

The connective tissue

- The connective tissue ,connects ,holds and supports body tissues and organs together.
- CT (mesodermal in origin).
- It is characterized by the presence of several types of cells widely separated and immersed in an abundant intercellular components formed by these cells.

Functions:

1- **Structural** function (**Support**)

Ligaments-tendons-capsules (surrounds organs)-CT between organs.

2-**Defensive** function

- phagocytic cells-**plasma** cells.

-The matrix provides a physical barrier to the invading microorganism.

3-**Neutritional** functions

-due to its rich content of blood vessels and abundant matrix and tissue fluid .

4-**Repair**

5-**Storage**

6-**Packing**

Constituents of connective tissue

I-Amorphous extracellular substance or matrix

II-Connective tissue fibers

III-Connective tissue cells

The relative abundance of cells, fibers and ground substance varies from region to region leading to the differentiation of connective tissue in the following types:

1-Connective tissue proper :

loose connective tissue –dense connective tissue(regular-irregular)
mucoid connective tissue-reticular connective tissue-adipose
connective tissue

2-Specialized connective tissue :

a-cartilage (semisolid matrix)

b-bone (solid matrix)

C-Blood and lymph(where the intercellular matrix is liquid)

I-Extracellular matrix

- It is composed of two substance :
- A-Amorphous intercellular substance (ground substnce)
- B-Tissue fluid

A-Amorphous intercellular substance(ground substnce)

-Its is a colorless transparent gelatinous substance

-Structural components of the ground substance :

1-Glycosaminoglycans(unbranched polysaccharides)-have a lubricating function and they interact with collagen fibrils to bind them.

2-Proteoglycans is formed of a core of protein .

3-Glycoproteins (contain a protein)

Function:

1-Proteoglycans (responsible for the gel state of the extracellular matrix) and act as lubricants.

2-Acts as a barrier to bacterial penetration due to their high viscosity.

3-Together with the basal lamina they form molecular filter .

B-Tissue fluid

1-It is similar to blood plasma .It contains a small percentage of plasma proteins of low molecular weight that escape through the capillary wall(is very small quantity)

II-Connective tissue fibers

There are three types of C.T. fibers:

1-The collagenous fibers.

2-The elastic fibers.

3-The reticular fibers.

1-Collagen fibers :

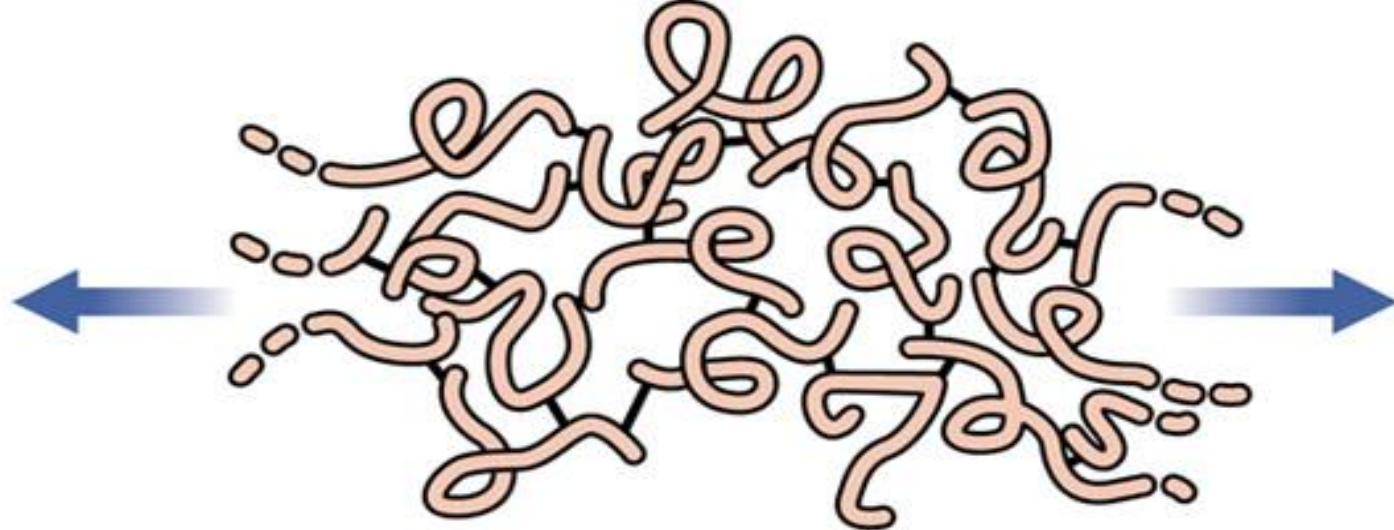
- The most numerous fibers in CT.
- Fresh collagen fibers are colorless but when Present in great number they are white.
- They are inelastic, flexible and have a great tensile strength.
- The individual fibers do not branch ,consist of a protein called **collagen** ,yields **gelatin** on boiling .
- Twelve types of collagen have been identified:
 - Type I----C.T.proper+bone.
 - type II-----in cartilage
 - Type III-----in reticular fibers
 - Type IV-----in basal lamina

2-Reticular fibers(reticulin):

- -They are thin branching fibers.
- -They are stained black by impregnation with silver ,Thus they are called argentophilic.
- -They are PAS positive due to their high content Of glycoprotein.
- -Supporting framework of the spleen ,lymph nodes,and bone marrow (supportive function)

3-Elastic fibers (elastin):

- They are capable of stretching to one and one –half times their length.
- Elastic fibers are abundant in(large blood vessels e.g.aorta+vocal cord)

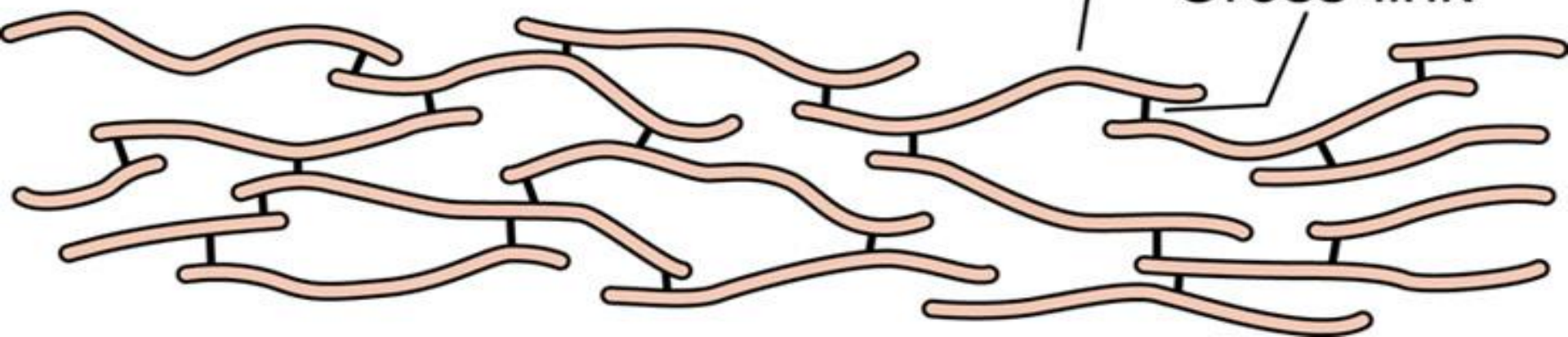


Stretch

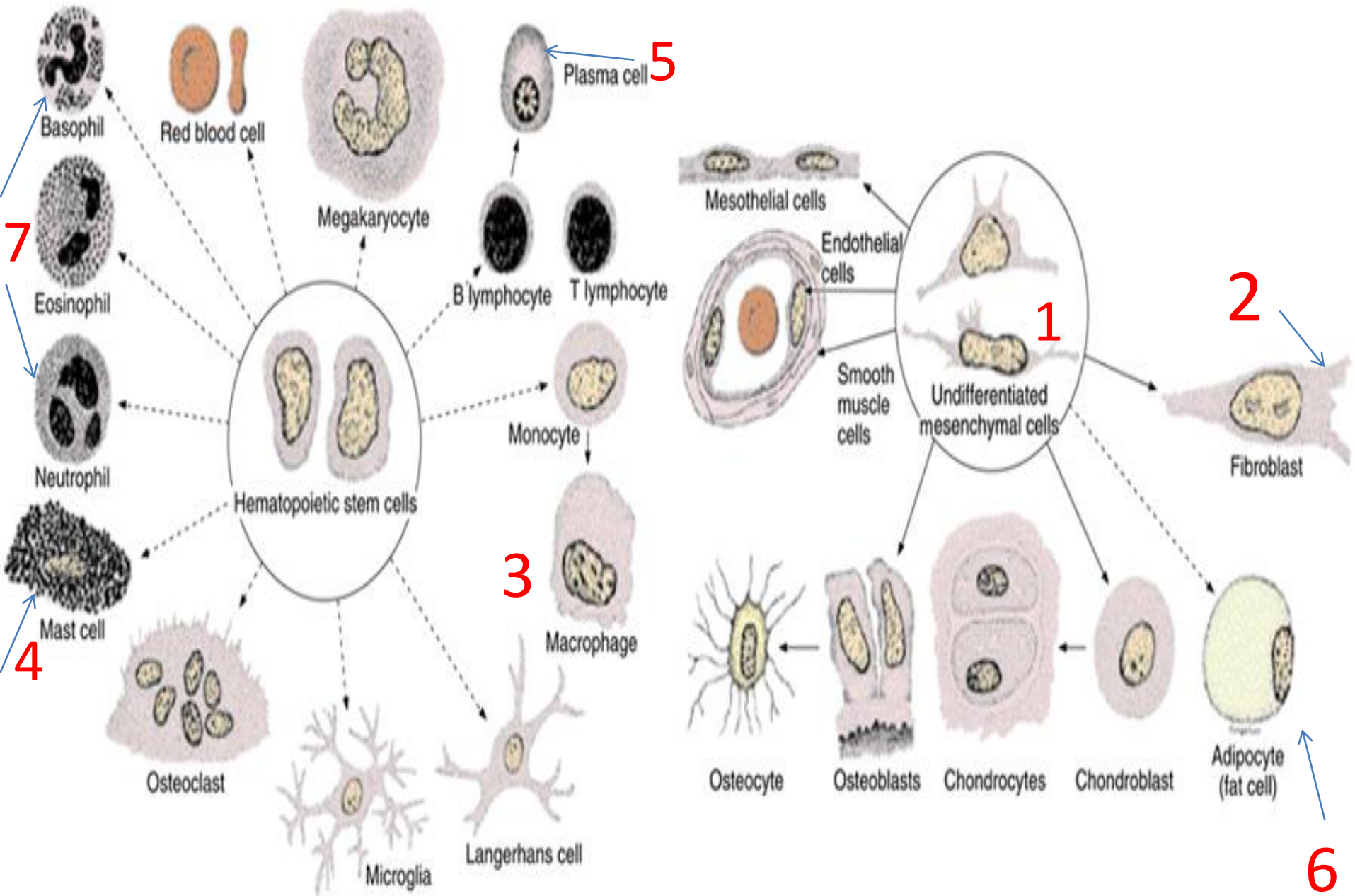
Relax

Single elastin molecule

Cross-link



III-Connective Tissue cells



III-Connective Tissue cells

1-Undifferentiated mesenchyme cells:

-small flat cells-stellate processes-ovoid pale nucleus –two nucleoli-
can differentiate into any type of C.T.cells.

2-Fibroblast

-**Fibroblast**(fusiform-have several radiating processes-abundant basophilic cytoplasm-ovoid large pale nucleus-prominent nucleolus-rich content of RER –well developed golgi apparatus).

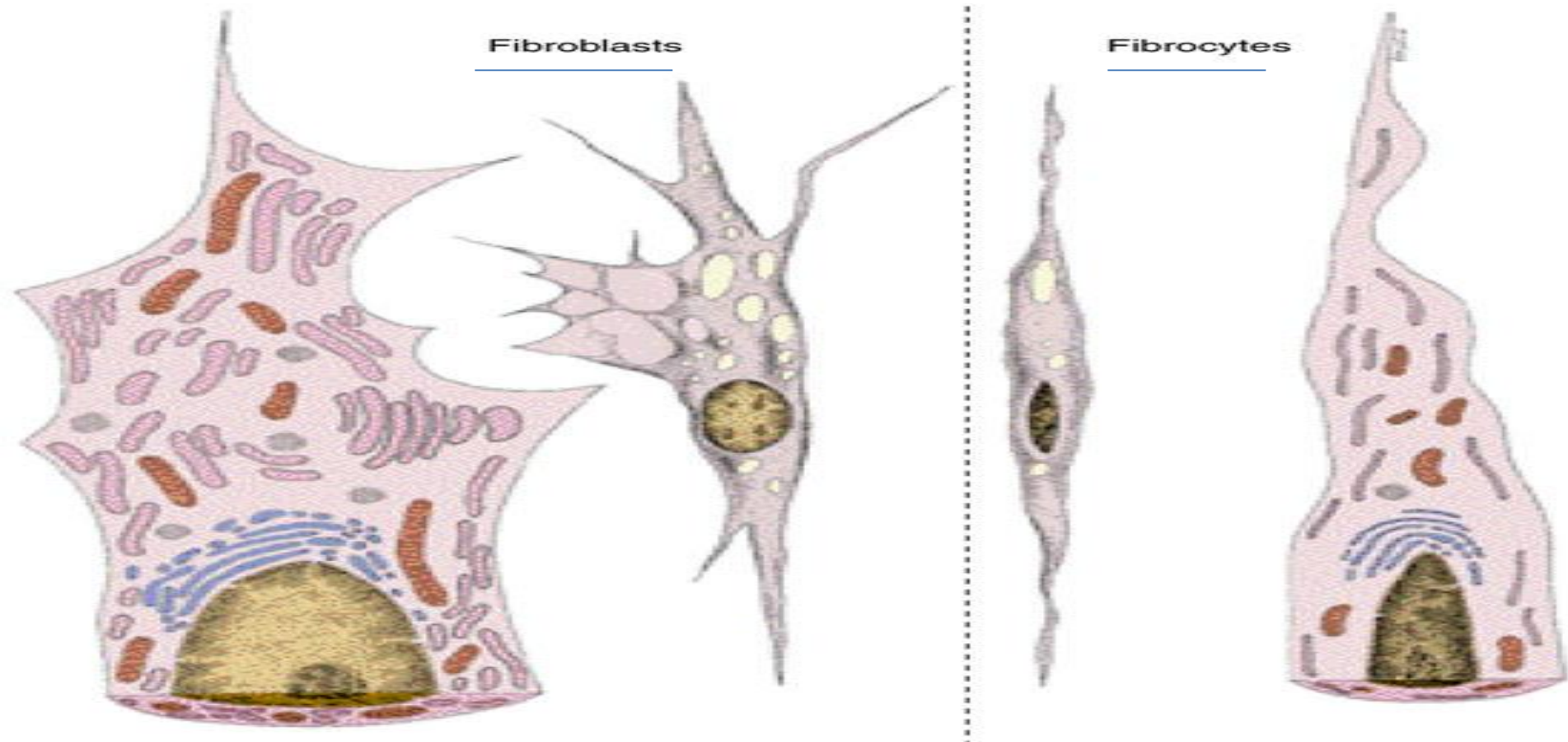
- Active cell which:

- * synthesizes (collagen ,reticular and elastic fibers).

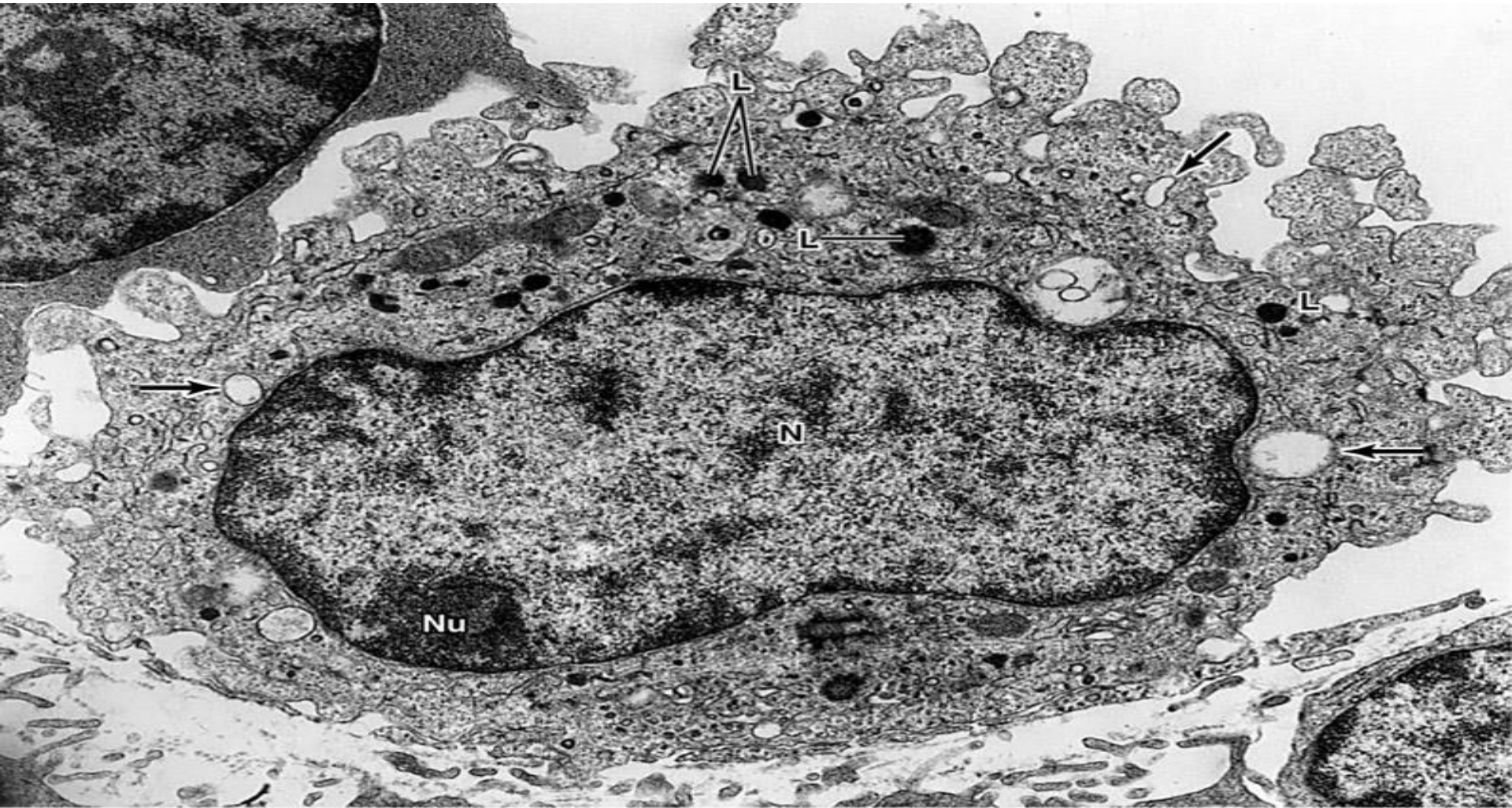
- *Synthesizes glycosaminoglycans and glycoprotein(inter cellular substance).

3--Fibrocyte (smaller-spindle –shaped cells-fewer processes-smaller dark ,elongated nucleus)(fewer cytoplasmic organelle)-less active than fibroblast .

Active (left) and quiescent (right) fibroblasts. External morphologic characteristics and ultrastructure of each cell are shown. Fibroblasts that are actively engaged in synthesis are richer in mitochondria, lipid droplets, Golgi complex, and rough endoplasmic reticulum than are quiescent fibroblasts (fibrocytes).



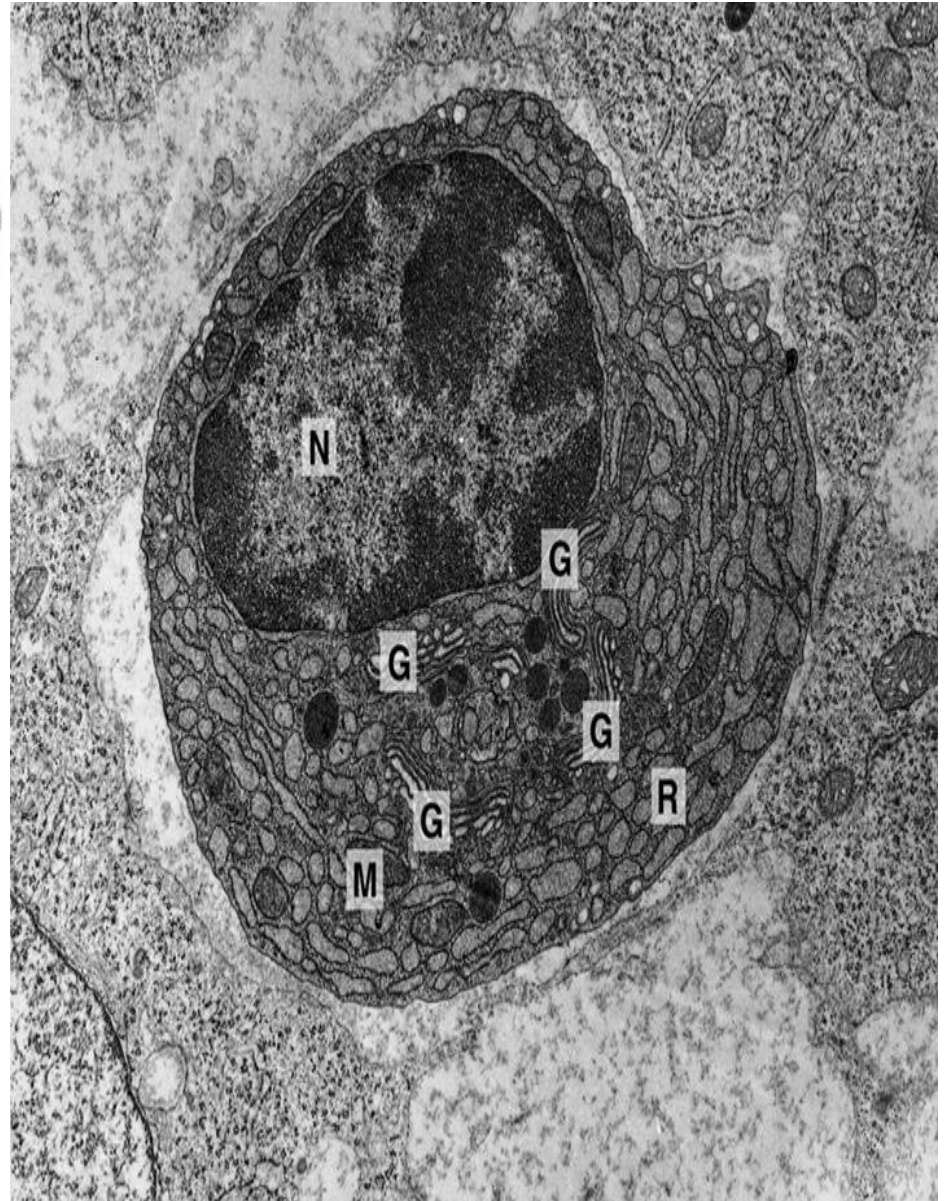
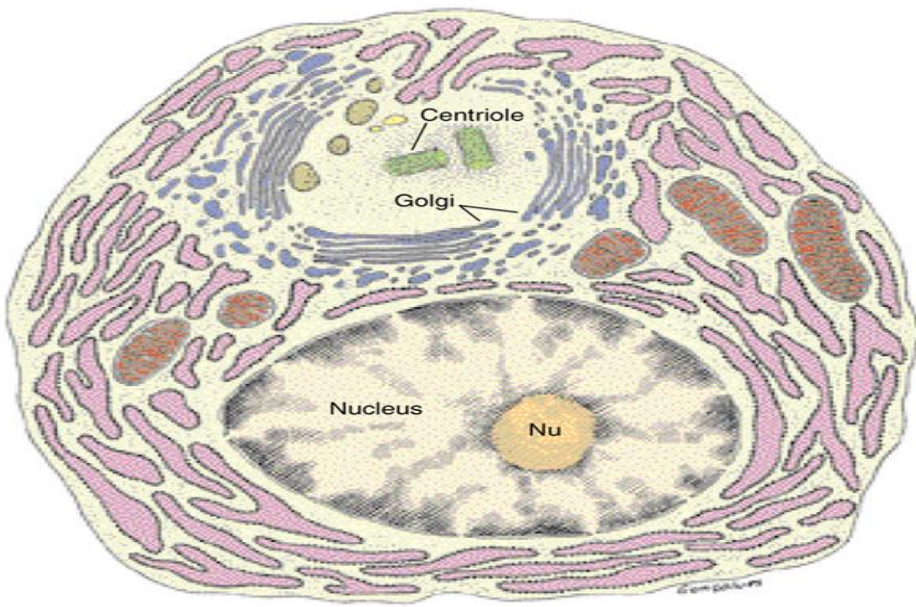
4-Macrophage



Electron micrograph of a **macrophage**. Note the secondary lysosomes (L), the nucleus (N), and the nucleolus (Nu). The arrows indicate phagocytic vacuoles.

5-Plasma cell

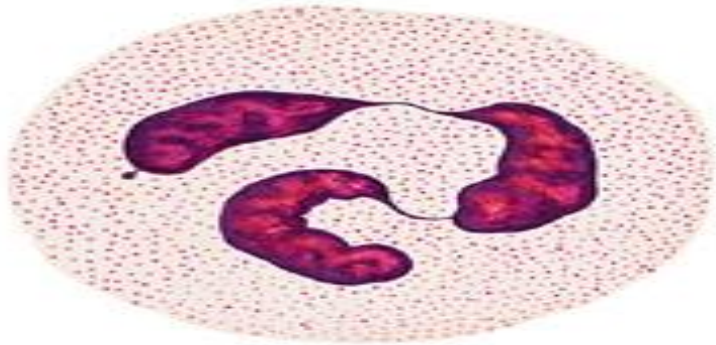
- -They are numerous in sites subject to penetration by bacteria and foreign proteins .They are derived from B lymphocytes.
- -large –ovoid –basophilic cytoplasm –spherical eccentrically nucleus (a cart-wheel appearance)-rich basophilic cytoplasm.
- -Function(synthesis of antibodies)



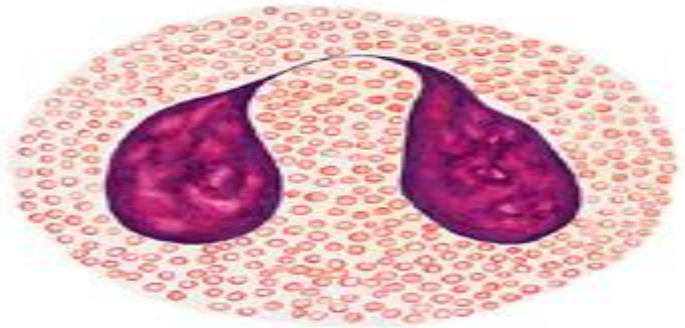
Electron micrograph of a plasma cell showing an abundance of rough endoplasmic reticulum (R). Note that many cisternae are dilated. Four profiles of the Golgi complex (G) are observed near the nucleus (N). M, mitochondria.

7-Leucocytes

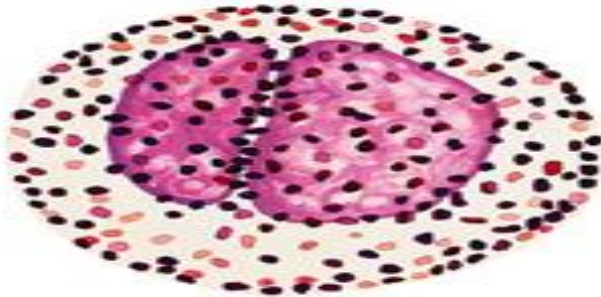
- They migrate from the blood across the capillaries and venules to appear and perform their function in the CT (eosinophil and lymphocytes).



Neutrophilic granulocyte



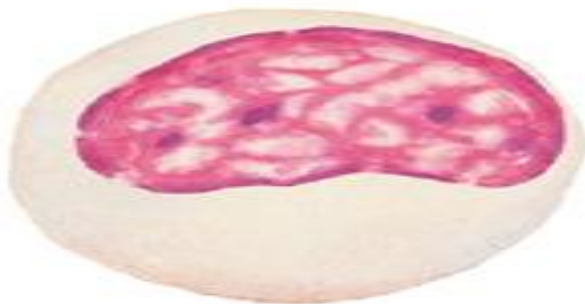
Eosinophilic granulocyte



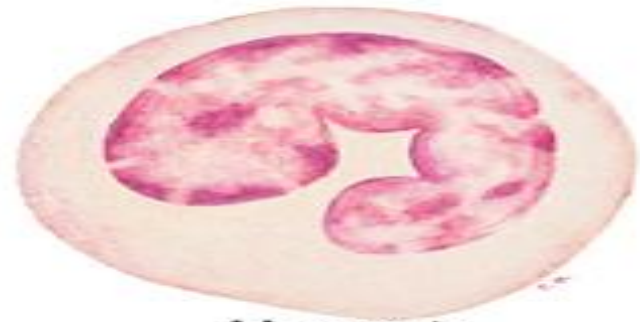
Basophilic granulocyte



Lymphocyte



Monocyte

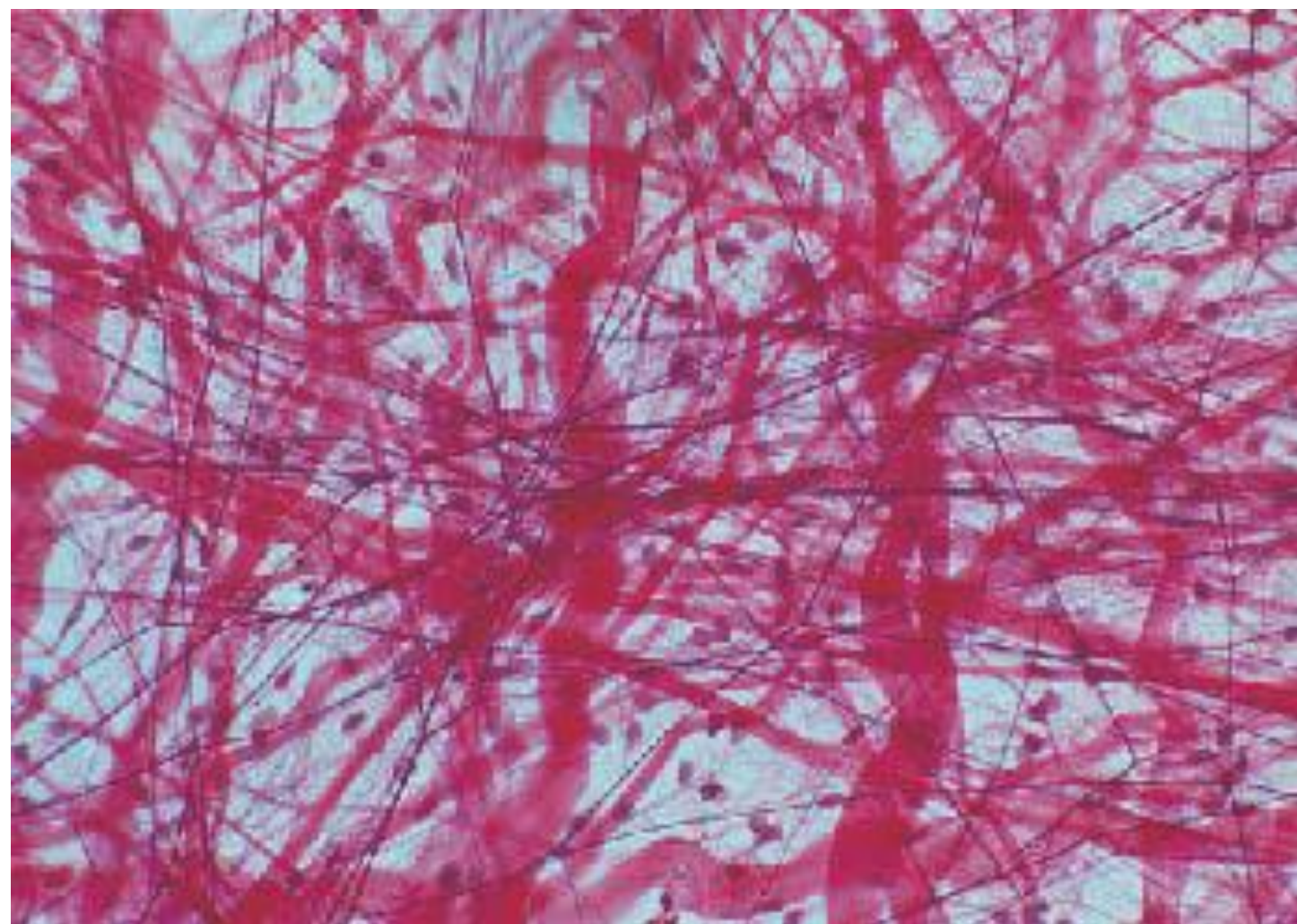


Monocyte

Types of connective Tissue Proper

(classification depends on the structural characteristic of the tissue)

- **I -Loose C.T. or areolar** C.T(flexible-richly vascular).(support epithelial T.)
- - All types of cells-fibroblast and macrophages predominate.
- -All types of fibers,collagen,elastic and reticular are present with small proportion of the reticular fibers
- -Good amount of ground substance.

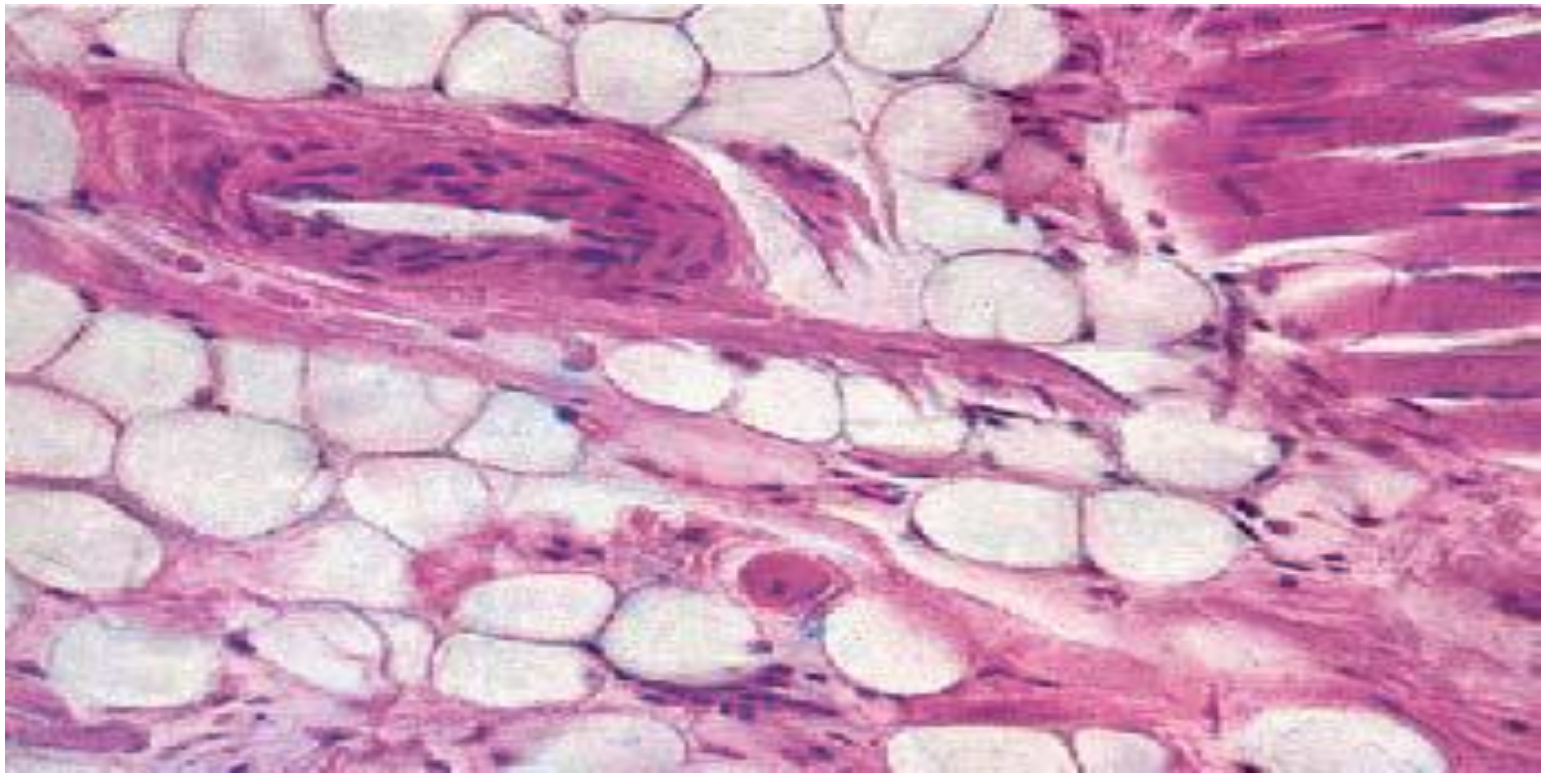


II-Dense connective tissue

- A-Irregular type (dermis of mammalian skin)
- *dense collagen fibers-little amount of ground substance –less flexible and more resistant than loose CT .
- B-Dense regular type (Tendon-ligament-perichondrium-periosteum- dura matter of the brain).
- *dense collagen fibers,fibrocytes(triangle shape)or tendon cells.

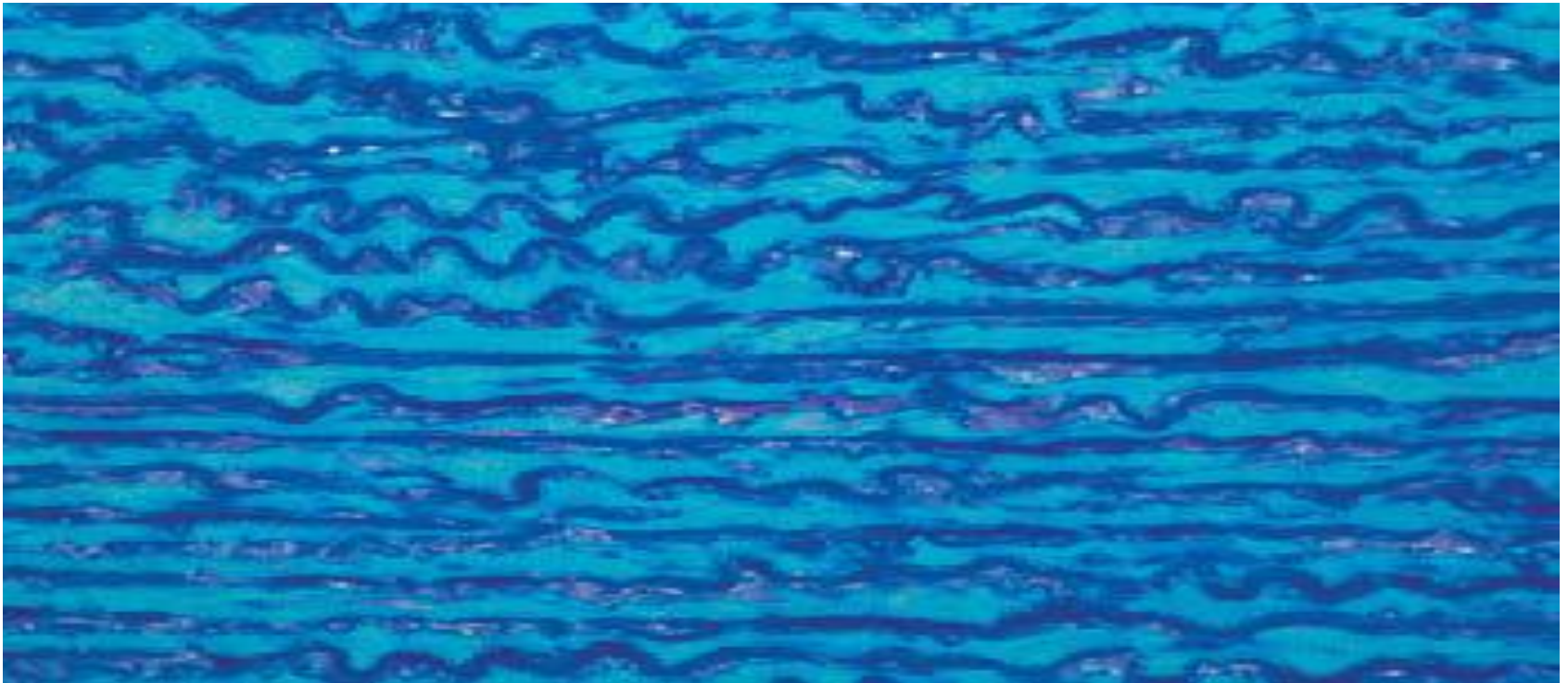
III-Adipose tissue

- -Components(adipocytes-collagenous fibers-rich blood supply)
- -Function:1-store energy in the form of triglyceride
- 2-subcutaneous adipose tissue shapes the body.
- 3-act as a fixative to vital organ as kidney and uterus.



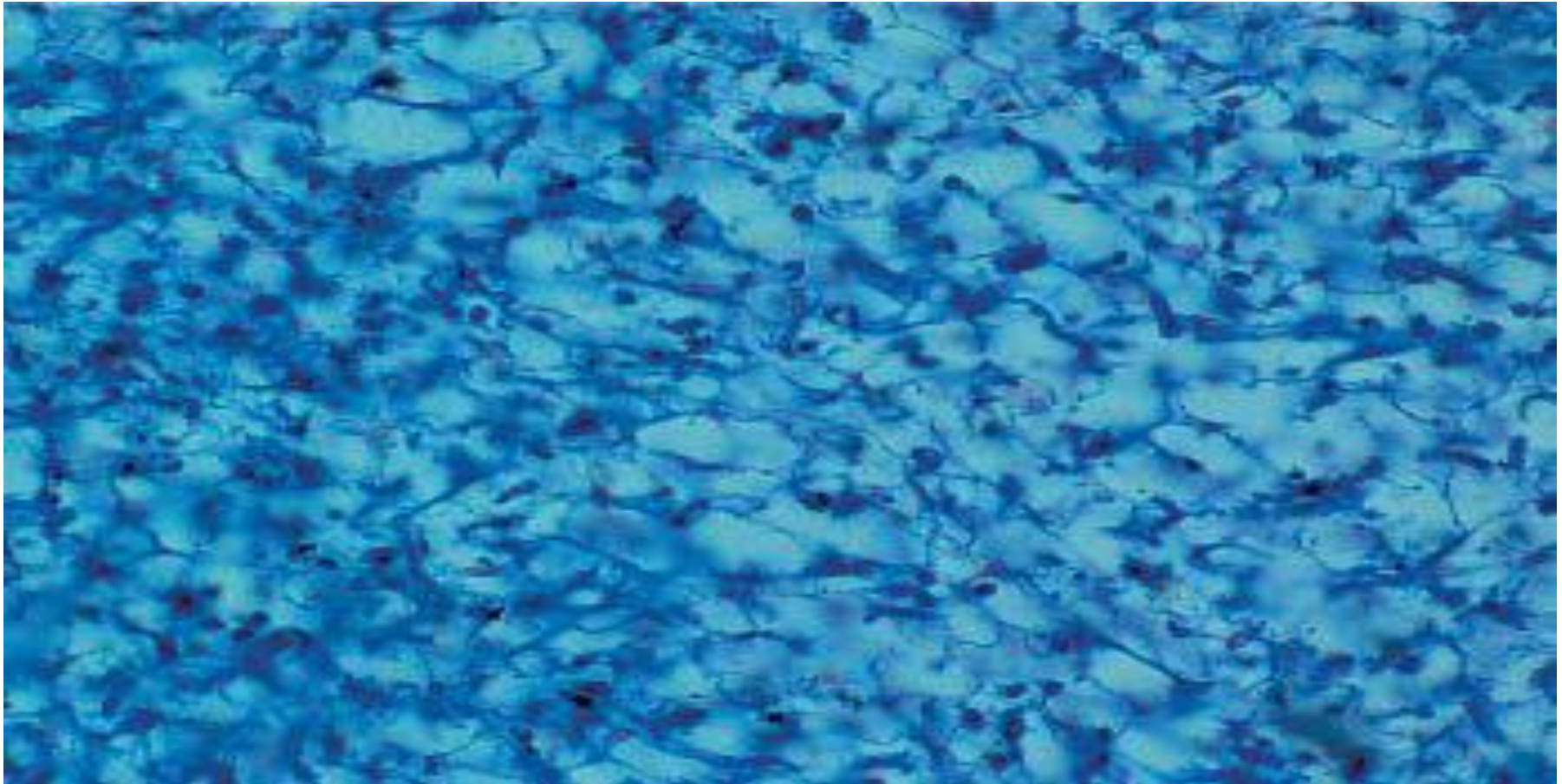
V-Elastic CT

- -Elastic fibers predominates(present when flexibility and elasticity are needed)(elastic lamina of arteries-vocal cords.



VI-Reticular C.T.

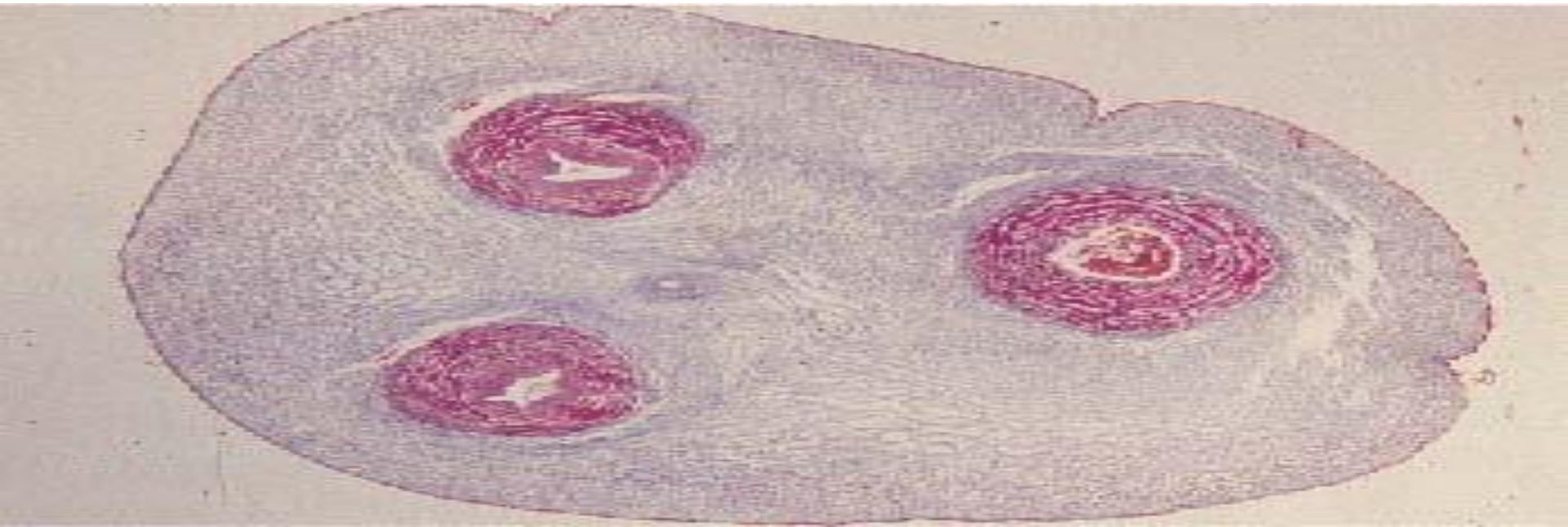
- -Components :
- 1-Reticular fibers-reticular cells(have long processes-large nuclei-fine chromatin-more visible nucleoli).
- -Present in(bone marrow-lymphoid tissue).



VII-Mucoid C.T.

Components:

- Fibroblast that come in contact with each other by their processes forming a network.
- Abundant amorphous intercellular substance (mucin)
- Present in Umbilical cord.



2-Specialized connective tissue

- -**Cartilage and bone** are modified C.T.in which amorphous intercellular substance is hardened to provide rigidity, support and attachment for soft tissues. Cartilage and bone form the skeleton of the body.

Cartilage

- -Cartilage is specialized type of CT which is firm. The firm matrix allows the tissue to bear mechanical stress .
- -Cartilage support soft tissue.
- -It acts as a shock absorbant and it also provides sliding surfaces for bones inside joint cavities ,facilitating bone movement.
- -It also keeps the patency of the respiratory tract.

- **Component of cartilage:**
- **1**-Intercellular ground substance (extracellular matrix).
- **2**-Cartilage cells namely (chondroblasts and chondrocytes).
- **3**-Collagen and elastic fibers embedded in the matrix.
- **Cartilage** is usually covered by a vascular fibro-cellular membrane called perichondrium except joint cavity.
- **The perichondrium** :It is essential for growth and maintenance of cartilage .
- The perichondrium consists of two layers :**
 - 1-outer fibrous layer (collagen fibers)**
 - 2-an inner vascular and cellular layer which is also called chondrogenic layer; the cells in this layer are chondroblasts which are capable of forming new cartilage .They are responsible for the appositional growth i.e.growth of cartilage at its periphery.**

- Cartilage is avascular tissue .Nutrients and oxygen reach the chondrocytes by leaving the blood vessels ,in the perichondrium, and diffusing through the intercellular substance.
- The cellular ground substance(matrix)(flexible):
- -Amorphous –gel-(proteoglycans with some proteins and glycoprotein)

It consists mainly of :

- A-chondro-mucoprotein:which is a protein polymer.
- B-Chondroitin sulphate (glucosaminoglycans).
- Because of the large number of sulphate group,the glucosaminoglycans are responsible for the basophilia of the intercellular substance

The cartilage cells:

1-chondroblasts 😞: (flattened oval-basophilic cytoplasm – oval nuclei-present in the inner cellular layer of perichondrium-develop from embryonic mesenchymal cells- in EM ,they have numerous ribosomes,RER,mitochondria,and well developed Golgi apparatus). Chondroblasts secrete the matrix and form the fibers ,then they become imprisoned inside lacunae forming chondrocytes.

2-Chondrocytes : (are the mature cartilage cells-are situated in spaces in the intercellular substance called lacunae –matrix is condensed around the lacunae forming the capsule which is stained more deeply basophilic because of its higher concentration of chondroitin sulphates.

- -The young chondrocytes are present underneath the perichondrium-elliptical in shape and can undergo mitosis – they synthesize type II collagen and intercellular matrix

- **Mature** chondrocytes are deeply stained – spherical –large nuclei –one or more nucleoli-rER well developed Golgi apparatus-large accumulation of glycogen and lipid.
- **The fibers** :Both collagen and elastic fibers are found in the matrix of cartilage.

Types of cartilage:

1-hyaline cartilage

2-elastic cartilage

3-white cartilage.

- **1-hyaline cartilage** 😞:(glassy -translucent appearance -have collagen fibers and few elastic fibers embedded in the matrix-is covered by perichondrium except inside joint cavities – chondrocyte {2,4,,8} –chondroblast.

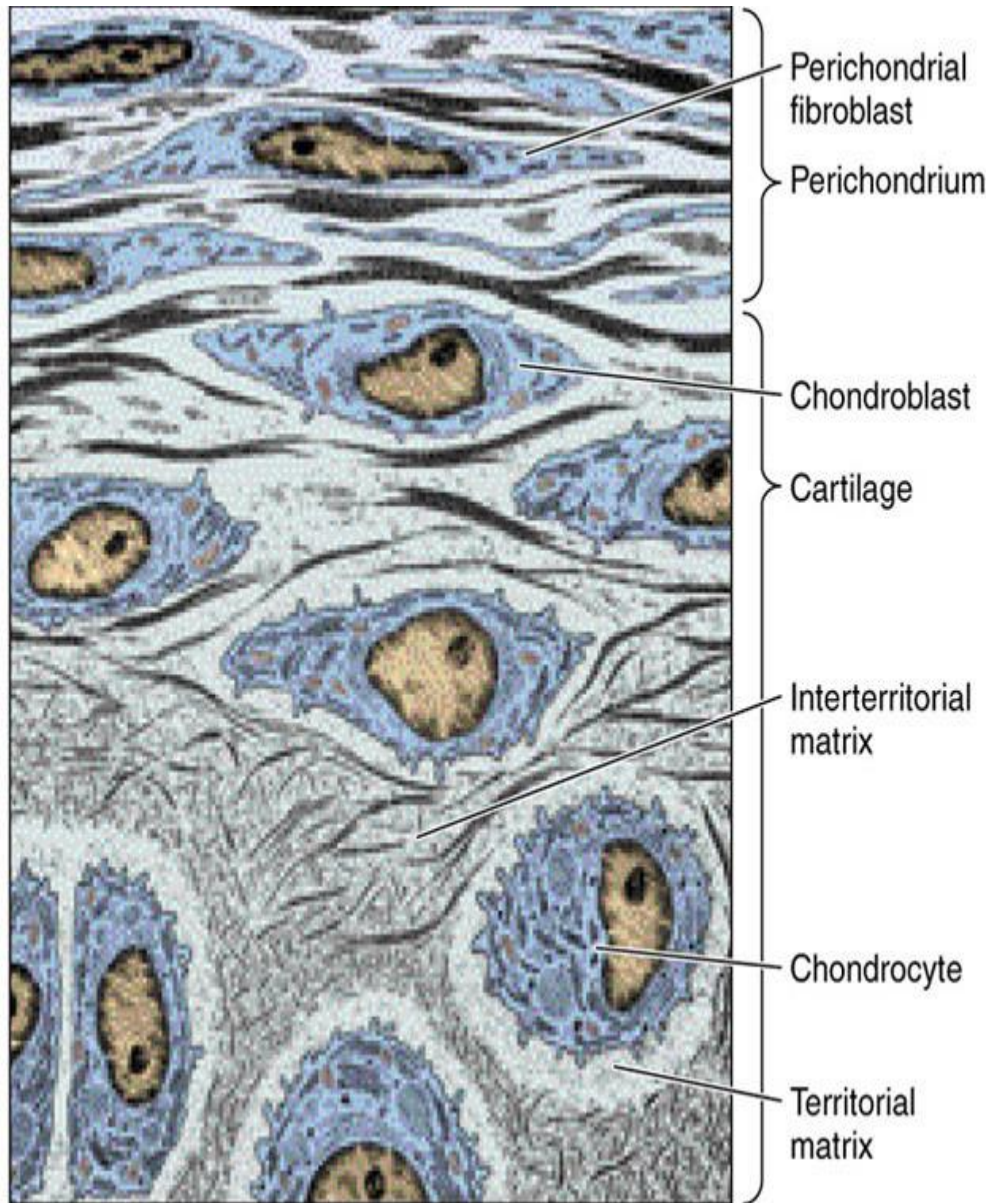
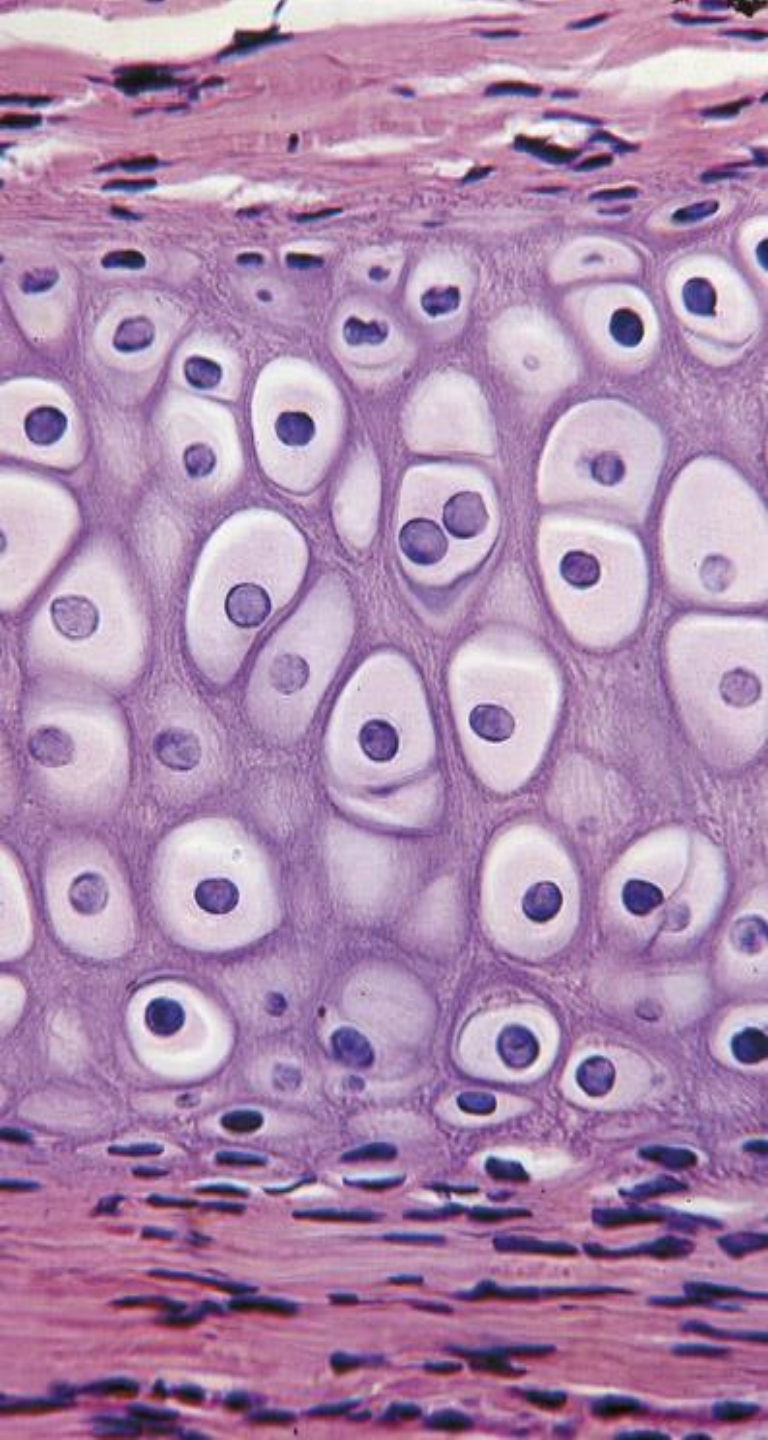
Sites 😞:nose-larynx –trachea.

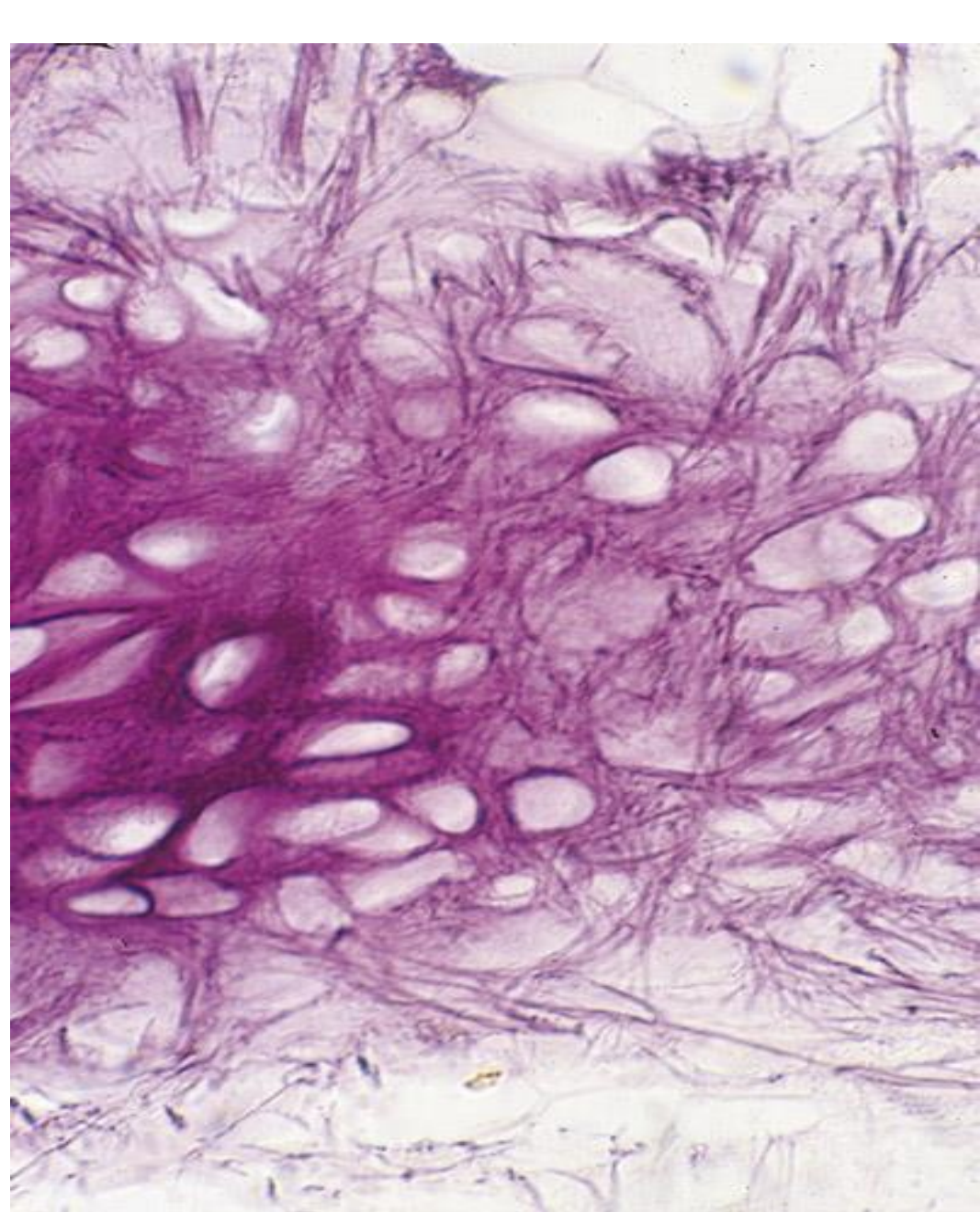
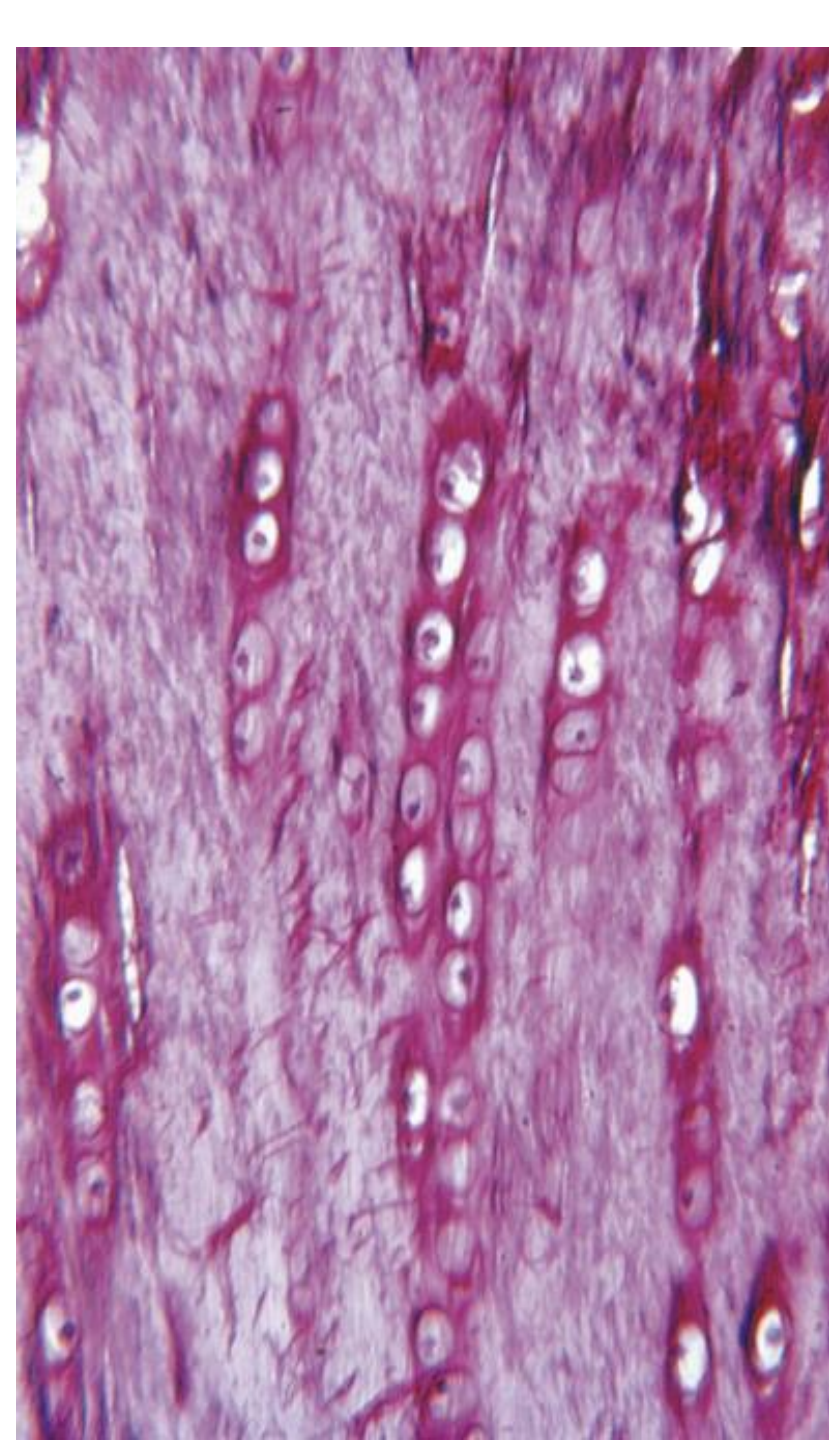
- **2-Elastic cartilage** : This type is covered by the perichondrium because it is never present inside joint cavities. intercellular substance contains very large number of elastic fibers-This type of cartilage is very flexible and resilient .
- -Fresh elastic cartilage has a yellowish colour caused by the presence of elasin in the elastic fibers.
- Sites:- ear pinna .

- **3-White fibrocartilage:** This type of cartilage is found wherever great strength combined with flexibility and rigidity is required .
- **-White fibrocartilage looks like dense fibrous tissue ,but the cells are typical chondrocytes ,present 1-2 capsule.**
- **-The matrix or intercellular substance contains thick bundles of collagen fibers .**
- **-This type of cartilage is never covered by perichondrium .**
- **Sites :The intervertebral disc**

Growth of cartilage

- **1-Appositional growth:**
 - -It is growth of cartilage at its periphery by adding new layers from outside .
 - -It is caused by mitosis of chondroblasts in the perichondrium, and then transform to chondrocytes.
- **2-Interstitial growth:**
 - It is growth of cartilage from inside .It occurs as a result of mitosis of chondrocytes within the cartilage, this cause cartilage to expand from inside .





Bone

- Bone is a type of connective tissue (hard-tensile-light in weight) due to the presence of calcified matrix+cellular +fibrous components .
- **Functions of bone:**
 - 1-support and maintenance
 - 2-protection of the internal vital organs (brain, heart).
 - 3-It forms the skeleton.4-Bone has an metabolic function by acting as a reservoir for calcium,phosphates.
- **The bone components**
 - 1-The bone matrix
 - 2-The bone cells.

1-The bone matrix

- It is formed of:

A-The ground substance :

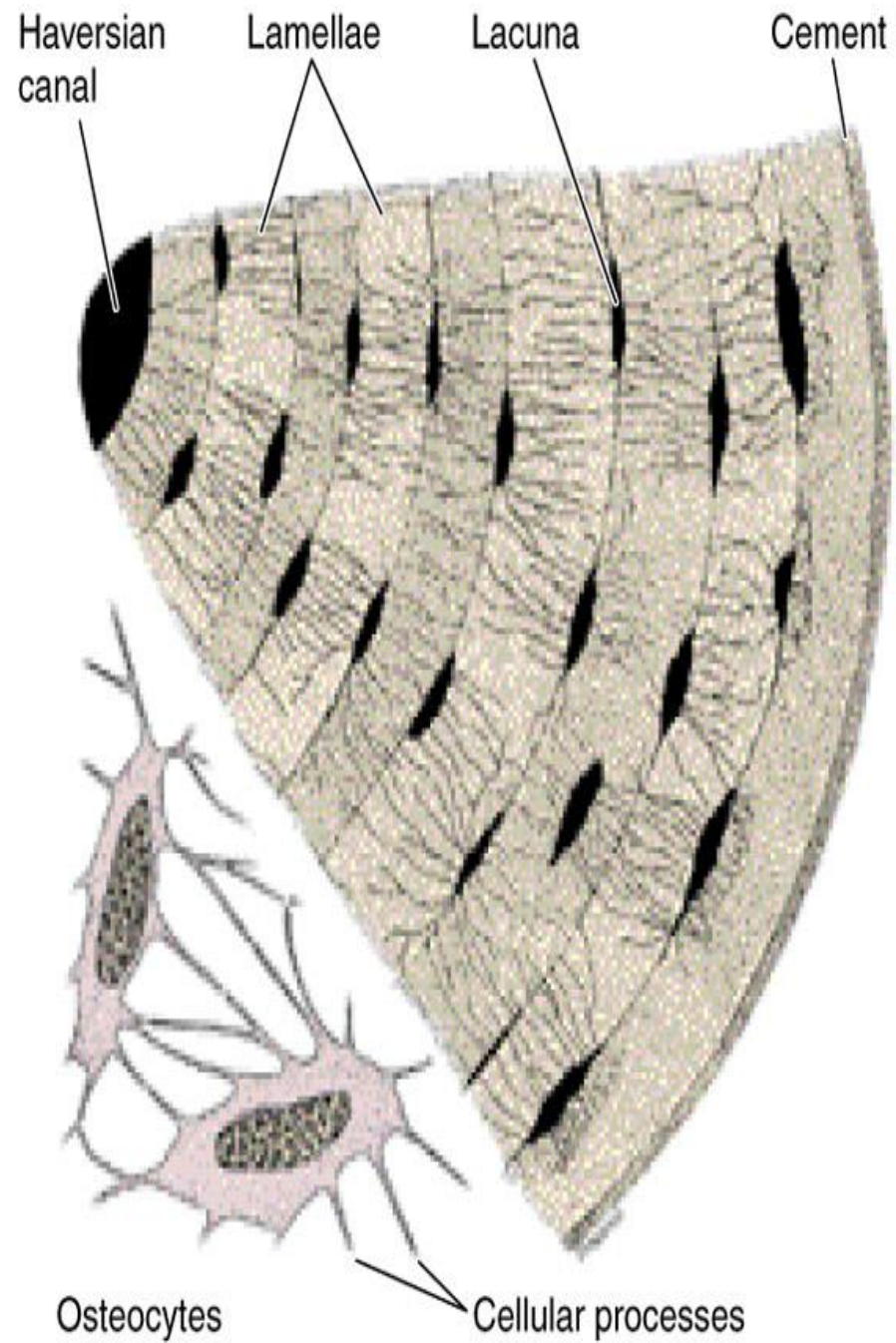
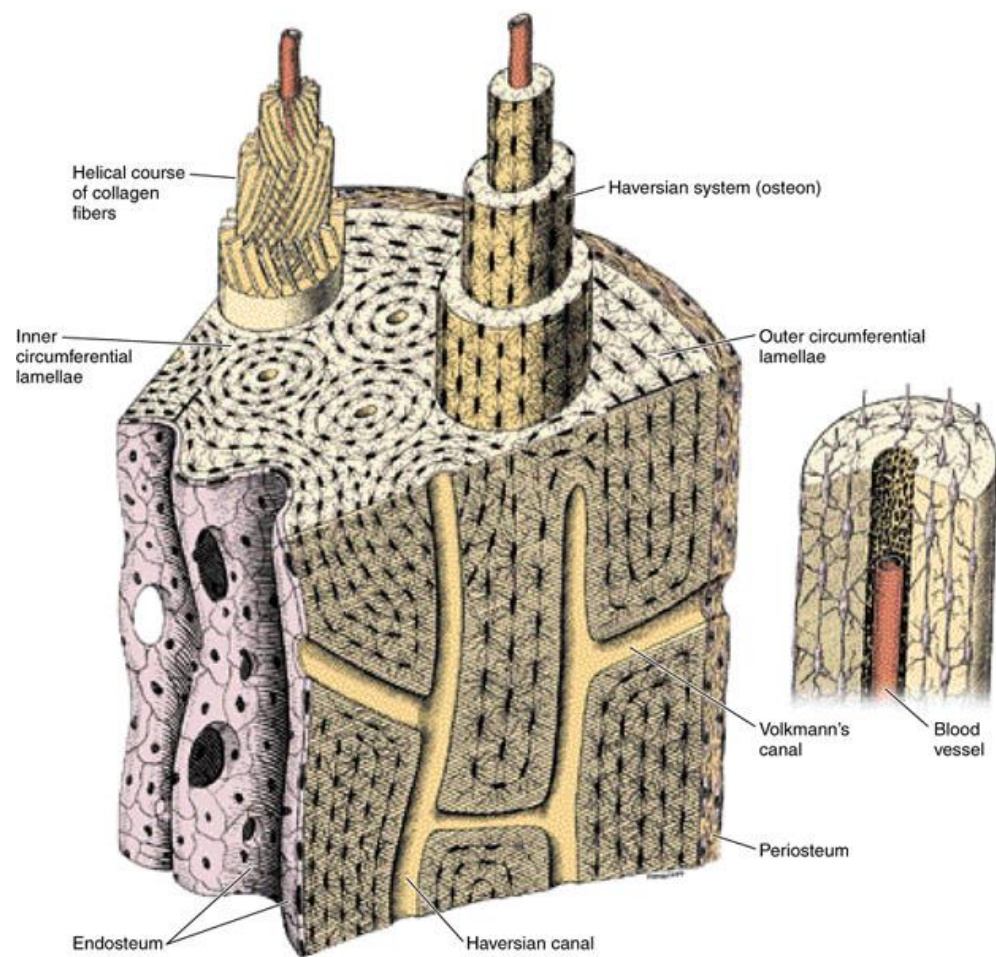
I-water II-Organic substance (glucosaminoglycans-adhesive molecule)

III-Inorganic substance (calcium phosphates –calcium carbonate)

B-The matrix fibers :

-Type I collagen fibers(are responsible for the eosinophilic staining of the bone matrix-is also responsible for the tensile property)

-Removal of collagen from a bone ,by boiling fragile bone .



2- The bone cells (There are four types of bone cells)

I-Osteoprogenitor cells

II-Osteoblasts

III-Osteocytes

IV-Osteoclasts

I-The osteoprogenitor cells

Function:The osteoprogenitor cells proliferate by repeated cell divisions giving rise to the more differentiated osteoblasts.

-They are active during growth and during healing of bone fracture.

II- The Osteoblasts (the bone forming cell)

Function:

- Secretion of protein components of the bone matrix (collagen fibers-mucopolysaccharides)
- Secretion of alkaline phosphatase enzyme ,which is essential for the preception of calcium salts from the blood into the bone matrix.

III-Osteocyte

- **Function:**The osteocyte is responsible for the maintenance of the bone structure as a whole.

IV-Osteoclast

- -Osteoclasts:are phagocytic cells,are concerned with removal (eating up)of old osseous tissue (bone resorption) by secreting hydrolytic enzymes, allowing the deposition of new bone elements.

Types of bones

- There are two types of bone in the body:
- A-The Compact bone
- B-Cancellous bone (spongy bone)