

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ





HISTOLOGY ***of Bone***

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LEARNING OUTCOMES

- Identify the histological structure of:
 - **Compact bone**
 - **Sponge bone**
- **Differentiate between four types of bone cells**
- **Ossification process**



THE BONE

● **Bone is a highly specialized variety of C.T. It forms the skeleton**

- **Constituents of bone**

Bone cells

Bone matrix

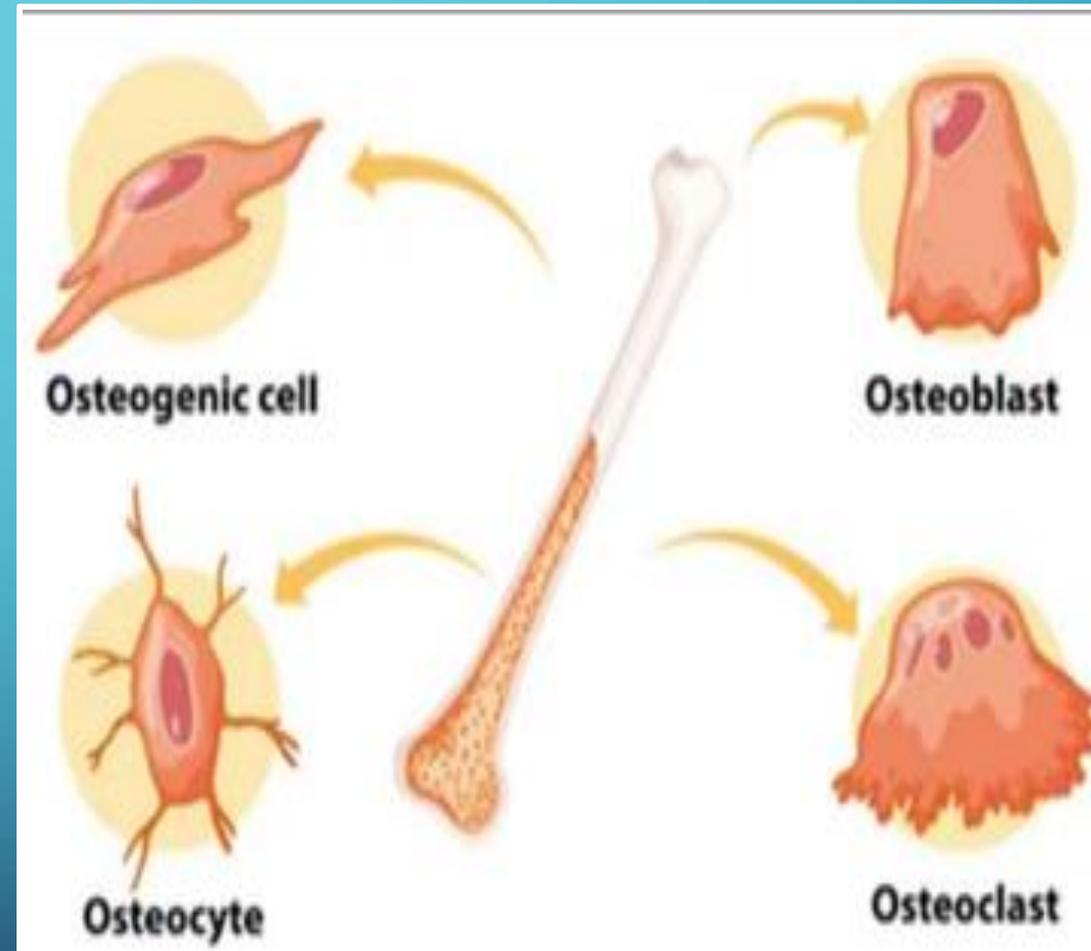
Periosteum

Endosteum

Bone cells

There are four Types of bone cells:

1. Osteogenic cells
2. Osteoblasts.
3. Osteocytes.
4. Osteoclasts.





1- OSTEOGENIC CELLS = OSTEOPROGENITOR CELLS

- **Origin:** pericytes, which present around blood Capillaries.

- **Sites:**

- 1- Inner osteogenic layer of periosteum.

- 2- Endosteum.

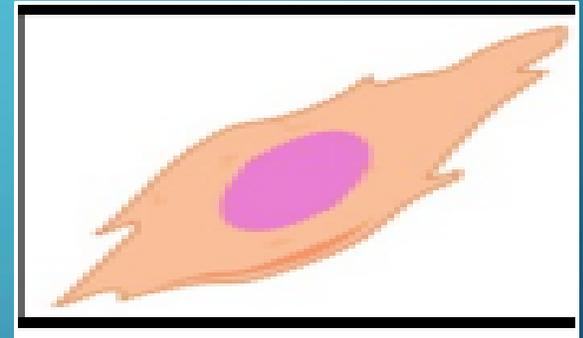
- 3- Bone marrow cavities

- **Structure:**

LM: They are flat cells with central flat nuclei and pale basophilic cytoplasm.

EM: Rich in ribosomes and rER.

- **Function:** They are capable to divide and give osteoblasts during growth and healing of fracture bone.





2- OSTEOBLASTS

- **Origin:** They arise from activated osteogenic cells.
- **Structure:**

LM:

They are small, oval branched cells with eccentric, open face nuclei and deep basophilic cytoplasm.

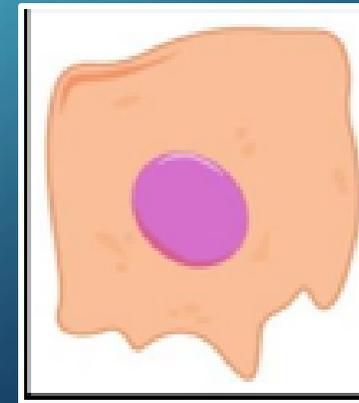
EM: They show plenty of ribosomes, rER, well developed Golgi apparatus and mitochondria.

- **Sites:**

- 1- Inner osteogenic layer of periosteum.
- 2- Endosteum.
- 3- Bone marrow cavities.

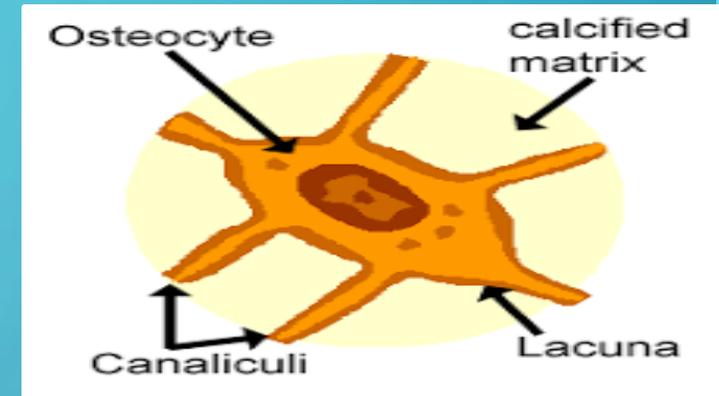
- **Function:**

They are responsible for bone formation (bone forming cell) during growth or bone fracture .



3- OSTEOCYTES

- **Origin:** they are mature osteoblasts
- **Structure:**
- **LM:**
 - They are oval, branched cells with oval, central nuclei.
 - The cytoplasm is slightly basophilic rich in alkaline phosphatase enzyme.
- **EM:**
 - They contain rER, ribosomes, Golgi apparatus, and many cytoplasmic microtubules.
 - The cells are present inside lacunae and connected with processes and these processes intercommunicate with one another by gap junctions.
- **Function:**
 1. They preserve the integrity of the bone matrix and maintain its inorganic components.
 2. They are related to mobilization of Ca^+ from the bone to the blood in times of need.



4- OSTEOCLASTS

- **Origin:** they arise from blood cells called monocytes.

- **Sites:**

On the inner surface of bone where resorption takes place.

- **Structure:**

- **LM:**

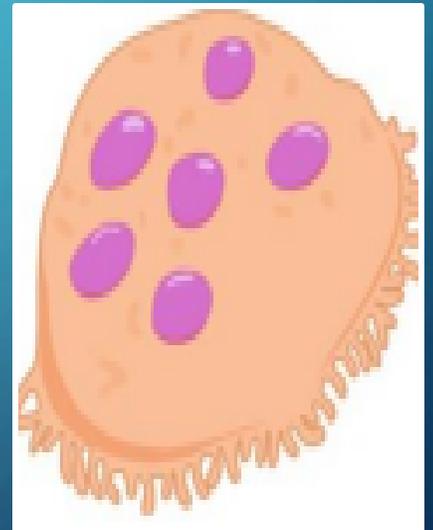
- **Size:** Osteoclast is large cell “20-30 μm ”.

- **Nucleus:** It is multinuclated cell “4-50” nuclei

- **Shape:** It is irregular in shape.

- **Cytoplasm:** The cytoplasm is foamy acidophilic.

- **Border:** The cells have striated or brush border facing the bone surface.

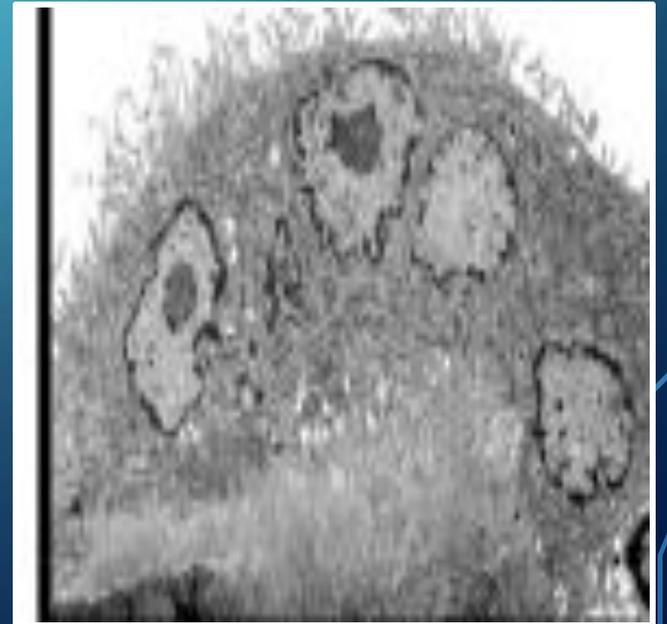


EM:

- Numerous finger like processes projecting from the cell membrane.
- Lysosomes of variable shape and size.
- Golgi apparatus & mitochondria

Function:

They are concerned with bone resorption (**bone remodeling**) during ossification: remove bone debris during ossification and after healing of bone fracture.



• ***Which cell is multinucleated***

1. **Osteoclast**

2. **Osteocyte**

3. **Osteogenic cell**

4. **Osteoblast**

• ***Which cell is involved in bone formation***

1. **Osteoclast**

2. **Osteocyte**

3. **Osteogenic cell**

4. **Osteoblast**



QUIZ!



BONE MATRIX

General characters:

- **It is hard or solid in consistency.**
- **It is rich in blood supply**

Structure of the bone matrix:

(1)Organic components.2) Inorganic components.

(1) The Organic components:

- **It constitutes about 50% of the dry weight of the bone matrix.**
- **It includes:**
 - **bone collagen “Type I”**
 - **Sulphated glycosaminoglycans.**
 - **Protein = Osteonectin: Which anchor cells with bone matrix.**

(2) The Inorganic components:

- **It constitutes about 50% of the dry weight of bone matrix.**
- **It is formed mainly of calcium and phosphorus salts and small amounts of sodium, carbonate, citrate, iron, Mg.**



Periosteum

- **It is a vascular C.T. membrane covering the bone from outside.**
- **It is formed of 2 layers:**

➤ **Outer fibrous layer:-**

It is rich in collagenous fibers, blood vessels and fibroblasts.

➤ **Inner osteogenic layer:-**

- **It is formed of osteogenic when stimulated during growth or healing of fracture can change into osteoblasts.**

• **Function of periosteum:**

(1) Provide attachment for muscles, ligaments and tendons.

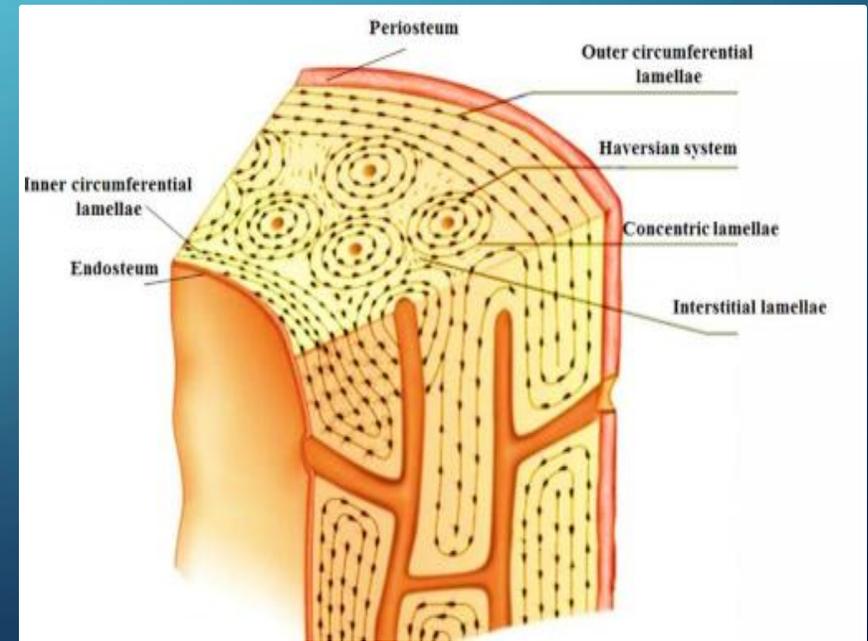
(2) Provide bone with blood supply and nourishment.

(3) Inner osteogenic layer is important for formation of bone during its growth and after its fracture.

Endosteum



- It is a vascular C.T. membrane that lines the inner surface of the bone
- Rich in **osteogenic cells, osteoblasts, osteoclasts and blood vessels**
- **Function of endosteum:**
 - (1) It supplies bone with blood supply and nourishment.
 - (2) Its osteogenic cells, osteoblasts are concerned with bone formation & osteoclasts are concerned with bone resorption during growth & healing after fracture.





There are two types of bone

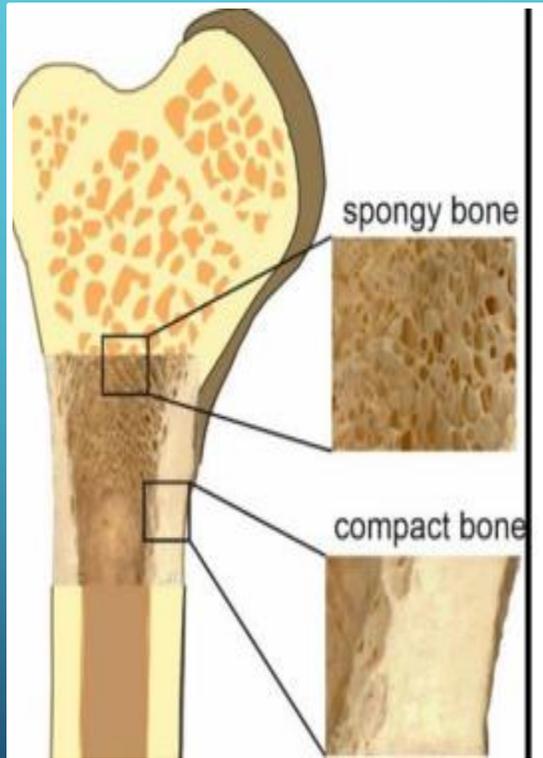
- **Compact bone**

1. Compact Bone

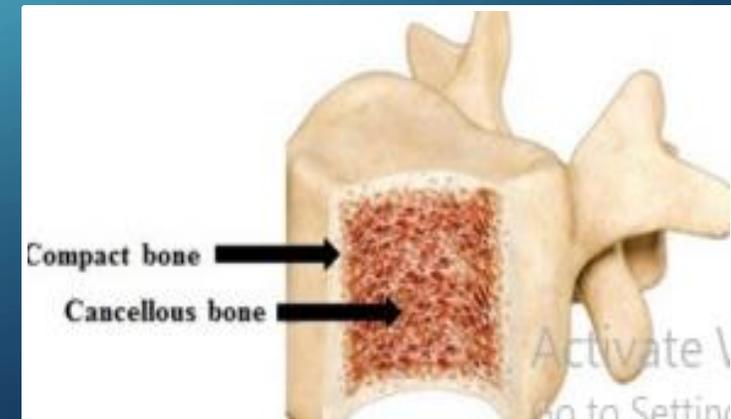
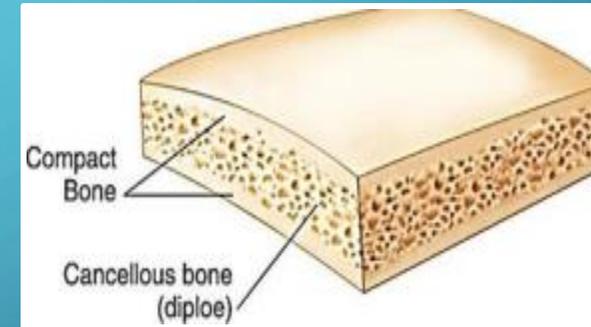
- **It is solid like ivory with no apparent holes i.e. compact**

Sites:

- **1- Shaft of long bones.**
- **2- Outer & inner tables of the flat bones of the skull.**
- **3- Outer covering of the vertebrae & ribs.**



- **Cancellous bone.**



(III) BONE MATRIX

The matrix is formed of lamellae of calcified osteoid tissue

in which osteocytes are embedded.

Bone lamellae are deposited in regular pattern as follows:

Outer circumferential lamellae:

These lamellae are present under the periosteum and parallel to it.

Inner circumferential Lamellae:

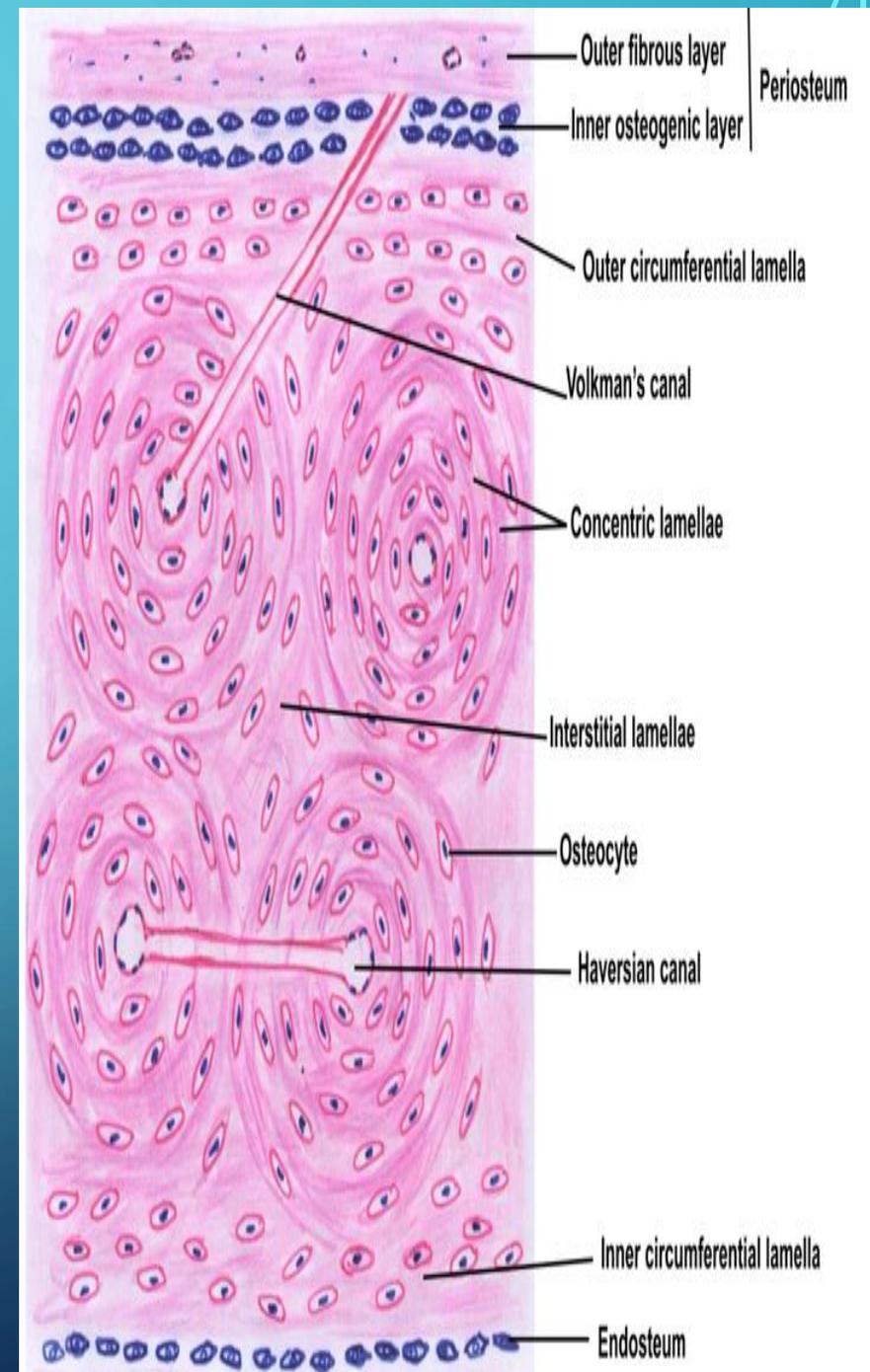
These lamellae are present under the endosteum and parallel to it.

Concentric bone lamellae:

lamellae circularly arranged around Haversian canals.

Interstitial bone Lamellae:

irregularly arranged between these lamellae



Haversian system = Osteon:

-It is the structural unit of the bone. -

It is formed of:

(1) Haversian Canal:

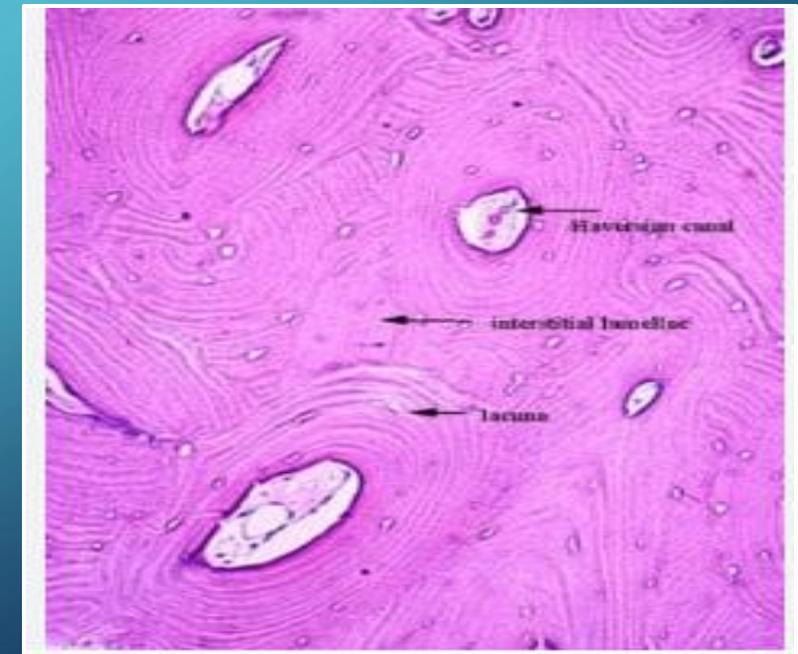
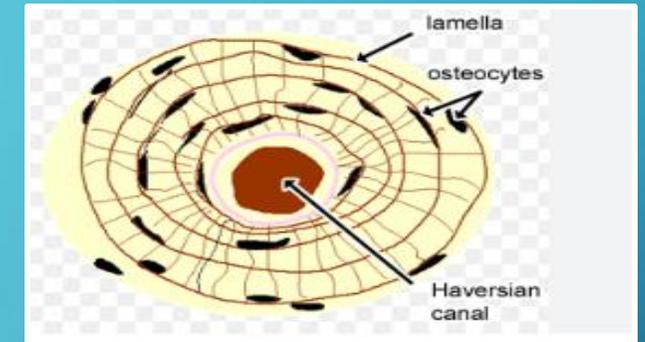
- It runs parallel to the longitudinal axis of the bone.

- It contains loose C.T., rich in blood Vessels and osteogenic cells.

(2) Concentric bone lamellae:

- It is formed of 4-20 cylinders of concentric bone lamellae arranged around Haversian canal.

(3) Osteocytes: - They are found in between the bone lamellae.

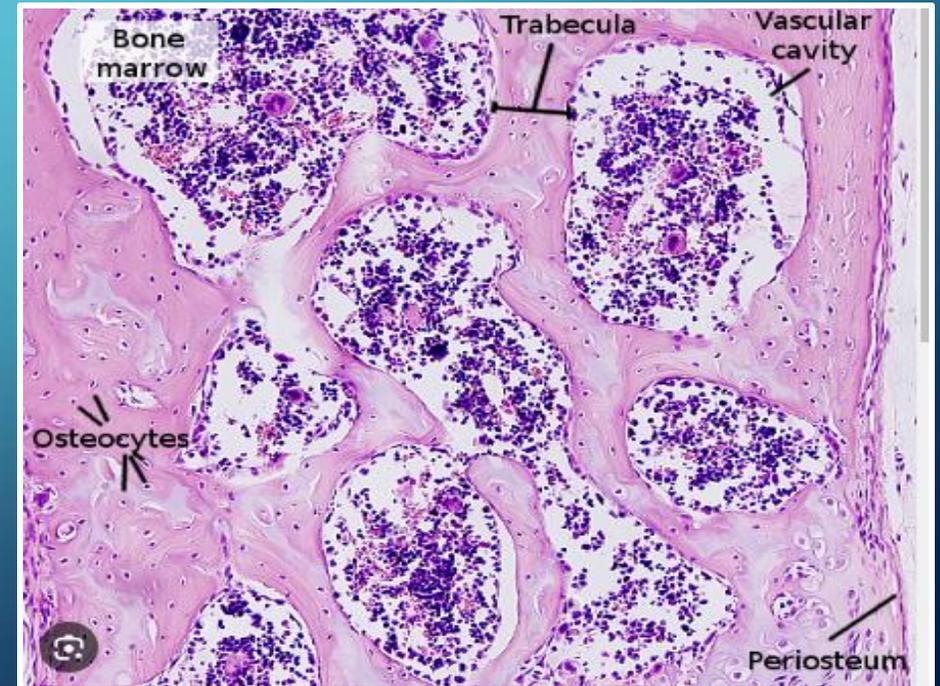


2- CANCELLOUS BONE

- It looks like – sponge with many holes, so called spongy bone.
- It is formed of bone lamellae in the form of **irregularly arranged bars** or **trabeculae** which branch and anastomose and separated by bone marrow spaces of irregular shape and size. These spaces are filled with active red bone marrow.

- **Sites:**

- (1) Epiphysis of long bones.
- (2) Central part of flat bones of the skull.
- (3) Young embryonic bone.
- (4) Bodies of vertebrae and sternum.





OSSIFICATION

- **Definition:**

It is the process of bone formation, which leads to its growth.

- **Methods of bone ossification:**

Intramembranous ossification: It occurs in mesenchymal membranes.

Intracartilagenous ossification: It occurs in cartilage model

INTRACARTILAGENOUS OSSIFICATION

“Growing end of long bone”

- **Definition:**

It is a type of ossification by which cartilaginous model is replaced by bone.

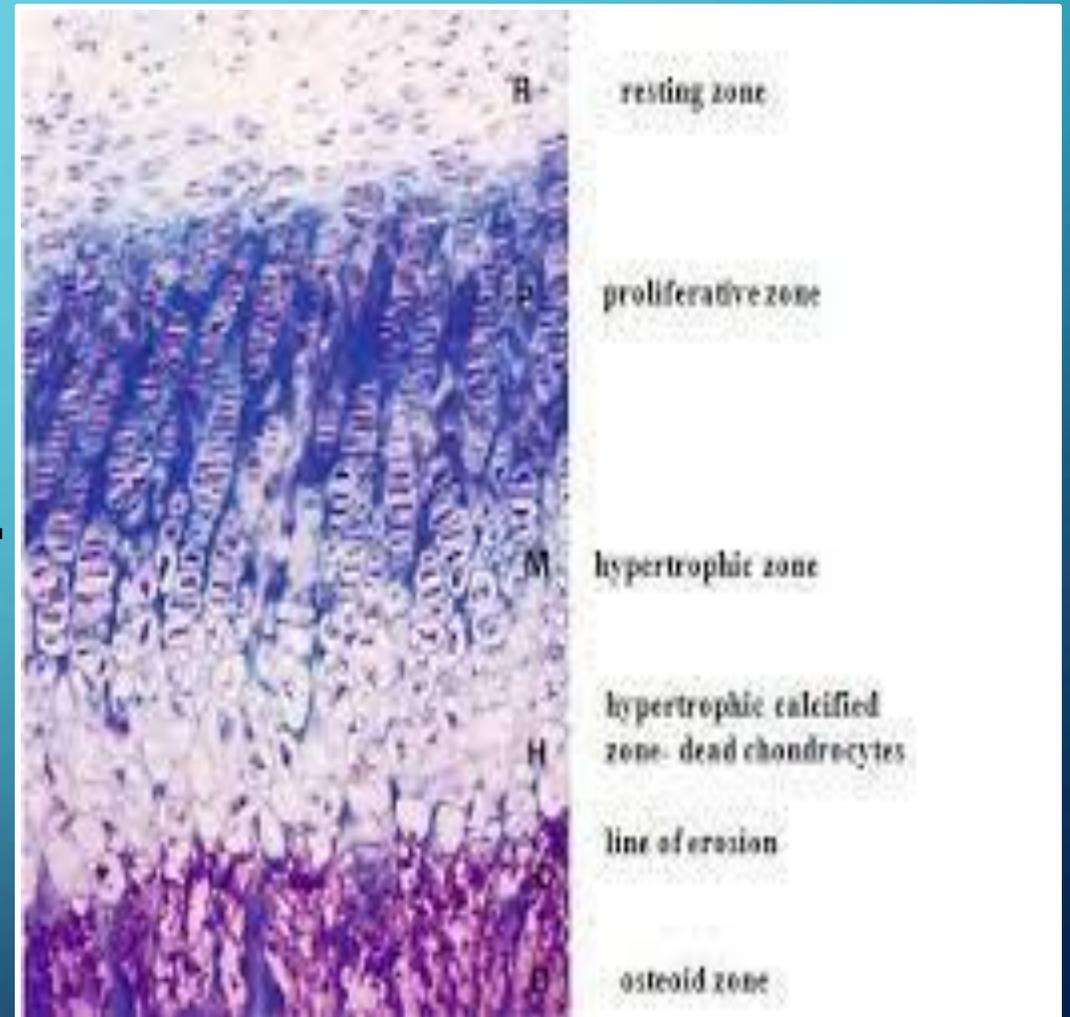
- **Sites:**

Epiphyseal plates of the cartilage



• Stages:

- (1) Stage of resting cartilage.**
- (2) Stage of proliferation.**
- (3) Stage of maturation and hypertrophy.**
- (4) Stage of calcification.**
- (5) Stage of invasion.**
- (6) Stage of spongy bone formation.**
- (7) Stage of remodeling and compact bone formation.**





QUIZ!

- ***Interstitial bone lamellae:***

1..Lie under & parallel to the periosteum.

2. Lie parallel to endosteum.

3. Lie in-between Haversian systems.

4. Lie in the osteons of the compact bone.



• **References**

- **Junqueira LC, Carneiro J: Junqueira's Basic Histology. Text and Atlas, fourteenth edition, Copyright © 2016 by McGraw-Hill Education.**
- **Student medical histology book, Mansoura university.**