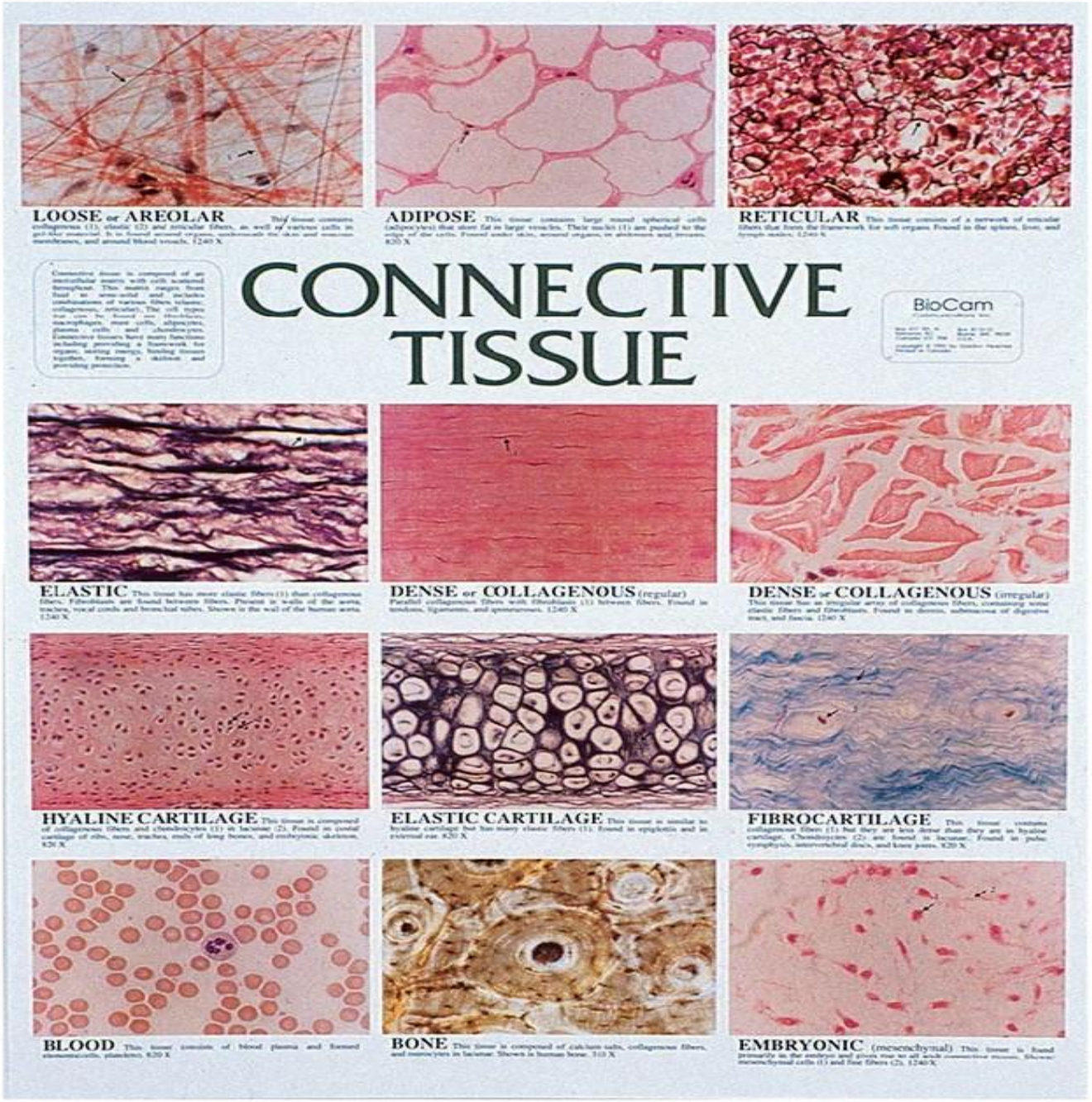



# Lab .10

BY
DR. MARYAM M. HUSSAIN

# 2-Special connective tissue:

**A-Skeletal special connective tissue:**

**1- Cartilage:** Is a connective tissue with a strong flexible matrix rich in collagen, chondronectin, chondroitin sulfate and hyaluronic acid.

- Cells of cartilage:

1- Chondroblast or perichondrial cells : They are located in the perichondrium, produce the matrix and resemble mesenchymal cell.

2- Chondrocyte: Located in lacunae and it is the mature cartilage cell .

- Cartilage is covered with special type of connective tissue called perichondrium which is composed of 2 layers:

1- Outer layer composed of fibers (fibrous layer).

2- Inner layer contains chondroblasts (cellular layer).

- Types of cartilages:-

A- Hyaline cartilage.

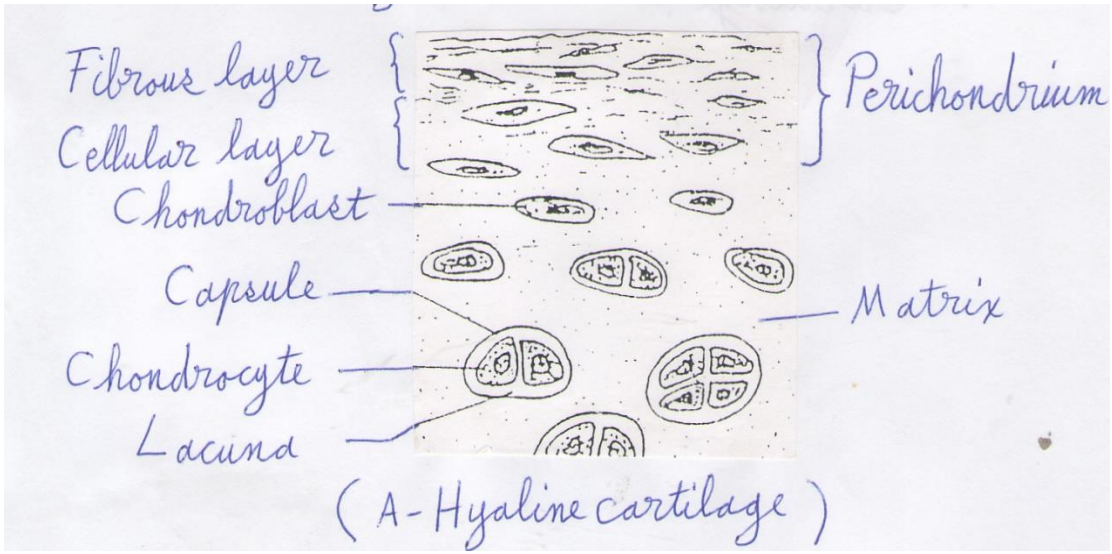
B- Elastic cartilage.

C- White fibrous cartilage.

# A- Hyaline cartilage:

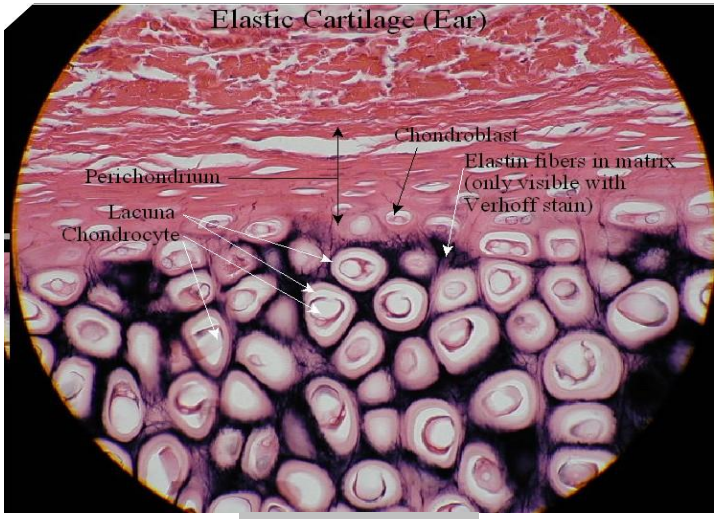
- It's clear with glassy appearance. Ground substance contains collagen fibers. The chondrocytes are often found in little cluster called (cell nest) consisting of 2 or more cells, and the cartilage covered with perichonderium, and it is the weakest of types of cartilage. Function: It forms cushion or epiphyseal plates at the extremities of long bones. This type is found in nose, larynx, ventral ends of the ribs, tracheal rings and bronchi.

Hyaline cartilage

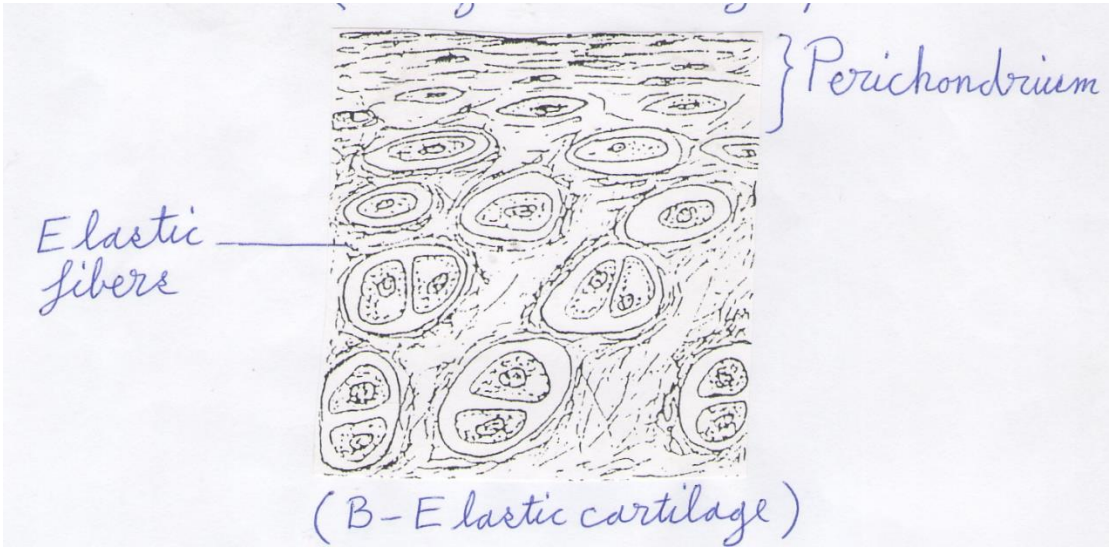


# B- Elastic cartilage:

- It's yellowish in life. Ground substance, rich in elastic fibers which interposed with the bundles of collagen fibers that give this type of cartilage more resiliency than the hyaline type and this type is covered with perichonderium. The function of elastic cartilage is to give the shape and to support the organ like pinna of the ear, epiglottis and Eustachian canal.

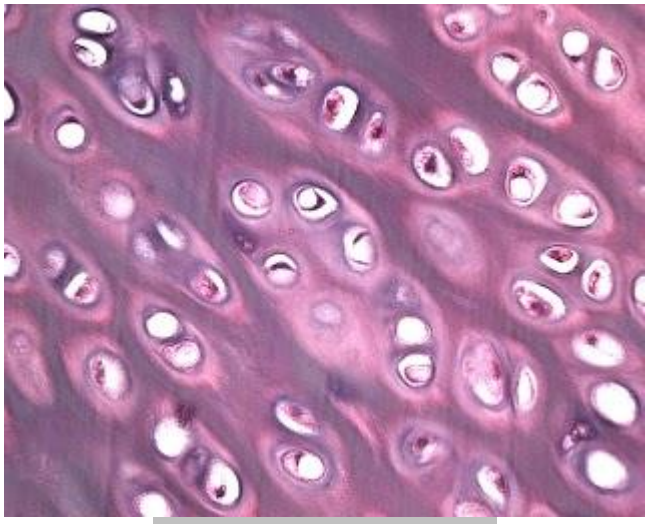



Elastic cartilage

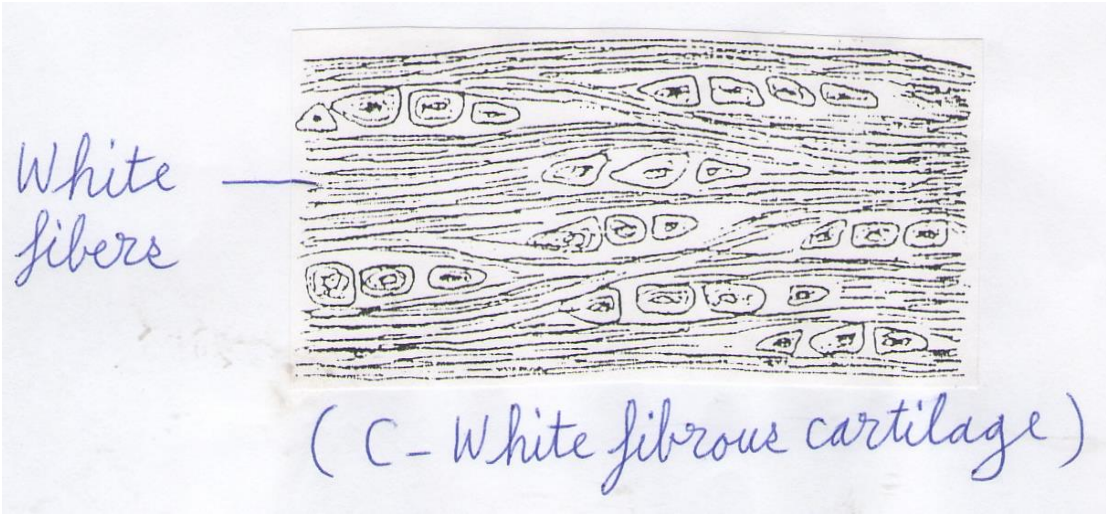


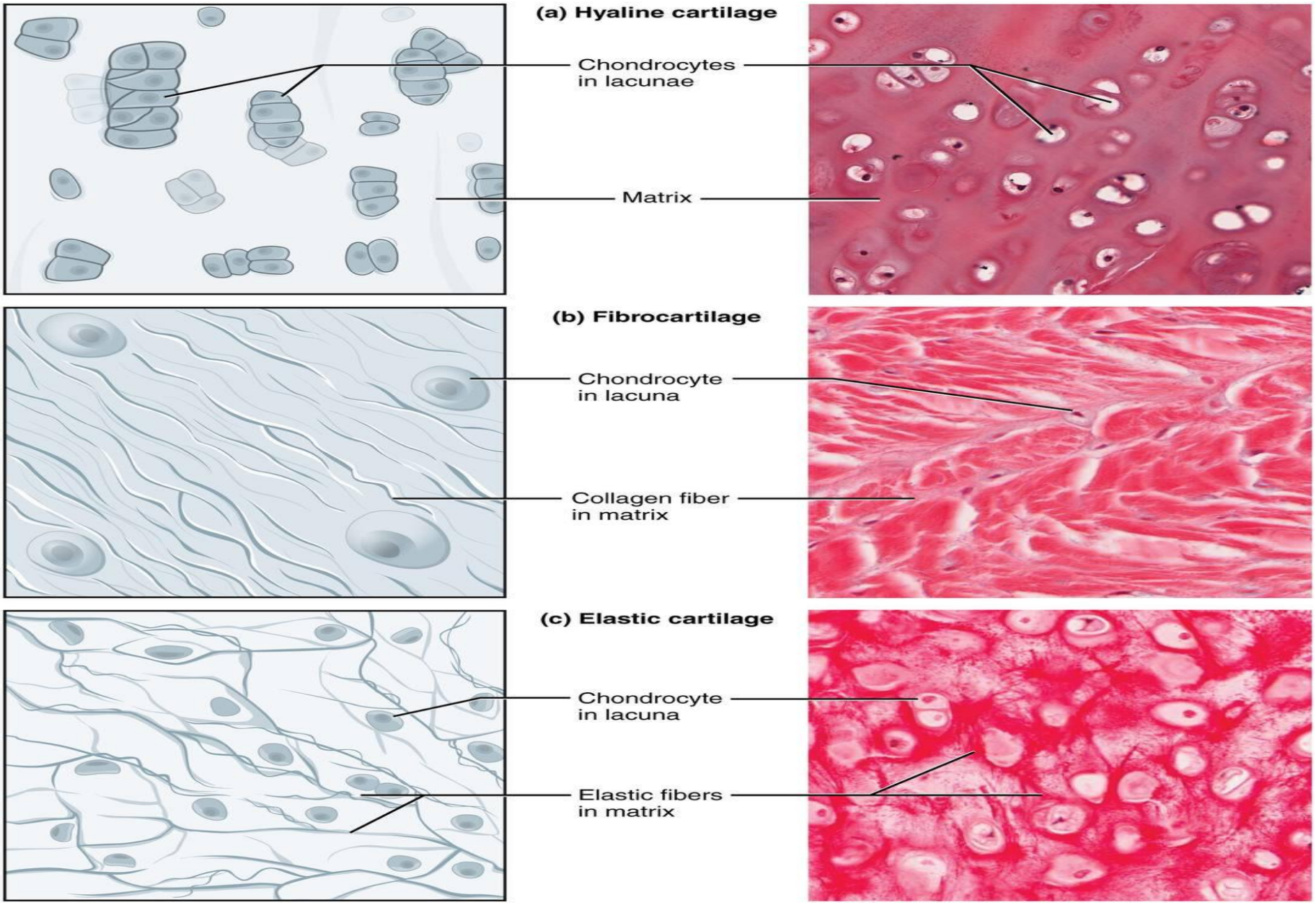
# C- White fibrous cartilage:

- This is the strongest kind of cartilage, because the lacunae are arranged in columns and dence collagen fibers arrange parallel to the lacunae, This type of cartilage does not have a perichondrium as it is usually a transitional layer between hyaline cartilage and tendon or ligament. This cartilage found in intervertebral disks, pubic symphysis and articular disks.



White fibrous cartilage




(a) Hyaline cartilage
Chondrocytes in lacunae
Matrix
(b) Fibrocartilage
Chondrocyte in lacuna
Collagen fiber in matrix
(c) Elastic cartilage
Chondrocyte in lacuna
Elastic fibers in matrix

# 2- Bones:

- It is the hardest tissue in the body (osseous tissue) that consists of **cells**, **matrix** and **fibers**.
- Matrix It consists of two types of material: **organic** and **inorganic**.
- The inorganic portion makes about half of the weight of the bone. It mostly consists of calcium hydroxyapatite, but there are also significant amounts of bicarbonate, citrate, magnesium, potassium, and sodium ions.
- The organic portion of the bone matrix consists of collagen fibers (type I), proteoglycans, and glycoproteins (e.g. osteonectin and osteocalcin).

**Periosteum which is consists of 2 layers:**

a) Outer layer consists of fibrous dense connective tissue (fibrous layer)..
b) Inner layer contains osteogenic cells (cellular layer).

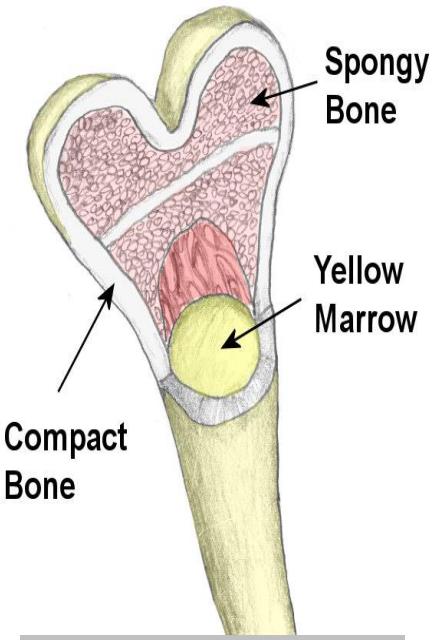
- And the central cavity of the bone is lined with **endosteum**.

- **Bones are classified into :**

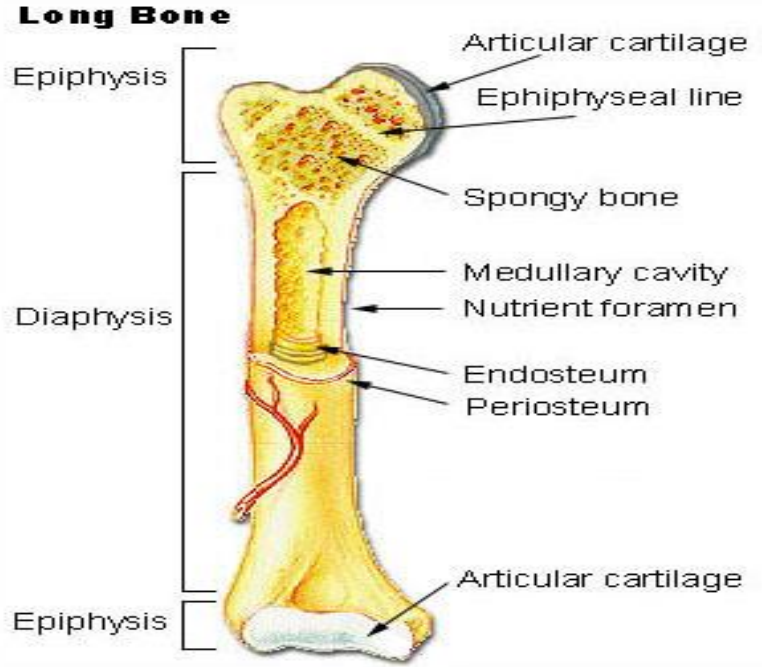
1- Compact bone.

2- Spongy bone.

- Longitudinal cut in a long bone we can see the 2 types of bones :
- Very dense bone in outer surface of the bone (compact bone), and porous portion lines marrow cavity (spongy bone).
- The shaft of the bone is called diaphysis which is compact bone, and the articulating end called epiphysis which is covered with a thin layer of compact bone that covers spongy bone .




Longitudinal section in a long bone




Longitudinal section in a long bone L.S.

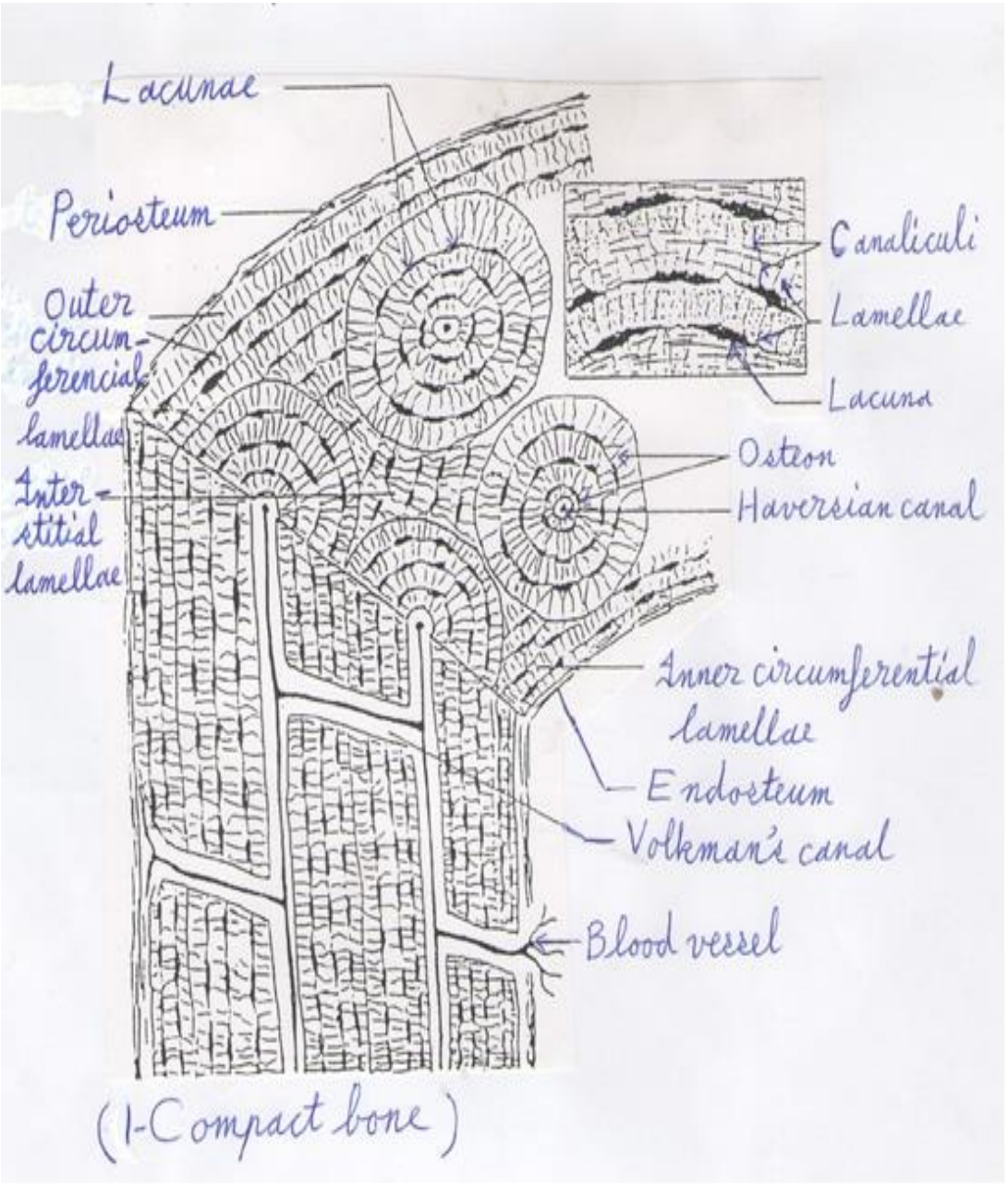
- The compact bone consists of lamellae arranged in 4 lamellar systems can be seen in the diaphysis :

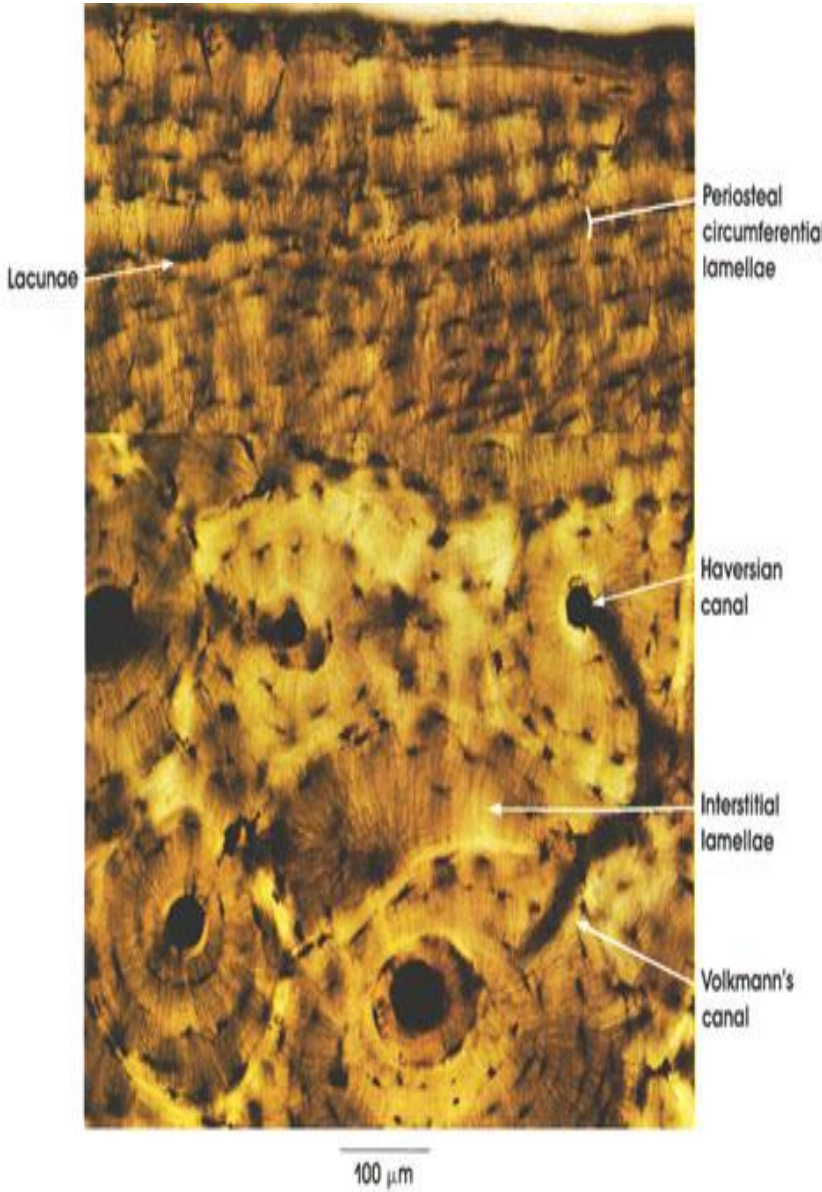
1-Outer circumferential lamellae:Just deep to the periosteum.

2-Inner circumferential lamellae: Encircle the marrow.

3- Haversian canal system (osteons).

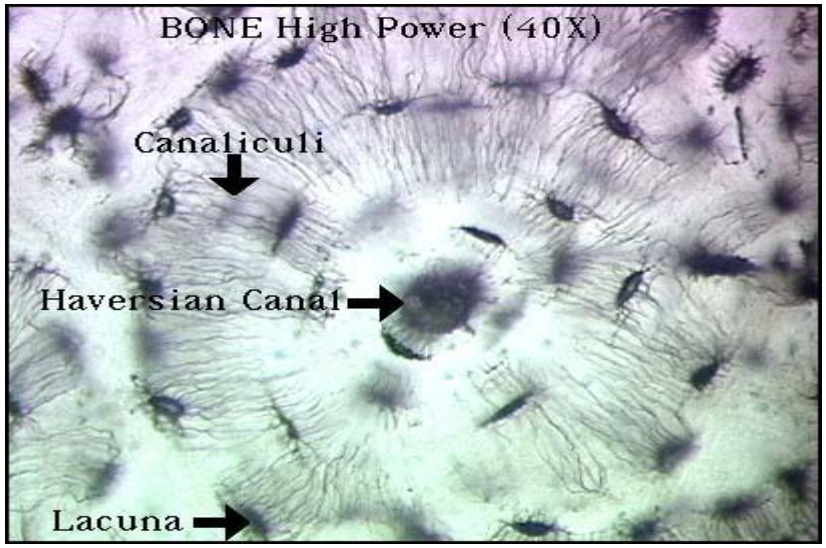
4-Interstitial lamellae.

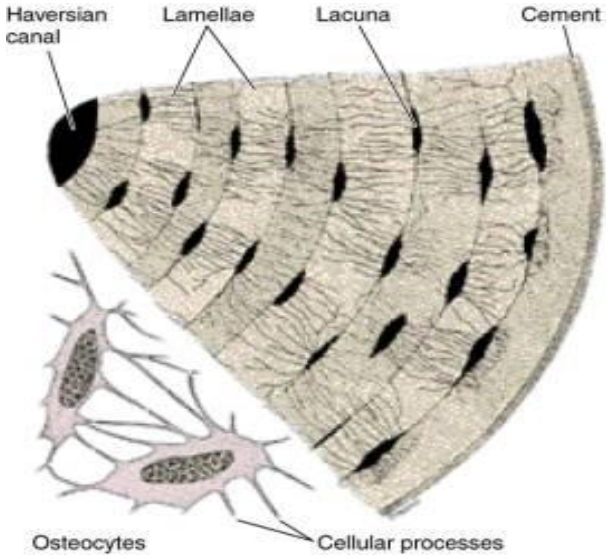



C.S. in the compact bone

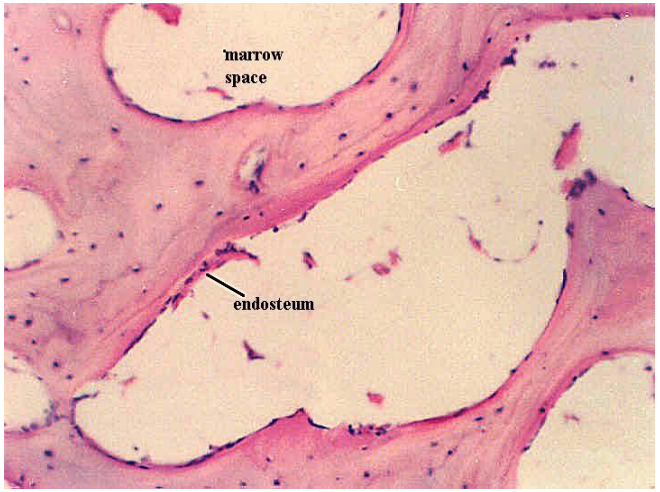
- Each osteon consists of cylinders of lamellae arranged centrically around vascular pore called Haversian canal, each canal of them lines with layer of neurovascular bundles, and the adjacent canals connect with each other by transverse canal called Volkmann's canal.



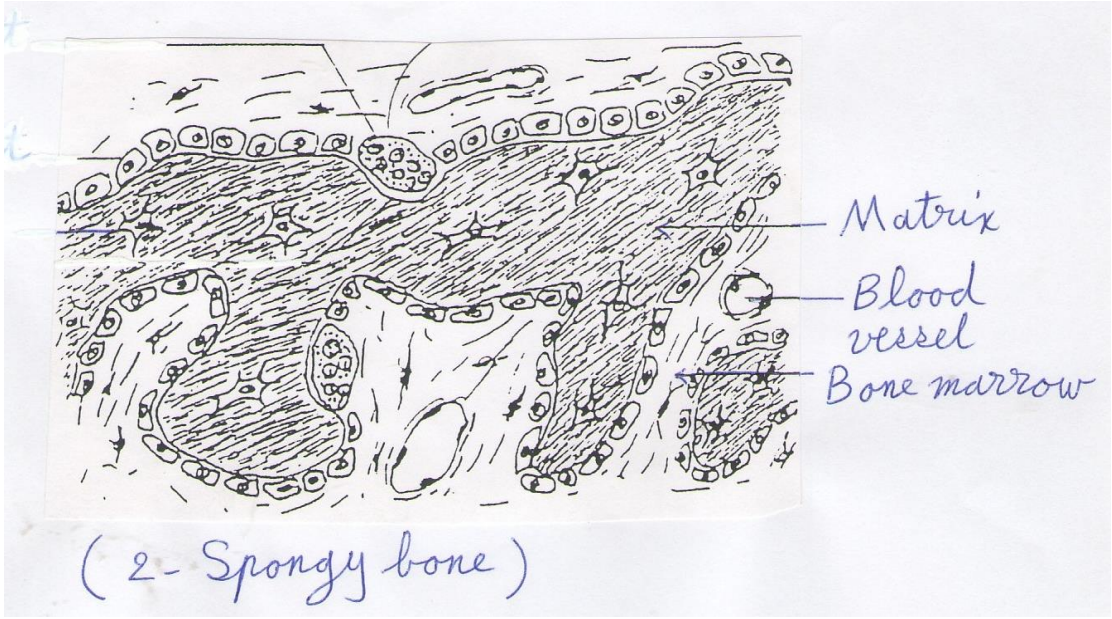



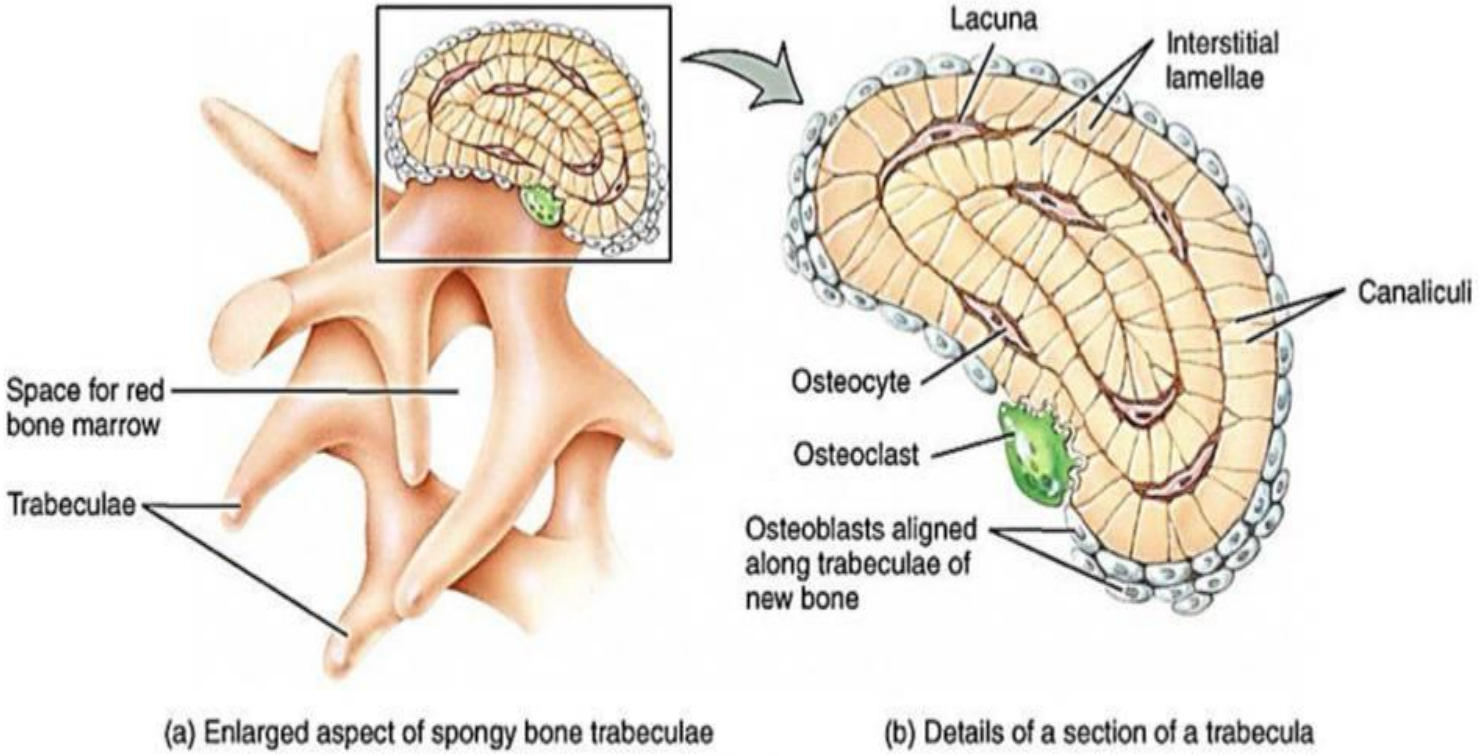

Osteon

- In spongy bone we can see branching bone trabeculae and spicules gutting out from internal surface of the compact bone towards the marrow cavity. There is no osteons but there is irregular arrangement of lamellae which contain lacunae that contain osteocytes.



Spongy bone (C.S.)



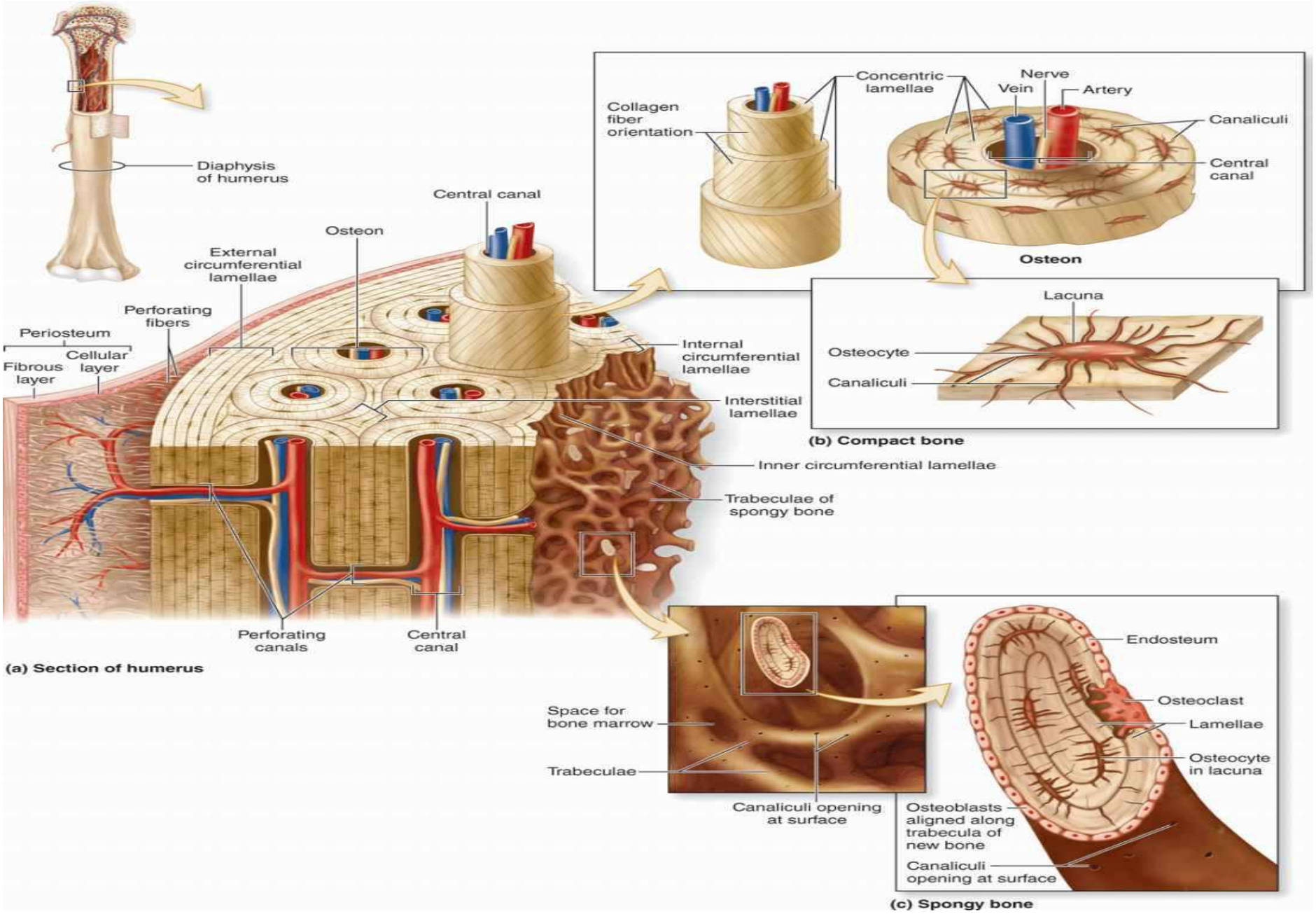



(a) Enlarged aspect of spongy bone trabeculae

(b) Details of a section of a trabecula

06.04

# Spongy Bone Structure


Diaphysis of humerus
Central canal
Osteon
External circumferential lamellae
Perforating fibers
Periosteum
Fibrous layer
Cellular layer
Internal circumferential lamellae
Interstitial lamellae
Inner circumferential lamellae
Trabeculae of spongy bone
Perforating canals
Central canal
(a) Section of humerus
Collagen fiber orientation
Concentric lamellae
Nerve
Vein
Artery
Canaliculi
Central canal
Osteon
Lacuna
Osteocyte
Canaliculi
(b) Compact bone
Space for bone marrow
Trabeculae
Canaliculi opening at surface
Endosteum
Osteoclast
Lamellae
Osteocyte in lacuna
Osteoblasts aligned along trabecula of new bone
Canaliculi opening at surface
(c) Spongy bone

# Histogenesis of bone (bone development).

- In the development of the embryo histogenesis of bone can be occurs by:

1- Intramembranous bone formation (in most flat bones).

2- Endochondral bone formation (in most of the long and short bones).

# How Bones Grow in Length

- The continuous growth of long bone depends on the presence of epiphyseal cartilage during the growth period. Histologically, the epiphyseal plate is divided into five clear zones:

**1-Zone of reserve cartilage** :

Chondrocytes distribute randomly within the matrix, and mitotically active, without proliferation or matrix production.

**2- Zone of proliferation:**

Chondrocytes proliferate rapidly to form rows of isogenous cells parallel to the direction of bone growth; these cells are larger than those in the first zone.

**3-Zone of maturation and hypertrophy:**

Chondrocytes undergo maturation and hypertrophy, and the glycogen accumulates in their cytoplasm, and the matrix compressed between cell rows.

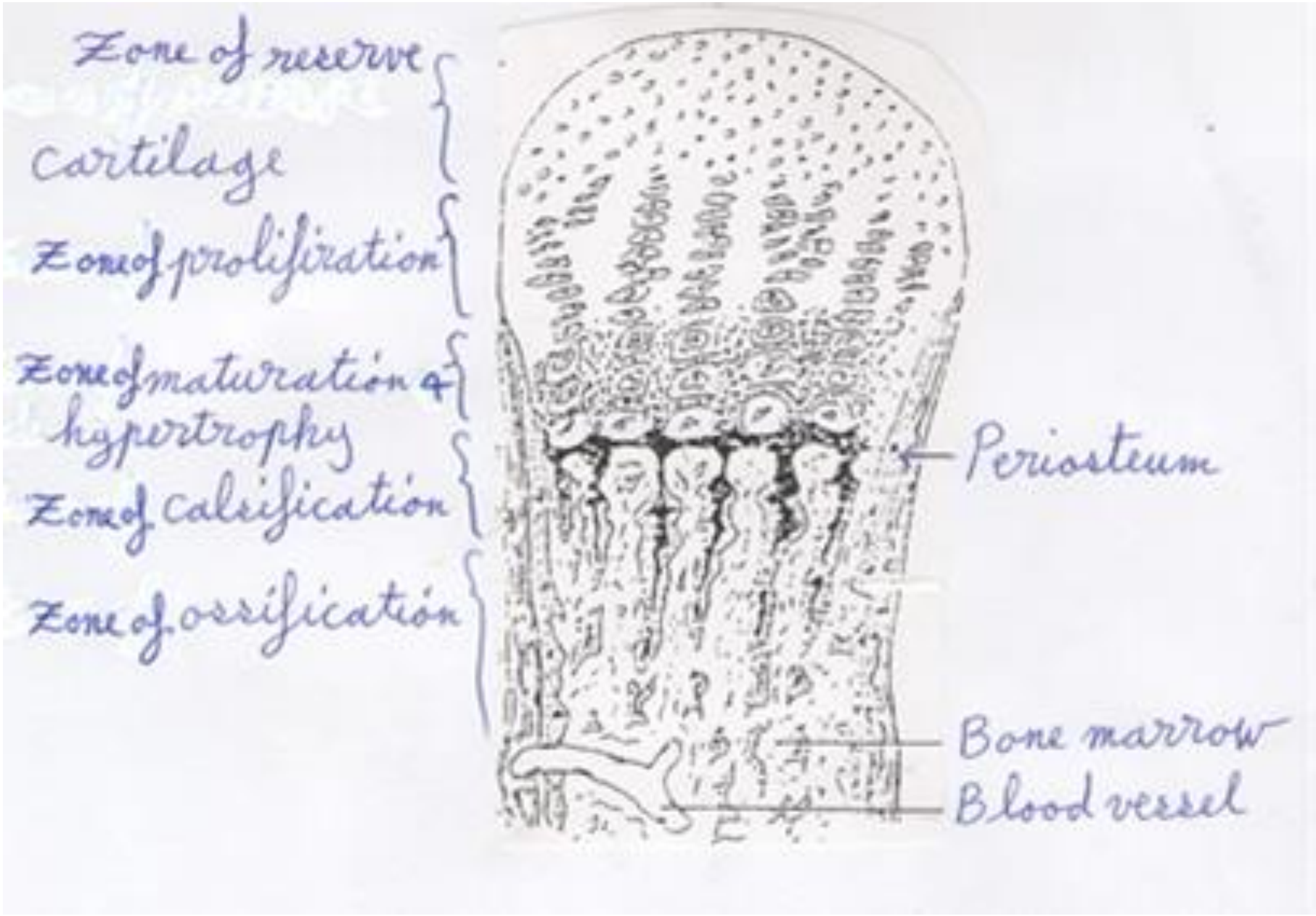
**4-Zone of calcification:**

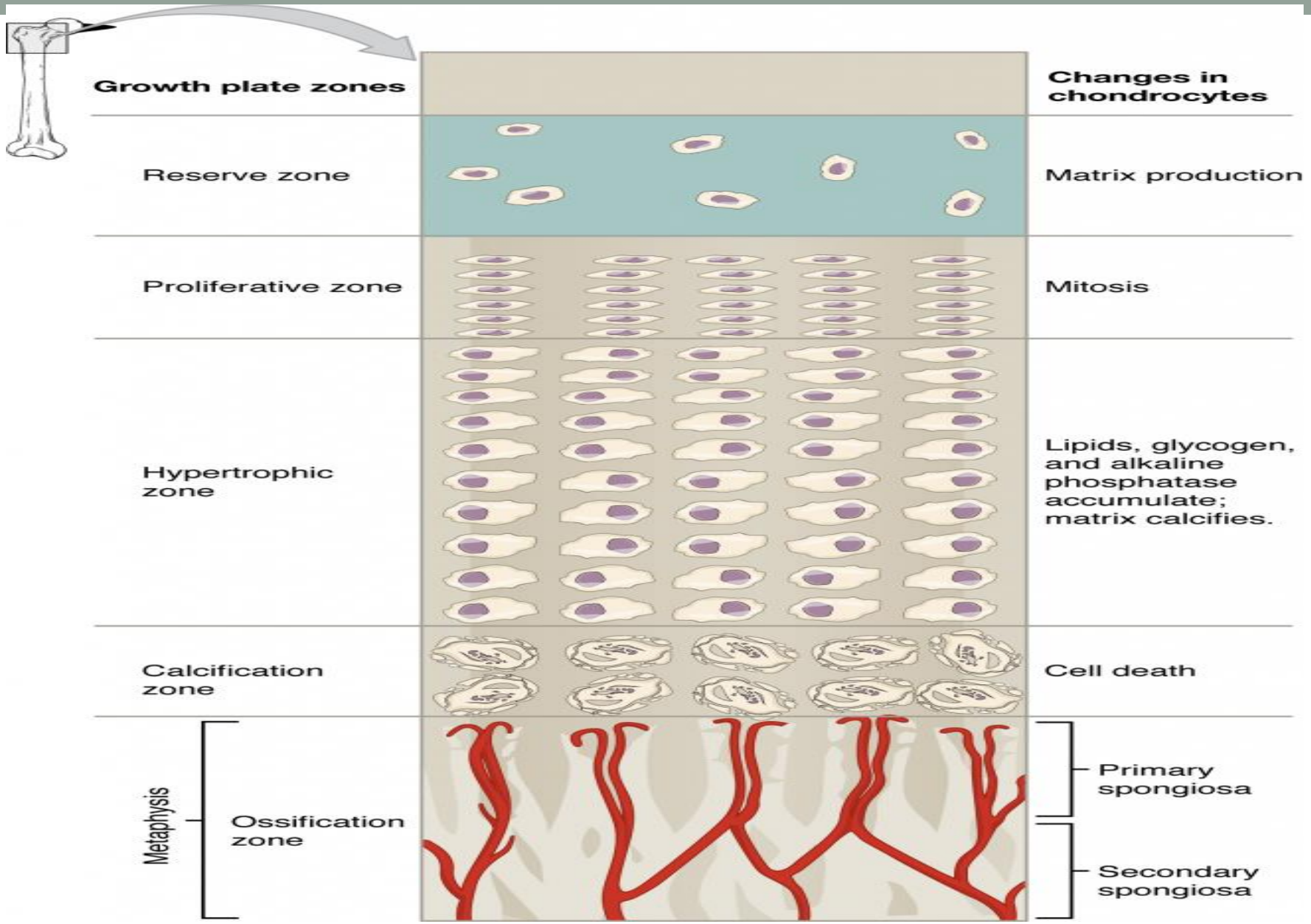
Lacunae confluent and hypertrophied, chondrocytes die, and matrix calcified.

**5- Zone of ossification:**

Capillaries and osteoblasts from the diaphysis penetrate this zone, and the osteoblasts secrete bone tissue on the remaining calcified cartilage.

- **The cell growth rate in the proliferation zone is equal to cell absorption rate in the ossification zone**.

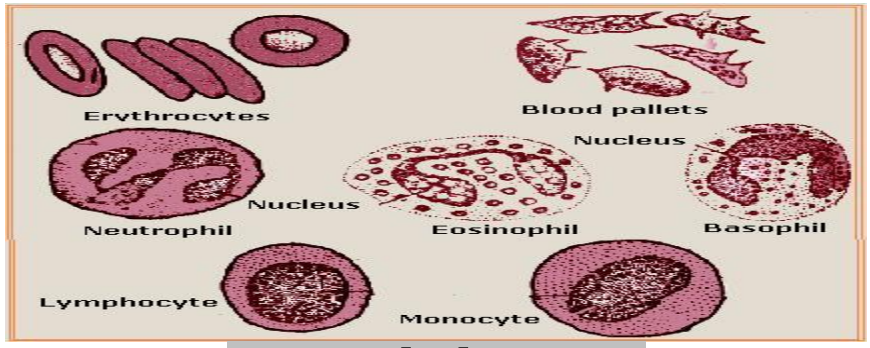

Zone of reserve cartilage
Zone of proliferation
Zone of maturation & hypertrophy
Zone of calcification
Zone of ossification
Periosteum
Bone marrow
Blood vessel




***Longitudinal Bone Growth***

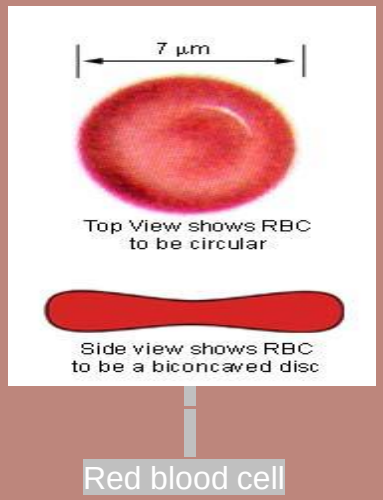
# B- Blood

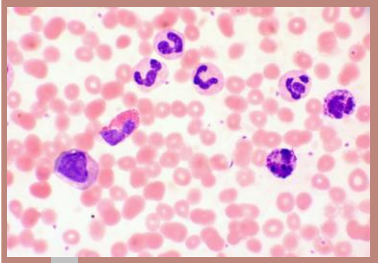
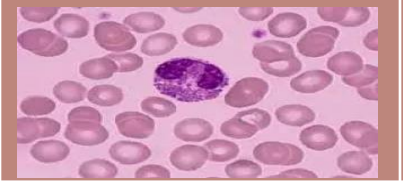
- Blood is a type of connective tissue, consisting of cells and cell fragments surrounded by a liquid matrix, which circulate through the heart and blood vessels. The cells and cell fragments are the formed elements, and the liquid is the plasma.
- The formed elements make up about 45%of the total blood volume. About 95% of the volume of the formed element consists of erythrocytes or red blood cells, the remaining 5% consist of leucocytes or white blood cells, and cell fragments called platelets or thrombocytes.
- The plasma makes up about 55% of the total blood volume. Plasma is a pale yellow fluid that consist of about 91% water and 9% other substances, such as proteins, ions, nutrients, gases, and waste products.

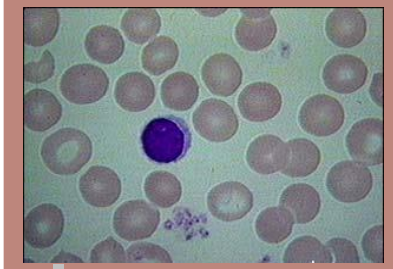


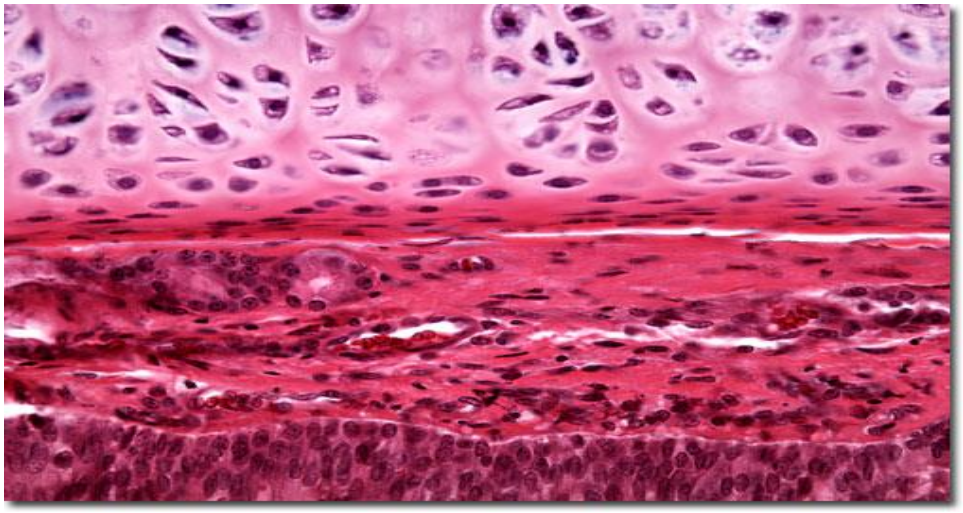
Formed elements

# Table(1):-Formed elements of the blood :-

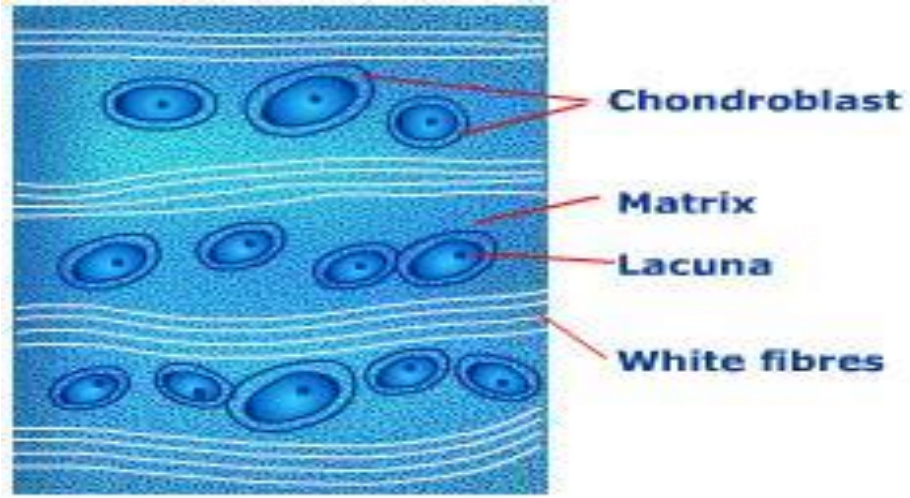
| Cell type | Description | Function | Approximate number per MLa |
|---|---|---|---|
| **Erythrocyte**   | Biconcave disk; no nucleus; contains hemoglobin, which colors the cell red. | Co2 and O2 transport. | 4.2-6.2 million cell per cubic mm. |
| **Leukocyte** | Spherical cell with a nucleus; White in color because it lacks hemoglobin. | Five types of leukocytes, each with specific function. | 6-10 thousand cell per cubic mm. |

| Cell type | Description | Function | Approximate number per MLa |
|---|---|---|---|
| **A-Granulocytes** | | | |
| 1-Neutrophil  Blood smear | Nucleus with two to fore lobes connected by thin filaments; cytoplasmic granules stain a light pink or reddish purple. | Phagocytizes microorganisms and other substances. | 60%-70% |
| 2-Basophil  Basophilic granulocyte | Nucleus with two indistinct lobes; cytoplasmic granules stain blue-purple. | Releases histamine, which promotes inflammation, and heparin, which presents clot formation. | 0.5%-1% |
| 3-Eosinophil  | Nucleus often bilobed; cytoplasmic granules stain orange-red or bright red. | Release chemicals that reduce inflammation; attacks certain worm parasites. | 2%-4% |

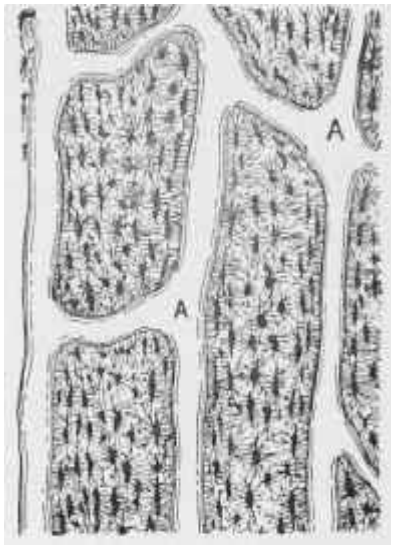
| Cell type | Description | Function | Approximate number per MLa |
|---|---|---|---|
| **B-Agranulocyte** | | | |
| 1-Lymphocyte  | Round nucleus; cytoplasm forms thin ring around the nucleus. | Produces antibodies and other chemicals responsible for destroying microorganisms; contributes to allergic reactions, graft rejection, tumor control, and regulation of the immune system. | 20%-25% |
| 2-Monocyte  | Nucleus round , kidney or horseshoe-shaped; contains more cytoplasm than does lymphocyte. | Phagocytic cell in the blood; leaves the blood and becomes a macrophage, which phagocytized bacteria, dead cells, cell fragments, and other debris within tissues. | 3%-8% |
| **Platelets**   | Cell fragments surrounded by a plasma membrane and containing granules. | Forms platelet plugs; releases chemicals necessary for blood clotting. | 250-400 thousand per cubic mm. |



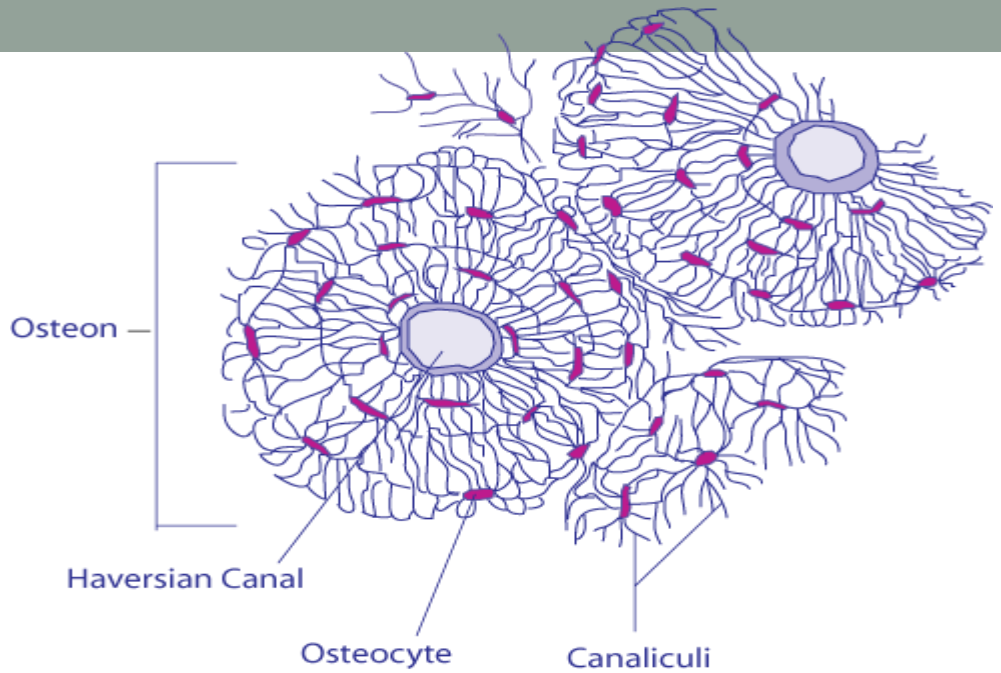
Hyaline cartilage



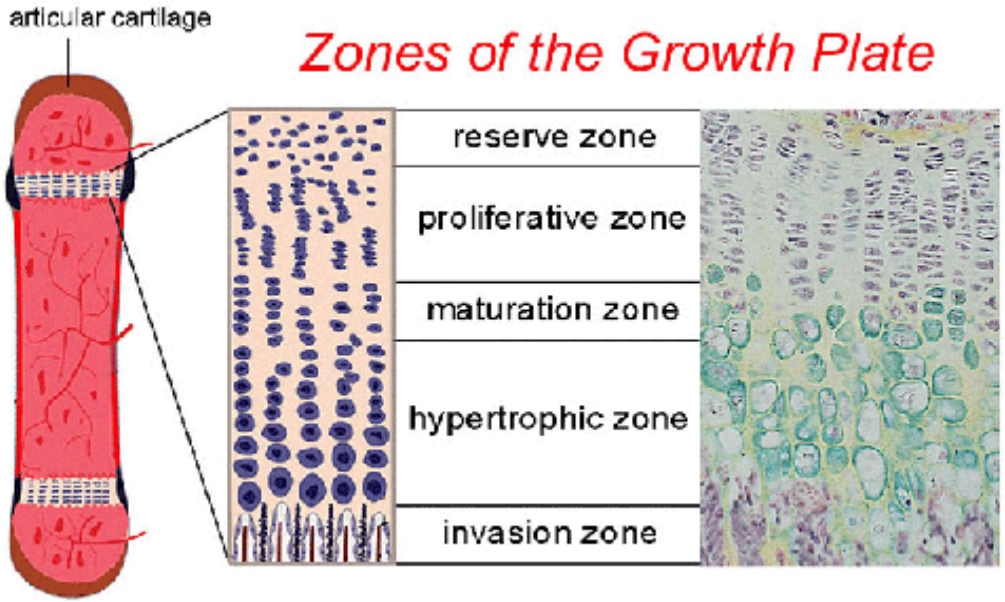

White fibrous cartilage



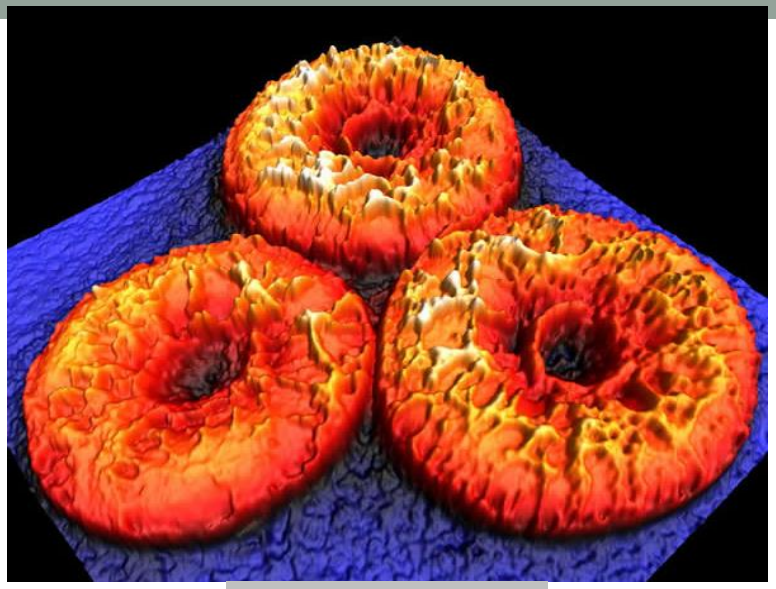

Longitudinal section in the compact bone



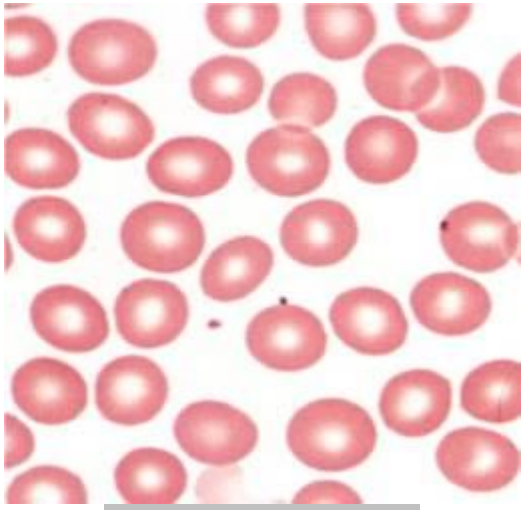

Cross section in the compact bone



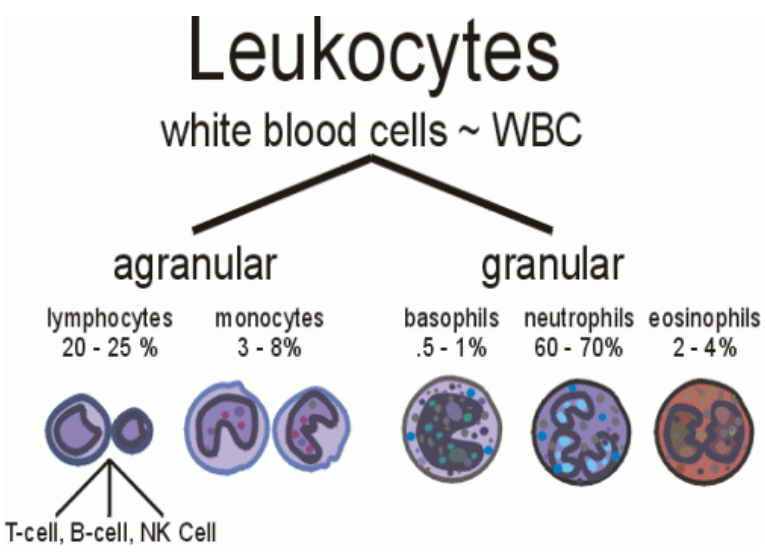

Endochondral ossification

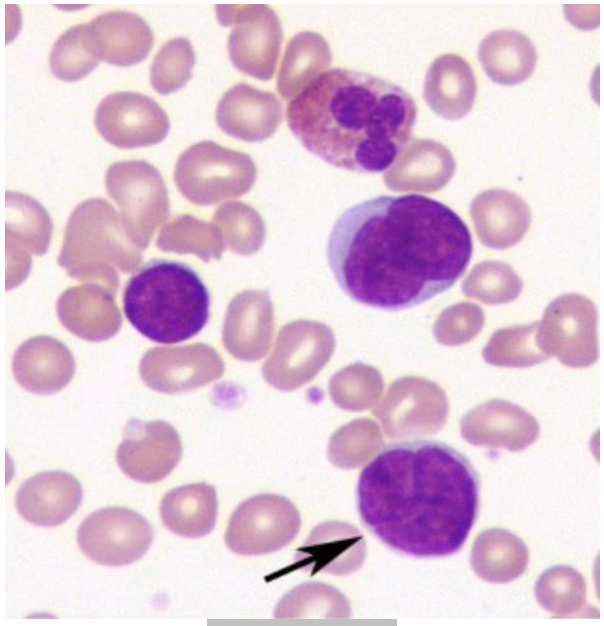


Red blood cells(e.m.)



Red blood cells(l.m.)



Blood smear

WBC and RBC’ s