

# MEDICAL BIOLOGY



# BONE TISSUE

- Bone tissue is a supporting connective tissue and is the main element of the skeletal tissue. It is composed of cells and an extracellular matrix in which fibers are embedded. Bone tissue is unlike other connective tissues in that the extracellular matrix becomes calcified.

# BONE

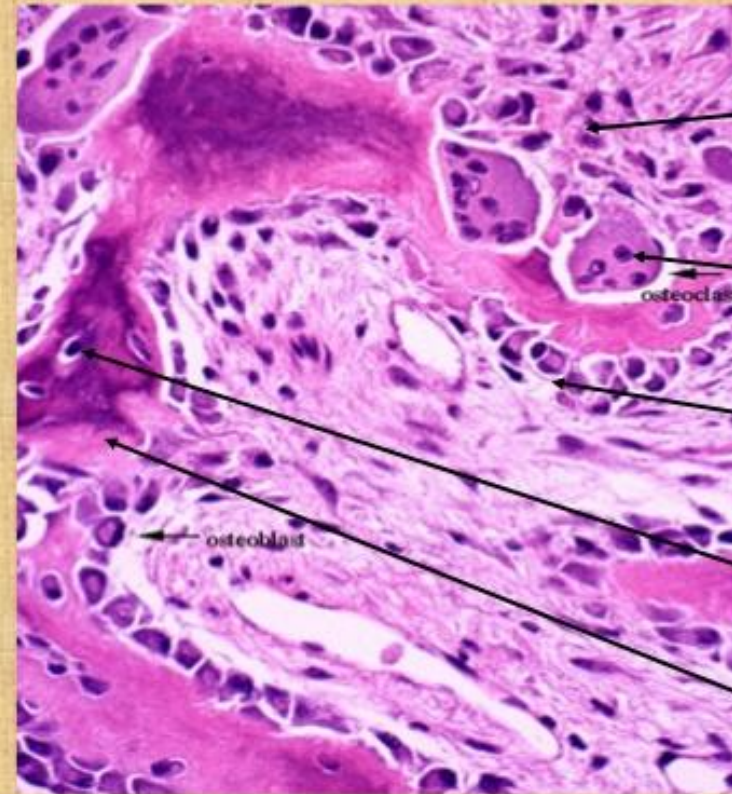
- **Bone functions**

- Support
  - Protection
  - Movement
  - Minerals homeostasis (maintain blood  $\text{Ca}^{++}$  &  $\text{P04}^{--}$  level equilibrium)
- Bone is a **hard**, but **brittle** tissue. Bone is a **dynamic** tissue, which throughout life bone tissue is continually being **formed** and **resorbed**.

# Bone Cells

- Osteoprogenitor cells
- Osteoblast (bone forming cells)
- Osteocyte (bone maintaining cells)
- Osteoclast (bone resorption cells)

Cells of Bone (Primary/Temporary)



**Osteoprogenitor**

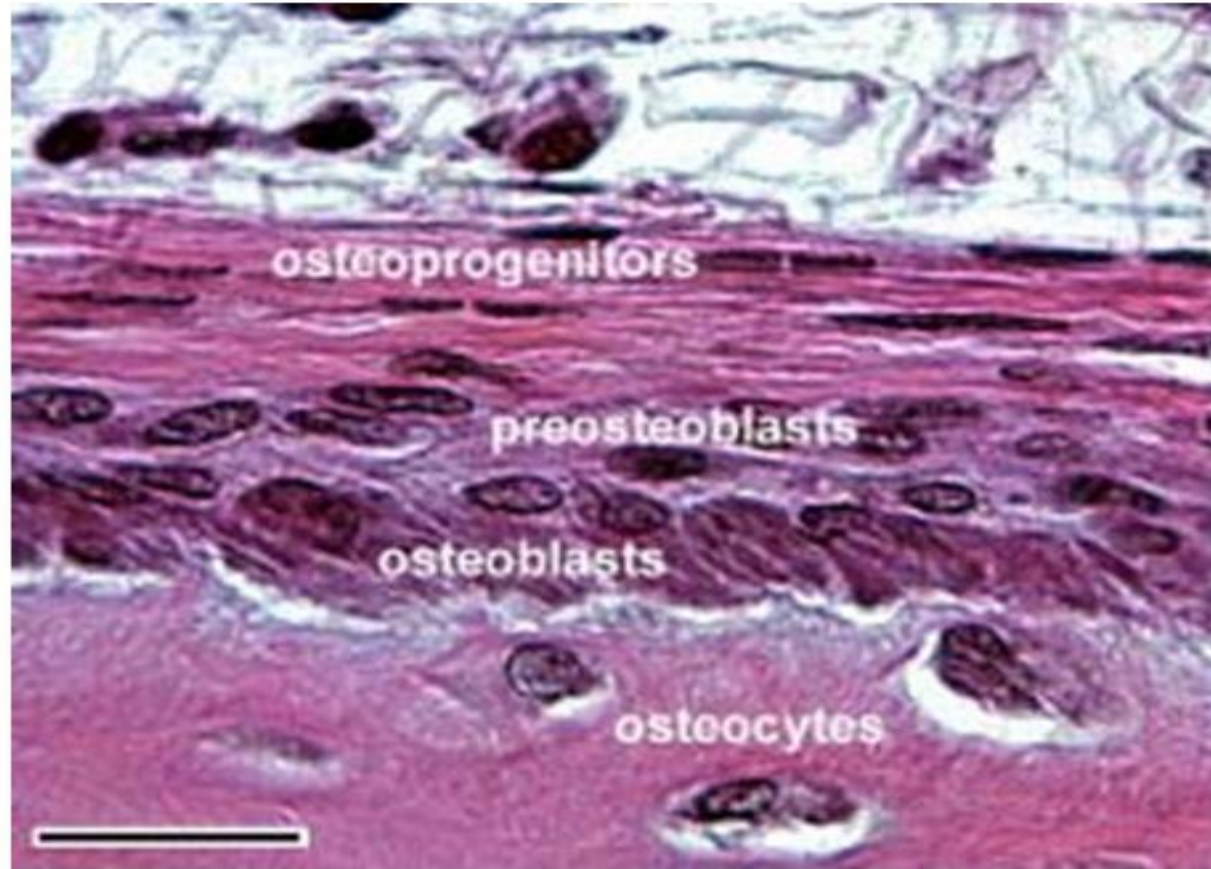
**Osteoclast**

**Osteoblast**

**Osteocyte**

**Osteoid**

# OSTEOPROGENITOR CELLS



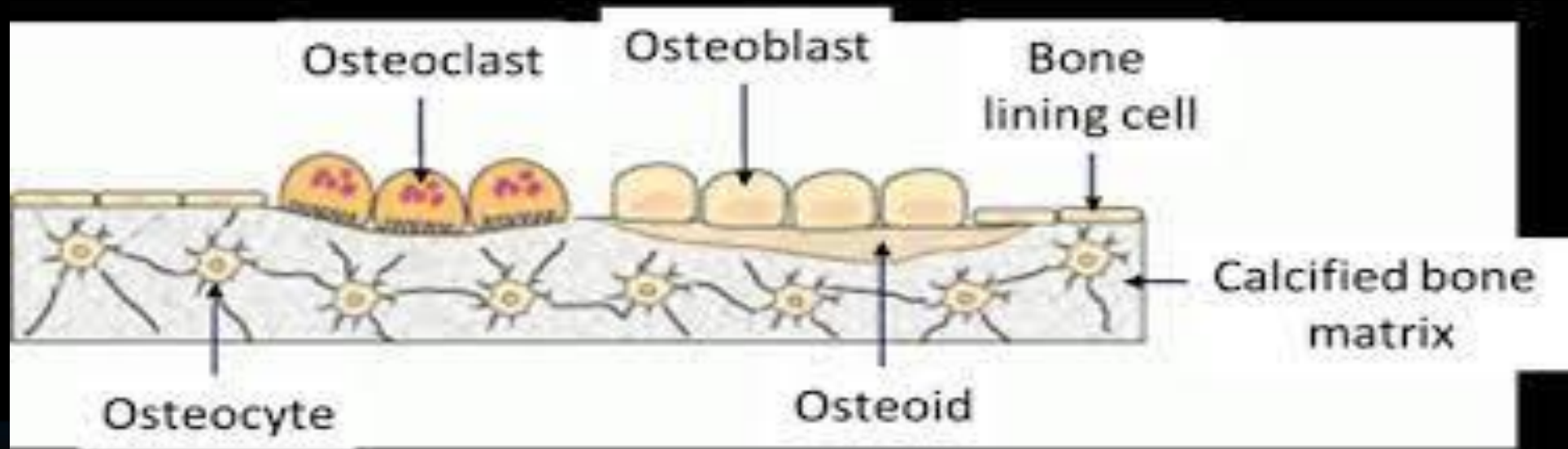
- Located in the periosteum and endosteum. Flat squamous cells. They are very difficult to distinguish from the surrounding connective tissue cells.

# Osteoblasts



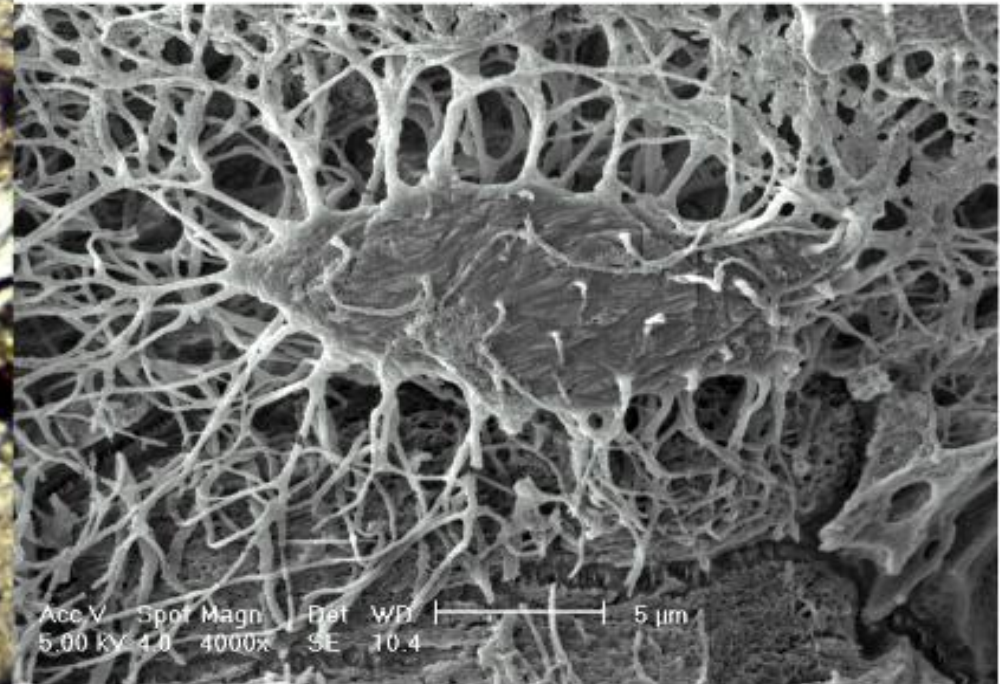
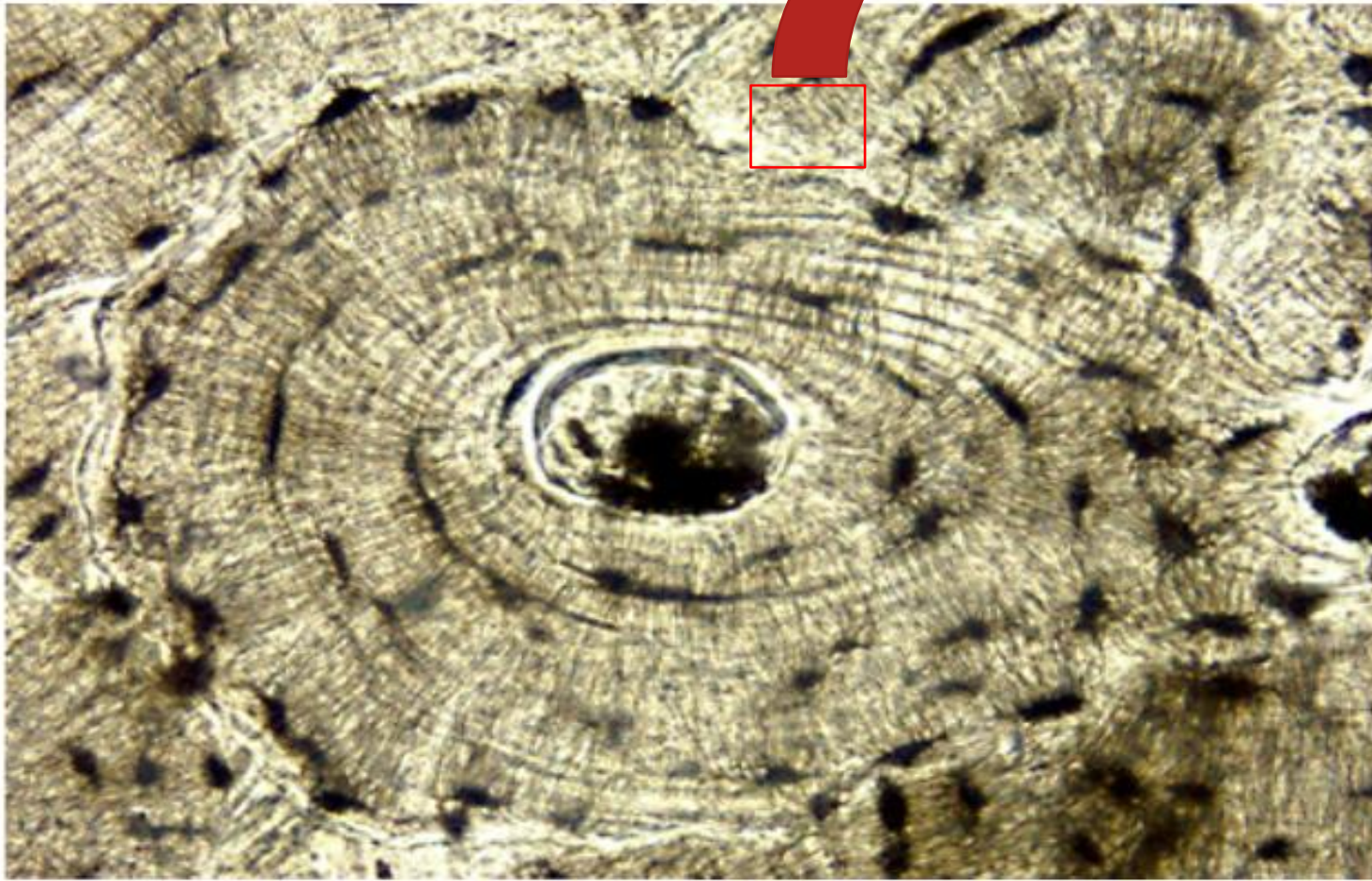
Osteoblasts are rich in the enzyme alkaline phosphatase, which plays a major role in the formation of the mineral deposits in the matrix.

The Matrix Closest To The Osteoblasts Is Not Yet Calcified And Is Known As **Osteoid Or Prebone**. This Osteoid Is Rich In Collagen Fibers. Small Membrane-bound Matrix Vesicles Are Budded Off Processes Of The Osteoblast Cell Membrane And Secreted To The Matrix. These Play An Important Role In The Calcification Process Of The Matrix.



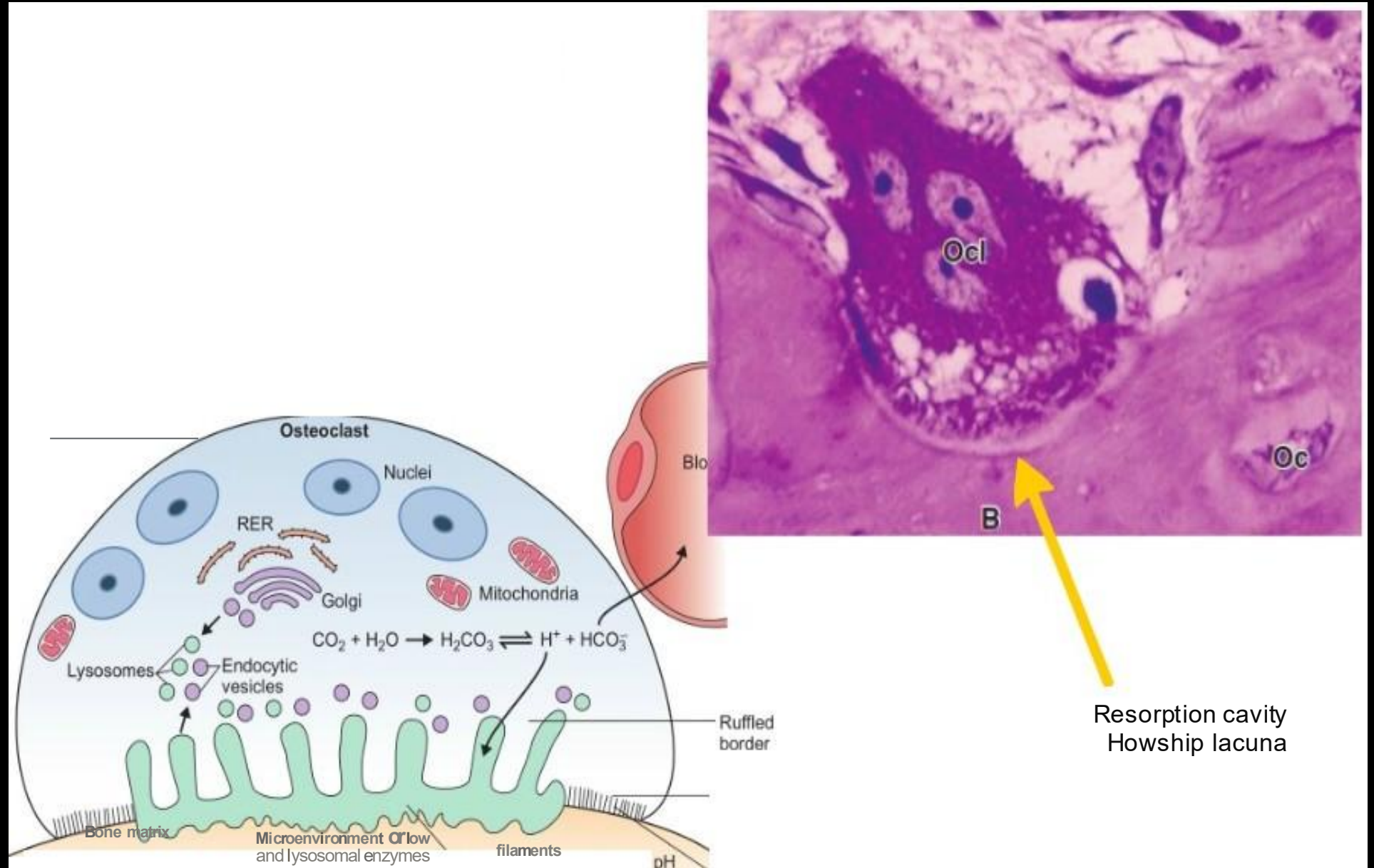
# OSTEOCYTES

Osteocytes cytoplasmic processes  
communicate cells with each other & with  
other cells via gap junctions



# OSTEOCLASTS

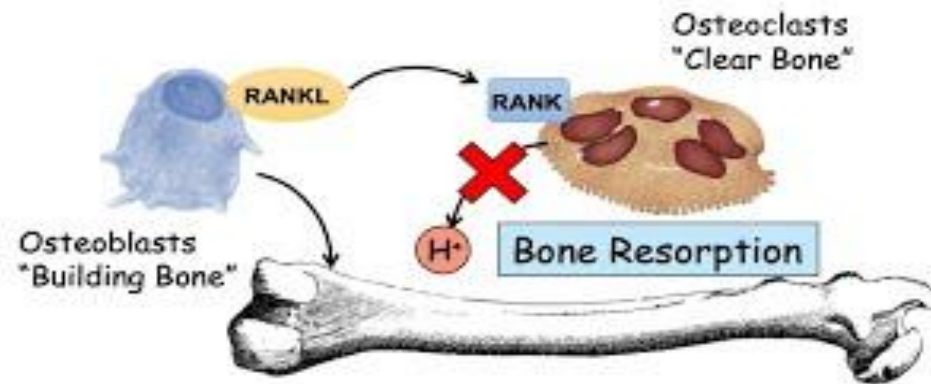
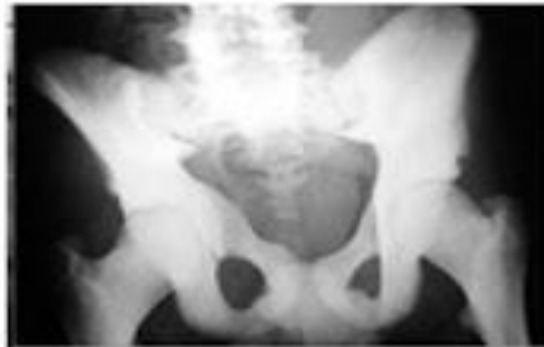
- ❑ large, motile &
- ❑ Multinucleated (50)
- ❑ eroding surface (ruffled border)
- ❑ Howship's lacunae
- ❑ originate from monocytes and are included in the mononuclear phagocyte system.

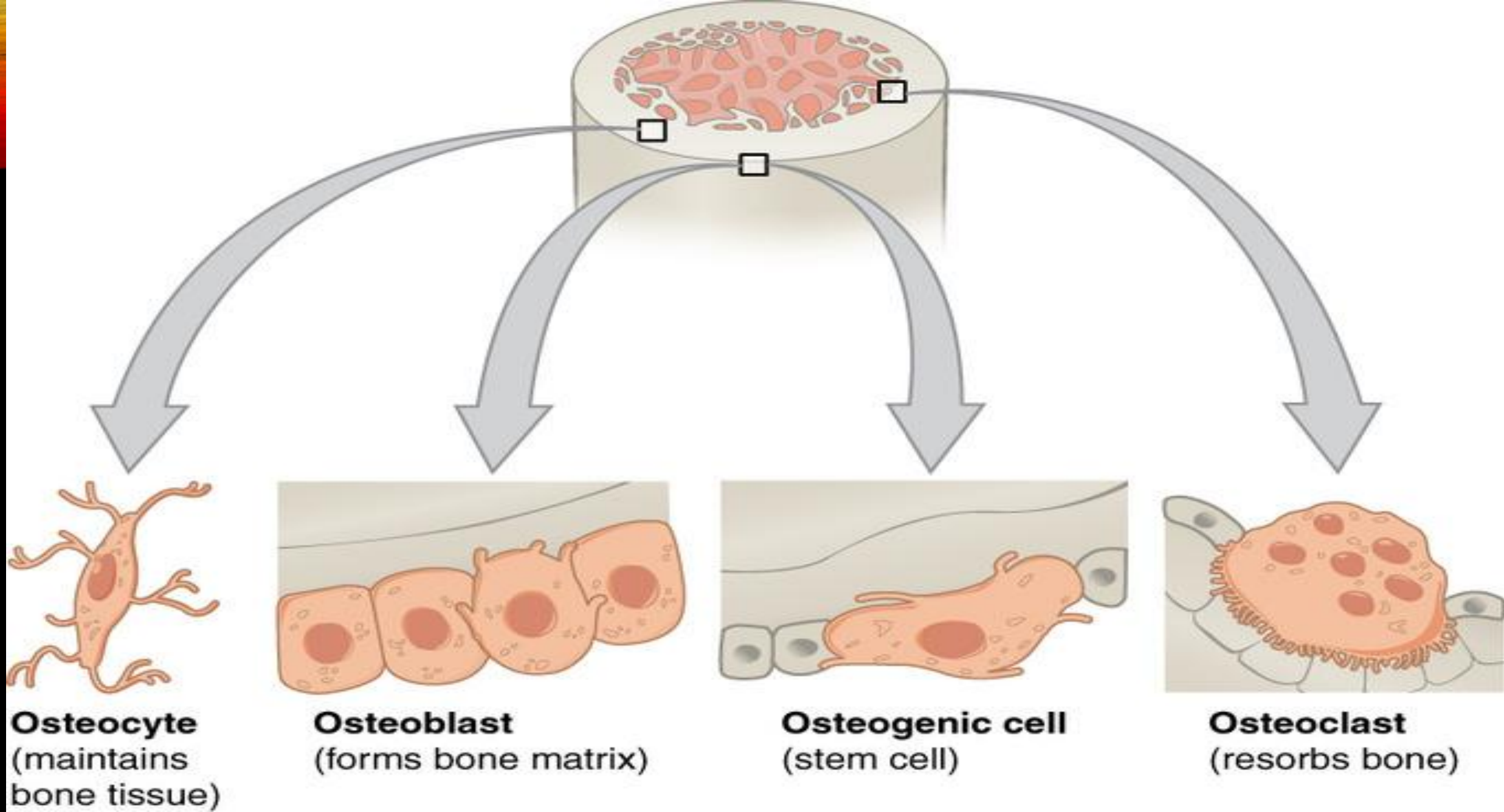




# Osteopetrosis

## Marble Bone Disease





# Osteo**C**lasts **C**rushing



# Osteo**B**lasts **B**uilding



# Bone matrix

**50% inorganic:** Calcium hydroxyapatite, noncrystalline calcium phosphate with bicarbonate, citrate, magnesium, potassium, and sodium ions

**Organic:** (type I collagen, proteoglycan and glycoproteins as osteonectin

Calcium-binding proteins, notably osteocalcin, and the phosphatases released from cells in matrix vesicles promote calcification of the matrix.

**Effects of Changing the Bone Matrix** (a) Normal bone. (b) Demineralized bone, in which collagen is the primary remaining component, can be bent without breaking. (c) When collagen is removed, mineral is the primary remaining component, thus making the bone so brittle it's easily shattered.



(a)

Without mineral

Without collagen



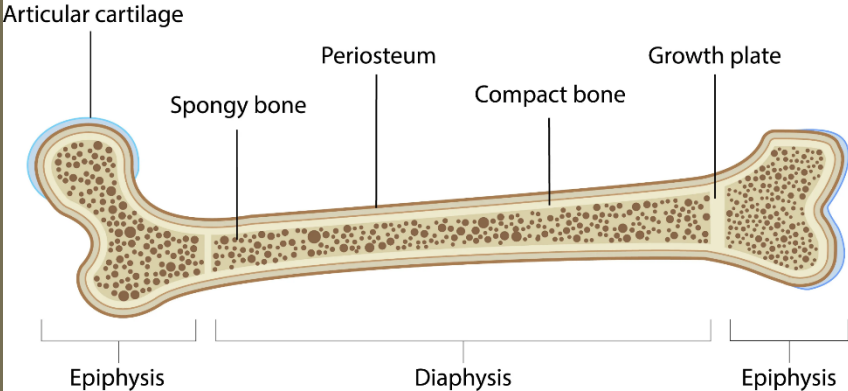
(b)



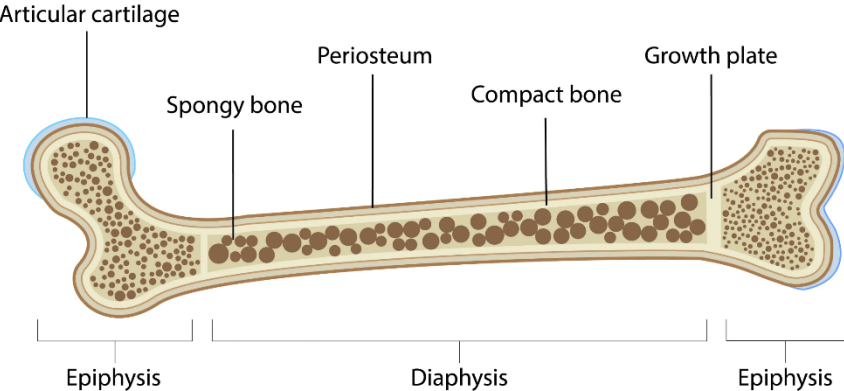
(c)

# Osteogenesis Imperfecta

## Healthy Bone



## Brittle Bone

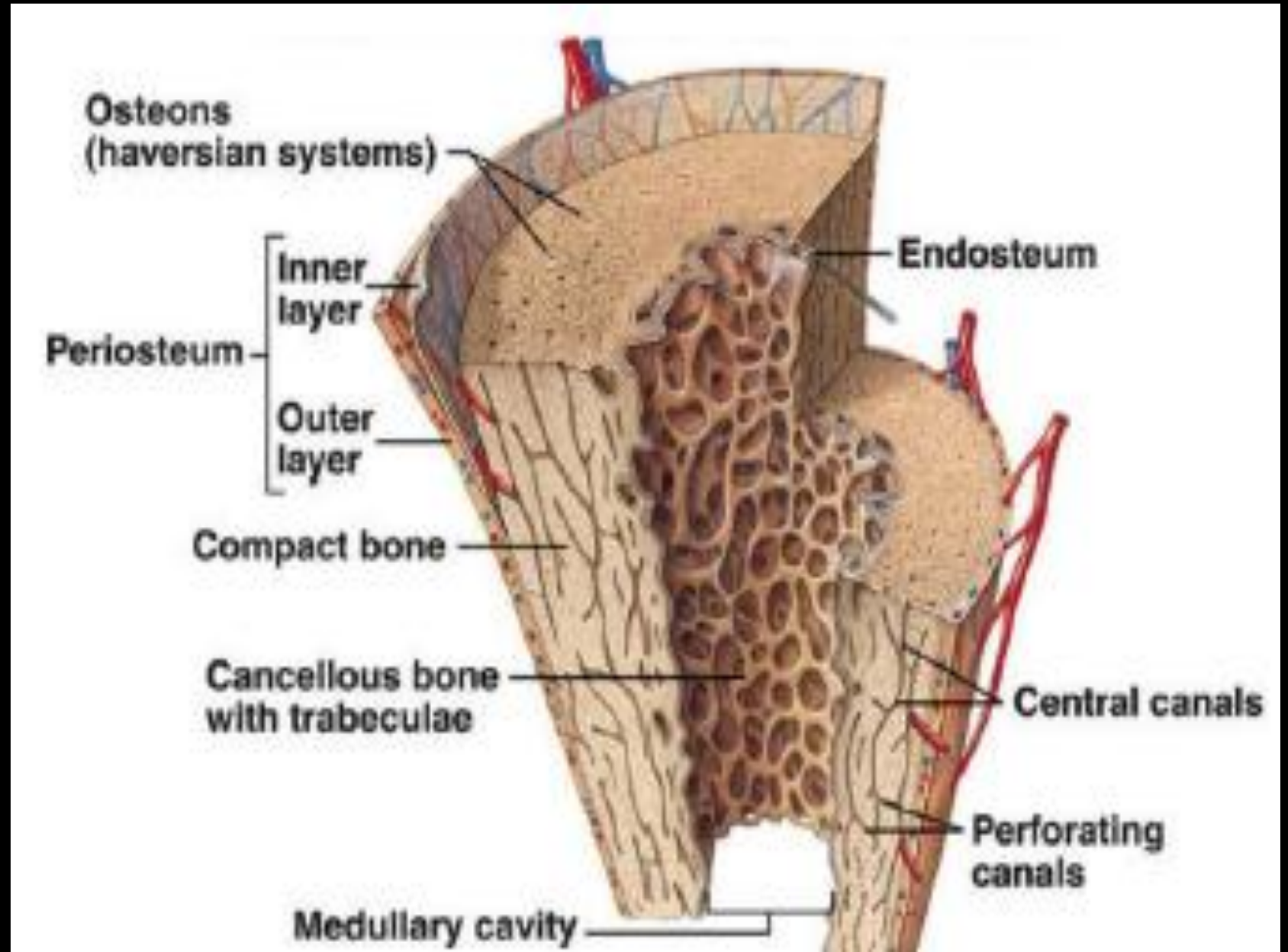


**Periosteum (Fibrous And Cellular Layers)  
Sharpey's Fibers**

**Endosteum (Cellular Layer)**

**Functions**

- 1. Nutrition Of Osseous Tissue**
- 2. Provision Of A Continuous Supply Of New Osteoblasts For Repair Or Growth Of Bone.**

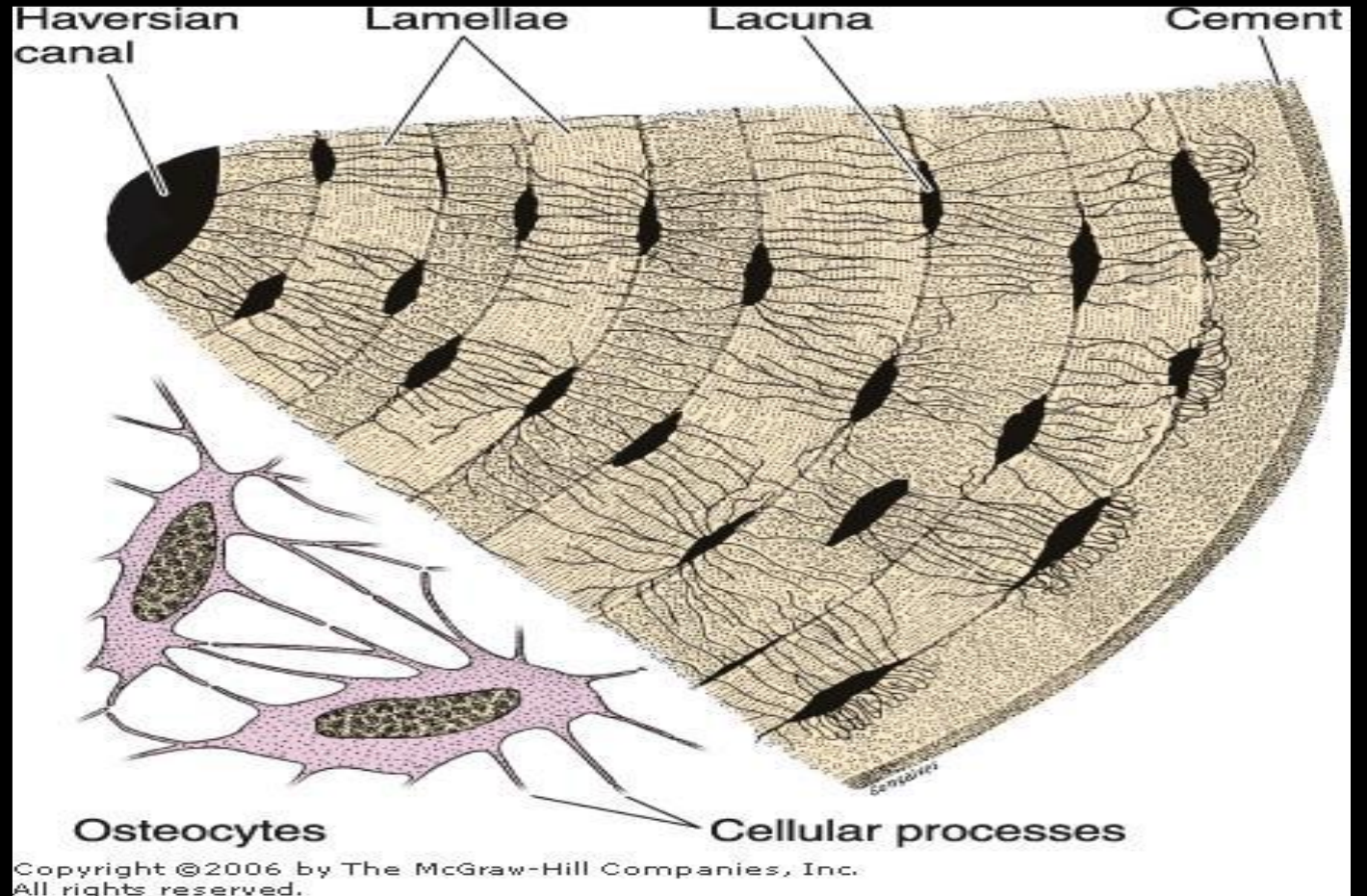
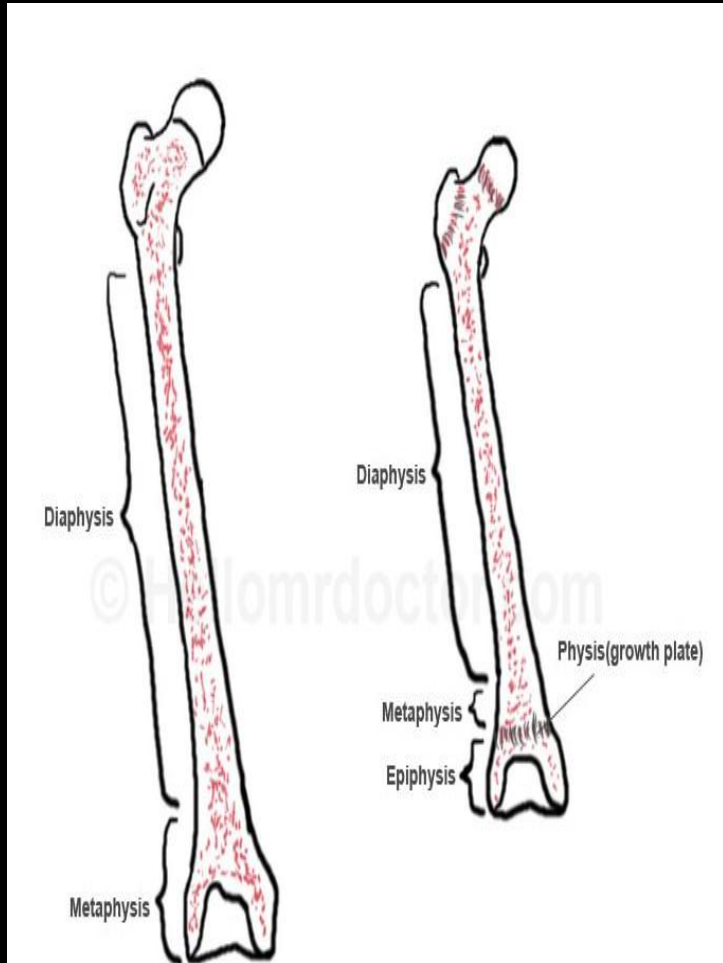


# TYPES OF BONE

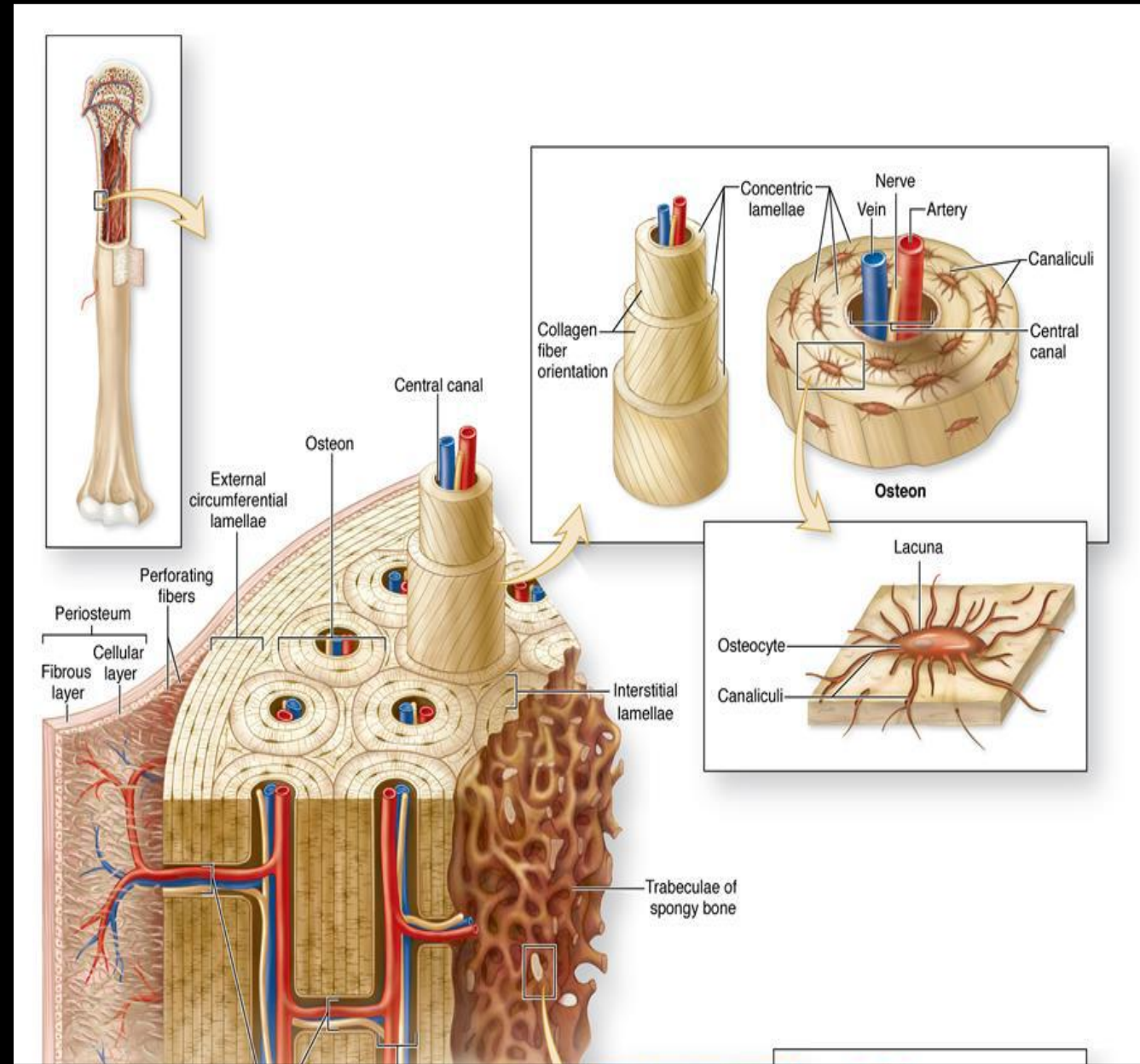
- Anatomical classification of **bones**: long, short, flat, & irregular bones.
- Macroscopic classification of **bone tissue**: compact bone, cancellous bone (microscopically they are almost identical).
- Developmental classification of bone tissue: primary & secondary.

# MACROSCOPIC CLASSIFICATION OF BONE TISSUE:

## COMPACT BONE:



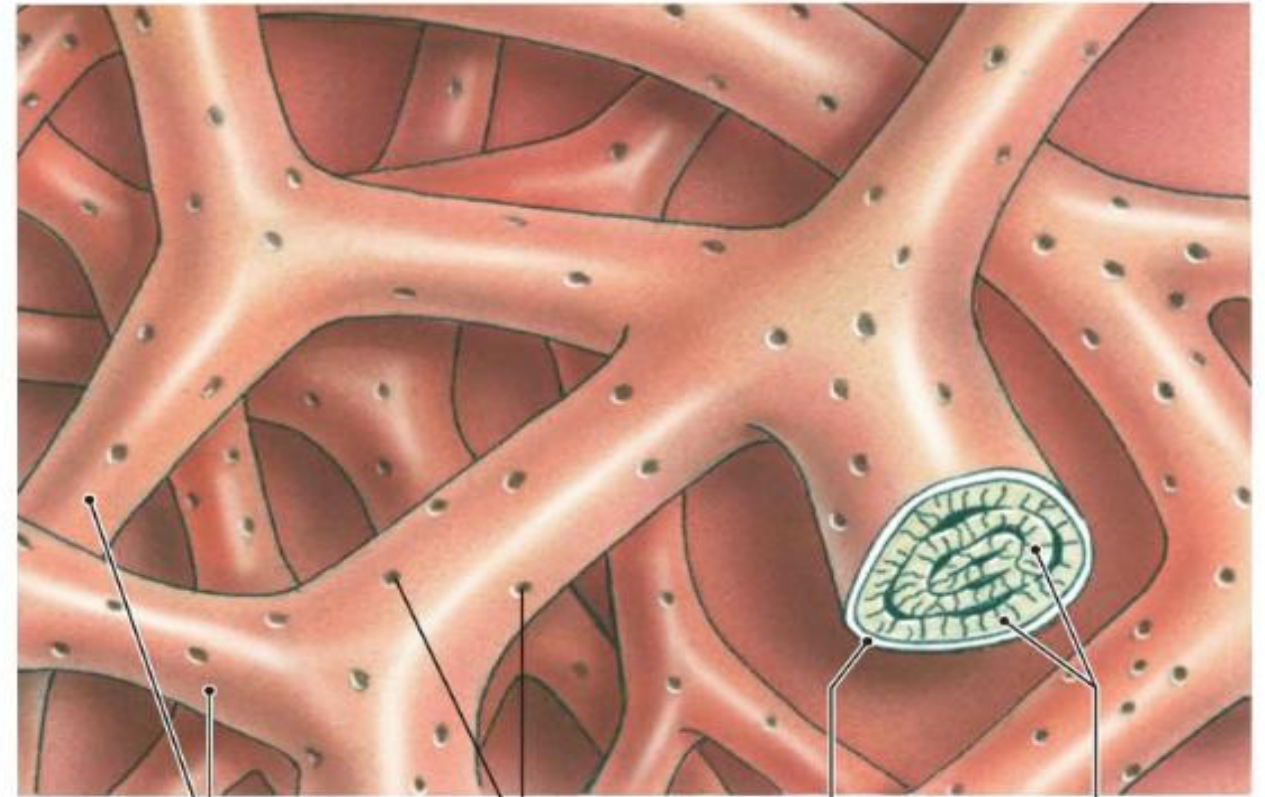
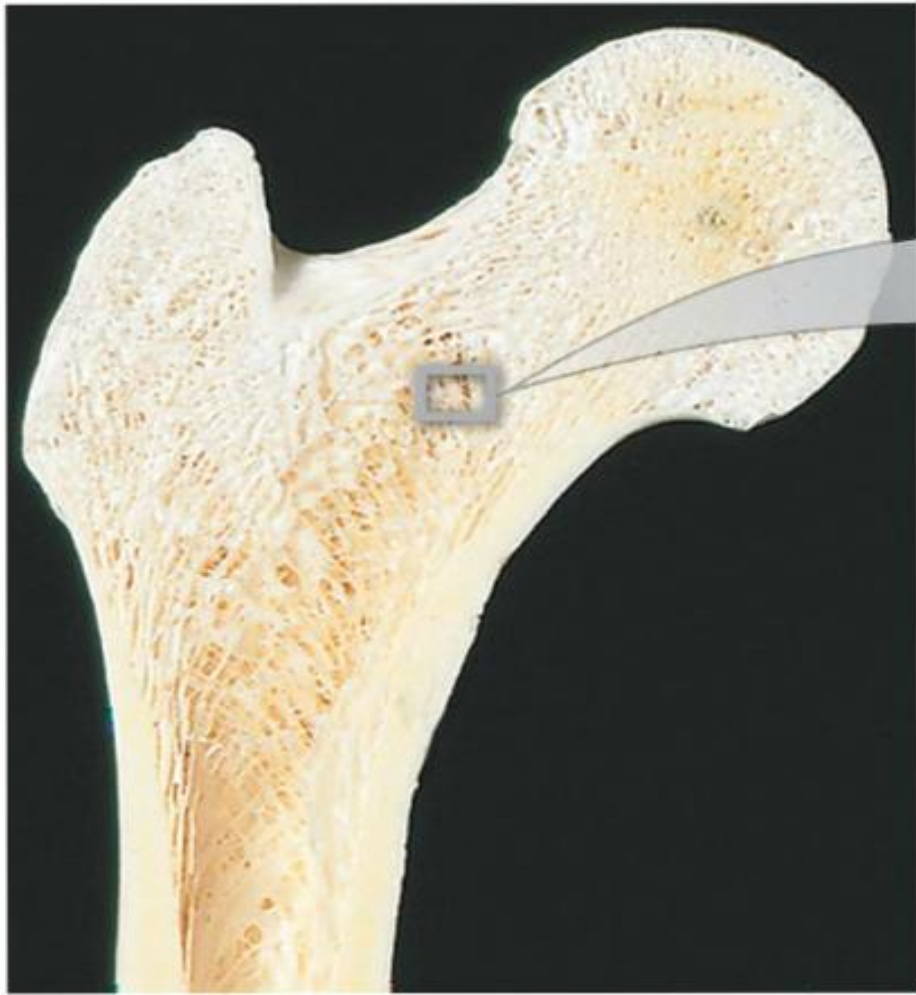
- - Outer circumferential lamellae:
- - Inner circumferential lamellae:
- - Osteons (Haversian systems):
- - Interstitial lamellae:



## NOTES:

- ☐ In each lamella, collagen fibers are arranged spirally, in a direction opposite to that of the collagen fibers of the adjacent lamella.
- ☐ Osteons are in a continuous renewal process, therefore, they differ in diameter & number of lamellae.
- ☐ Surrounding each osteon is a layer of amorphous material called the **cementing substance** that consists of mineralized matrix with few collagen fibers.
- ☐ Perforating canals are not surrounded by concentric lamellae, they perforate the lamellae of haversian systems. Perforating canals are lined with endosteum & filled with loose connective tissue.
- ☐ Blood vessels & nerves enter the bone via foramina & are distributed through all central & perforating canals.

# SPONGY (TRABECULAR BONE)

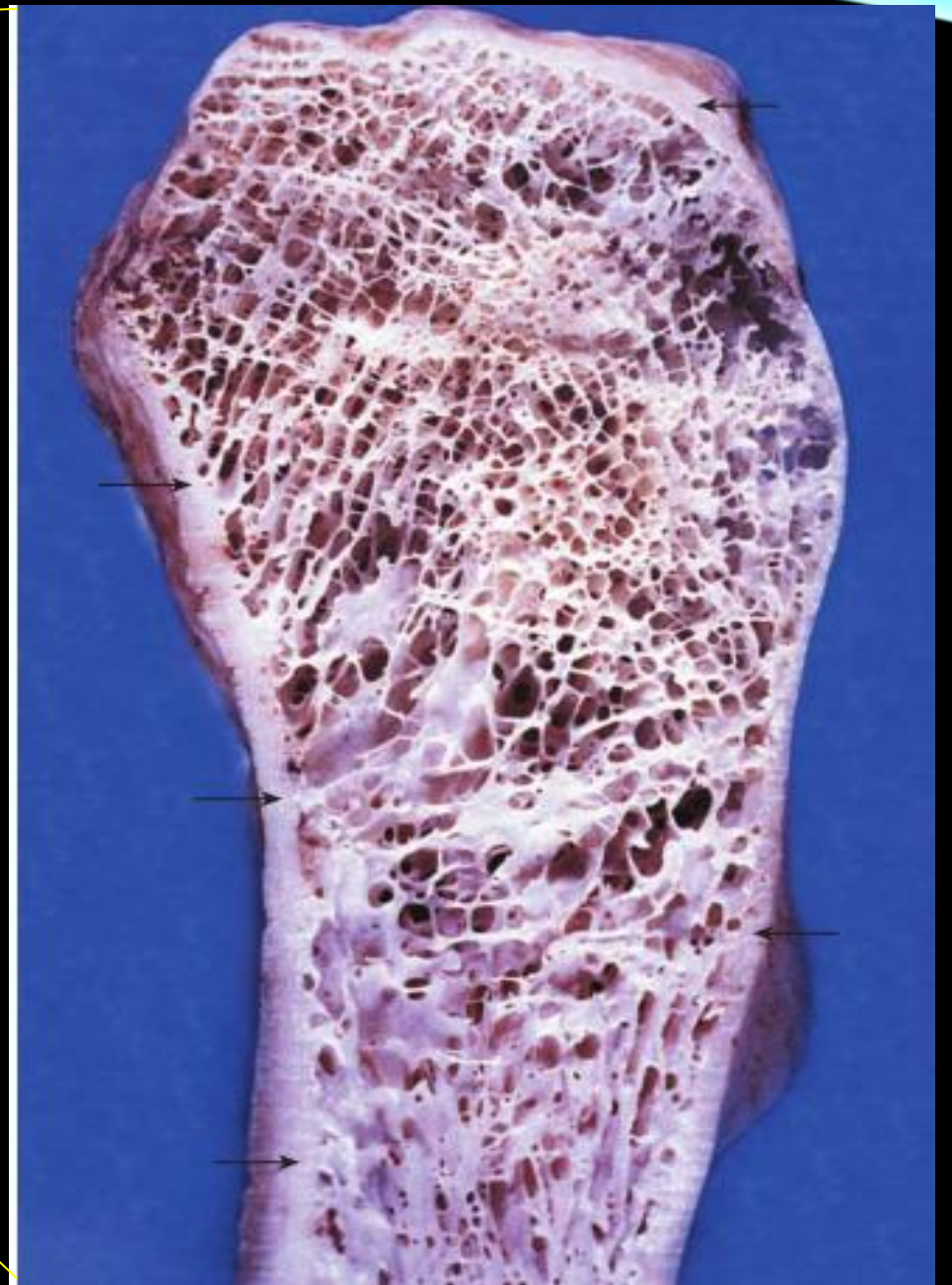
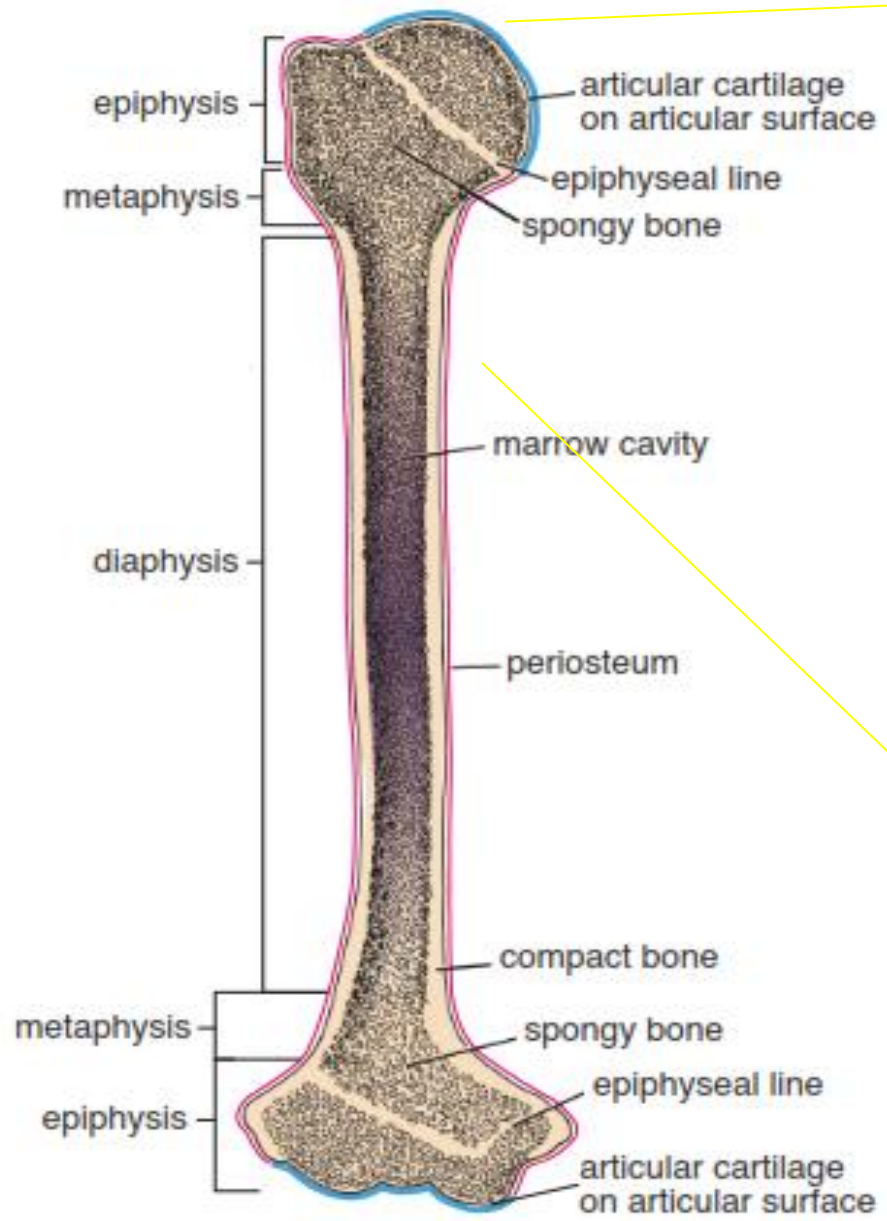


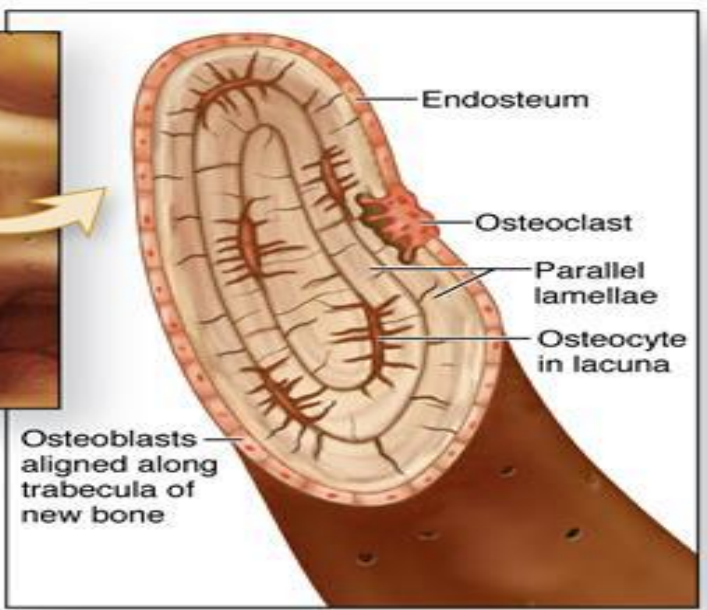
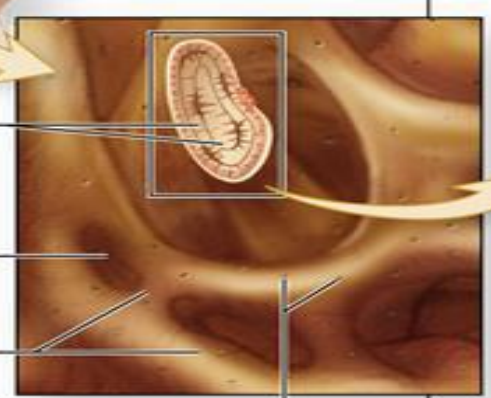
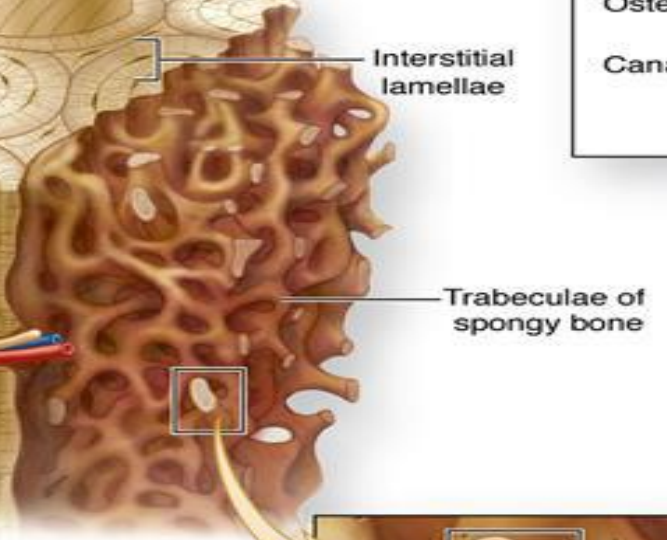
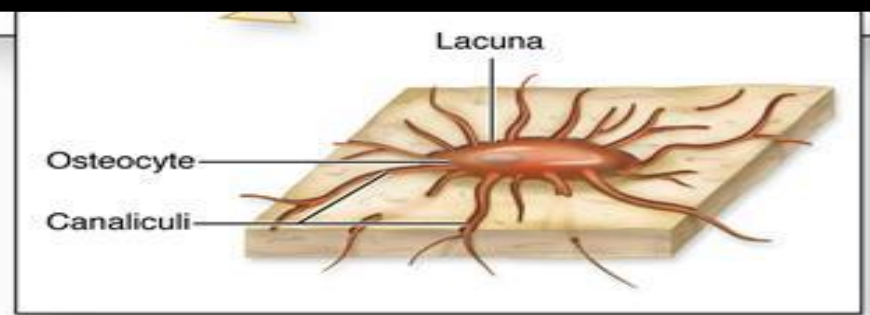
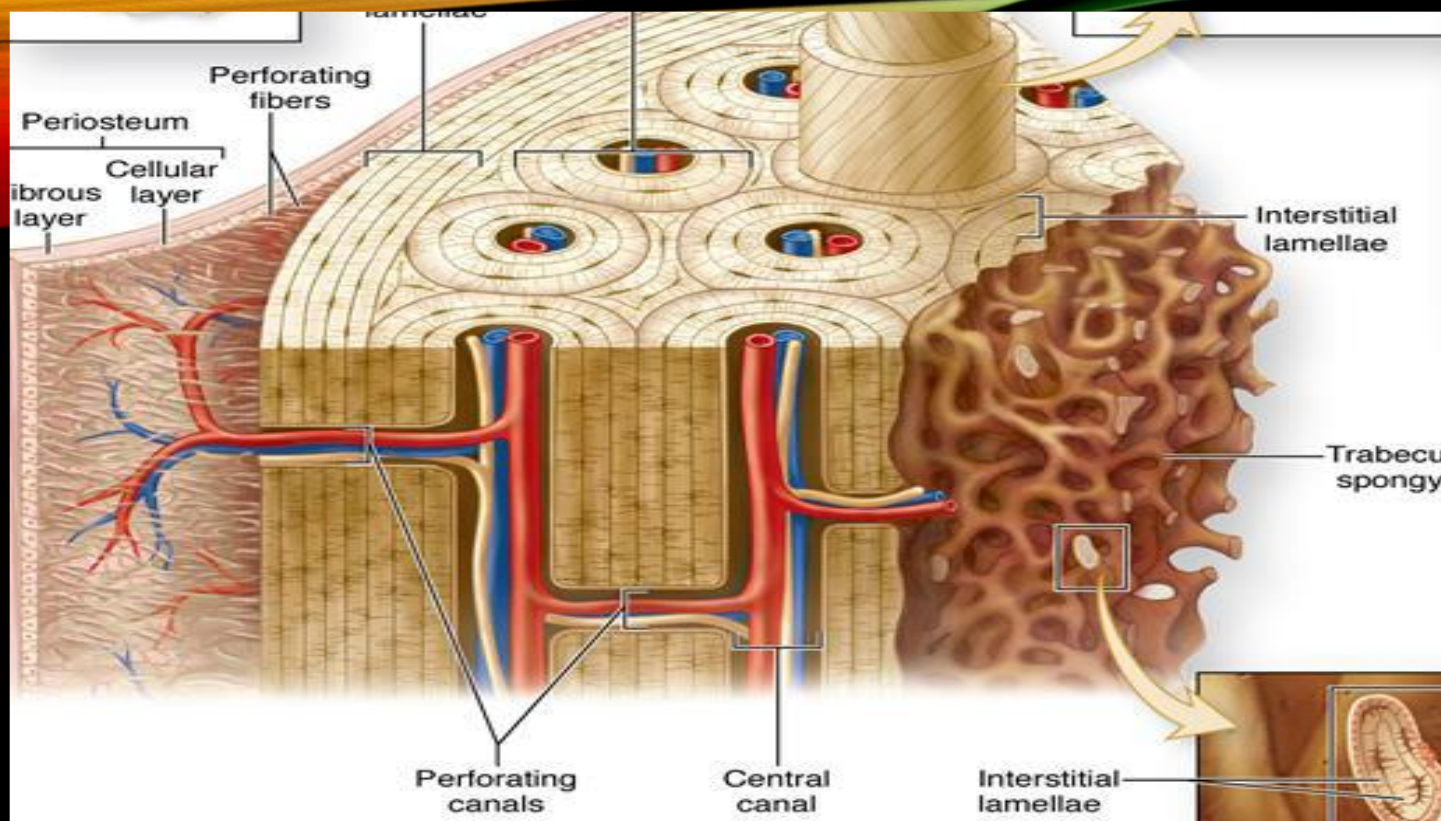
Trabeculae of spongy bone

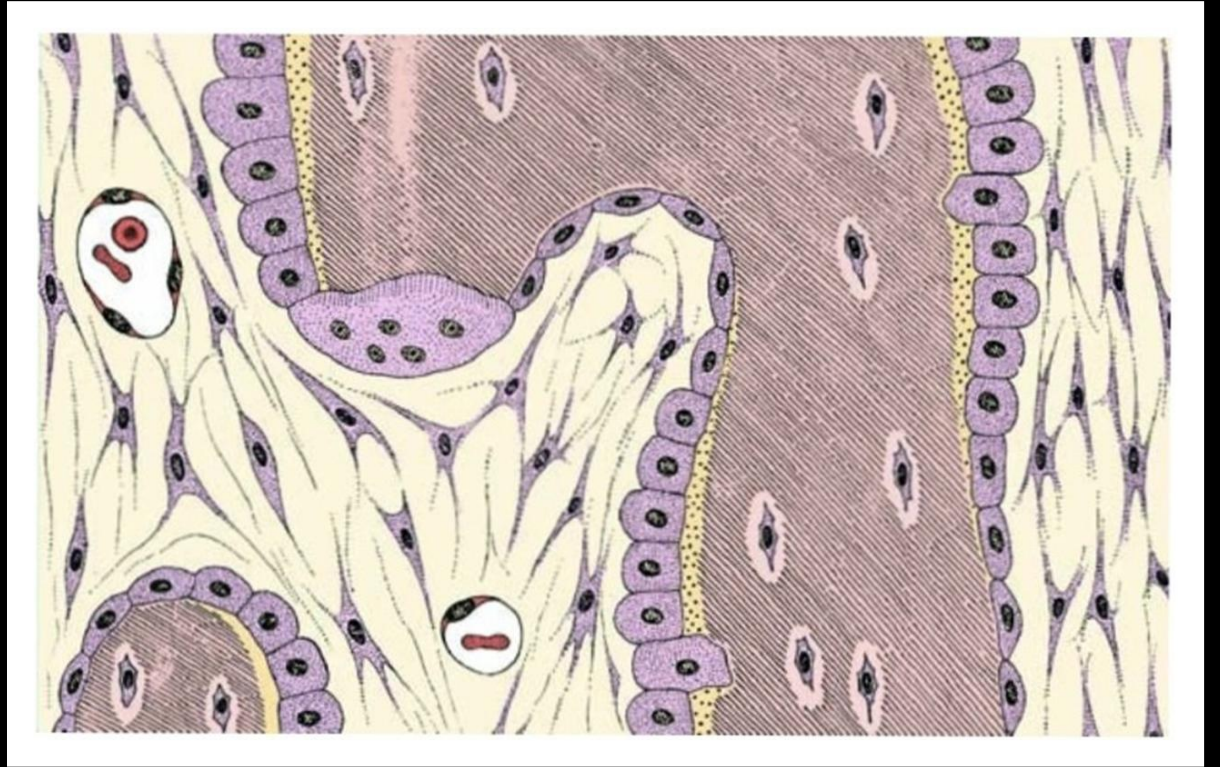
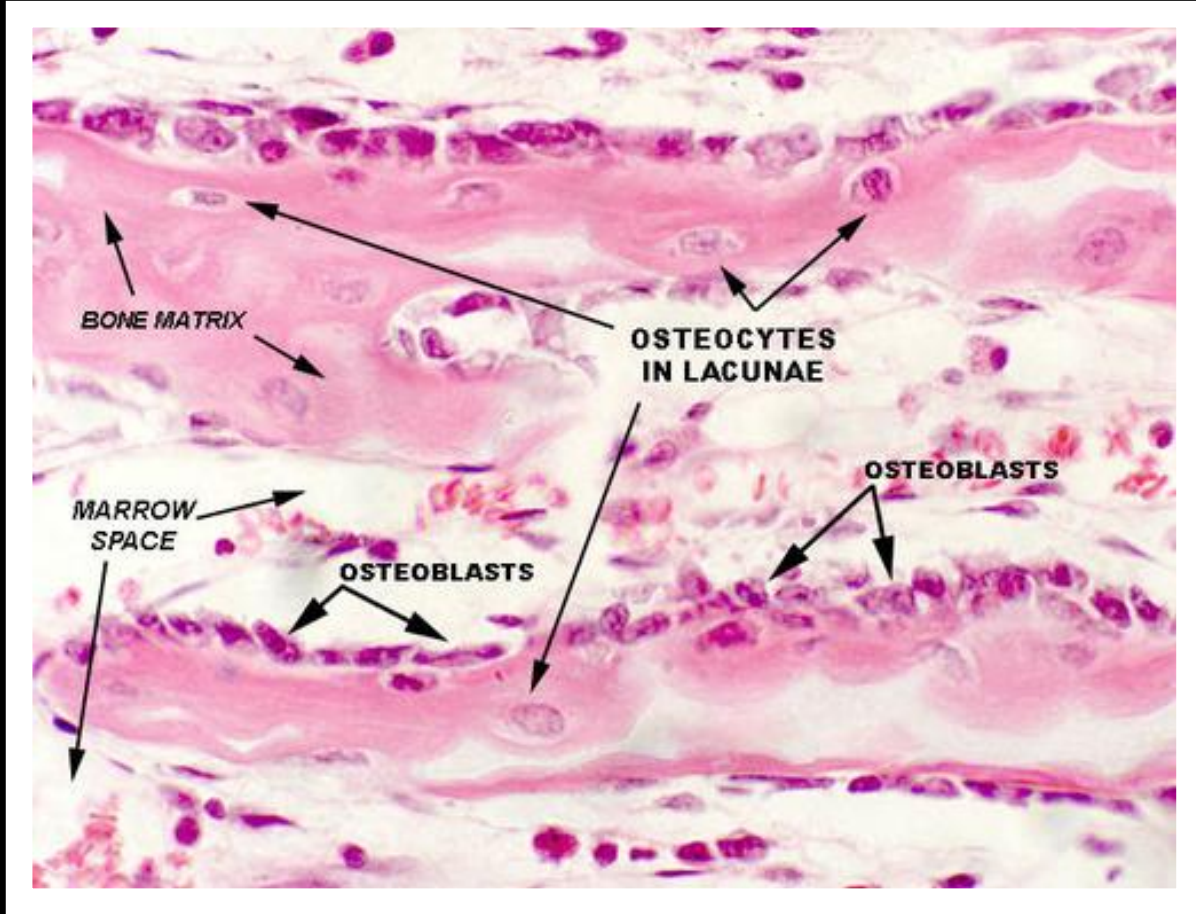
Canaliculi opening on surface

Endosteum

Lamellae







# DEVELOPMENTAL CLASSIFICATION OF BONE TISSUE:

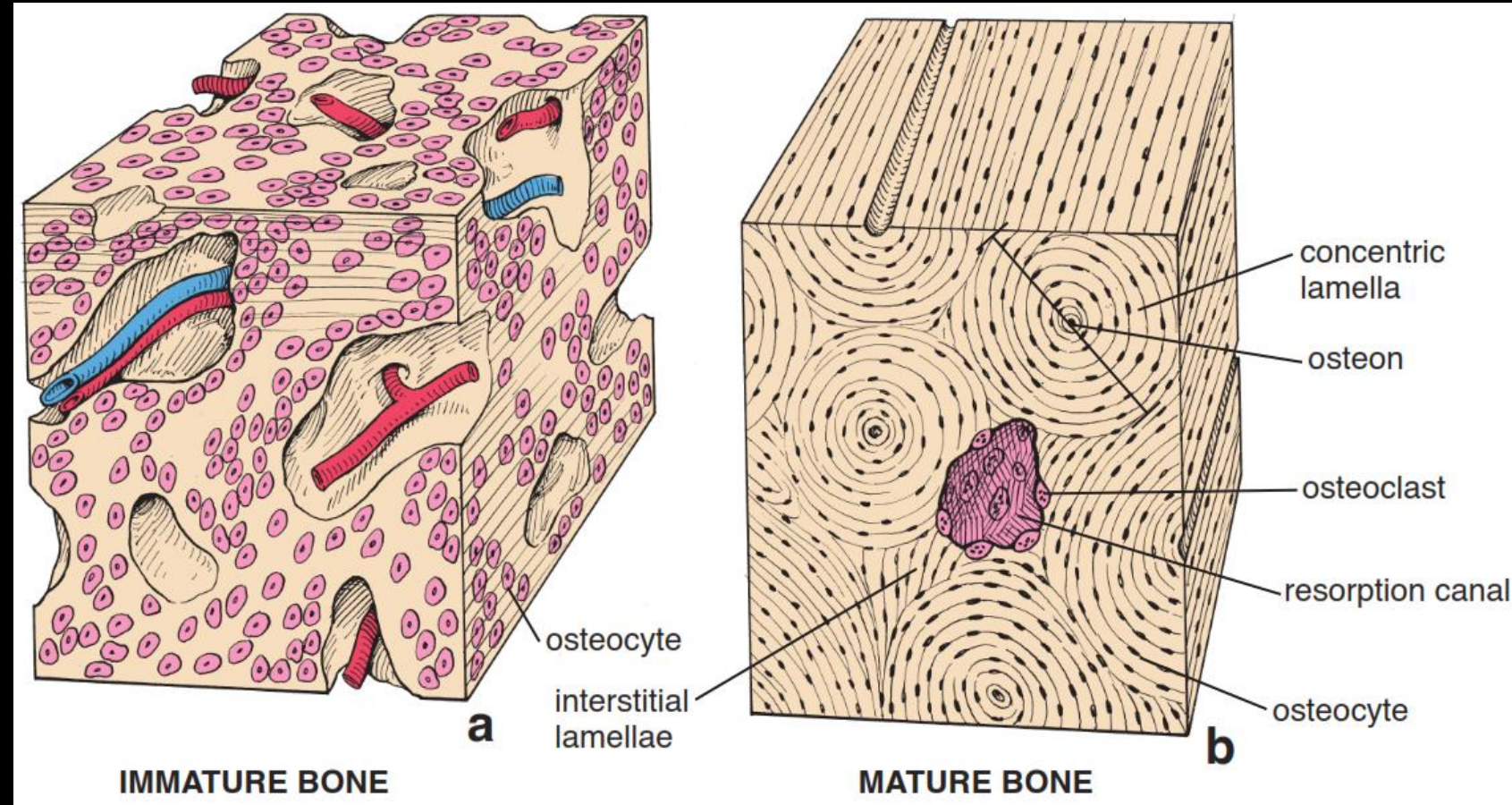
- **Primary bone tissue** (immature, woven) :
- Primary bone tissue is usually temporary, it is replaced in adults by secondary bone tissue except in few places (near the sutures of the flat bones of the skull, in tooth sockets, and in the insertions of some tendons).
- **Secondary bone tissue** (mature, lamellar) :

- Immature Bone Does Not Display An Organized Lamellar Appearance

- Immature Bone Contains Relatively More Cells Per Unit Area Than Does Mature Bone

- The Cells In Immature Bone Tend To Be Randomly Arranged, Whereas Cells In Mature Bone Are Usually Arranged With Their Long Axes In The Same Direction As The Lamellae

- The Matrix Of Immature Bone Has More Ground Substance Than Does The Matrix Of Mature Bone



## CLINICAL NOTES:

- Cancer originating directly from bone cells (a primary bone tumor) is uncommon (0.5% of all cancer death), although a cancer called **osteosarcoma** can arise in osteoprogenitor cells. The skeleton is often the site of secondary, **metastatic tumors**, however, arising when cancer cells move into bones via small blood or lymphatic vessels from malignancies in other organs, most commonly the breast, lung, prostate gland, kidney, or thyroid gland.

