

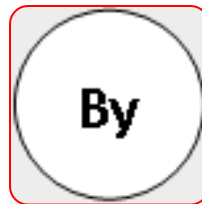


بسم الله الرحمن الرحيم
السلام عليكم ورحمة الله وبركاته

Histology

Lecture 2

Cartilage & Bone



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(2024-2025)

Cartilage

Learning objectives:

After the lecture, students should be able to:

- Define cartilage.
- Compare between cartilage & bone.
- List types of cartilage and mention their sites.
- Describe the structure of cartilage.
- Know the cartilage growth & repair.

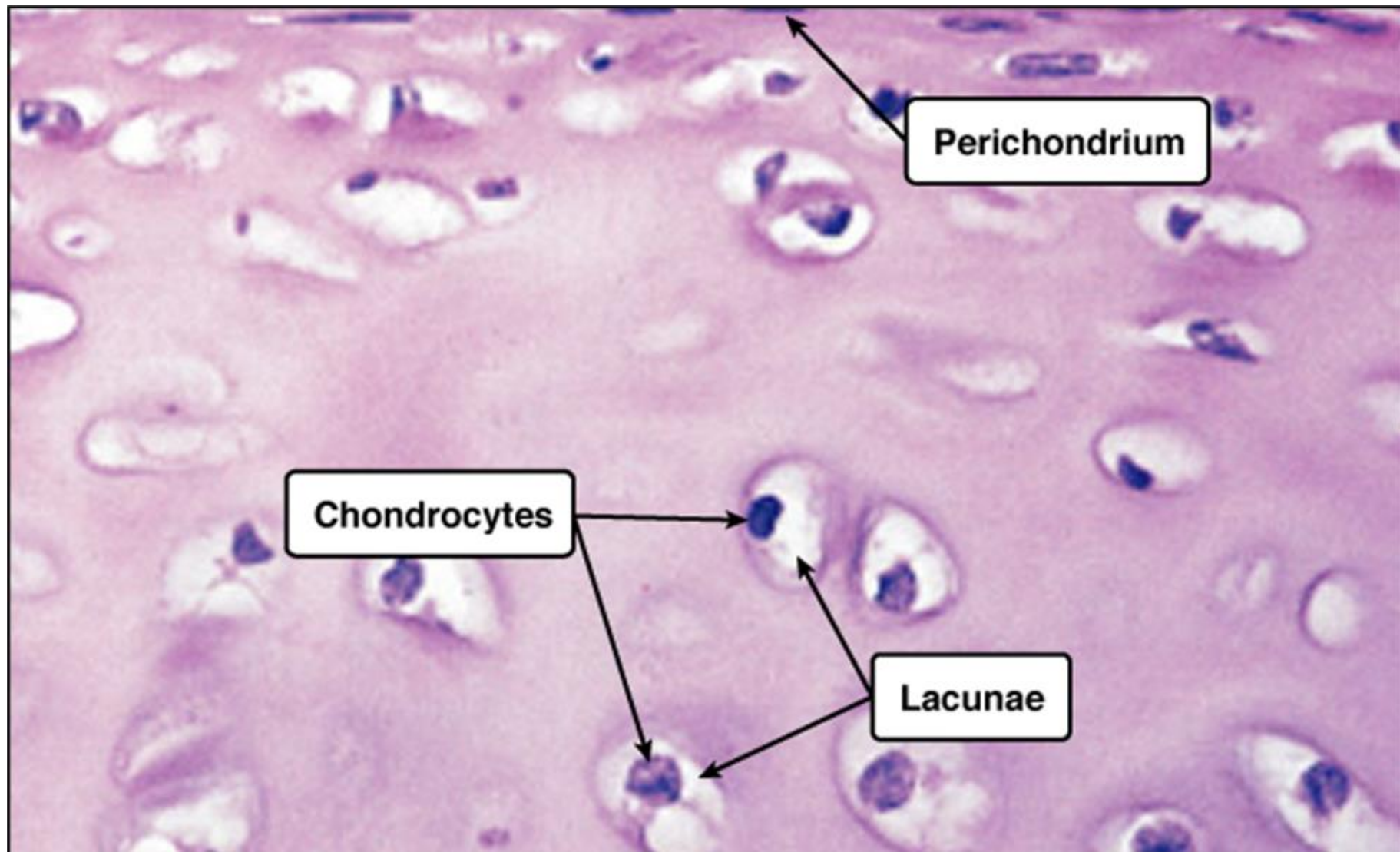


Cartilage

❖ Definition :-

It is a supporting form of connective tissue that develops from **mesenchyme** and consists of **intercellular substance & cells**.

The cells are present in spaces called **“lacunae”**.



Differences between cartilage & bone

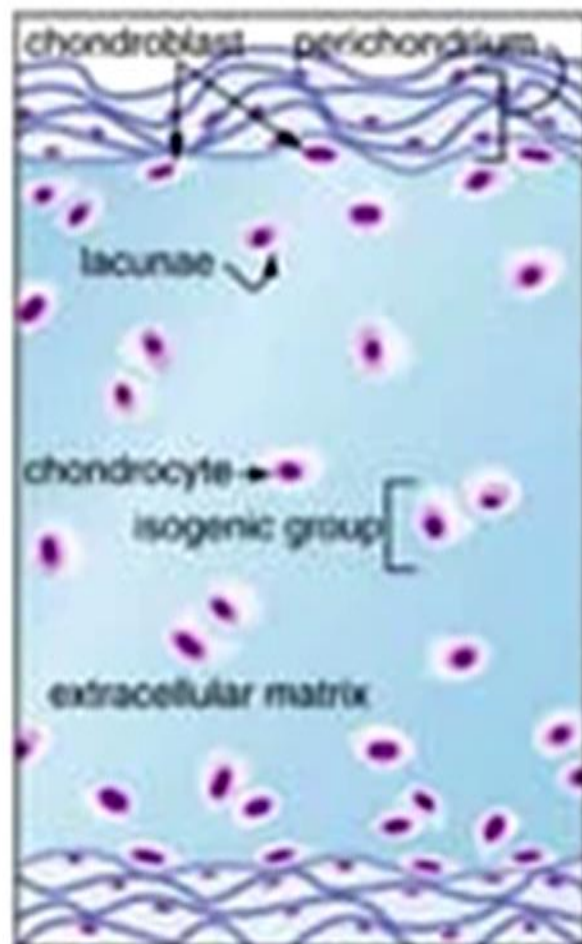
	Cartilage	Bone
Matrix	Not calcified	Calcified
Vascularity	A vascular	Vascular
Growth	Interstitial growth Appositional growth	Only Appositional growth

Types of cartilage

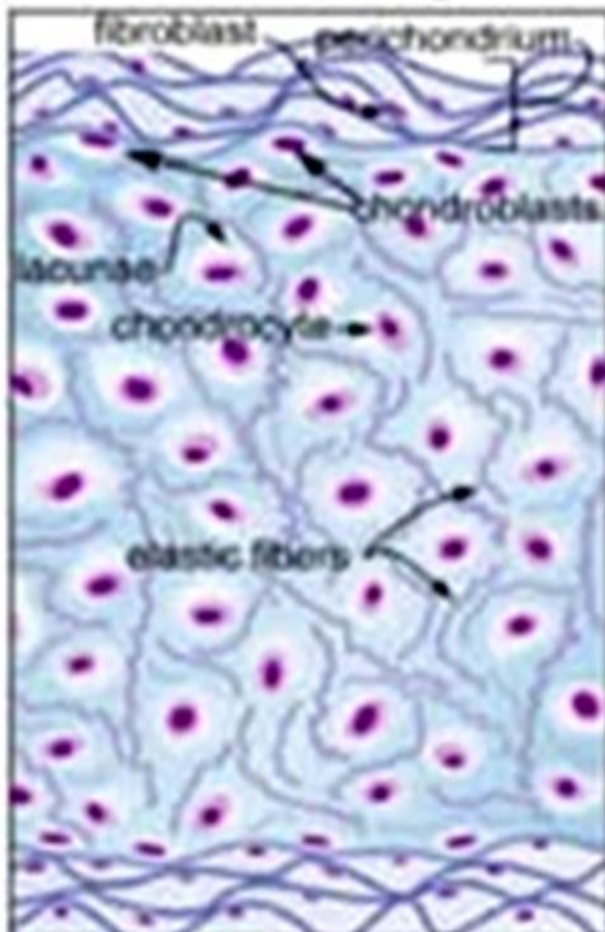
- 1. Hyaline cartilage:** Sites: Skeleton of embryo. In adults: in the articular surfaces of joints, epiphyseal plate of long bones, in the respiratory passages (nose, larynx, trachea, bronchi) & in the ribs.
- 2. Elastic cartilage:** Sites: auricles of the ear, wall of the external auditory canals, Eustachian tube, epiglottis & larynx.
- 3. Fibrocartilage:** Sites: in intervertebral discs, symphysis pubis, semilunar cartilage of knee joint, lips of glenoid cavity & tendon insertions.

Hyaline cartilage / Elastic cartilage / Fibrocartilage

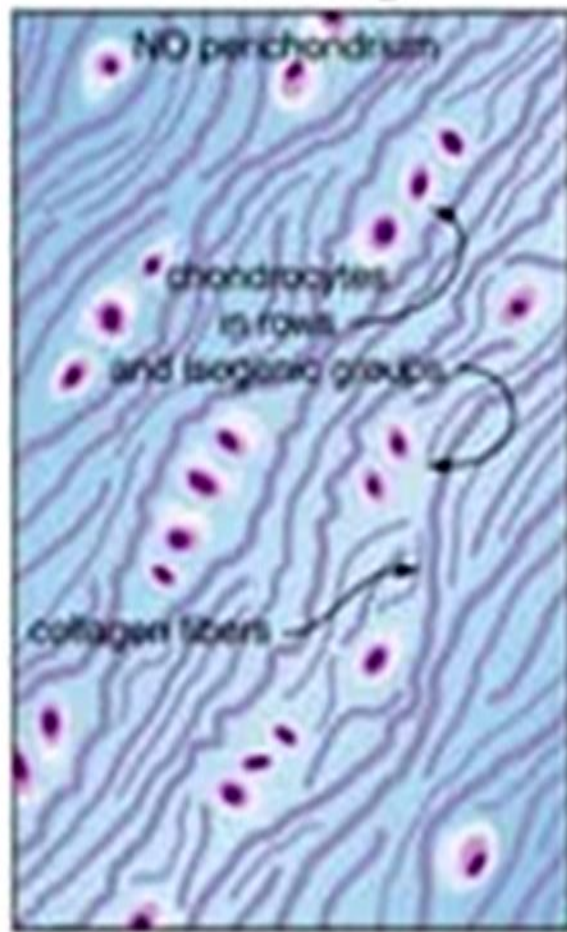
Hyaline Cartilage



Elastic Cartilage



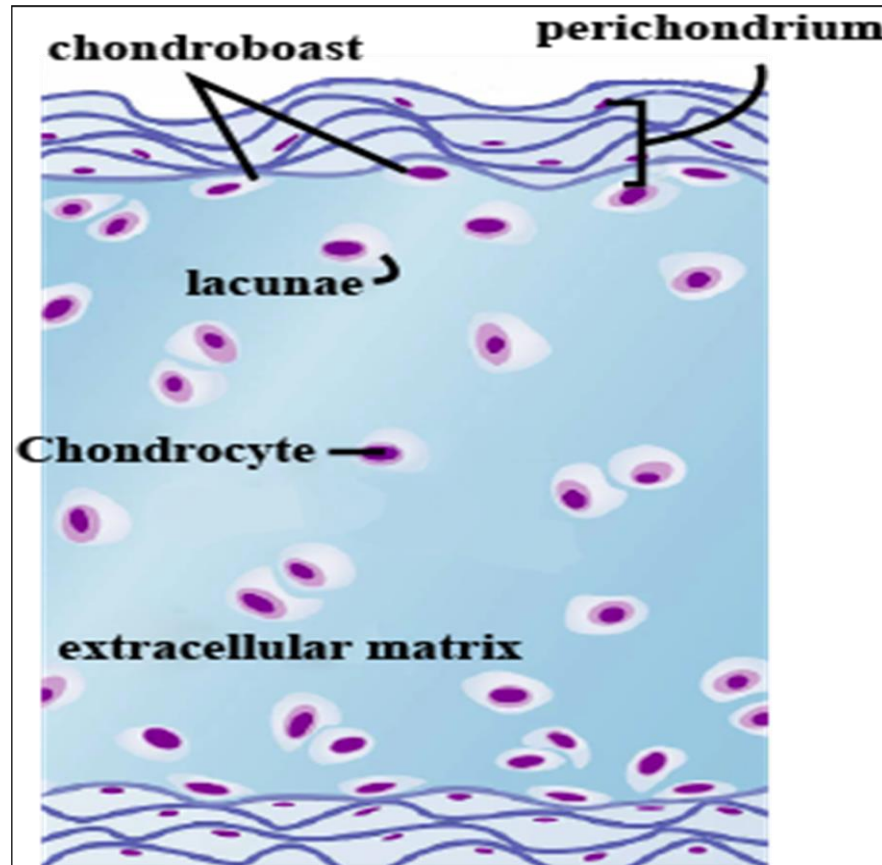
Fibrocartilage



😊 Microscopic structure of hyaline cartilage



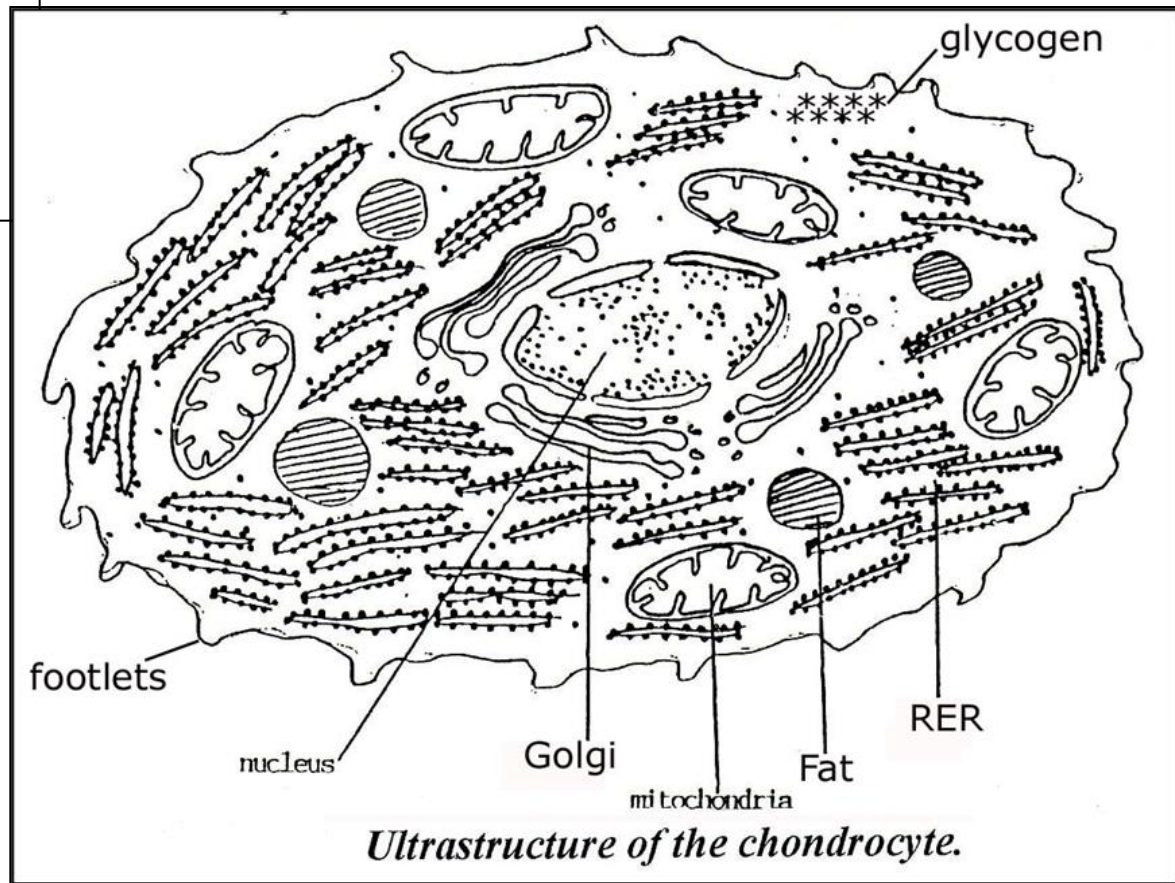
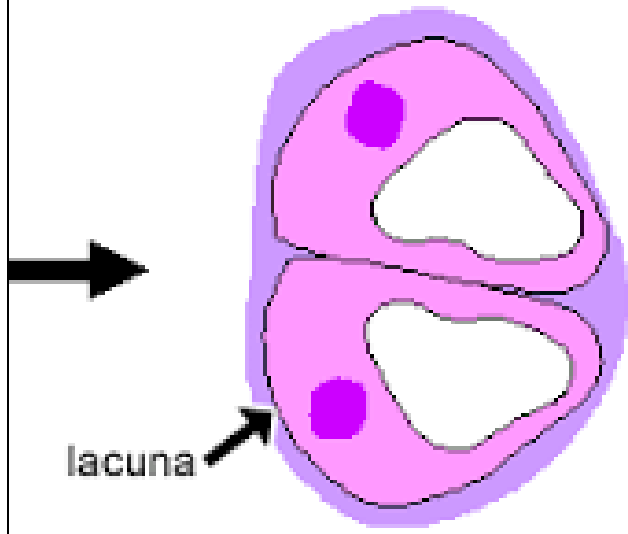
- Hyaline cartilage is composed of (1) cartilage cells (chondrocytes- located in lacunae) embedded in an (2) extracellular matrix (ECM) and is covered with (3) perichondrium.



(1) Cartilage cells (chondrocytes)

- Are located in **lacunae** in the ECM.
- **With E/M:**
 - The outline of the cell is irregular
“cytoplasmic footlets”.
 - It demonstrates well developed RER & Golgi body.
- **Function:** They synthesize and maintain ECM components.

chondrocyte



(2) Extracellular matrix (ECM)

- ECM has high concentrations of GAGs, proteoglycans & collagen fibers (type II).
- High content of water (60%- 80% of the weight of fresh hyaline cartilage) allows cartilage to serve as a **shock absorber**, a role of major functional importance.

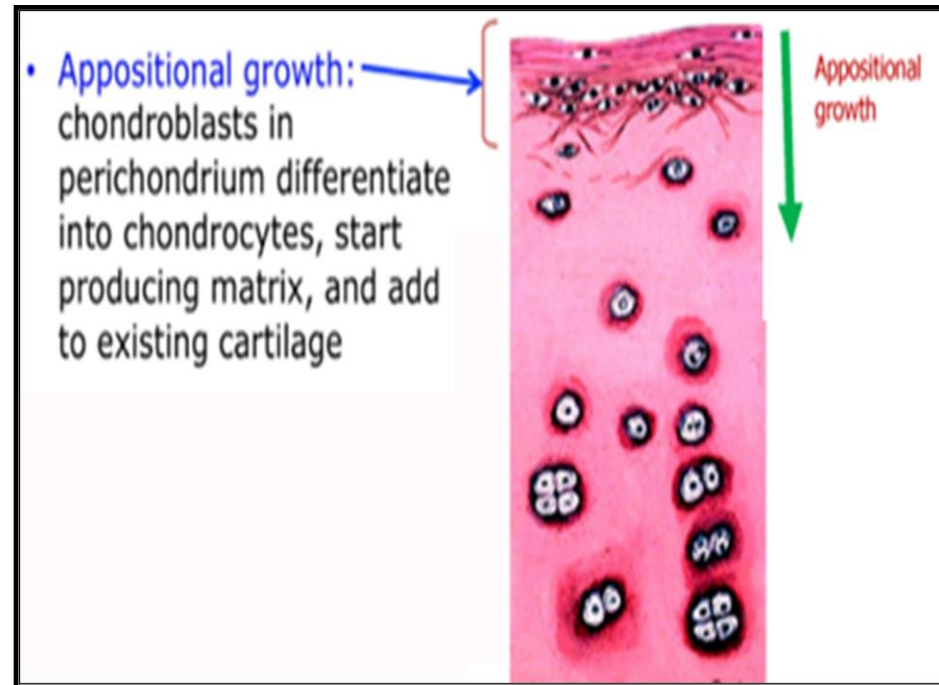
(3) Perichondrium

- Hyaline cartilage is covered by a layer of **dense connective tissue (perichondrium)** which is essential for the growth and maintenance of cartilage.
- Articular cartilages of joints **lack** perichondrium and are nourished by diffusion of oxygen and nutrients from the synovial fluid.

The perichondrium consists of:-

1. The outer layer: Consists of collagen (type I) & fibroblasts.

2. The inner layer: Contain **mesenchymal** stem cells which provide a source of chondroblasts. The chondroblasts are very active; they divide and differentiate into **chondrocytes** to form newly formed cartilage by appositional growth.

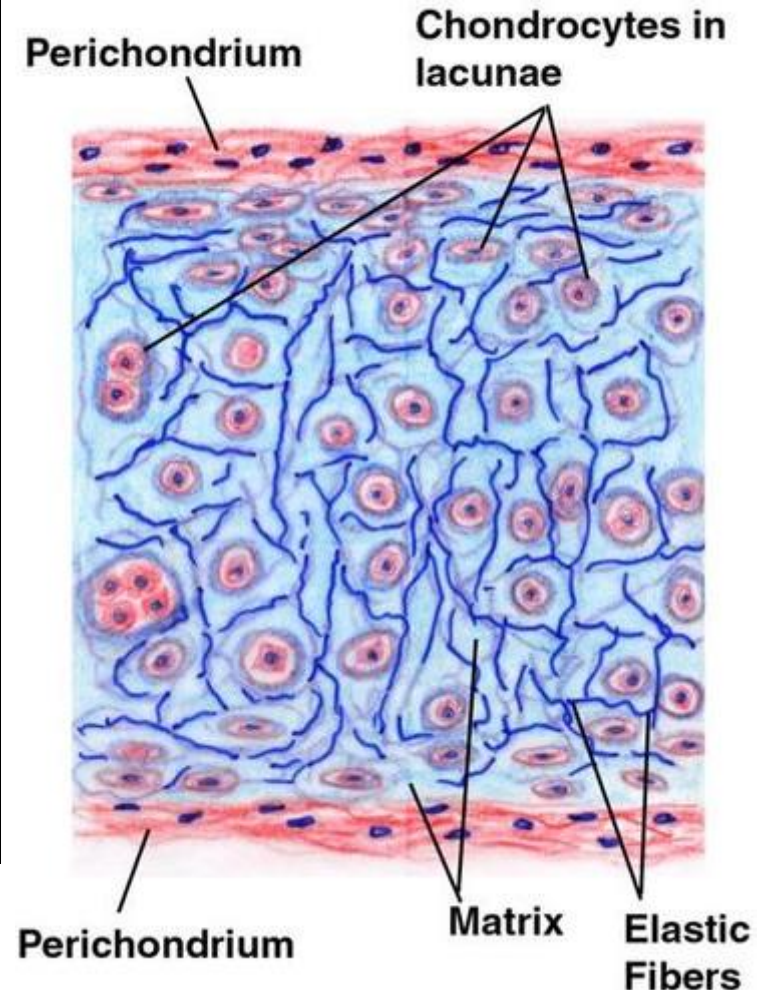




Microscopic structure of elastic cartilage



- It contains **type II collagen fibrils** as well as abundant network of **elastic fibers**, so it is more flexible than hyaline cartilage.
- Elastic fibers are demonstrated by “**orcein stain**”.

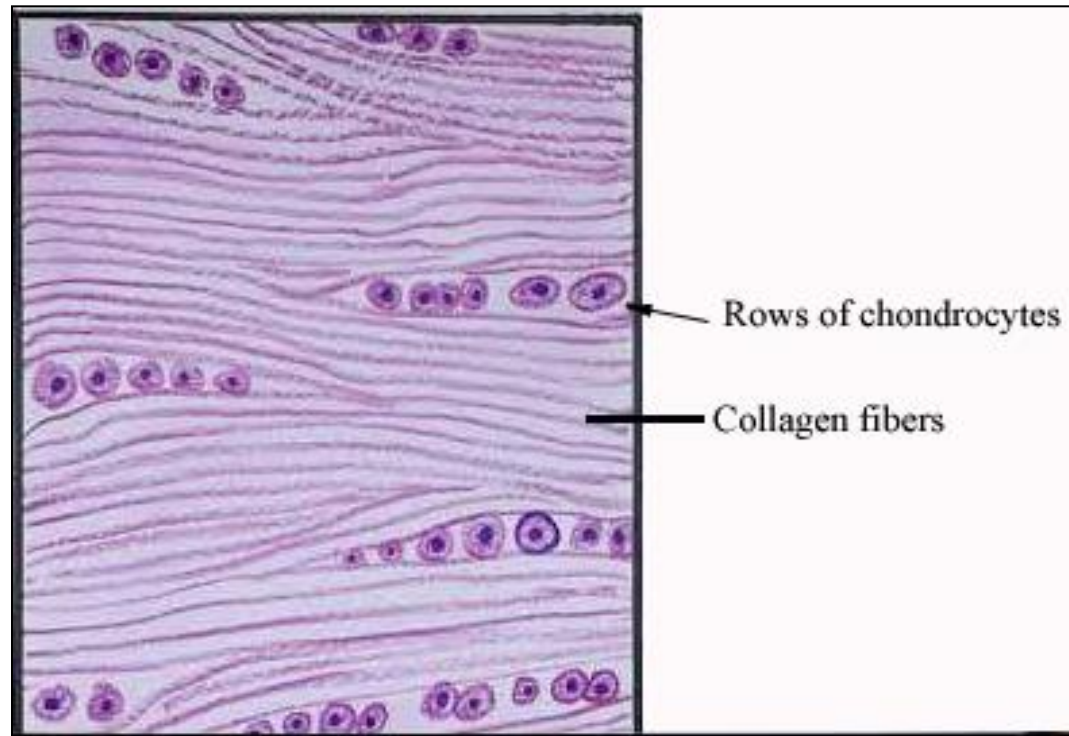




Microscopic structure of fibro cartilage



- Rows of chondrocytes are separated by **bundles of type I collagen** and scattered fibroblasts, adding **extra strength** to this tissue.
- **No perichondrium in fibrocartilage.**



Cartilage growth

1- Interstitial growth:

Occurs within the substance of the cartilage by **mitotic division of pre-existing chondrocytes** and lay down matrix around them.

By this method cartilage **increases in size**. This occurs in moderately **young cartilage** in which the intercellular substance is not too stiff.

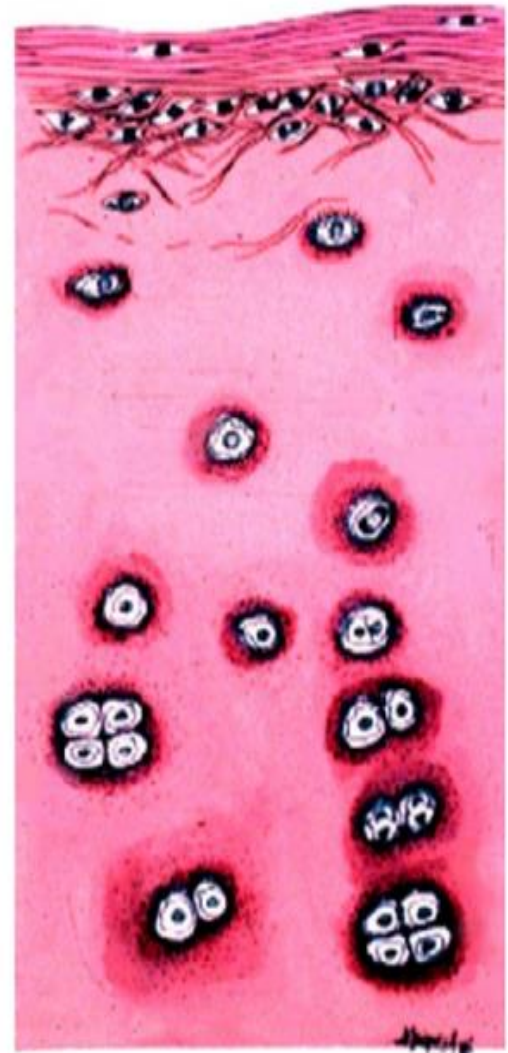
Cartilage growth

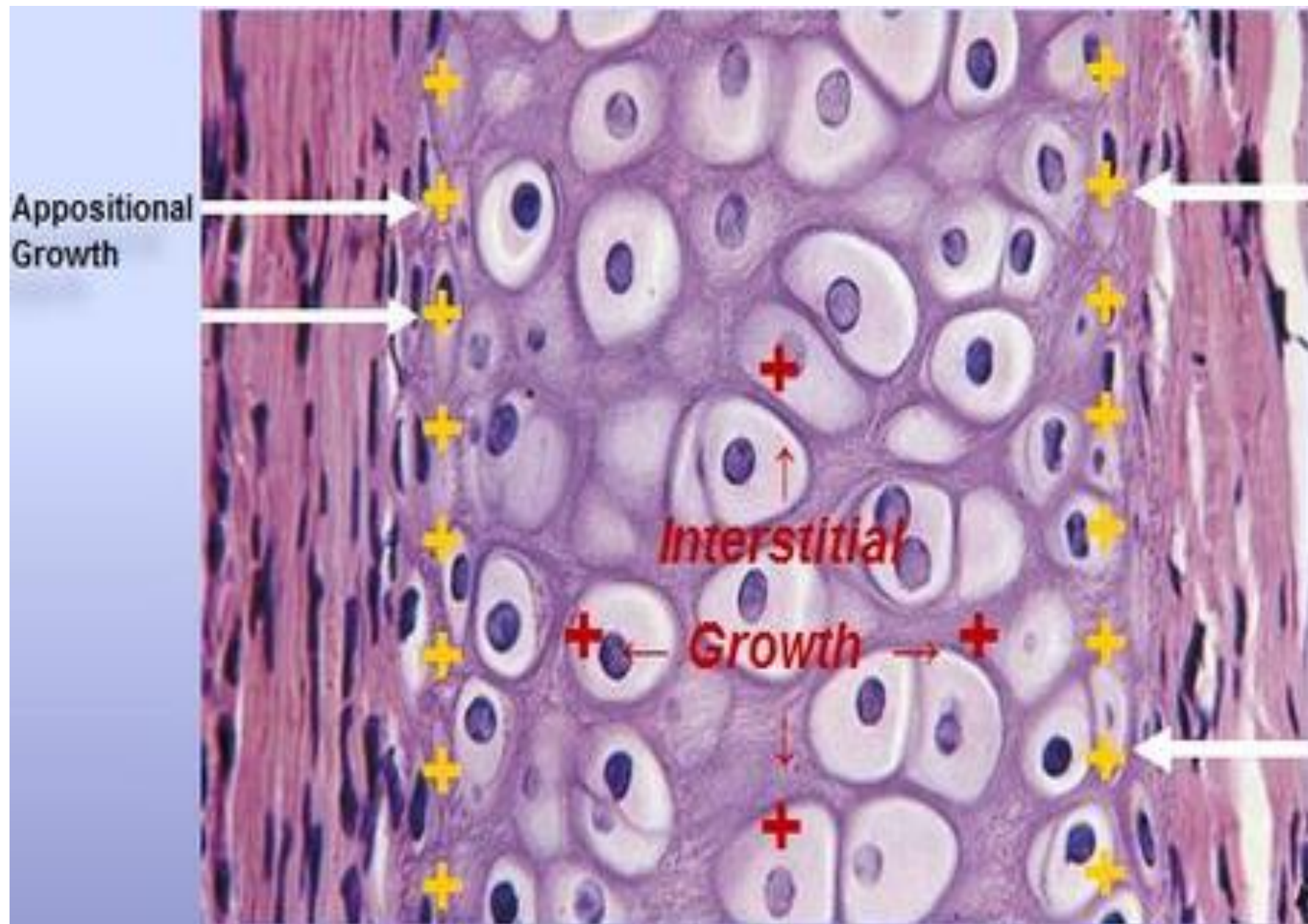
2- Appositional growth:

A new cartilage is laid down at one of its surfaces by differentiation of **mesenchymal stem cells** in the perichondrium into **chondroblasts/chondrocytes** which form ECM.

Cartilage can grow by two mechanisms

- **Appositional growth:** chondroblasts in perichondrium differentiate into chondrocytes, start producing matrix, and add to existing cartilage
- **Interstitial growth:** proliferation and hypertrophy of existing chondrocytes





Cartilage repair

- Regeneration of cartilage occurs in young cartilage only.
- In adults, cartilage damage results in connective tissue scar.

Bone

Learning objectives:

After the lecture, students should be able to:



- Define bone.
- Mention the composition of bone matrix.
- Describe bone cells.
- List types of bone.
- Know the bone growth.

Bone

❖ Definition :-

Bone is a specialized connective tissue composed of (1) **calcified** intercellular substance (bone matrix), (2) bone cells, (3) Periosteum & (4) Endosteum.

(1) Bone matrix

- *It is composed of inorganic and organic materials.*

A. The inorganic materials:

- Form about 75% of the dry weight of bone
- Consist mainly of **calcium** in the form of hydroxyapatite crystals.
- Other minerals including Mg^{+} , Na^{+} and K^{+} bicarbonate and citrate.
- Decalcification of bone will result in flexible bone like a tendon.

B. The organic materials:

- Form about 25% of the dry weight.
- About 90% of the organic material is **collagen**.
- The remaining are sulphated GAG and glycoprotein together with other materials.
- Removal of the organic bone matrix will result in fragile bone on handling (egg- shell consistency).

(2) Bone cells



Osteogenic cell
(develops into an
osteoblast)



Osteoblast
(forms bone
tissue)



Osteocyte
(maintains
bone tissue)



Ruffled border

Osteoclast
(functions in resorption, the
destruction of bone matrix)

1- Osteogenic cells

Site:

In the inner L. of periosteum and endosteum.

Function:

- During bone growth & repair → Proliferate & differentiate → osteoblasts.



2- Osteoblasts

Function:

“Bone forming cells”

- Synthesis and secretion of constituents of organic bone matrix.



Structure:

EM: “Secretory cell”

- Well developed **RER** and **Golgi**.
- **Secretory vesicles** contain **type I collagen** and other organic components of bone matrix.
- **Matrix vesicles** contain “**alkaline phosphatase enzyme**”
 - liberate phosphate ions → precipitation of calcium & and formation of the hydroxyapatite crystals of the bone matrix.

3- Osteocytes

- Once Osteoblast surrounded with intercellular substance → “osteocyte” (lacunae) .

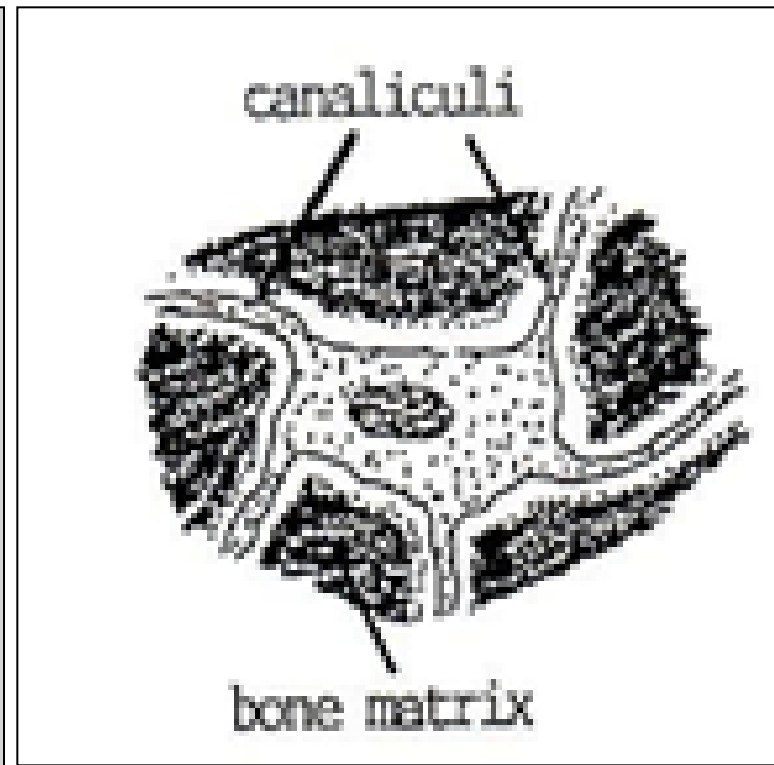
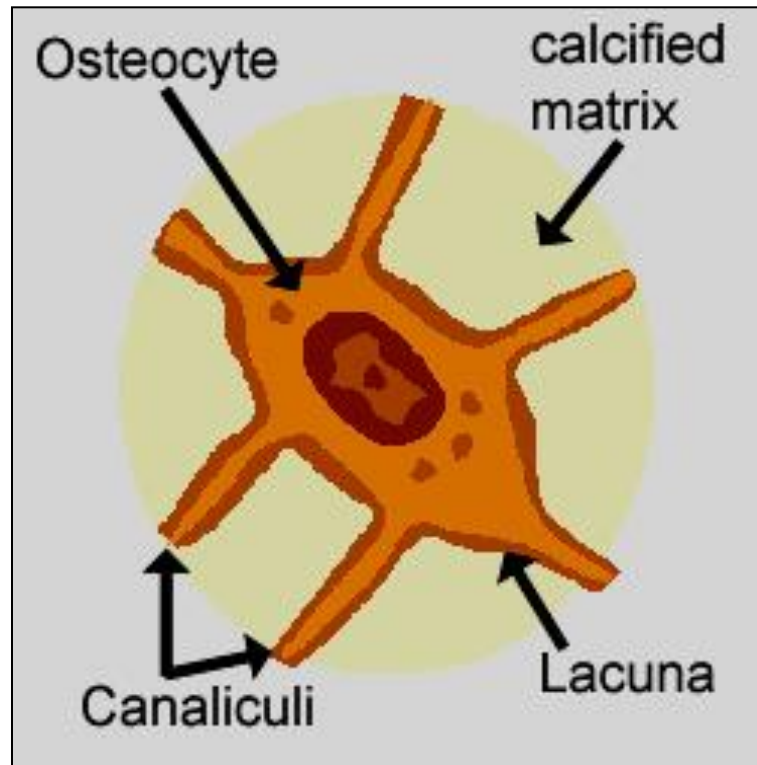
- Function:

Osteocytes are involved in “maintenance of the bony matrix”.

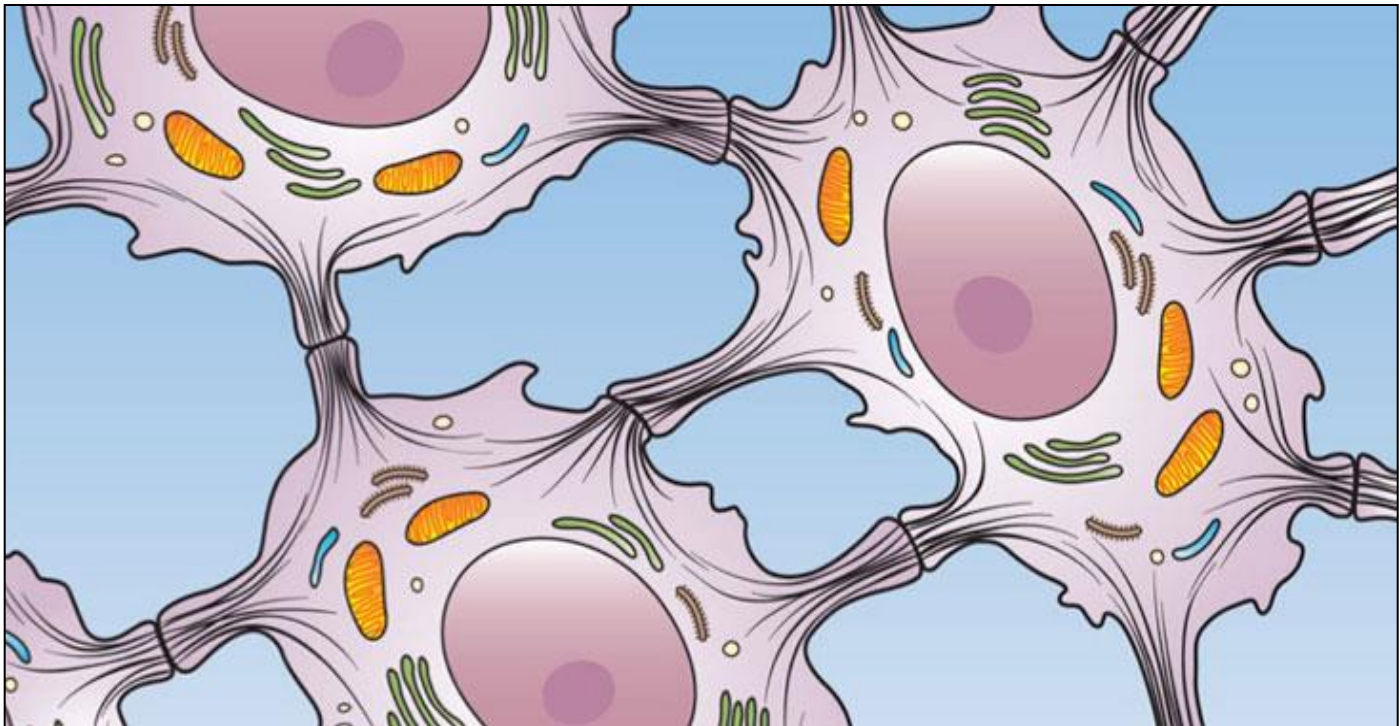
Death of the osteocytes → resorption of matrix.

Structure:

- Osteocytes extend **cytoplasmic processes** that traverse the matrix through **canaliculi**.



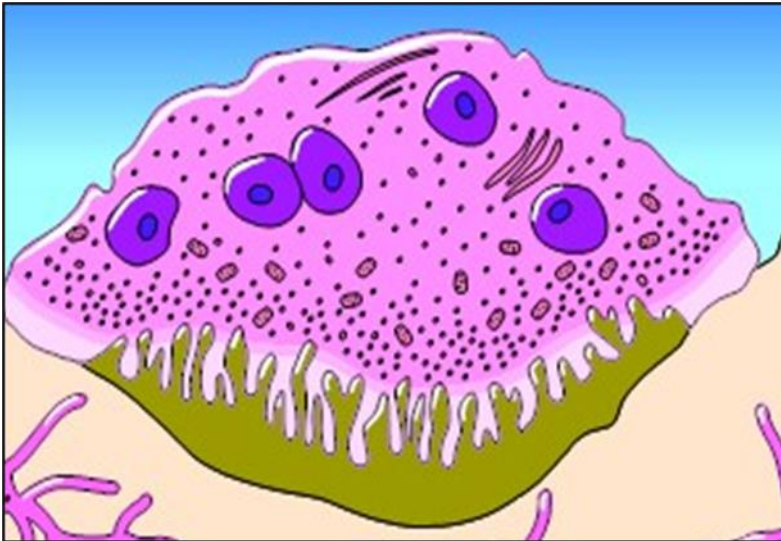
- Processes of adjacent cells make contact through **gap junctions** → flow of ions and small molecules (e.g. hormones controlling bone growth and development).



4- Osteoclasts

Structure:

Large **multinucleated** cells (6-12 nuclei) (up to 50 nuclei). Osteoclasts occupies pits in the surface of the bone called **“Howship's lacunae”**.



Function of osteoclasts:

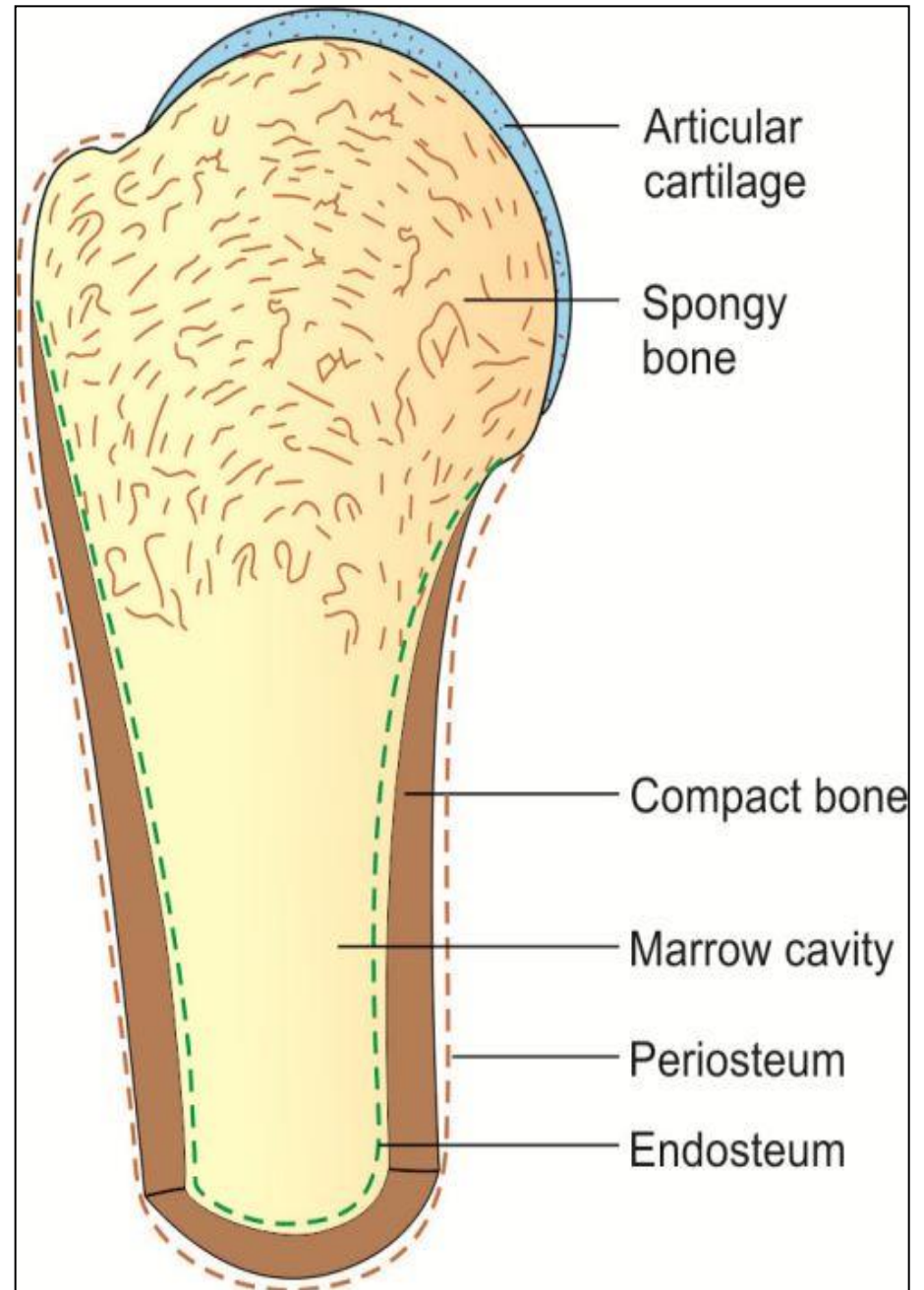
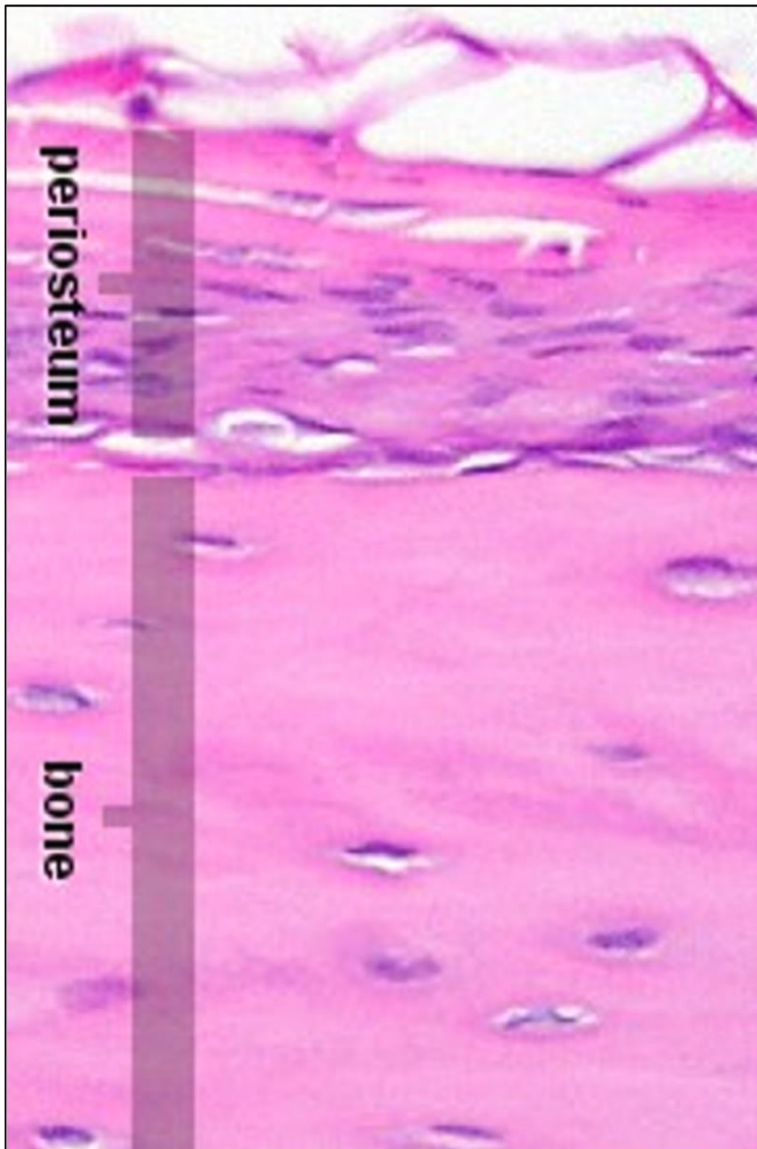
“Bone resorption and remodeling”.

❖ Resorption = break down of bone matrix.

❖ Remodeling = maintenance of bone shape.

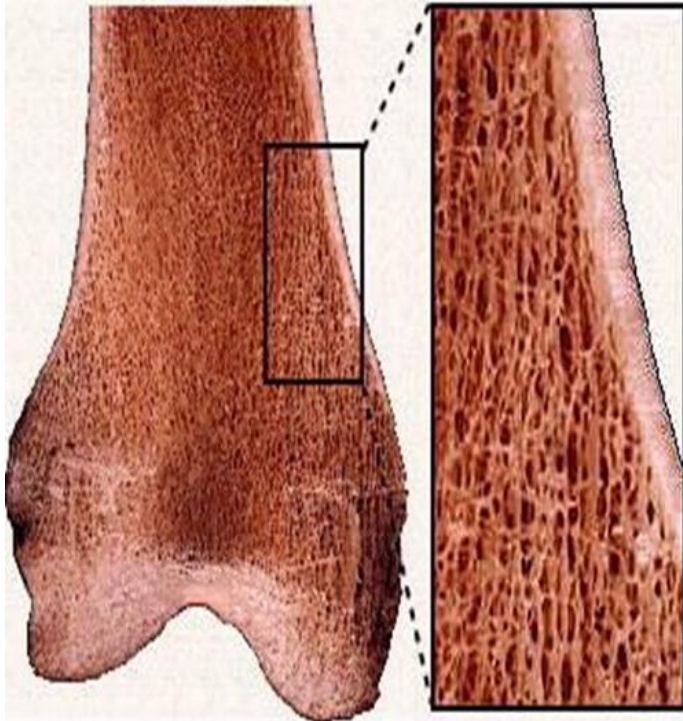
(by adding bone at new surface and removing or resorbing it at the other surface during bone growth).

- (3) **Periosteum**: It is the C.T that covers the bone. It consists of an **outer** vascularized dense fibrous layer and an **inner** osteogenic layer. Bundles of collagen fibers (**Sharpey's fibers**) penetrate the bone matrix, binding the periosteum to bone.
- (4) **Endosteum**: It is a very thin C.T. layer containing flattened osteogenic cells and osteoblasts and lines the bone marrow cavity.

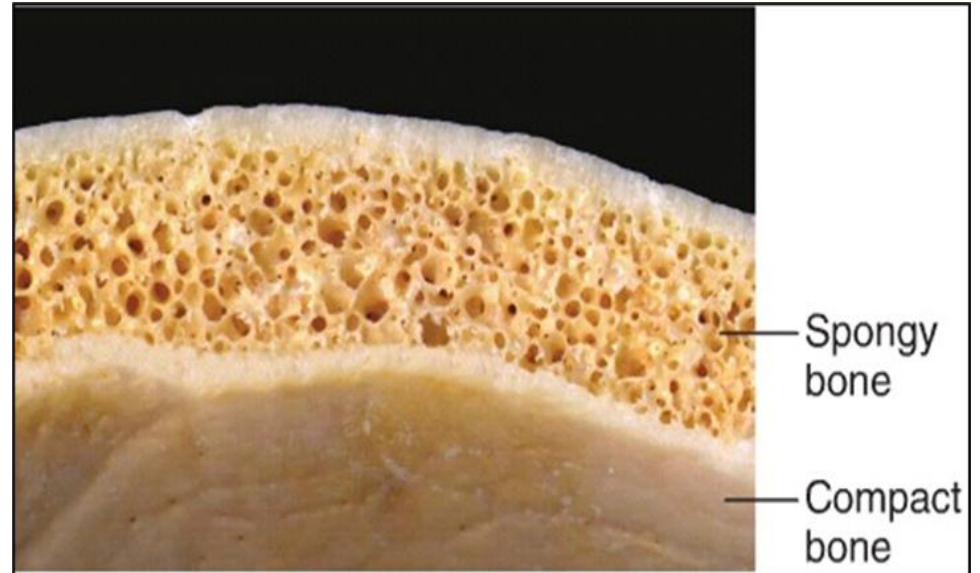


Types of bone

Compact



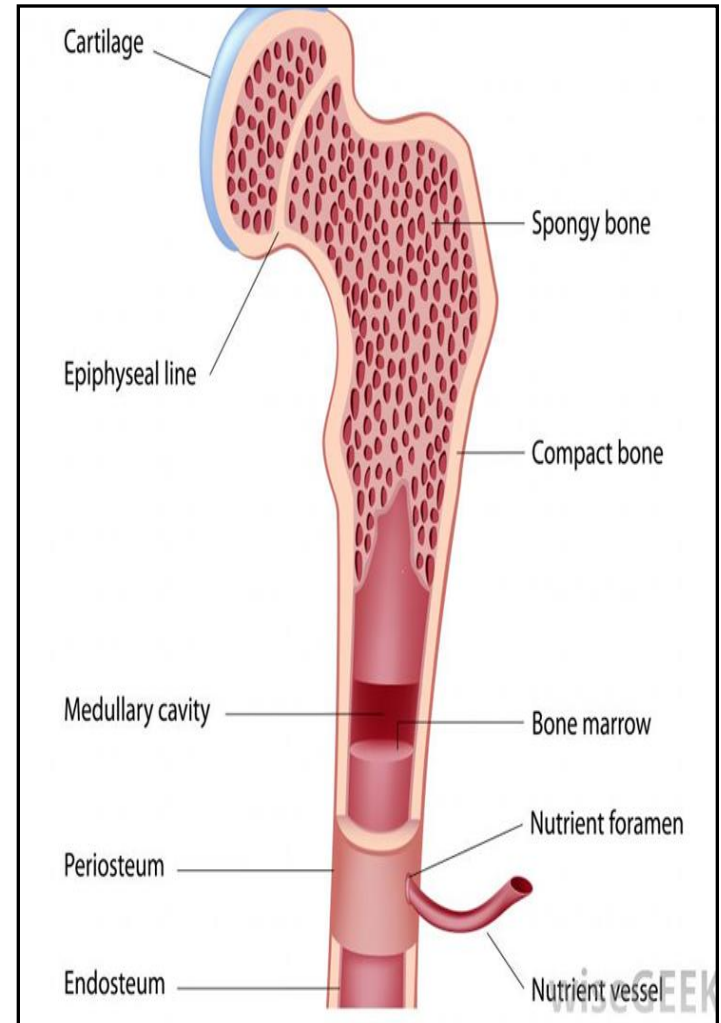
Cancellous



1. Compact bone

Sites:

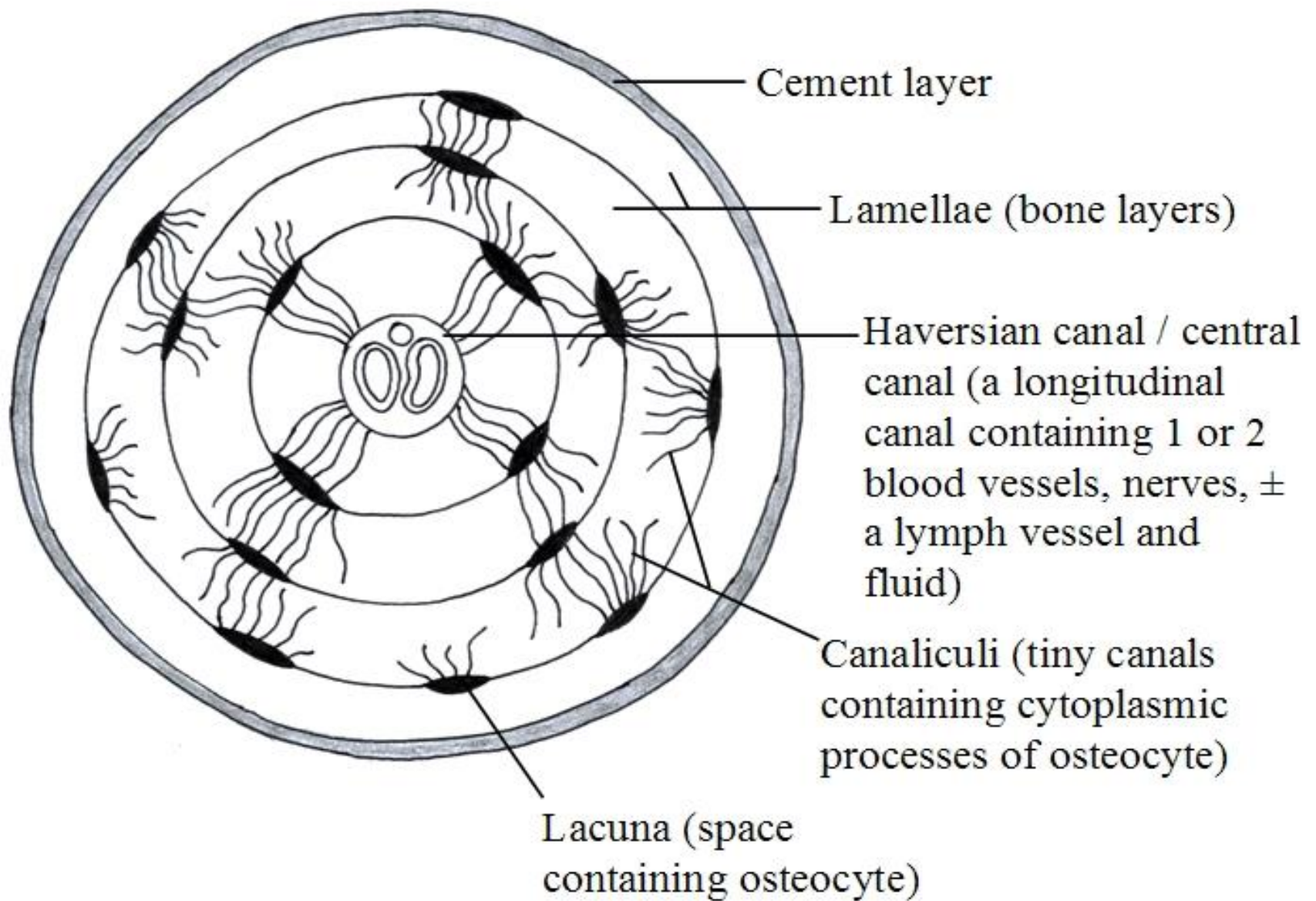
Shaft of long bones, the outer part of the epiphysis & the outer part of the short bones.



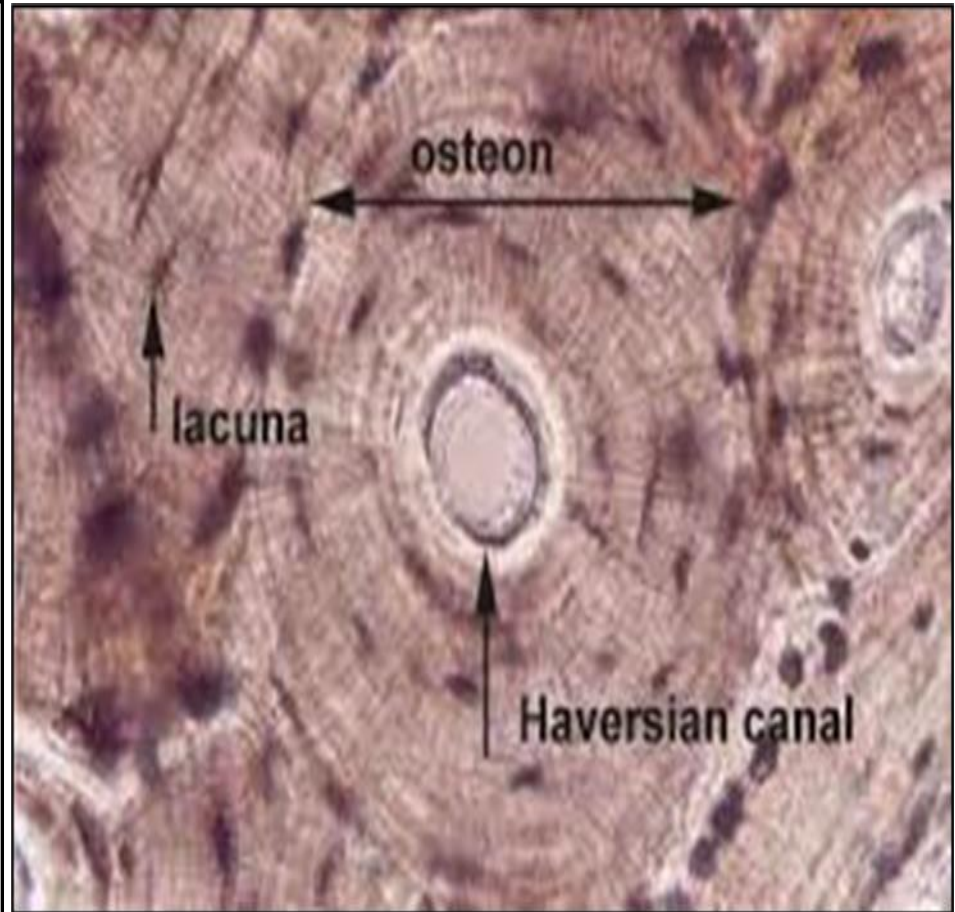
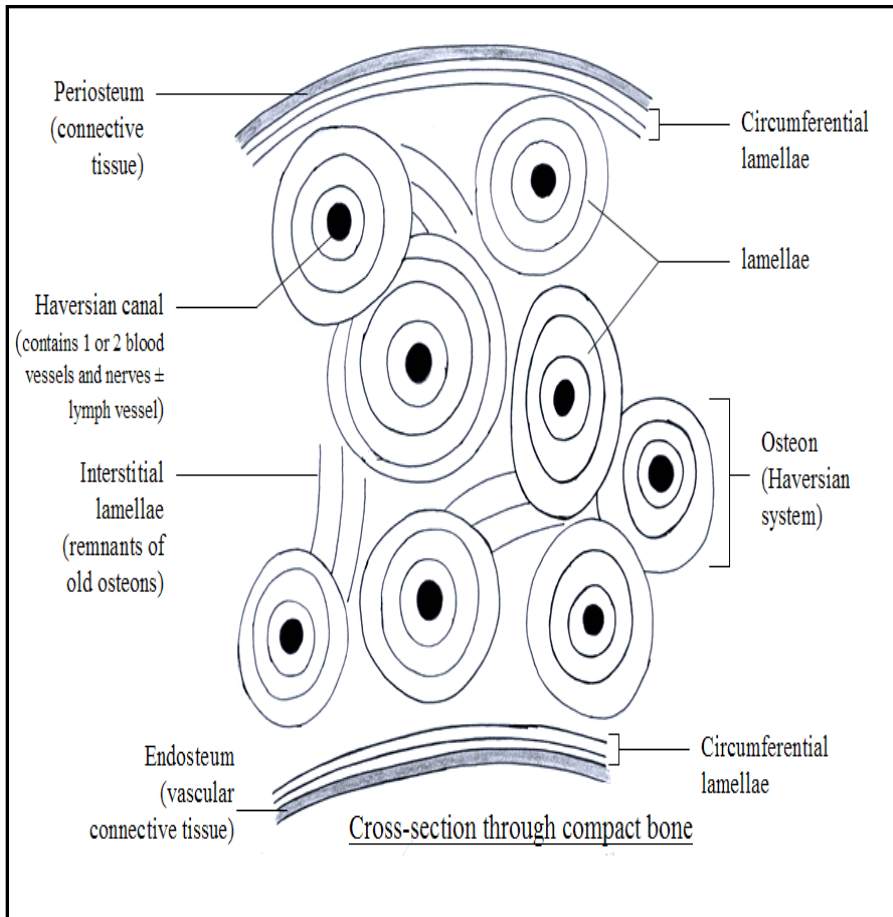
Structure:

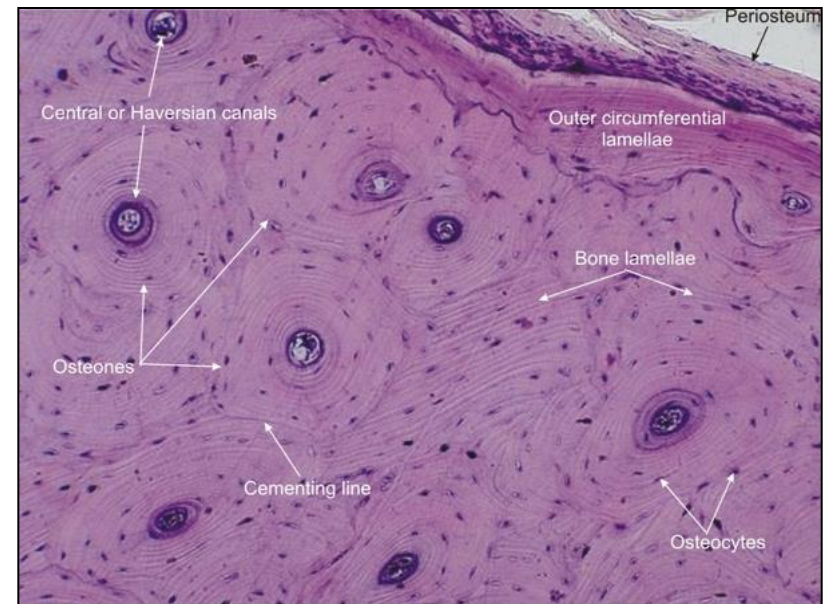
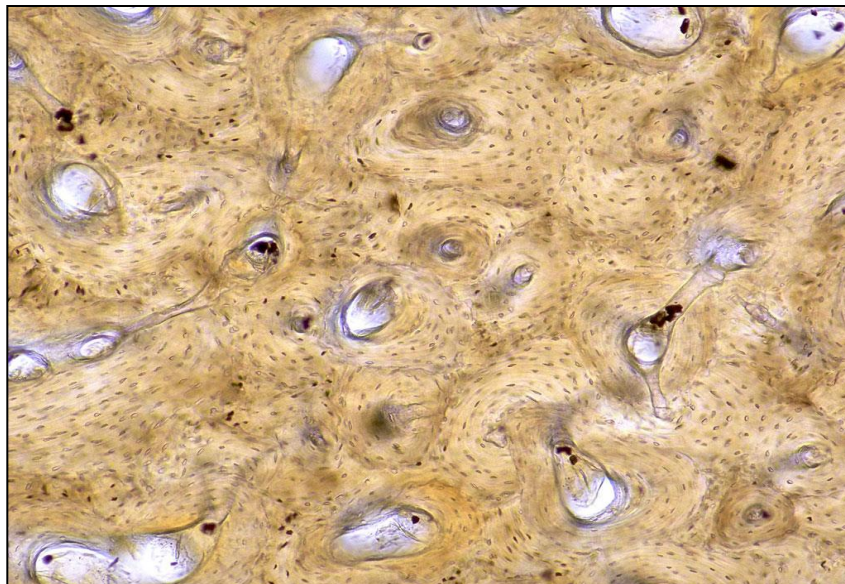
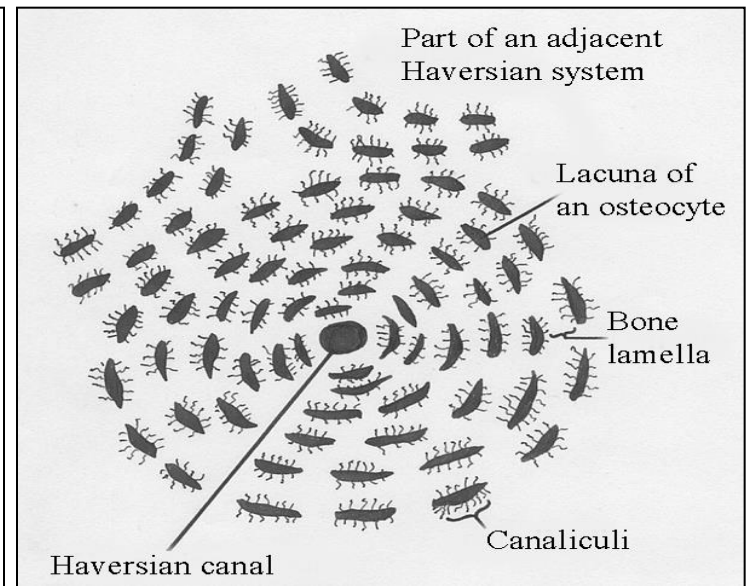
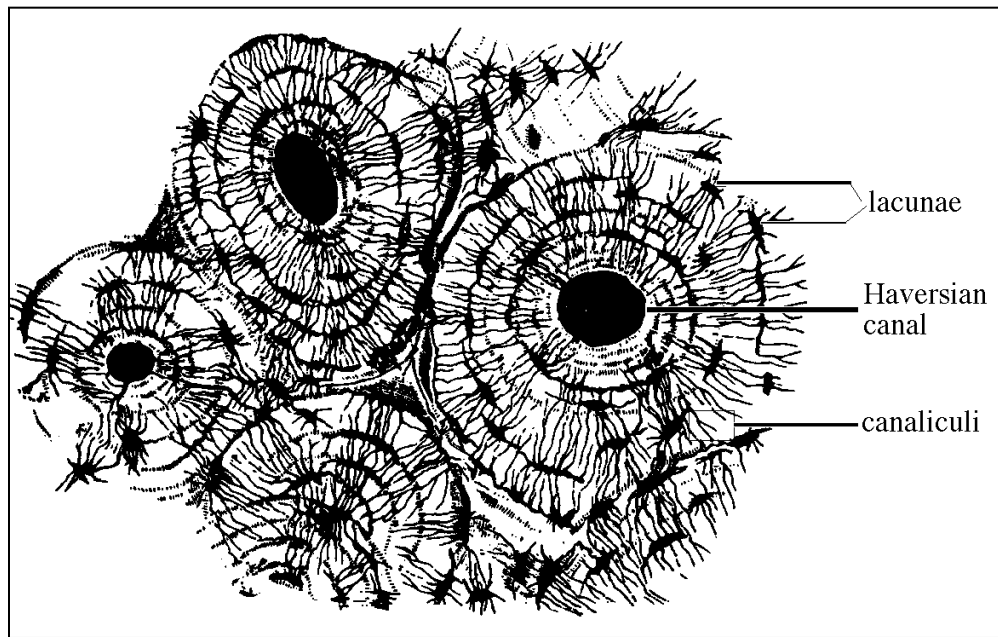
➤ **Compact bone is characterized by the presence of “Haversian systems” or “osteons”**

= (Haversian canal surrounded by concentric lamellae of bone).



A single osteon in cross-section

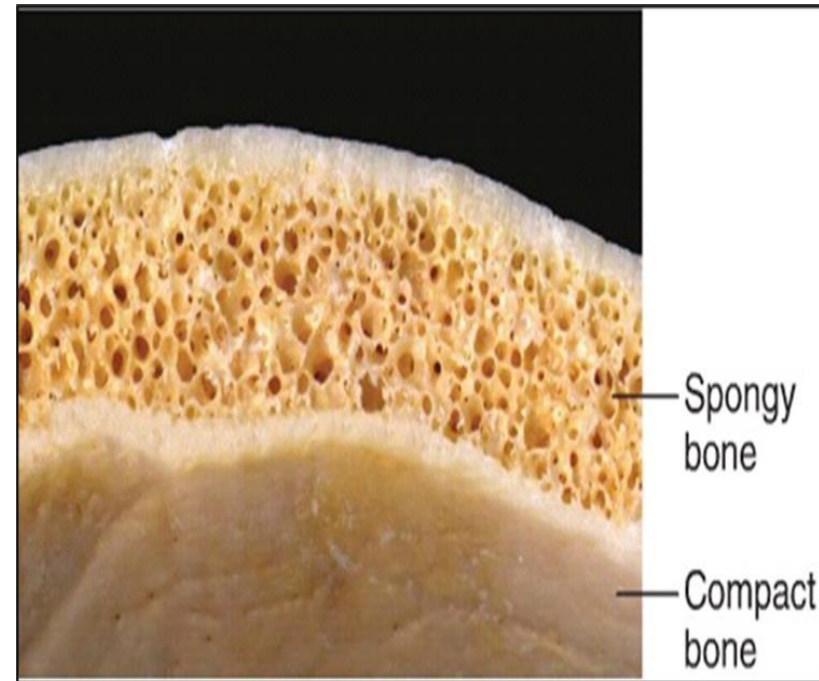




2- Cancellous (spongy) bone

Sites:

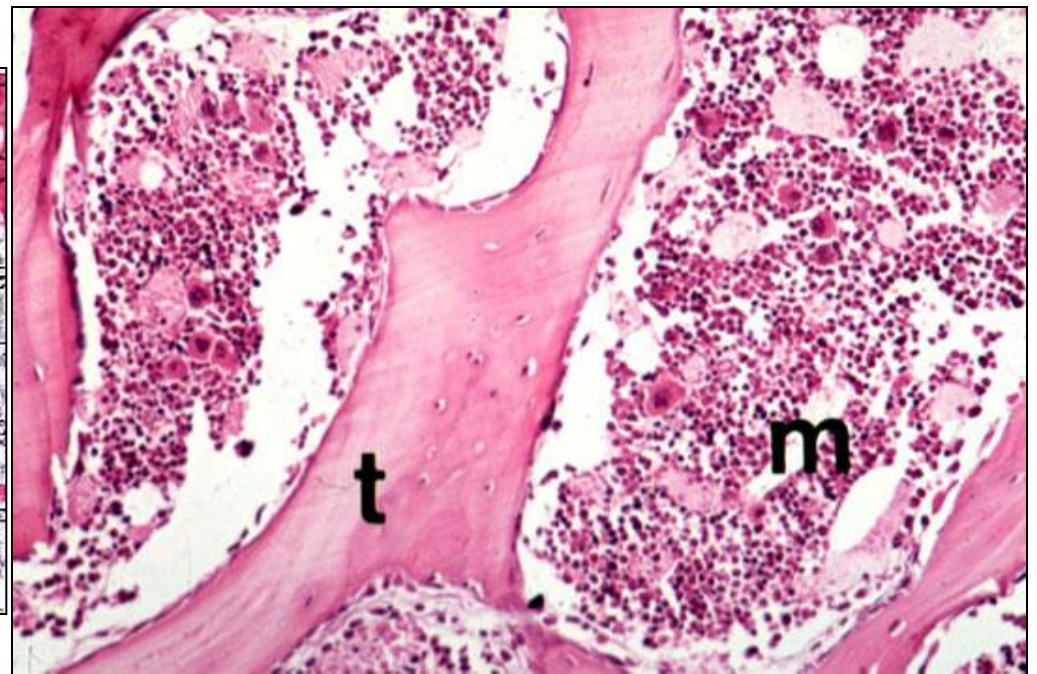
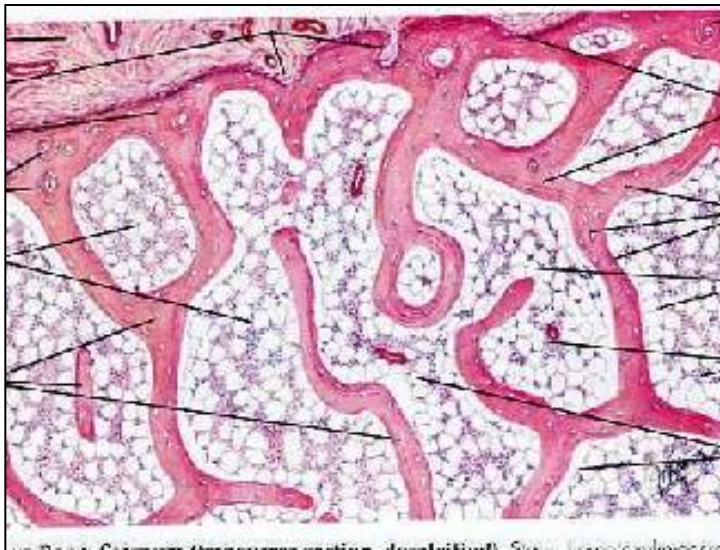
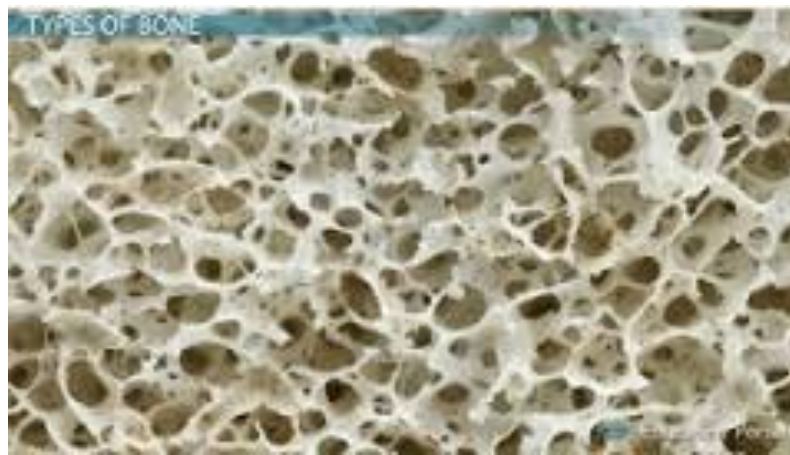
Found in (ends of long bones and inside flat bones such as: the hip bones, sternum, sides of skull, and ribs).



2- Cancellous (spongy) bone

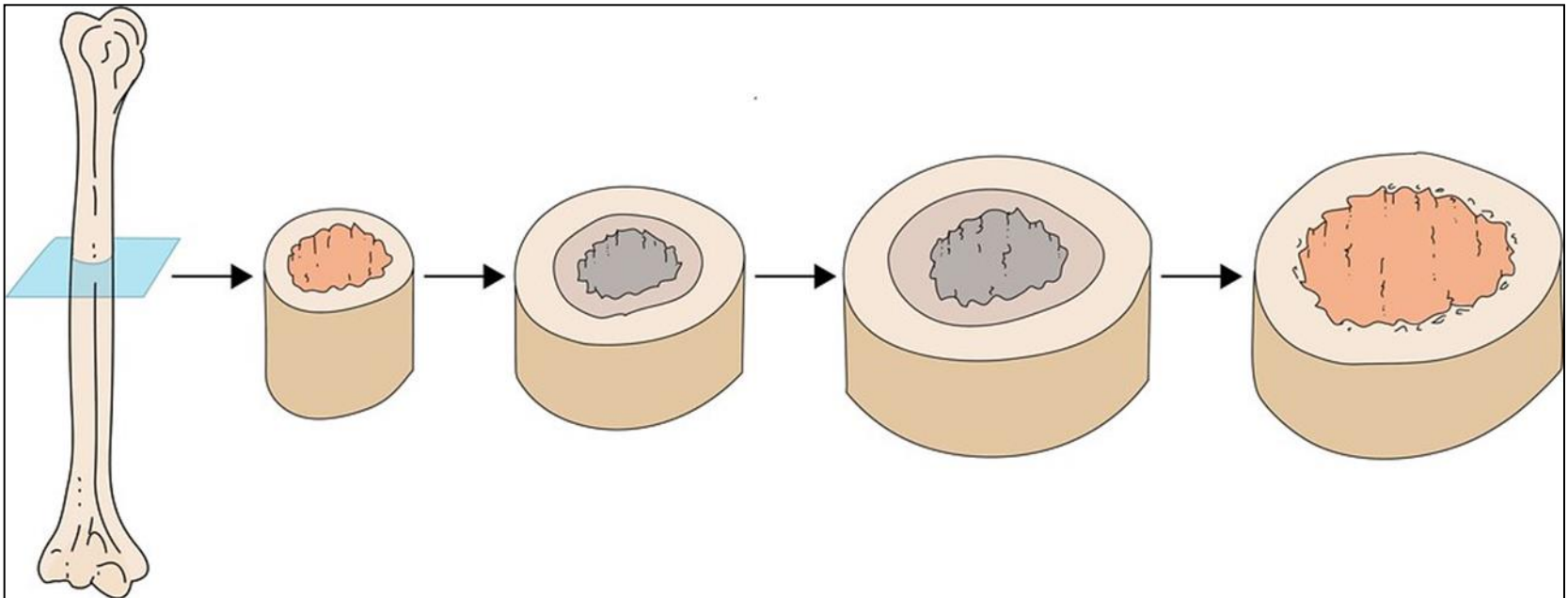
Structure:

- **No Haversian systems.**
- Cancellous bone is composed of **Irregular bone trabeculae separated by bone marrow spaces** which are lined with osteogenic cells.
- The bone trabeculae are composed of osteocytes and intercellular substance and covered with periosteum.



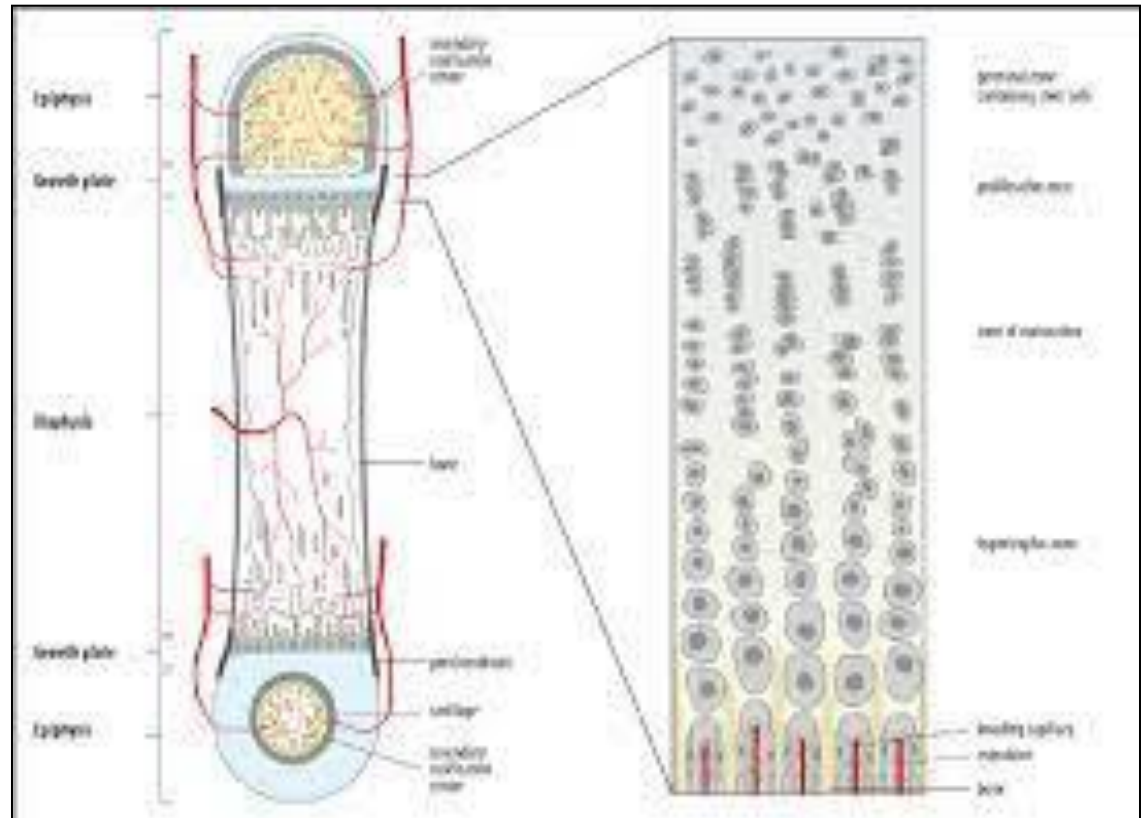
Bone growth

- Bone Growth in width occurs **only by appositional growth** at the bone's surface {Periosteal cells differentiate into osteoblasts which lay down new bone matrix components}.



Bone growth

- Bone growth in length occurs **at the epiphyseal plate** (hyaline cartilage) which is continuously replaced by bone (till the age of 20 years in males & 17 years in females).



A close-up photograph of a hand holding a yellow daffodil flower. The hand is positioned in the lower right, with fingers gently gripping the green stem. The flower is in full bloom, showing its characteristic six petals and a central corona. The background is a soft, out-of-focus light blue and white, suggesting an outdoor setting. The overall mood is warm and appreciative.

Thank You

Dr. Sohair Eltony