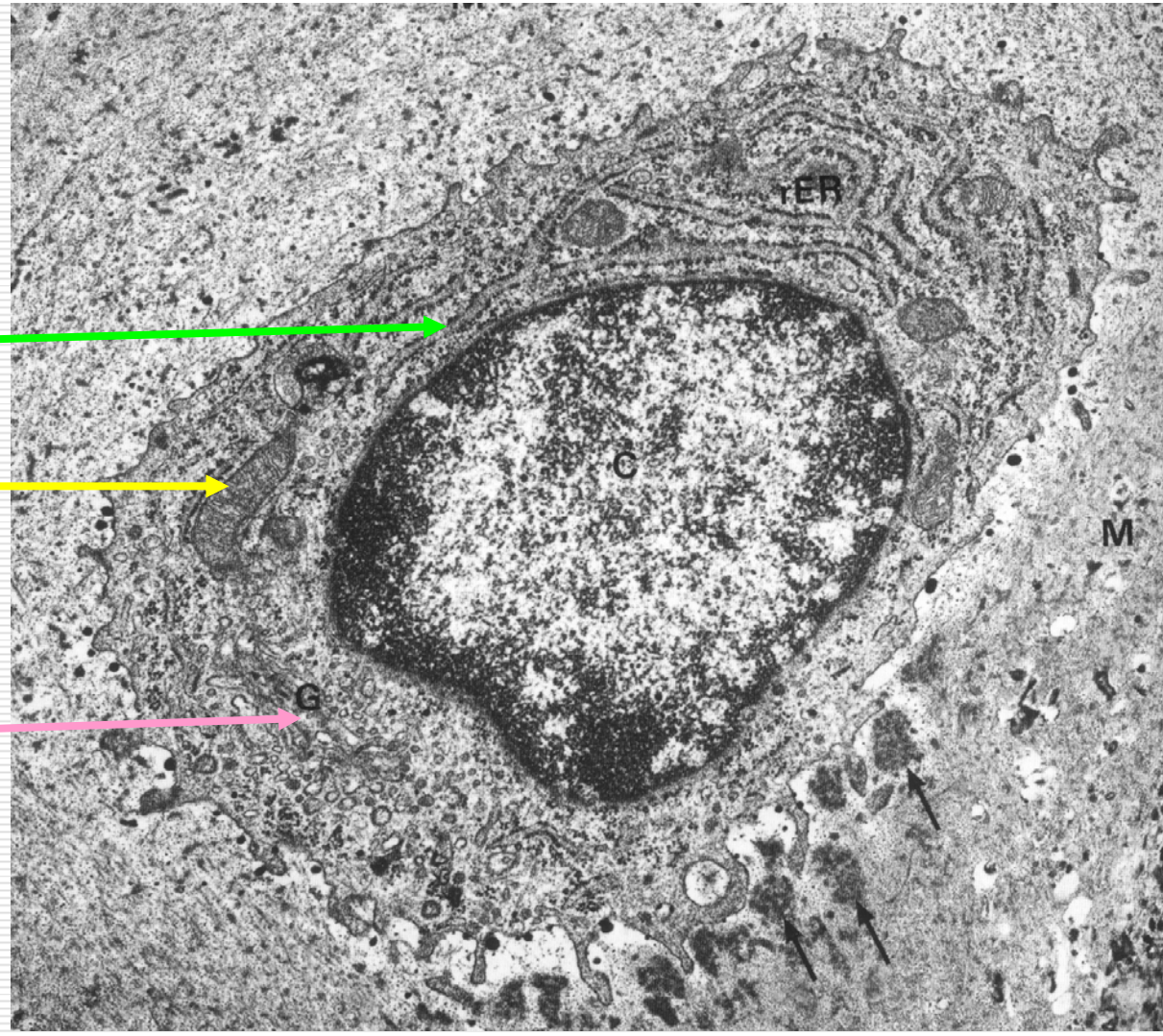
- **central cell:**
  - **mature, large, round， isogenous groups**
  - **a large centrally-placed nucleus，basophilic cytoplasm**



- Chondrocytes are enclosed by cartilage matrix.
- lacunae : small cavities occuped by cells
- Capsule: cartilage matrix surrounding chondrocyte, intense basophilia



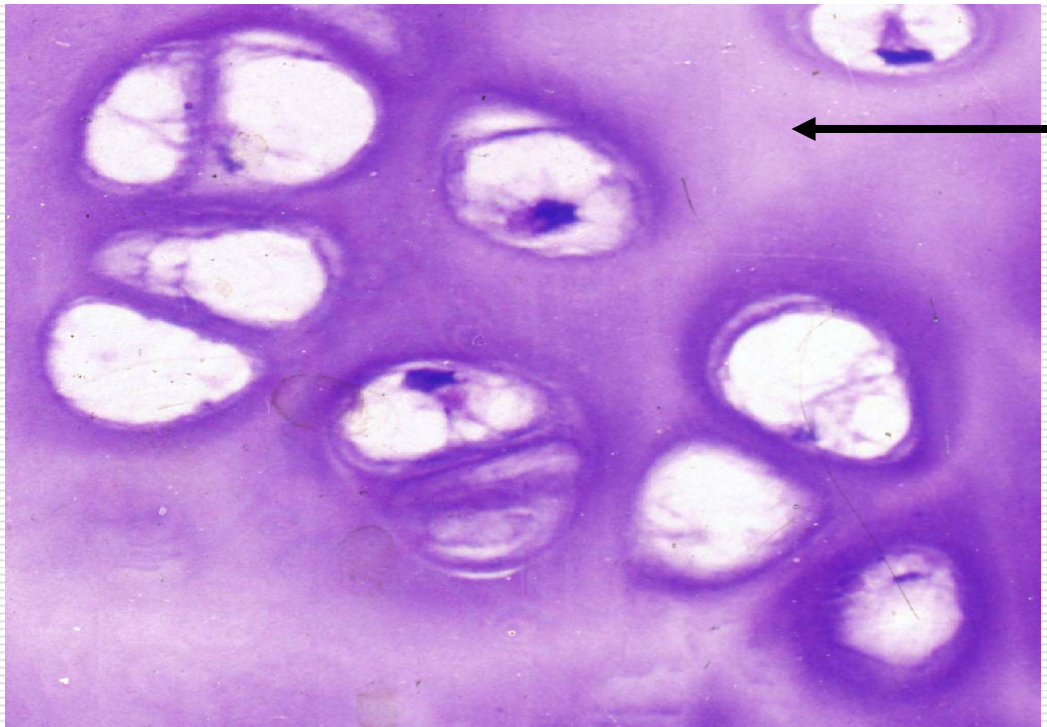
- EM:
- rough endoplasmic reticulum
- mitochondria
- Free ribosomes
- Golgi complex



----Function:

- **The chondrocytes are involved in the production of fibers and ground substance.**

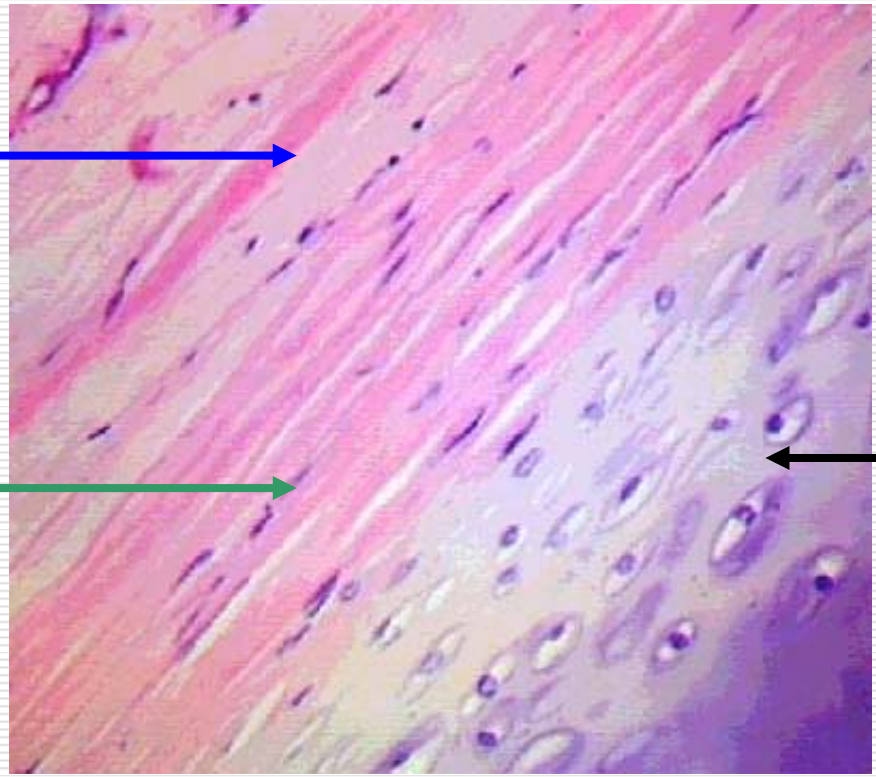
- collagenous fibrils : not be seen under the light microscope
- ground substance
  - basophilic
  - main component :chondromucoprotein.
- Function: retain a large amount of water;



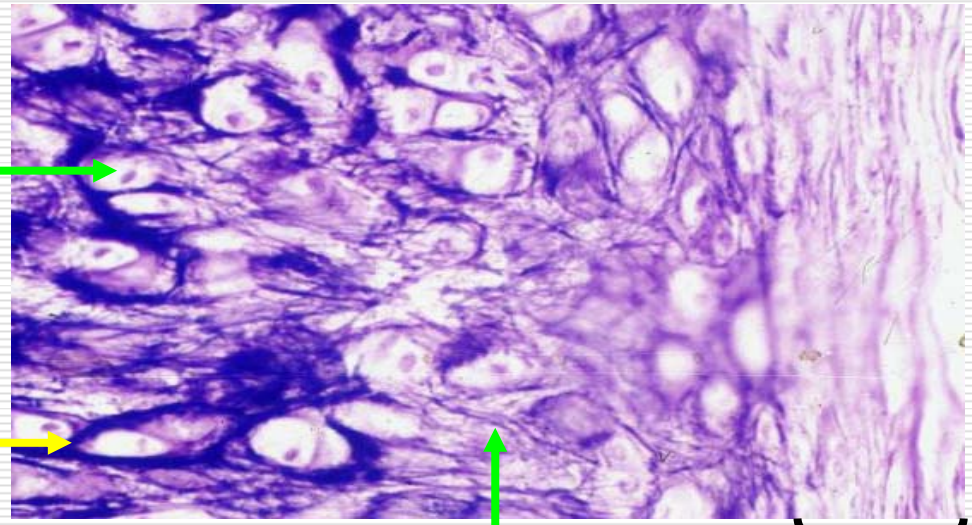
nourish chondrocytes

cartilage matrix

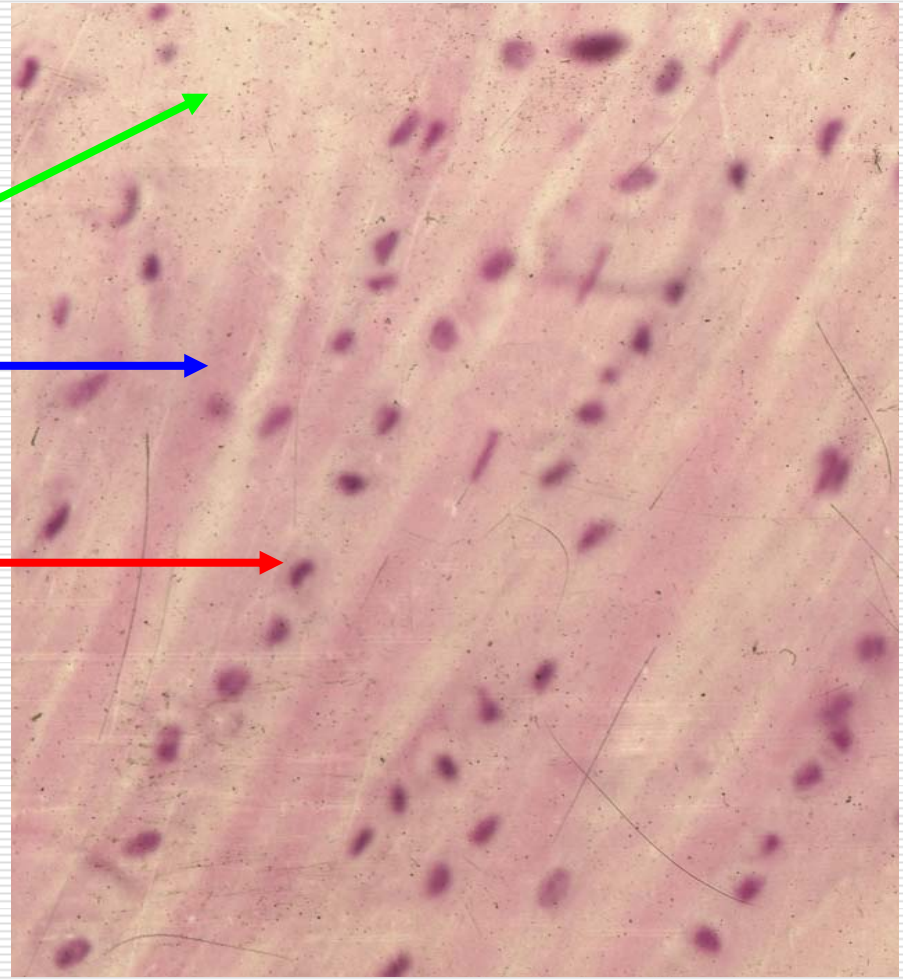
- perichondrium : connective tissue
- The outer zone : more fibers and fibroblast, protection
- The inner zone : well vascularised , more chondroblasts



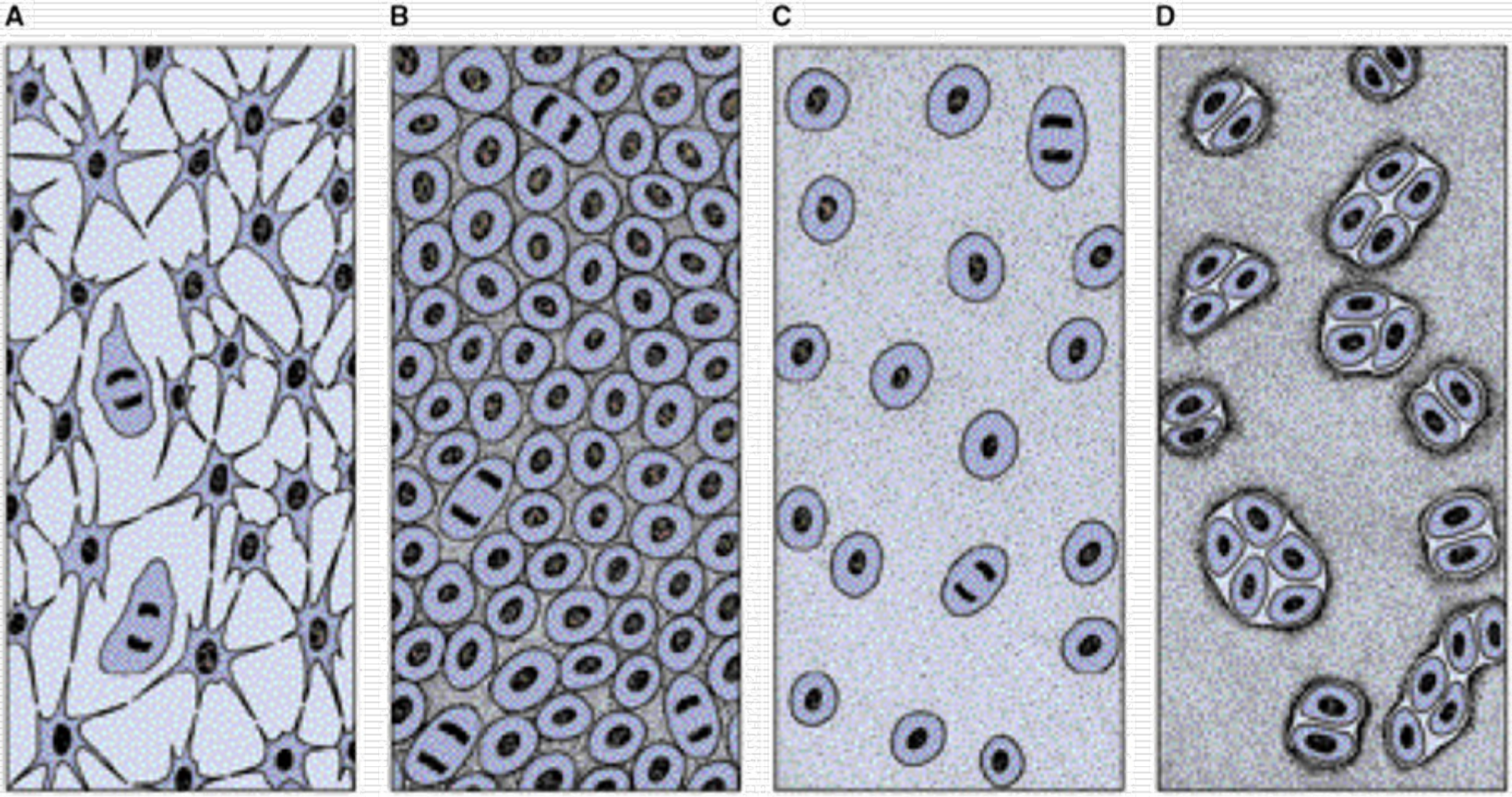
- external ear, eustachian tube, epiglottis , laryngeal cartilages
- elastic fiber
- more elasticity and flexibility



- intervertebral discs, the symphysis pubis
- small amounts of ground substance
- large number of collagenous fibers
- Chondrocytes are arranged in rows.



1.4 Histogenesis and Growth of Cartilage



Mesenchyme mesenchymal cells chondroblasts chondrocytes

1.4.1 Interstitial growth

- inner chondrocyte proliferation→ produce fiber and matrix.
- immature cartilage

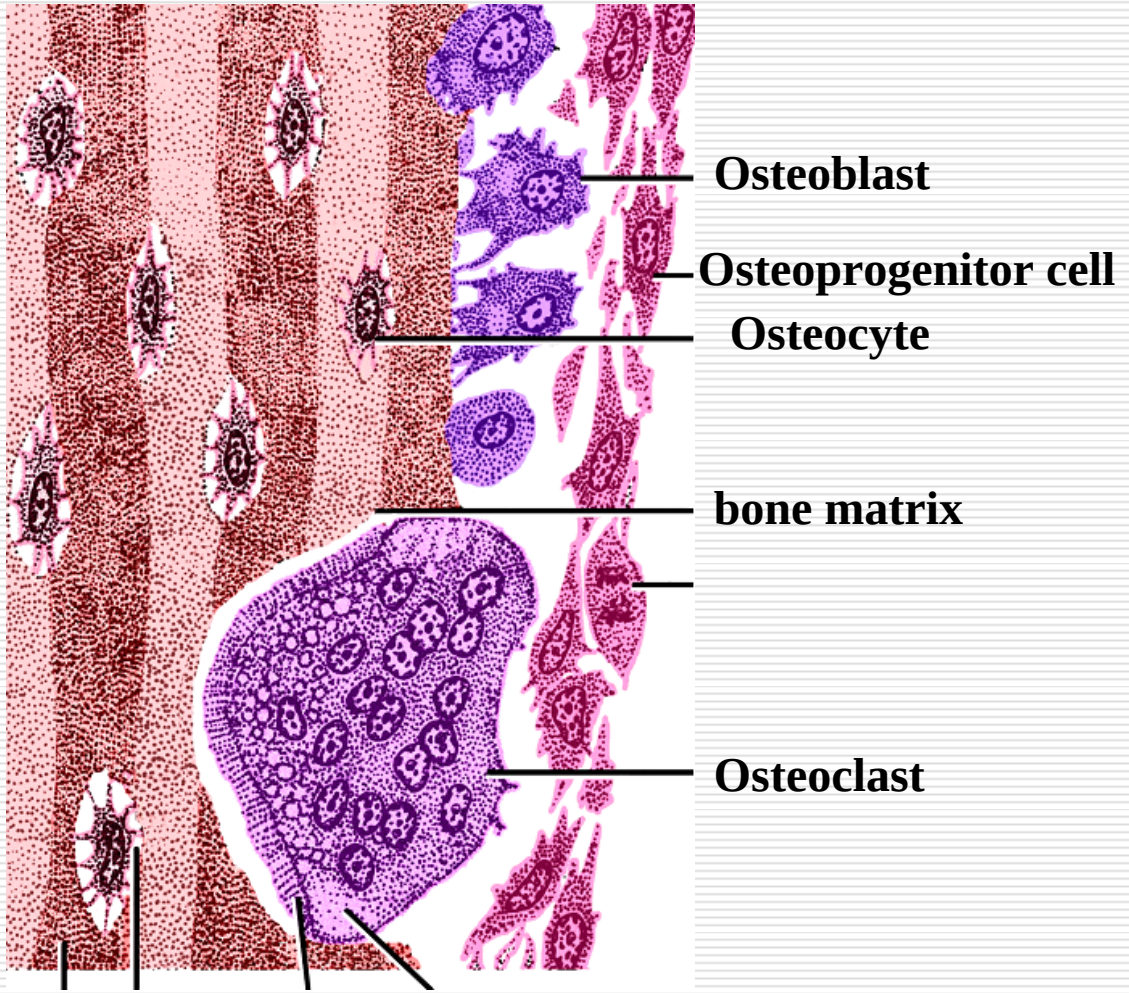
1.4.2 Appositional growth

- Between perichondrium and cartilage
- Chondroblasts →cartilage cell (chondrocyte) → produce fiber and matrix.
- growing and mature cartilage

II Bone or Osseous Tissue

- a kind of connective tissue specialized for support and protection
- bone tissue
  - cells: 4 types
  - matrix: fibers , ground substance
- Long bone
  - Spongy bone
  - Compact bone
    - Circumferential lamellae
    - Osteon
    - Interstitial lamellae
    - periosteum, endosteum
  - bone marrow

- four types of cells
  - Osteoprogenitor cell
  - Osteoblast
  - Osteocyte
  - Osteoclast
- bone matrix

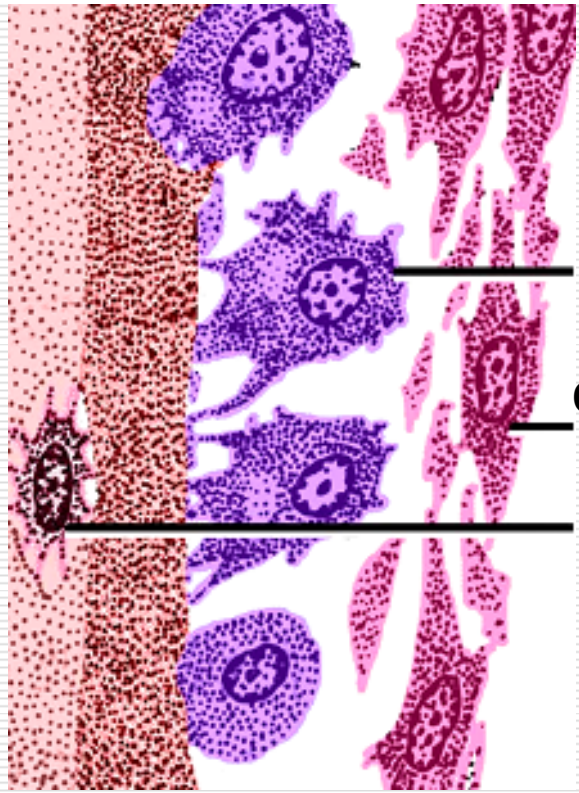


Ideograph of bone tissue

- lie in endosteum and in the inner zone of the periosteum.
- small and spindle-shaped
- an oval nucleus
- weak basophilic cytoplasm

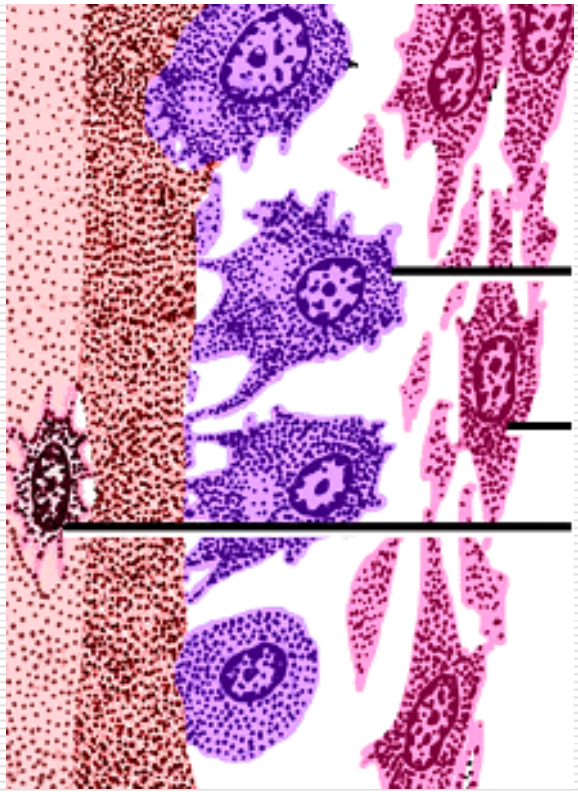
---Function:

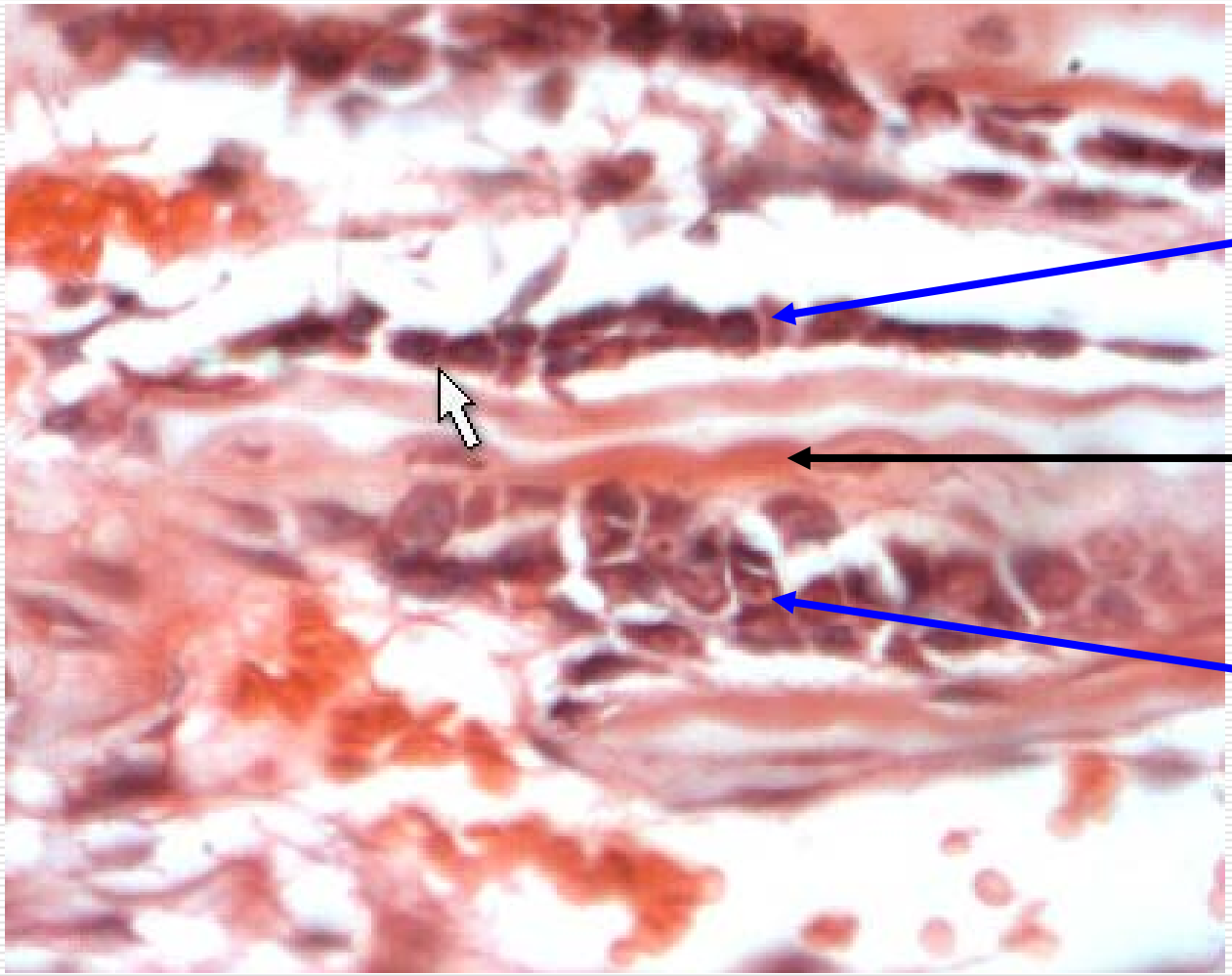
- differentiated into osteoblast



Osteoprogenitor cell

- an epithelioid layer
- locate on the surface of new bone tissue
- cuboidal or low columnar cell
- strong basophilic cytoplasm



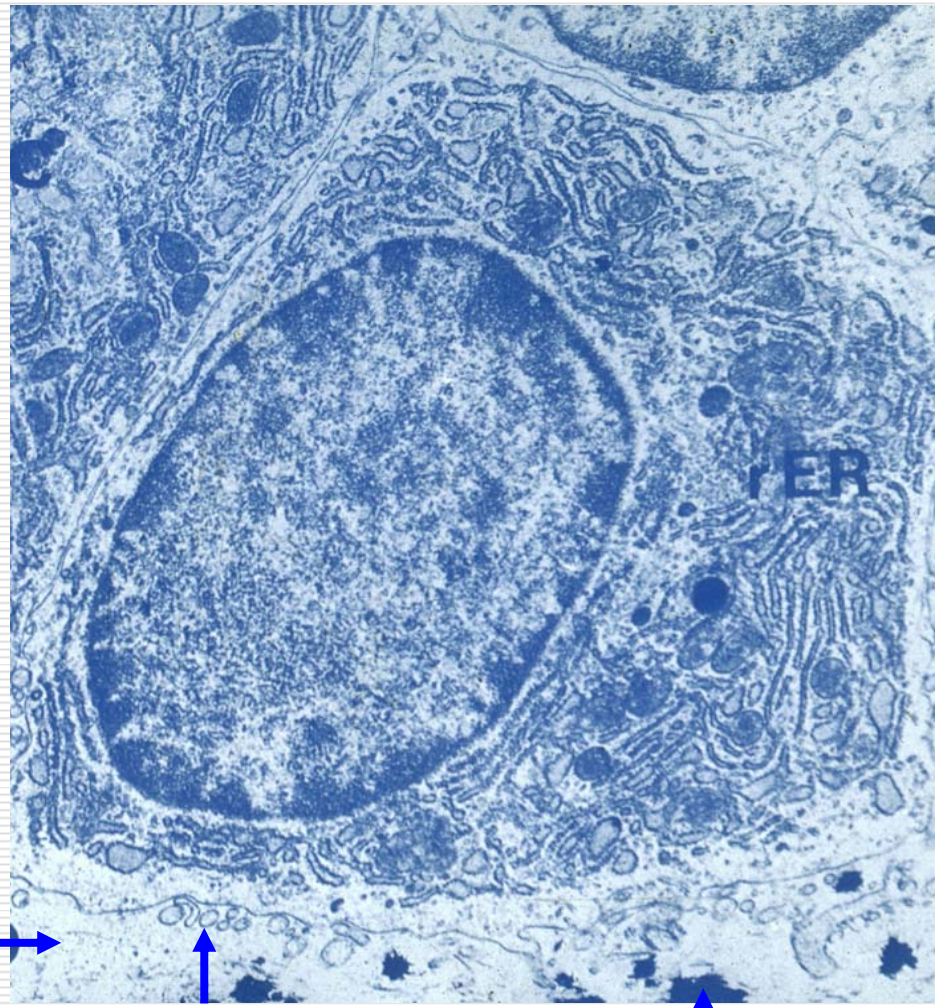

Osteoblast
New bone tissue
Osteoblast

EM:

- short, slender processes
- rough endoplasmic reticulum
- Golgi apparatus.

---Function:

- synthesize bone collagen fiber
- osteoid
- promote calcification
- become osteocytes



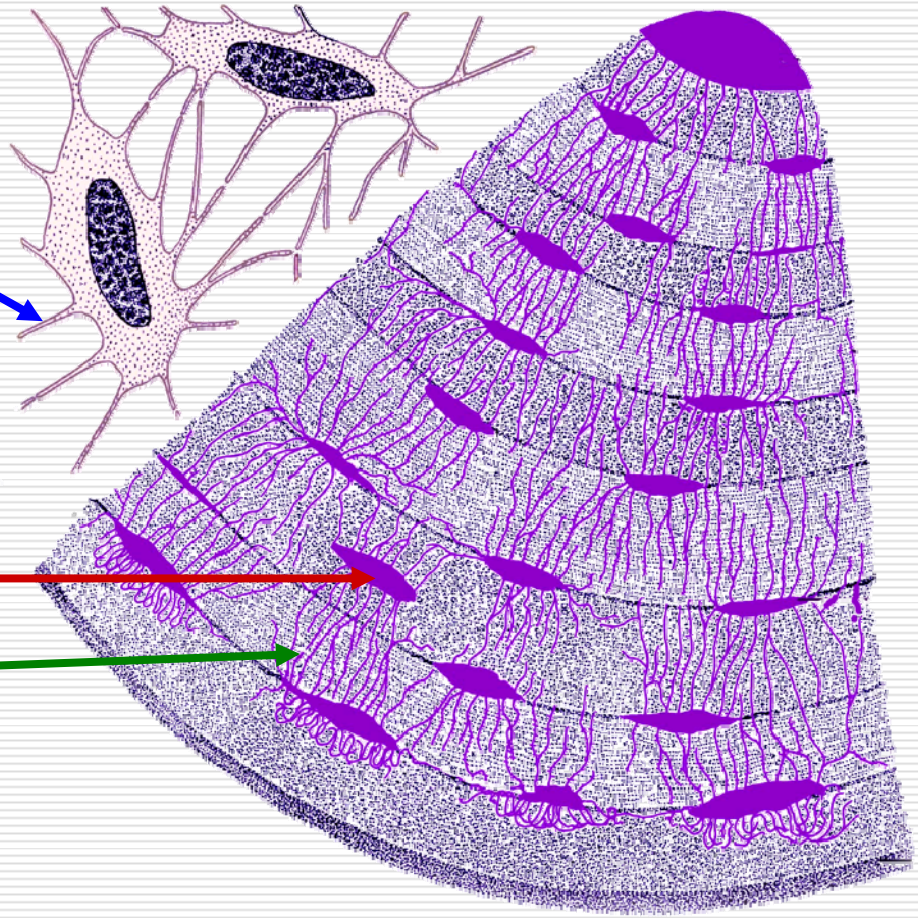
- ovoid in shape with fine processes

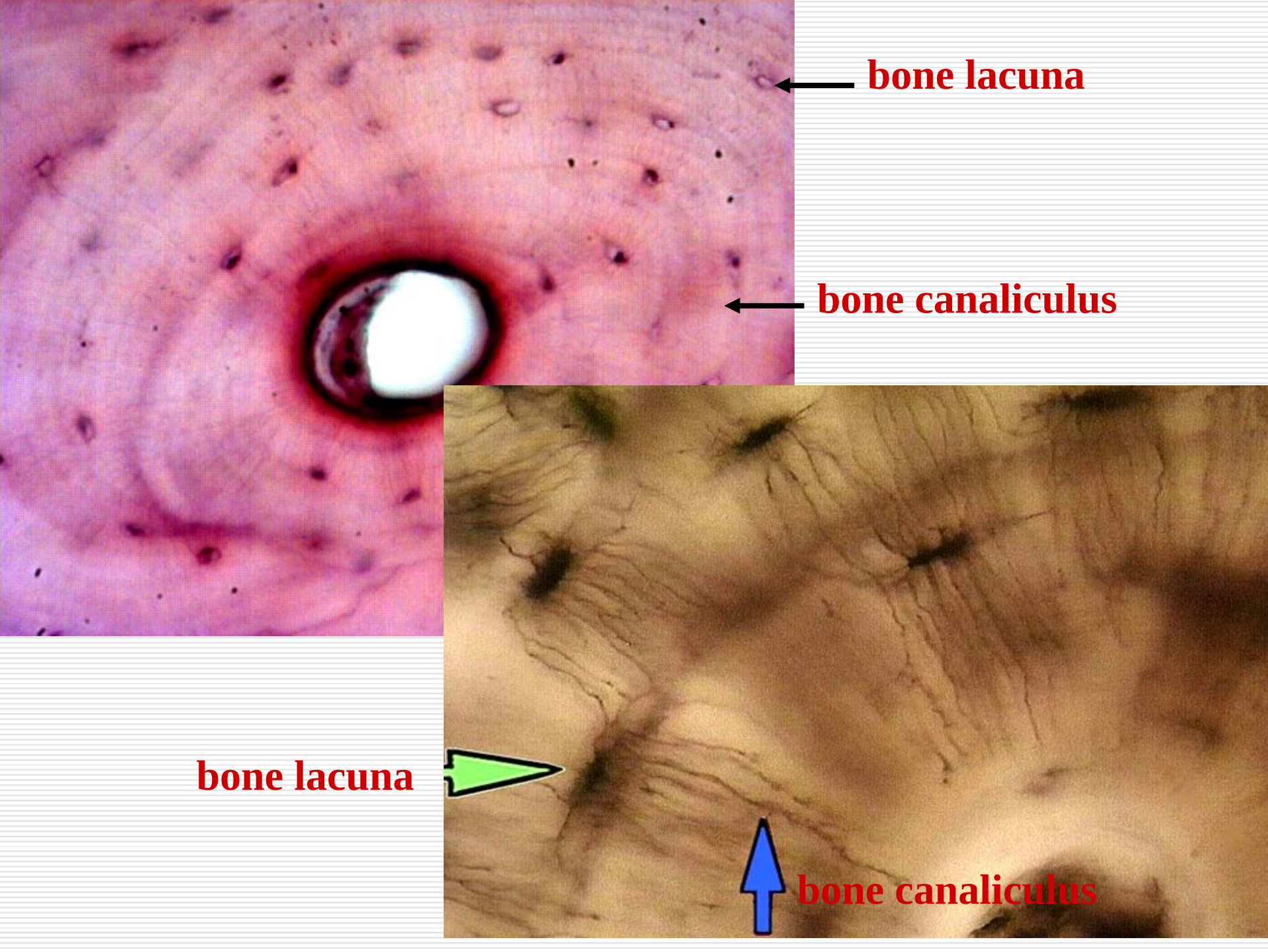
Gap junction

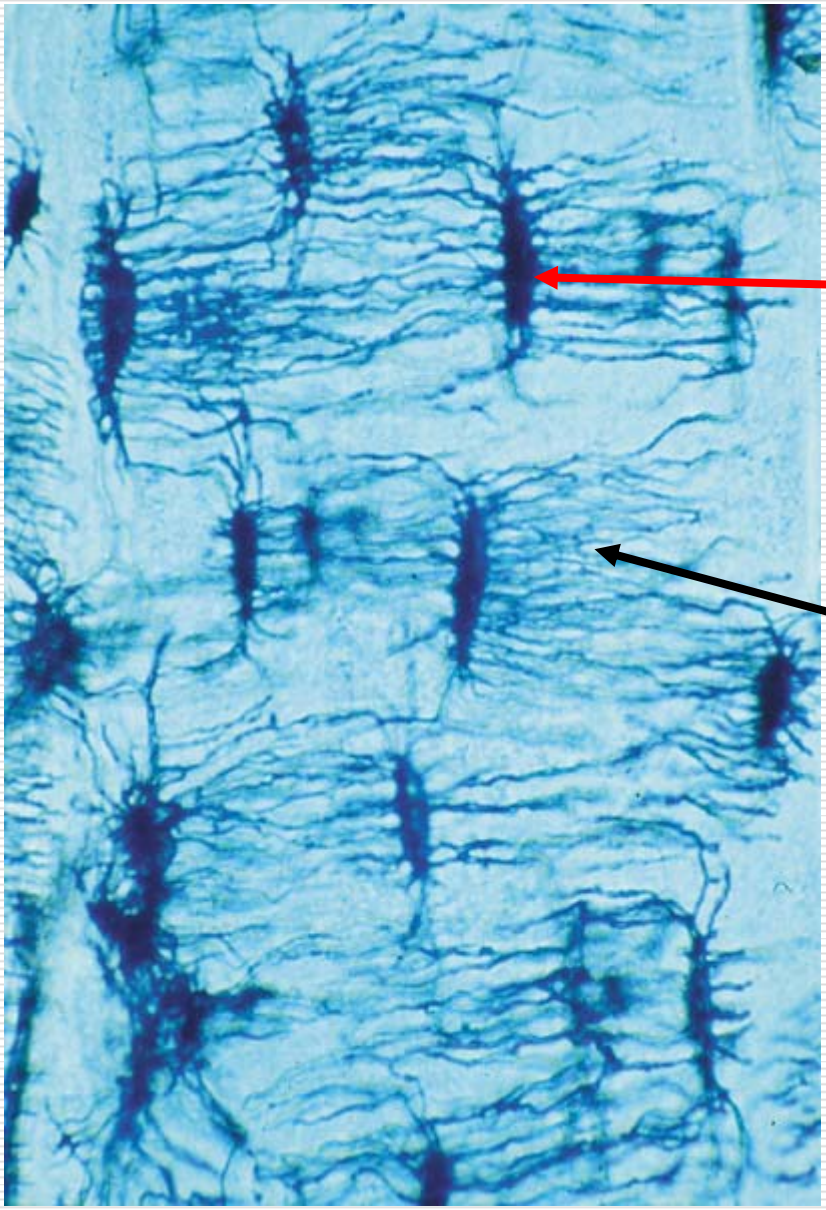
- acidophilic and the dark nucleus

- located in bone lacuna and bone canaliculus

exchange of metabolites

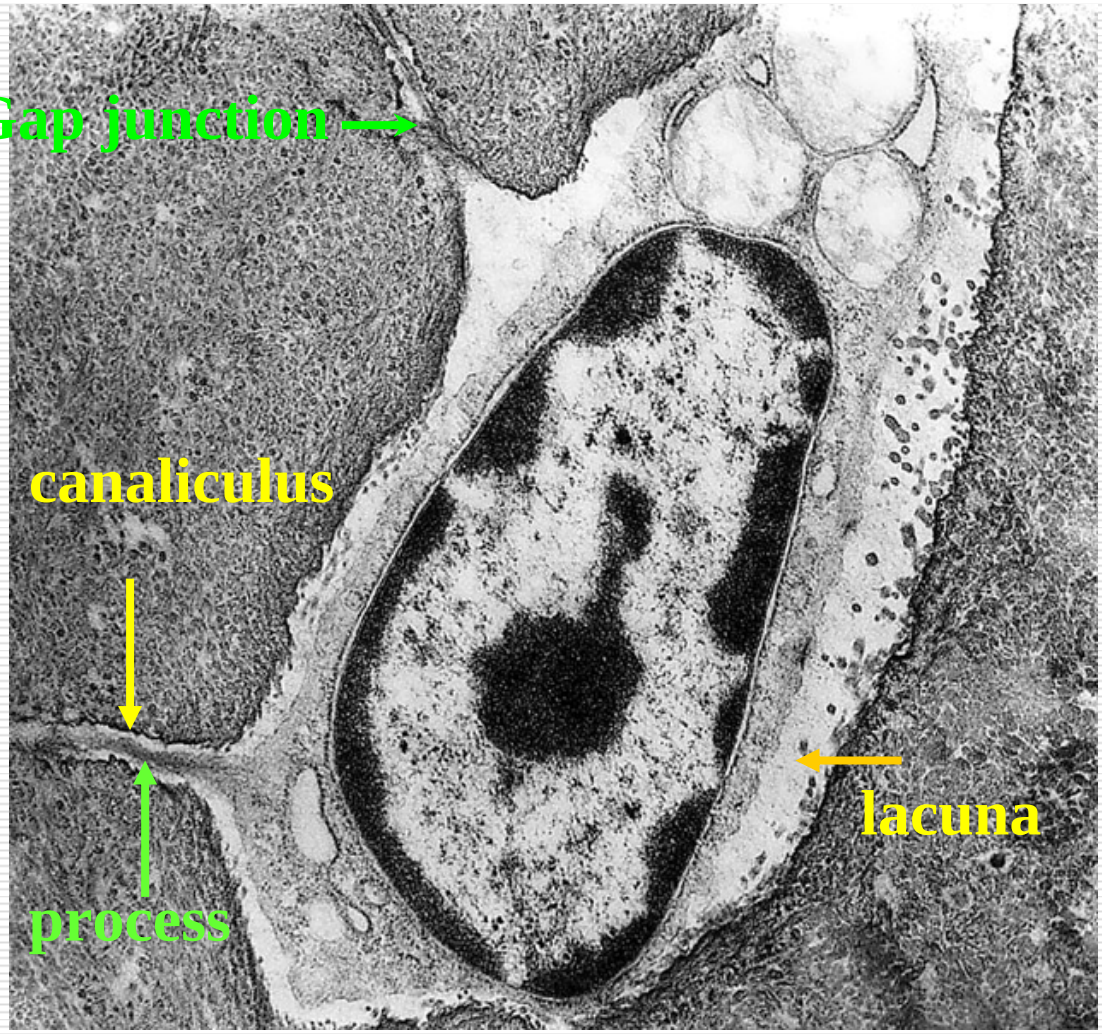



bone lacuna
bone canaliculus
bone lacuna
bone canaliculus

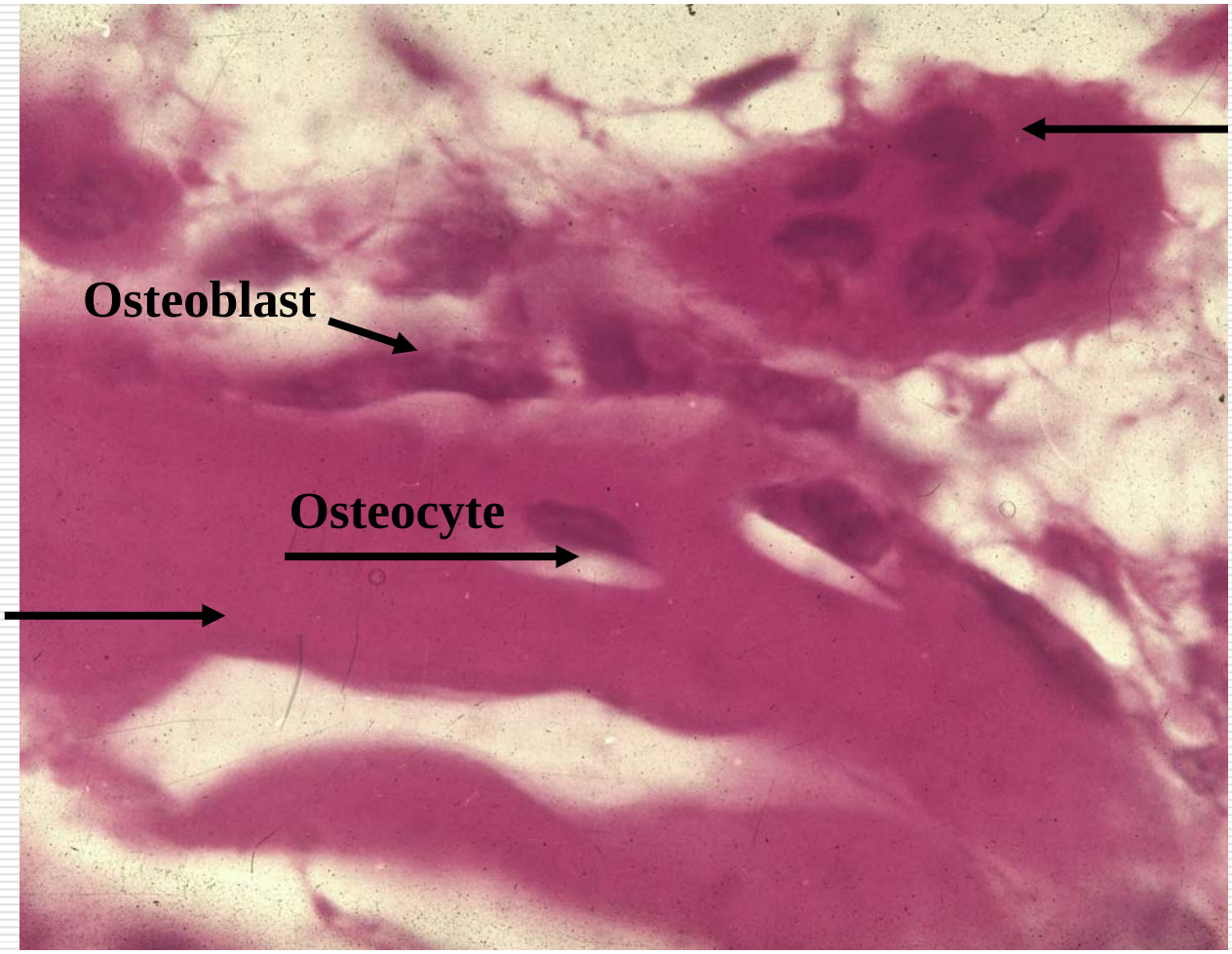

bone lacuna
bone canaliculus

- reduced organelles
- connected via gap junctions in bone canaliculus

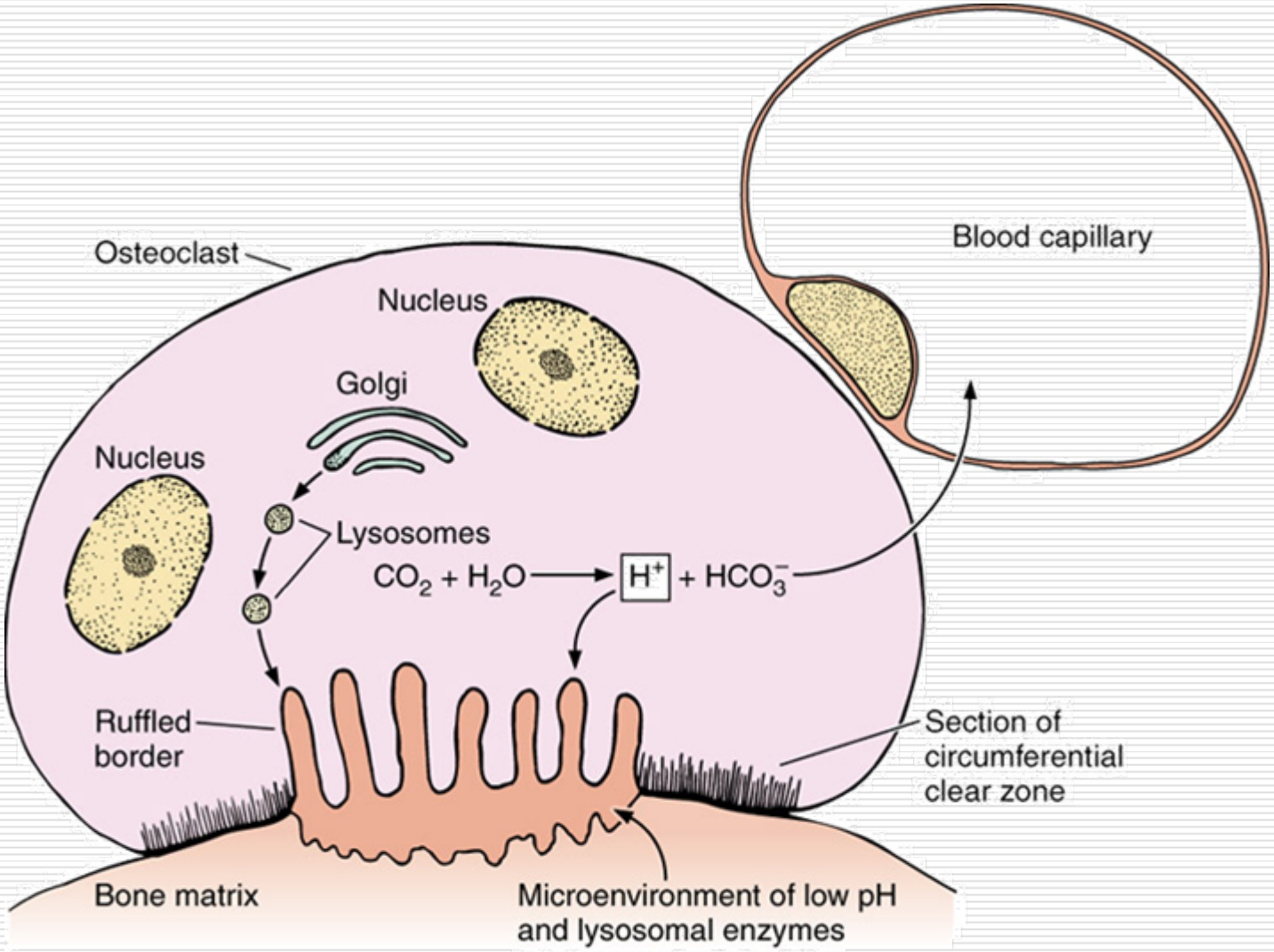
Function: Maintain bone matrix, balance Ca and P



- multinucleated giant
- acidophilic cytoplasm
- located on the surface of the matrix



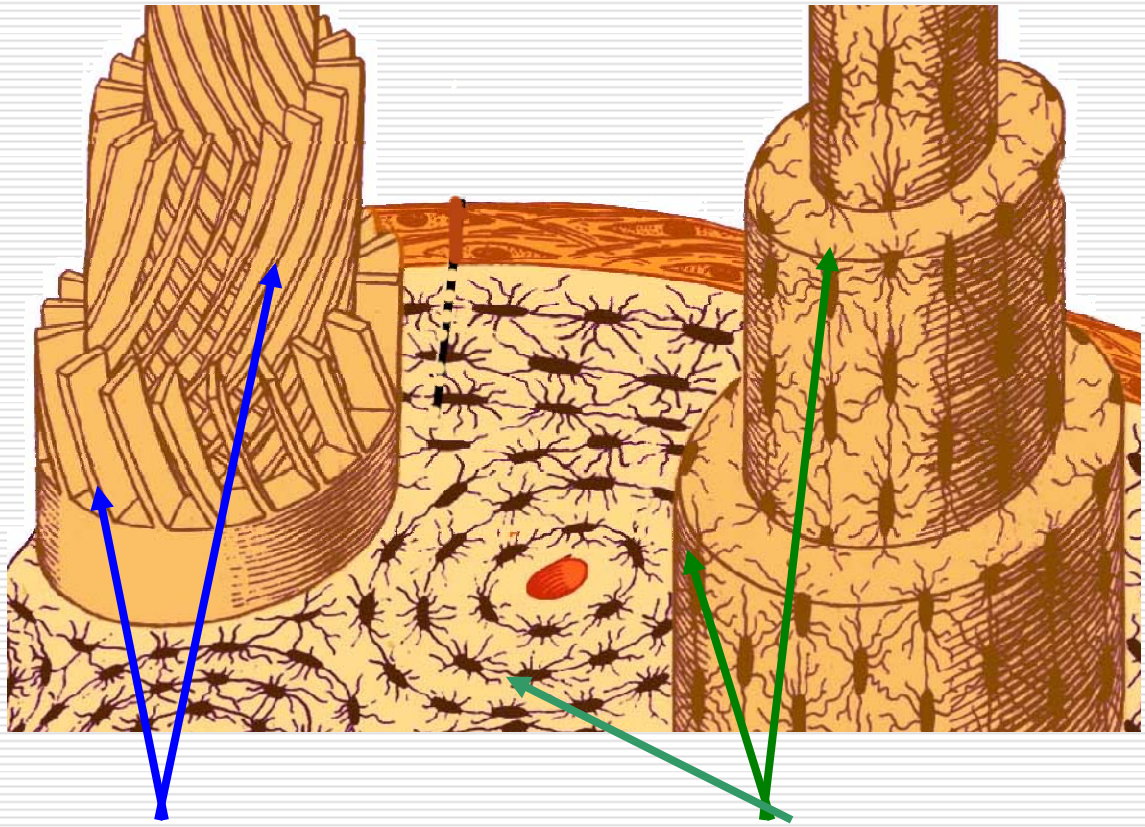
- lysosomes
- Mitochondria
- Rough endoplasmic reticulum
- Golgi complex
- ruffled border



---Function: dissolve and absorb bone matrix

---organic matter:

- collagen fibers , ground substance
- In one lamella, the fibers are parallel
- the fibers of adjacent lamellae run at right angles



collagen fibers Lamellae

---inorganic matter: bone salts

- **hydroxyapatite crystal:**

  $Ca_{10}(PO_4)_6(OH)_2$

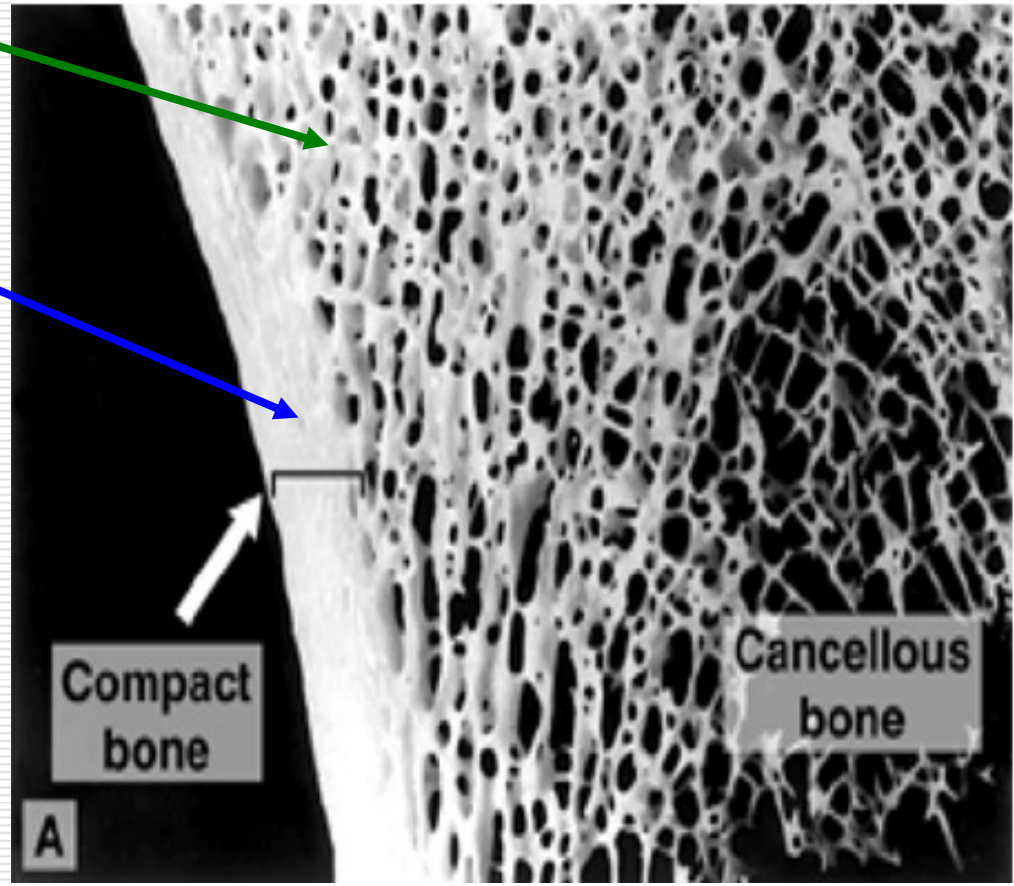
- **Needles-shaped**
- **lie alongside the collagenous fibrils**

2.2.1 Spongy bone

- with numerous interconnecting cavities

2.2.2 Compact bone

- the dense areas without cavities
- three patterns:
  - circumferential lamellae
  - osteons
  - interstitial lamellae

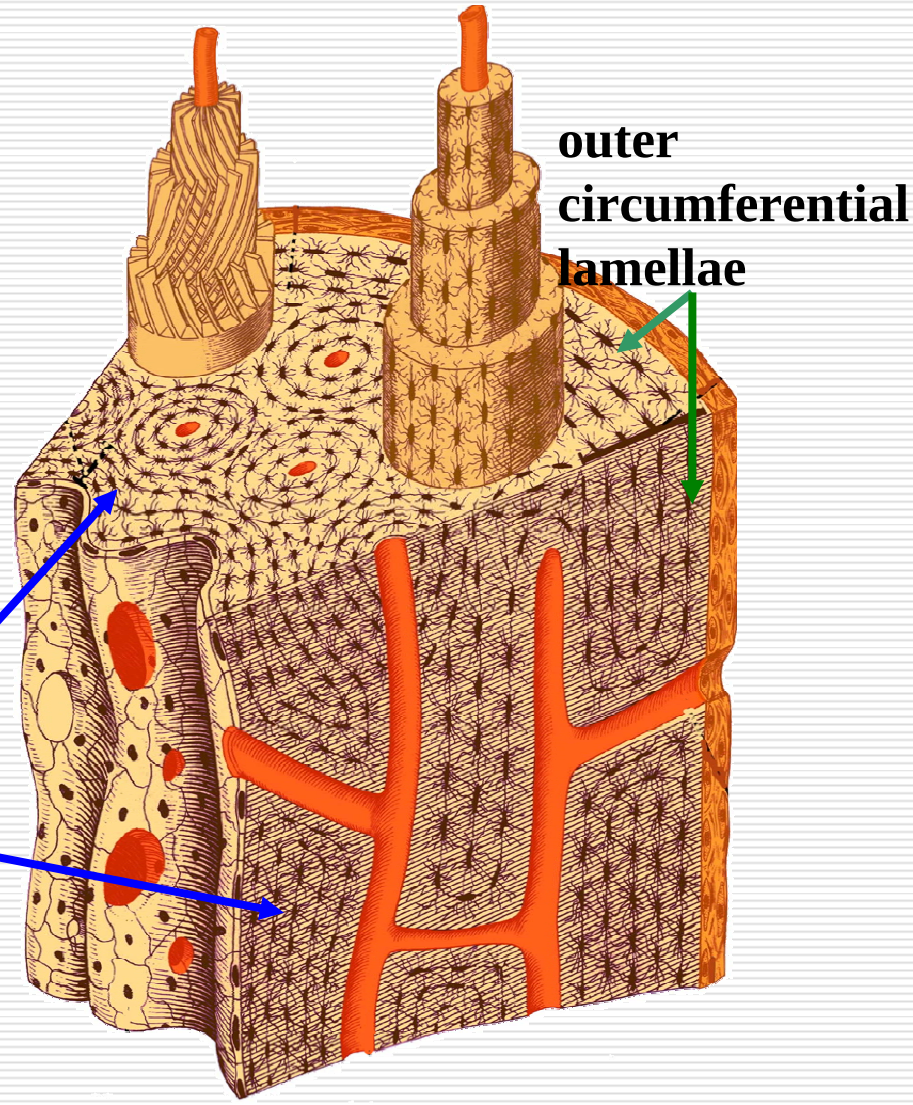


- outer circumferential lamellae

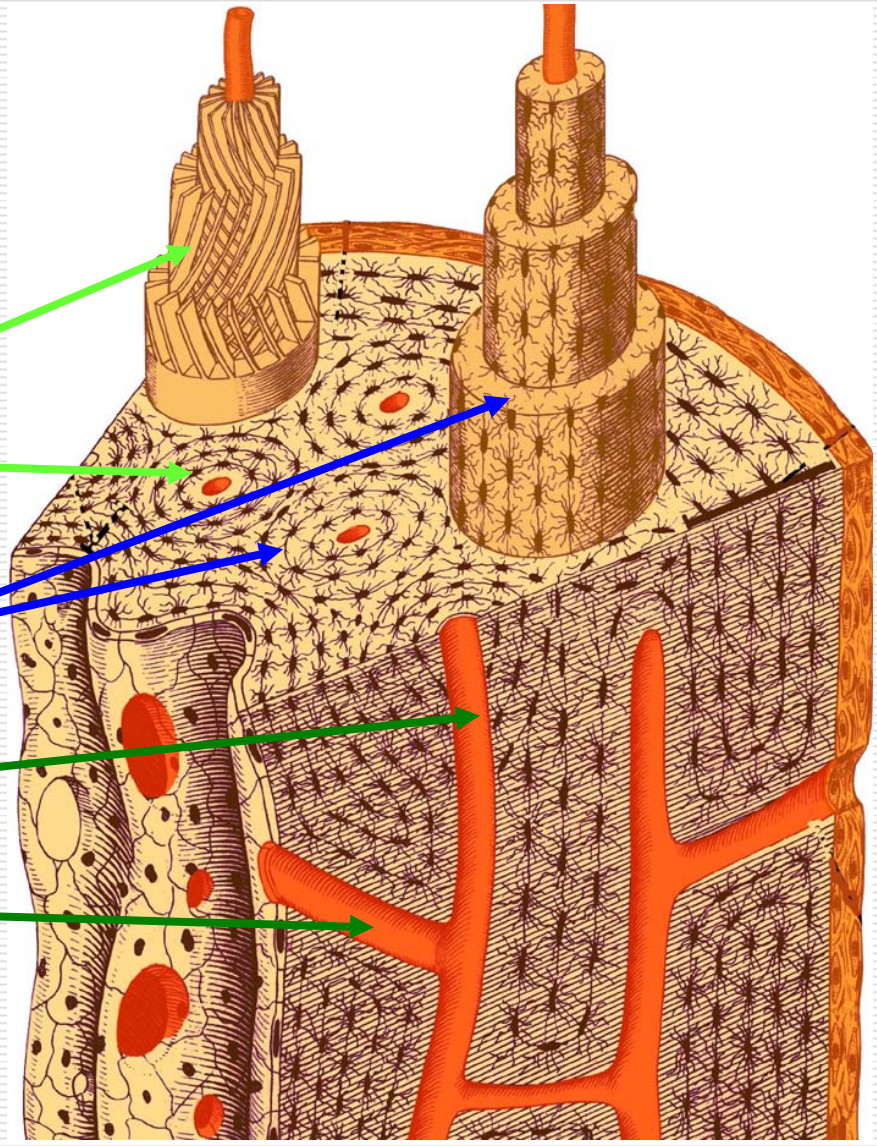
  thick and regular

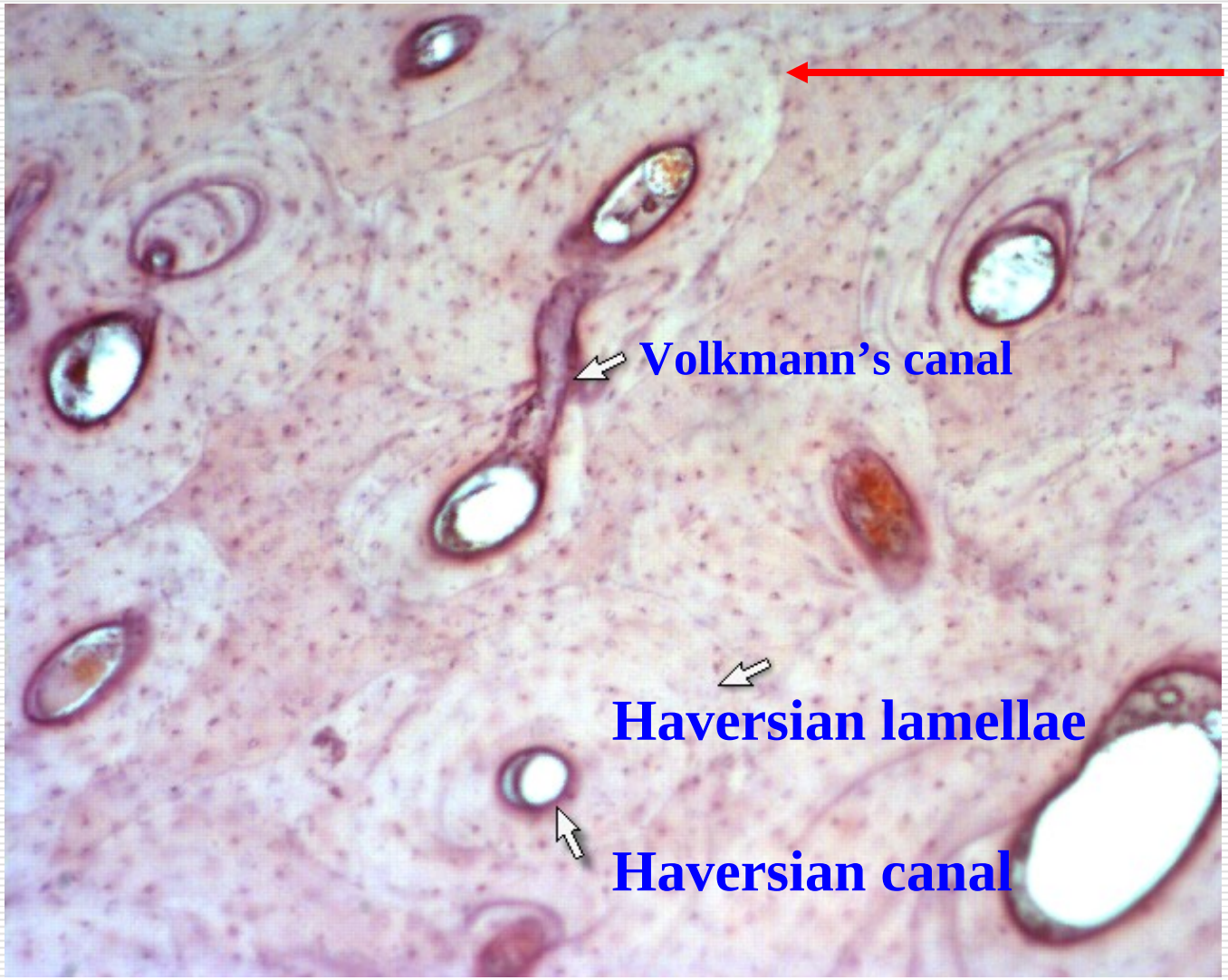
- inner circumferential lamellae

  thin and irregular

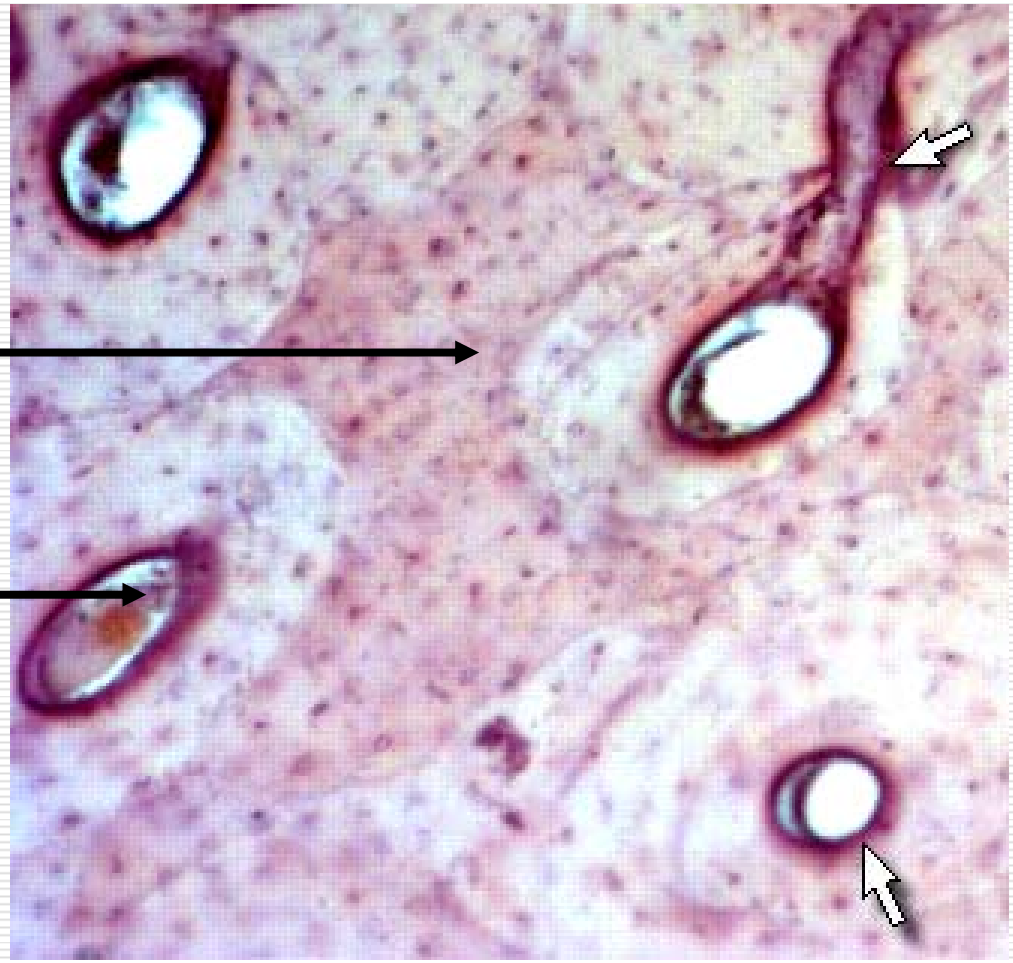


- between circumferential lamellae
- long cylinder
- Haversian lamellae
- Haversian canal
- Volkmann’s canal




cementing line
Volkmann's canal
Haversian lamellae
Haversian canal

- among Haversian systems
- triangular or irregular shape

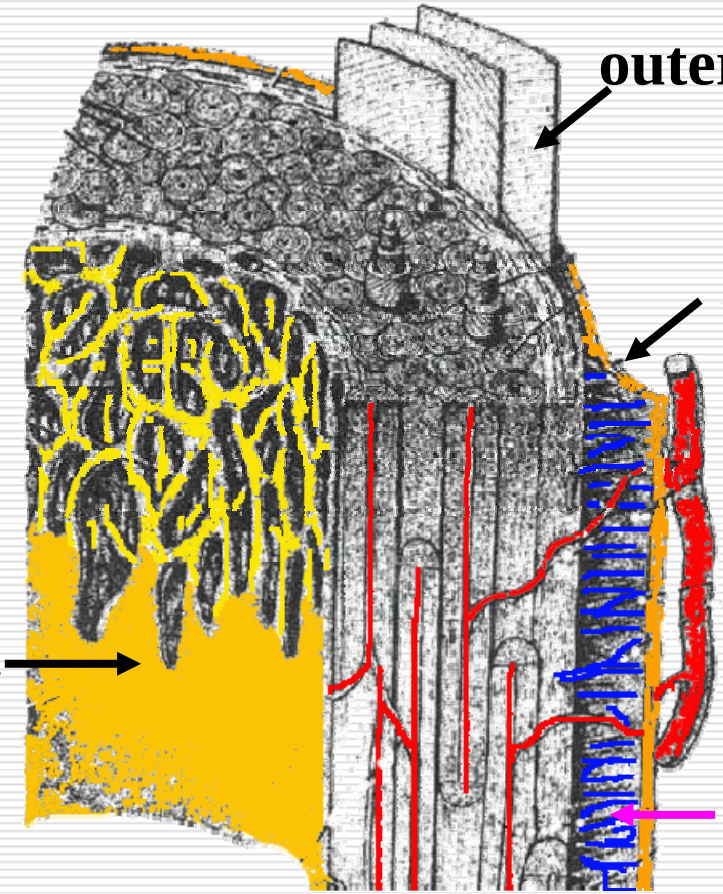


---Periosteum:

- outer layer: Sharpey's fiber
- inner layer: blood vessel, nerve, osteoprogenitor cells

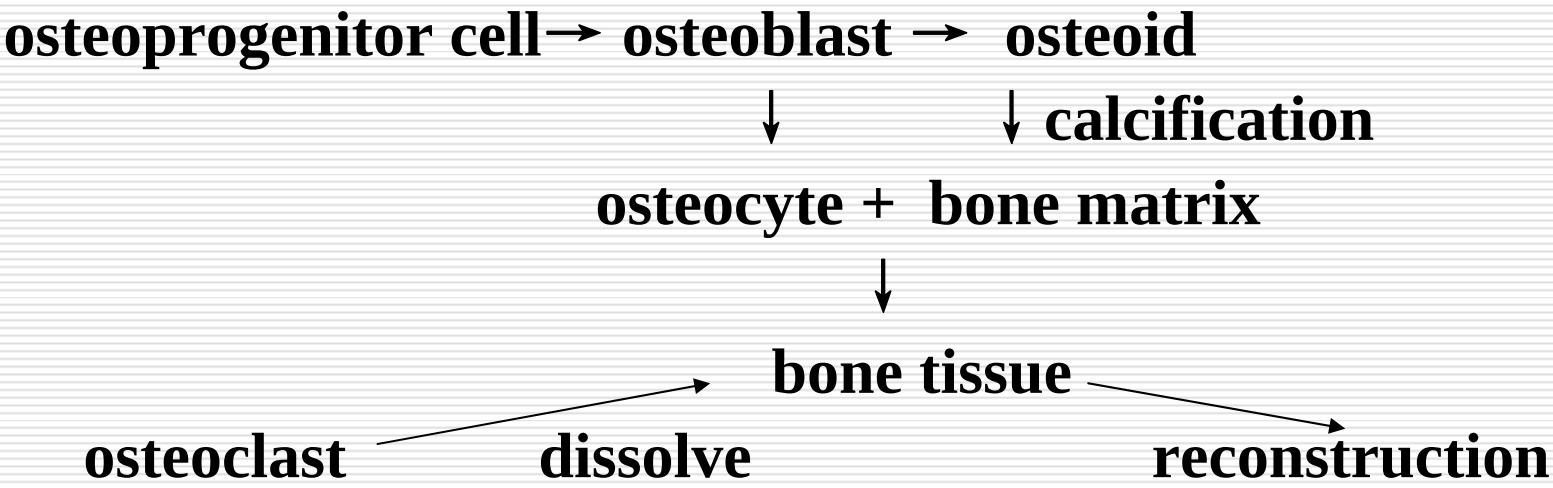
---Endosteum: osteoprogenitor cell

---Function:protection, growth, repair,reconstruction



III Histogensis of Bone

(Osteogenesis or Ossification)



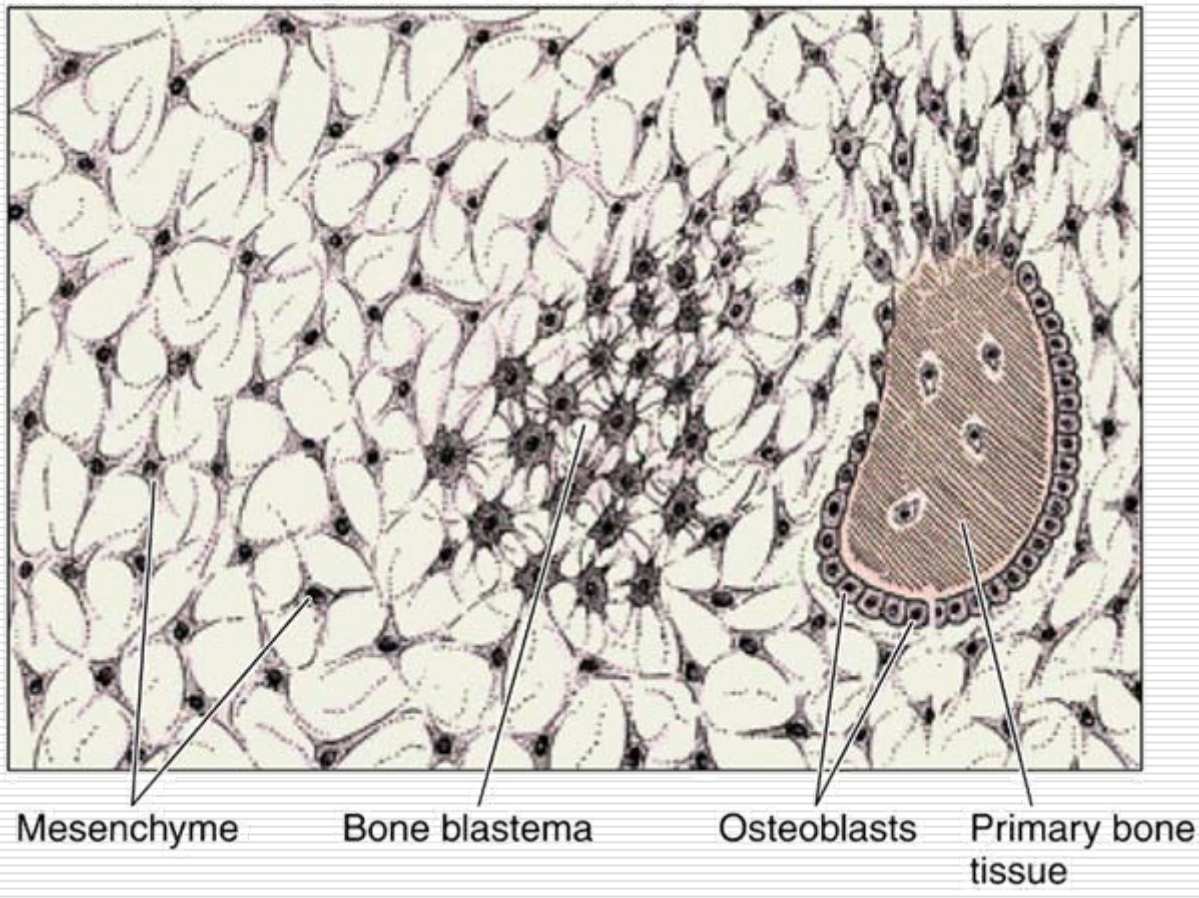
- Intramembranous ossification

  directly within a membrane of primary connective tissue.

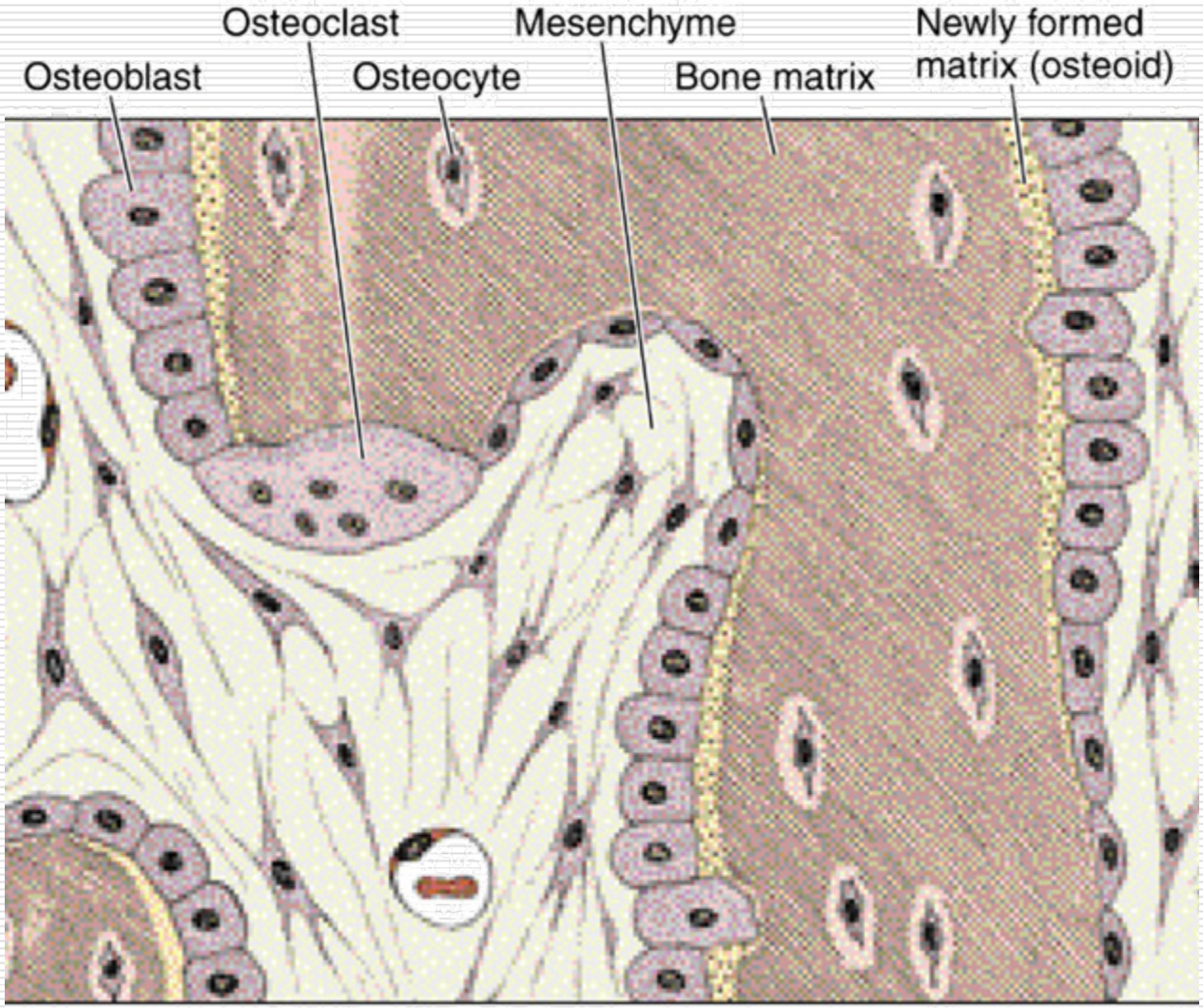
- Intracartilaginous ossification

  within a pre-existing cartilaginous model.

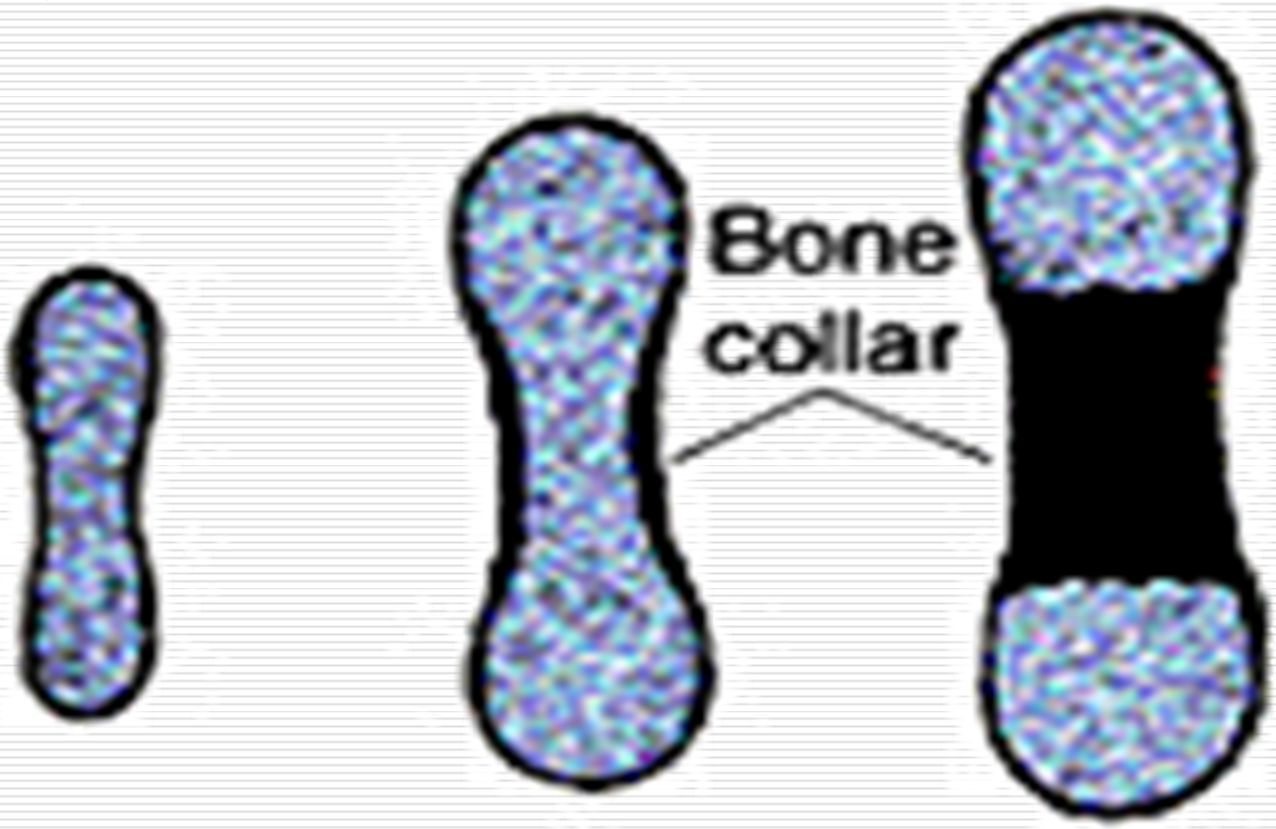
- Mesenchymal cells round up
- form a blastema
- osteoblasts differentiate
- produce primary bone tissue.



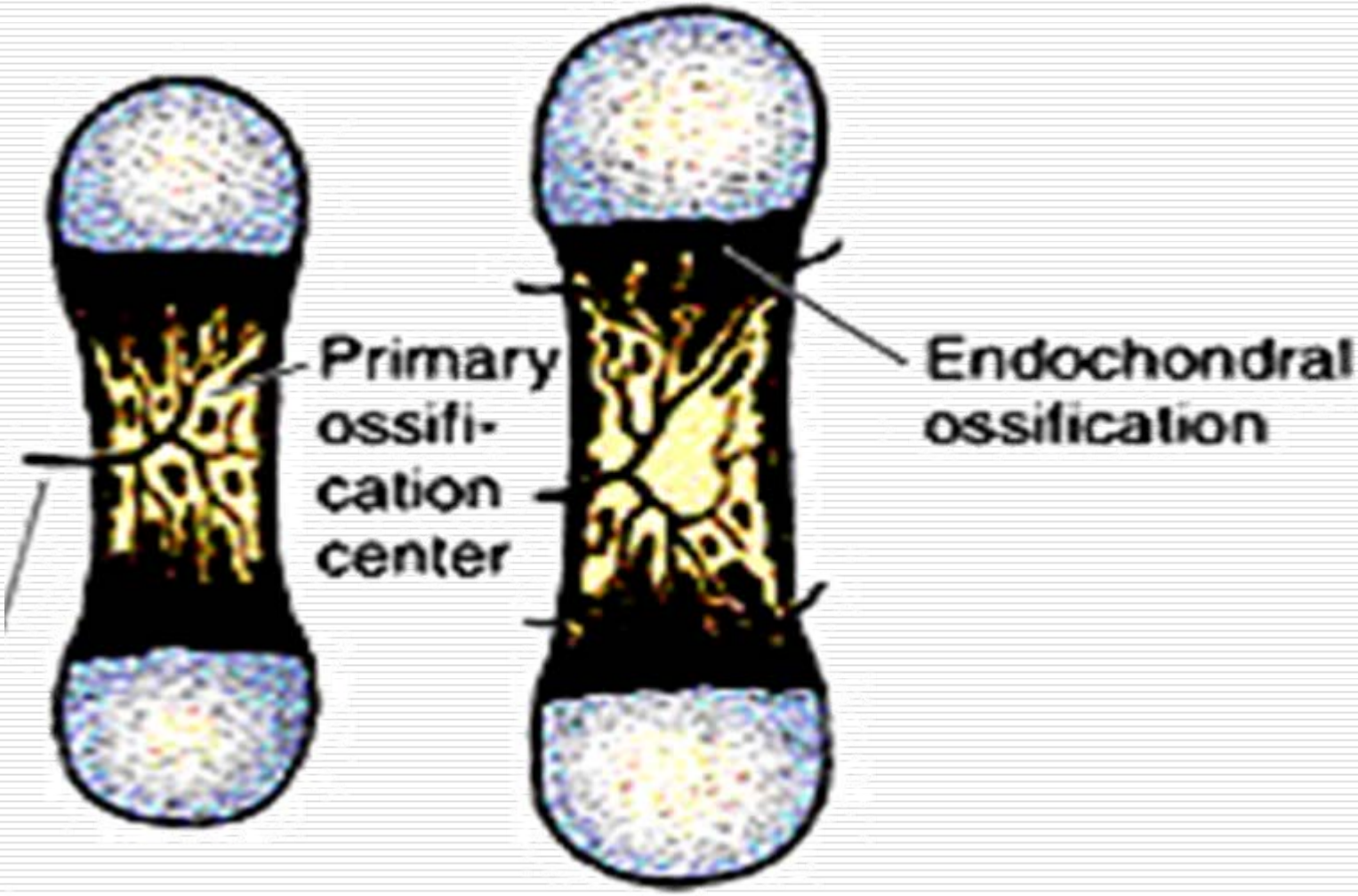
- Osteoblasts are synthesizing collagen
- form a strand of matrix that traps cells
- osteoblasts differentiate to become osteocytes



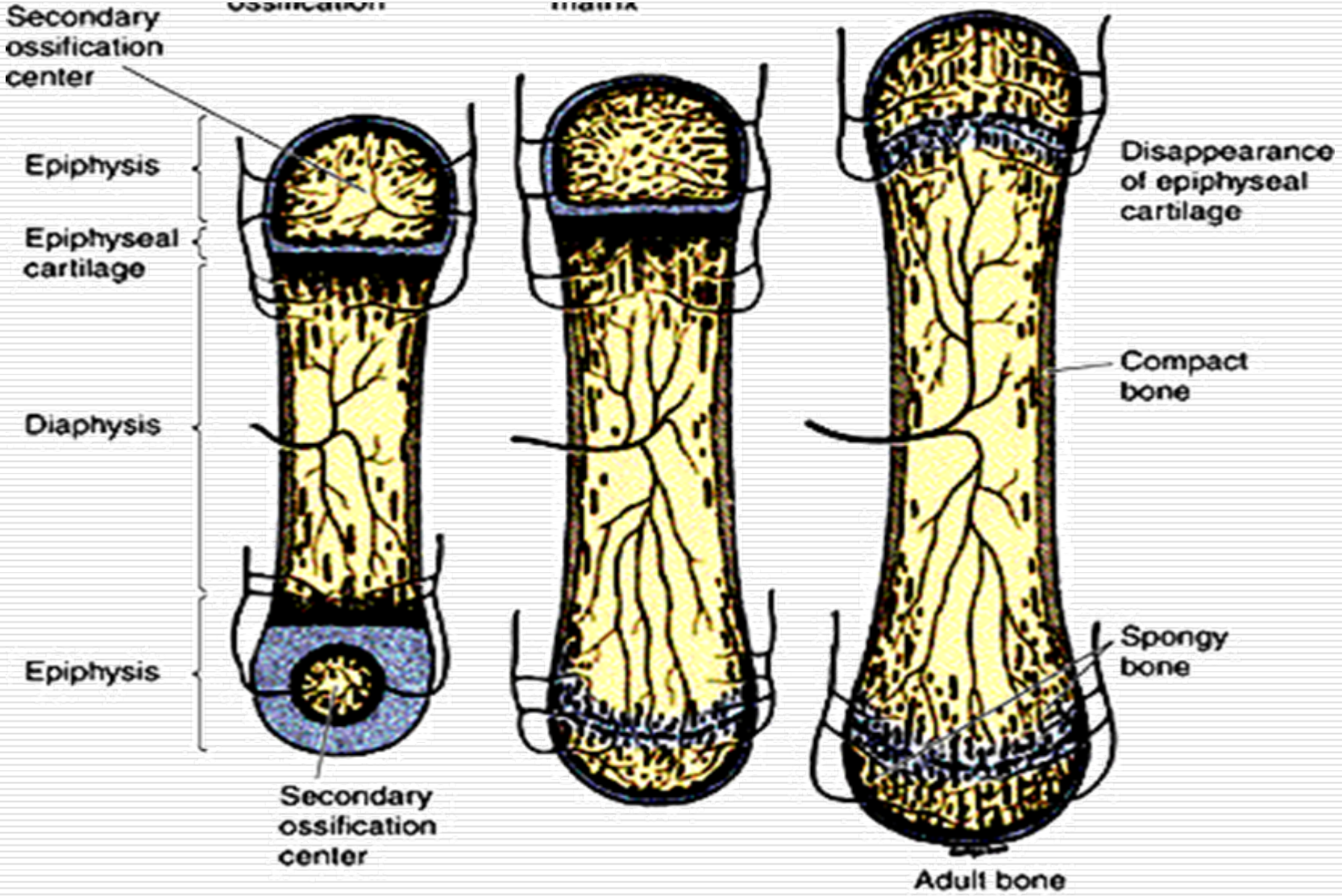
- **Formation of cartilage model**
- **Perichondral Ossification (Formation of bone collar)**

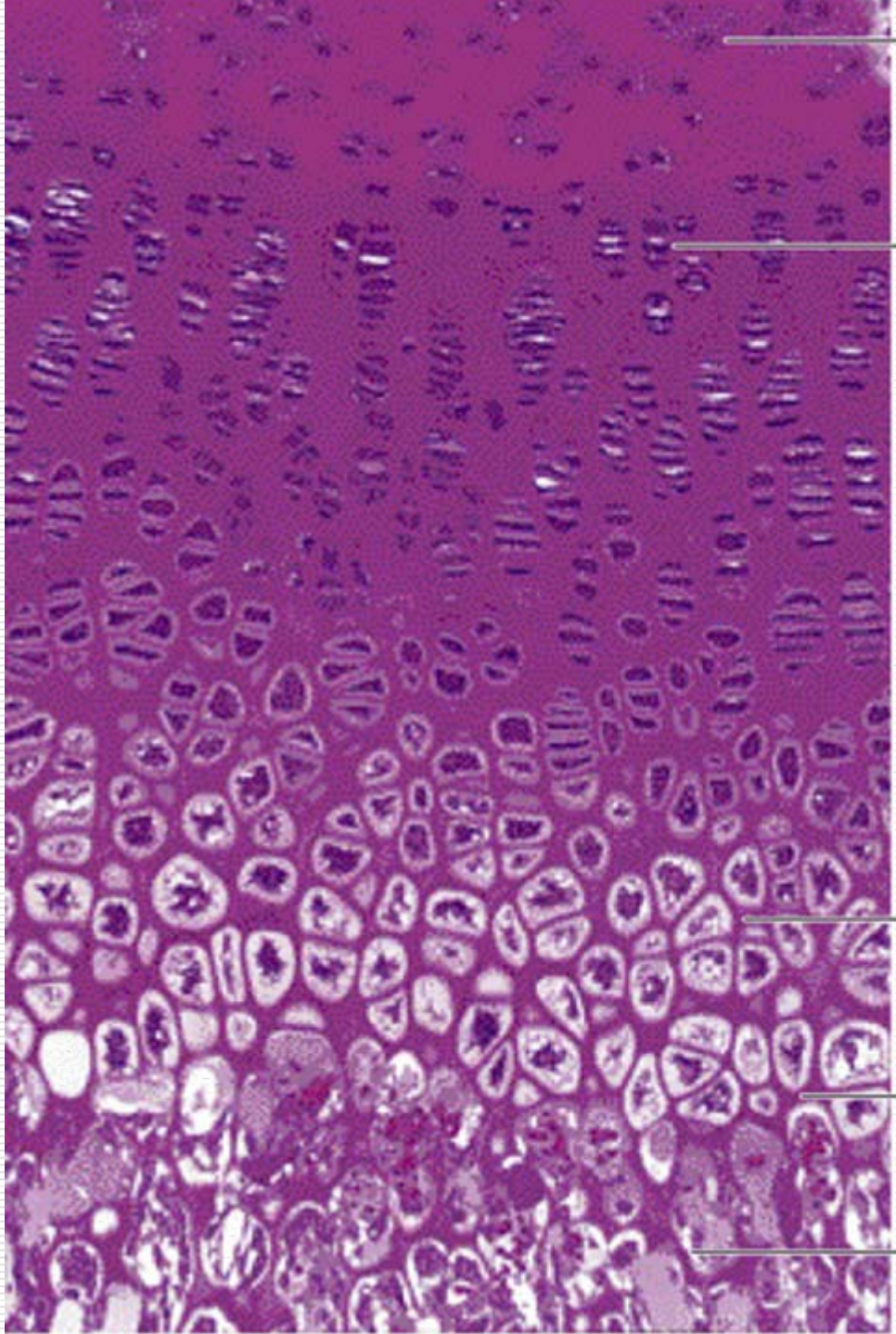


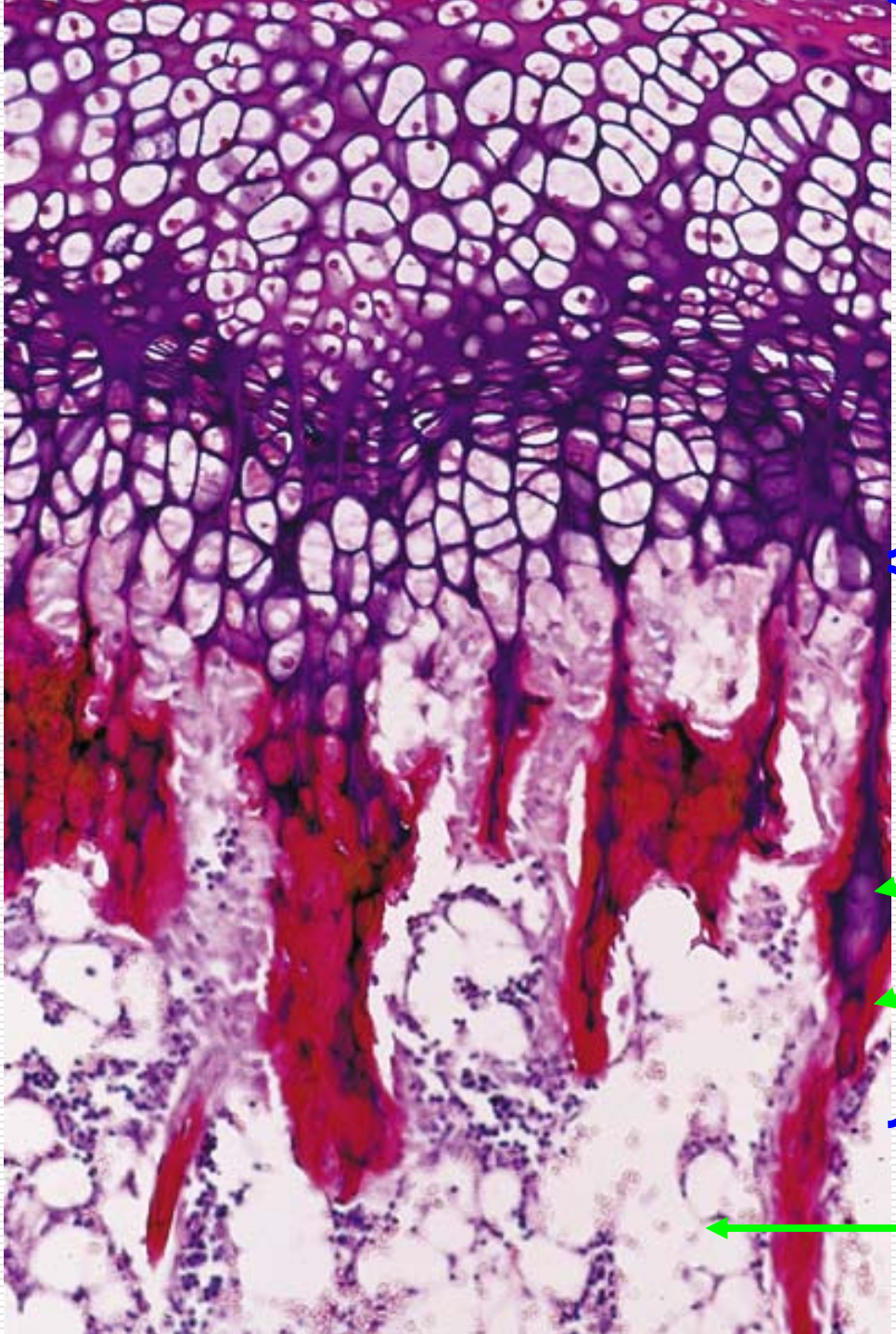
- **Formation of primary ossification center and bone marrow cavity**



- Formation of secondary ossification center and epiphyses
- growth of bone by growth of epiphyseal plate (5 zones)
- Disappearance of epiphyseal cartilage in adult bone




Resting zone
Proliferative zone
Hypertrophic cartilage zone
Calcified cartilage zone
Ossification zone


Calcified cartilage zone
Ossification zone
Cartilage matrix (purple)
recently formed bone tissue (red)
Bone marrow and fat cells

Summary

- Master the types of cartilage
- Master the structure of hylaline cartilage
- Master the types and structure of bone cells (osteoblast & osteoclast)
- Master the osteon
- Know the 5 zones of of epiphyseal plate