Biology

Connective Tissue

It is the most numerous tissues in the body, which connects the structures with each other, it characterized by:

- binding and supporting the organs.
- it is vascular except the cartilage.
- it is derived from mesoderm layer.

Connective tissue is composed of:

- Cells
- Extracellular material

The extracellular matrix is composed of:

- fibers (collagen fibers, reticular fibers, elastic fibers)
- ground substance is a highly hydrophilic viscous complex of anionic macromolecules.

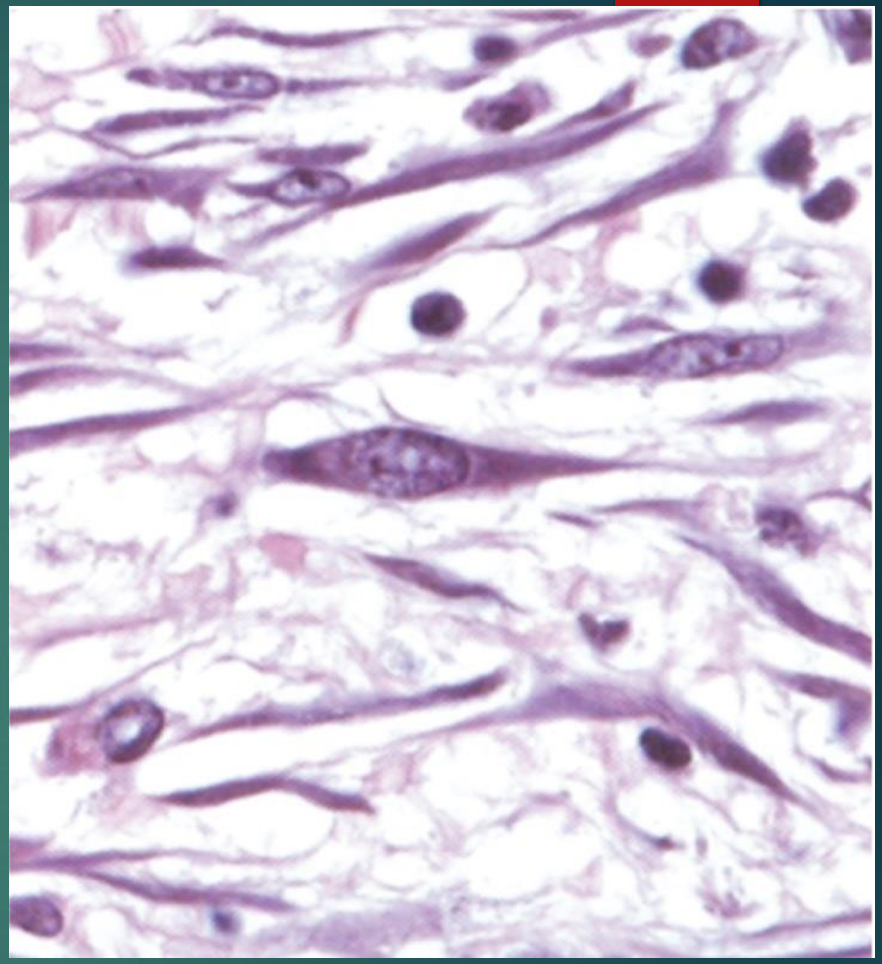
Functions of connective tissue

- 1-Establishing a structural framework and Protecting delicate organs:
- 2-Transporting fluids and dissolved materials:
- 3-Storing energy reserves:
- 4-Defending the body from microorganisms:

Connective tissue component

Cells:

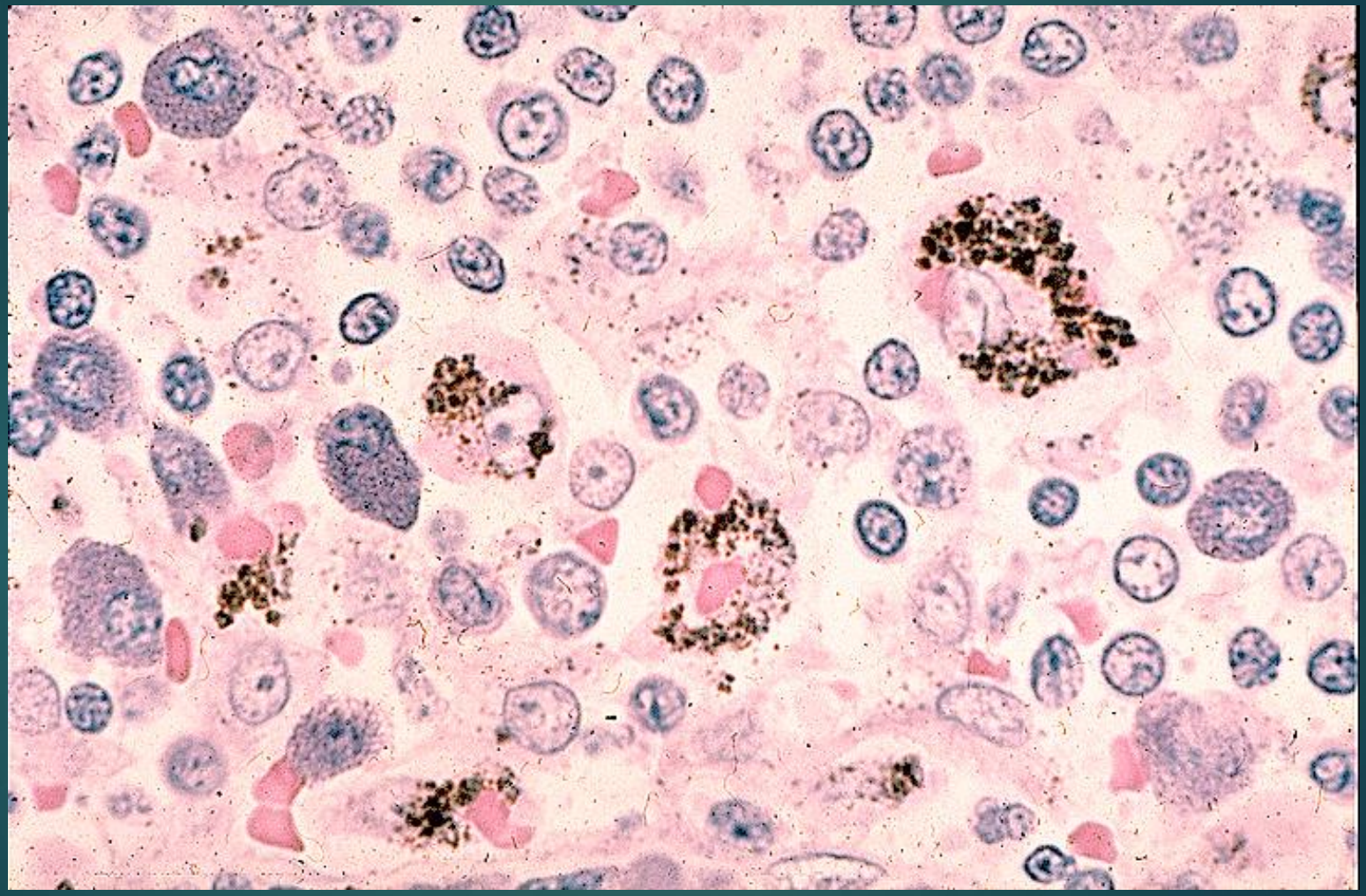
Fibroblasts:



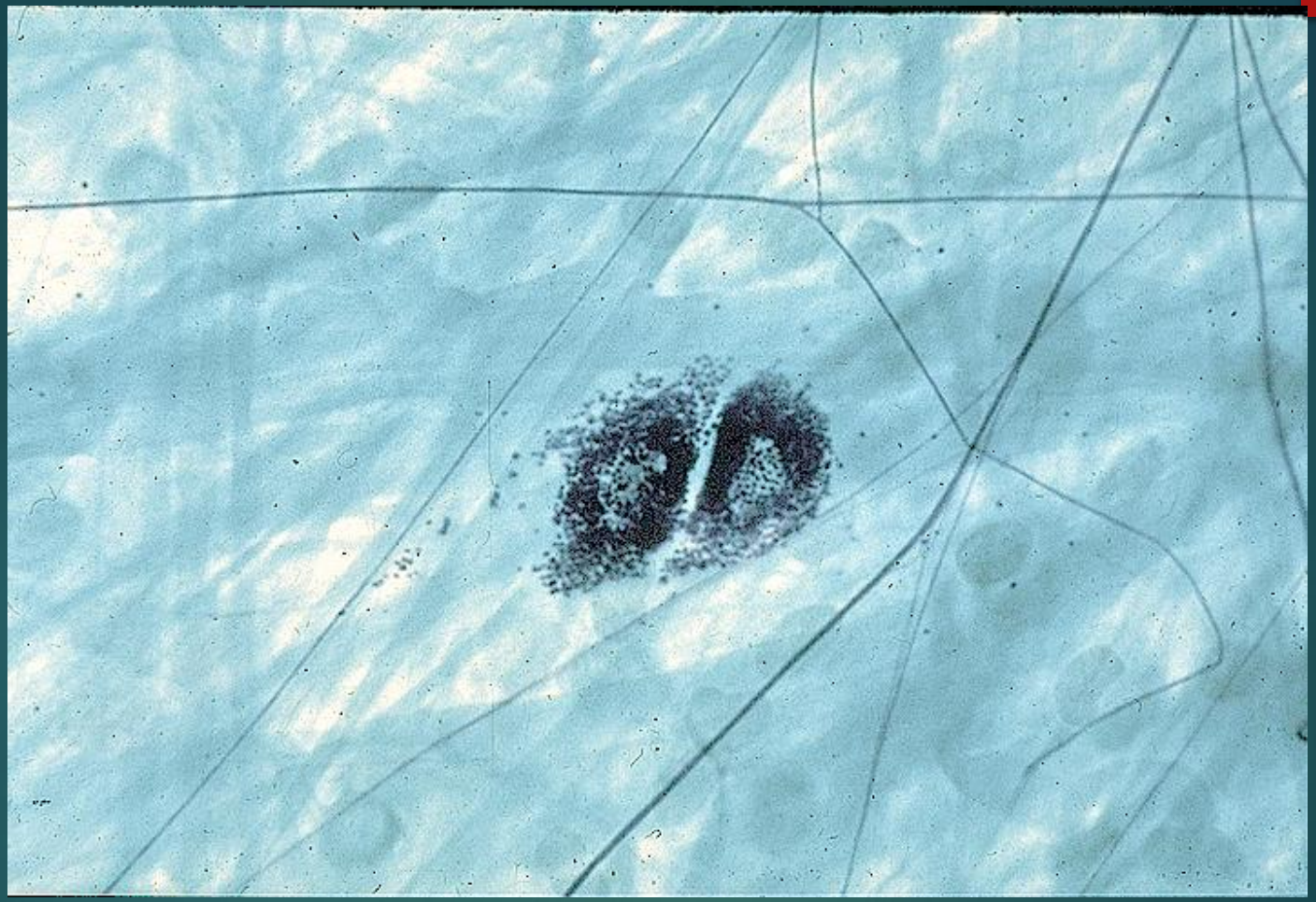
MEDICAL APPLICATION

- Myofibroblast
- wound contraction.

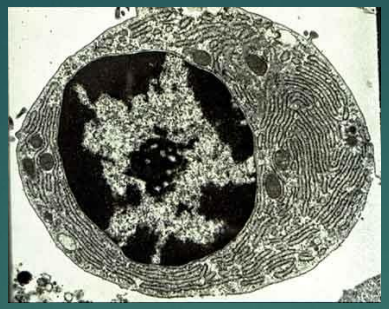
- Macrophages

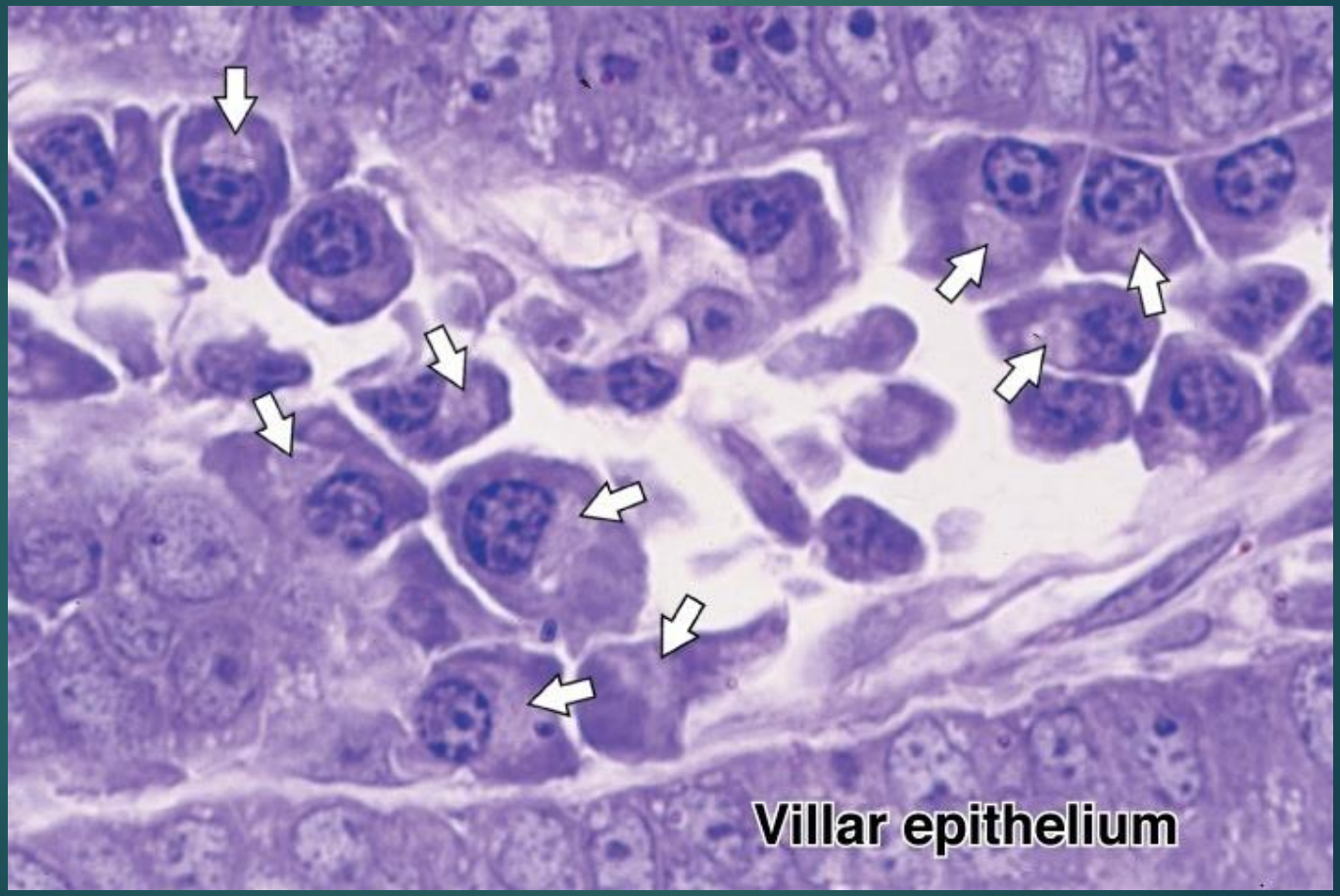


Mast cells

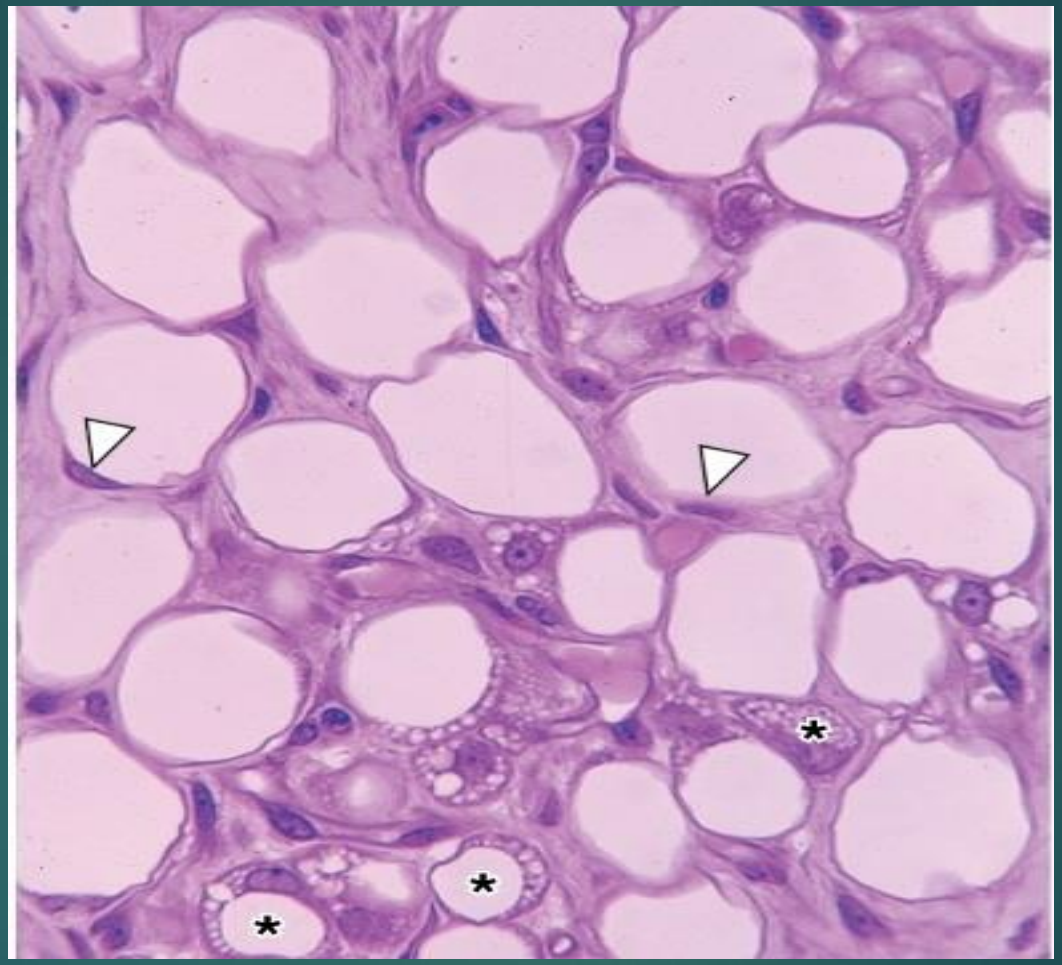


Plasma cells:

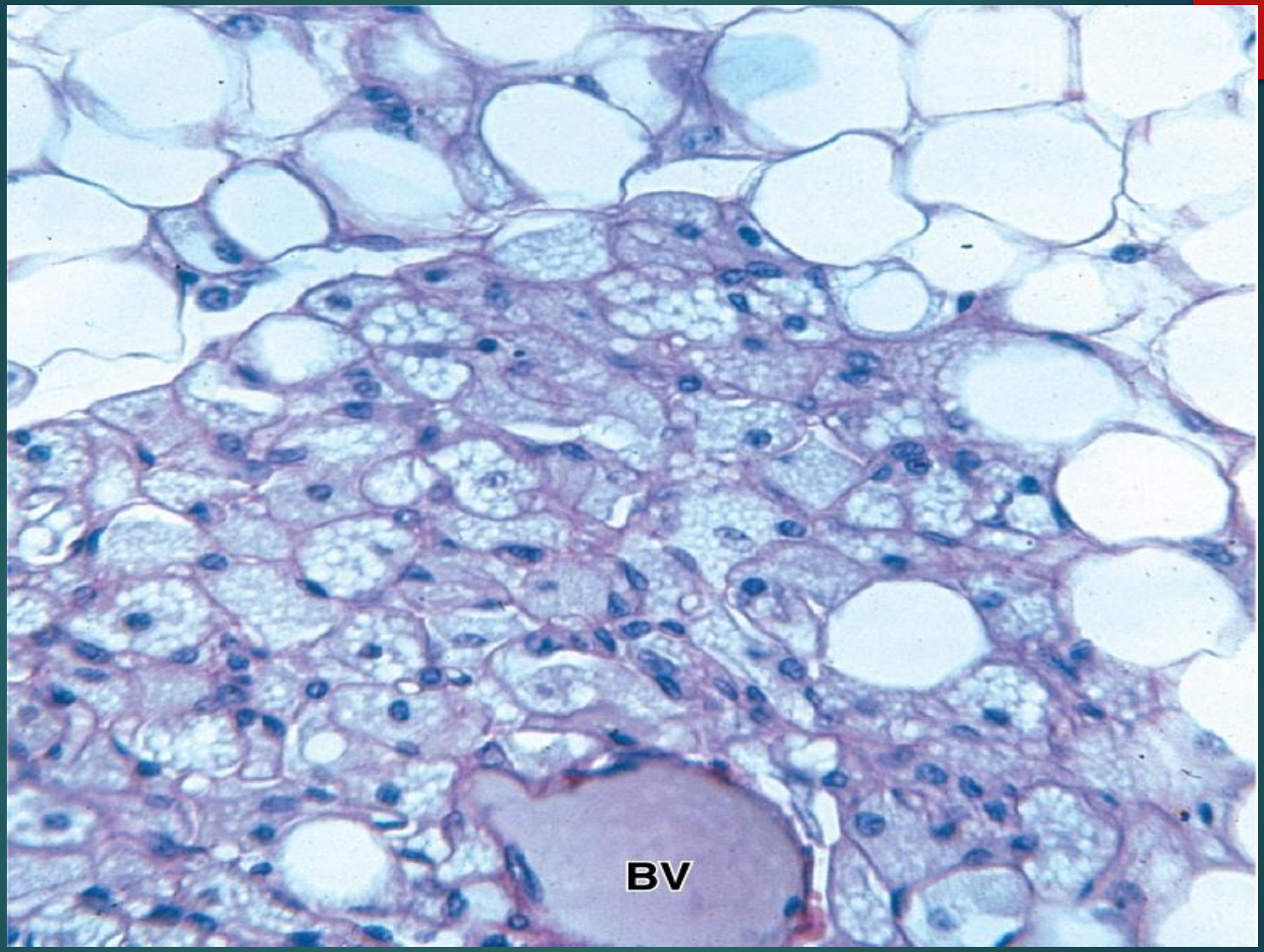




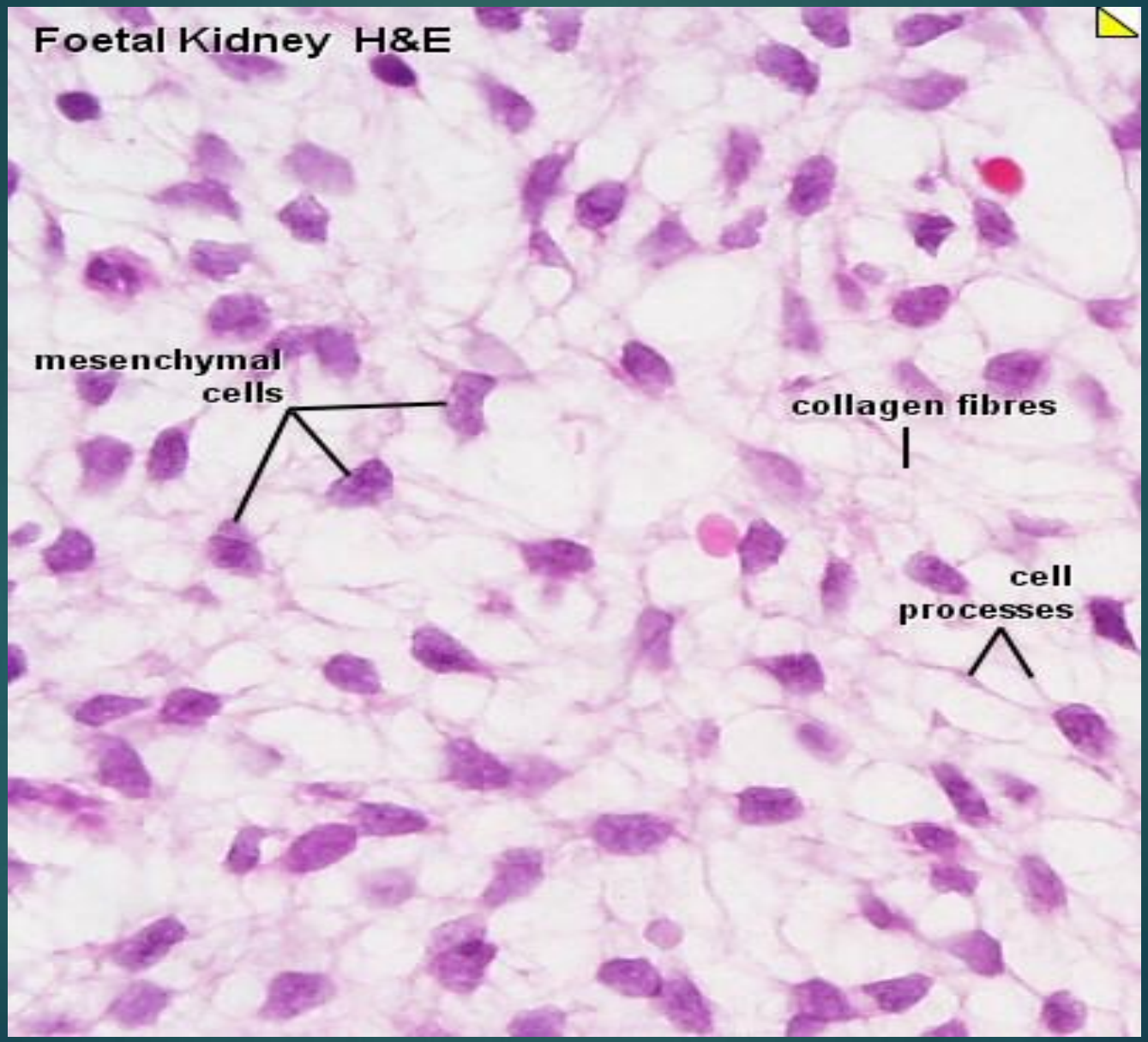
- **Adipose cells:**
- Adipocytes are the cells that primarily compose adipose tissue, specialized in storing energy as fat and produce leptine hormone to control the appetite .There are two types of adipose tissue, white adipose tissue and brown adipose tissue.
  - **White fat cells (unilocular cells):**
- White fat cells contain a large lipid droplet surrounded by a ring of cytoplasm. The nucleus is flattened and located on the periphery. The fat stored is in a semi-liquid state.



- **Brown fat cells(multilocular cells):**
- It is especially abundant in newborns and in hibernating mammals. Its primary function is to generate body heat in animals or newborns that do not shiver .Brown adipocytes contain numerous smaller droplets and a much higher number of mitochondria (rich in iron) and make it brown. Brown fat also contains more capillaries than white fat, since it has a greater need for oxygen than most tissues.


BV

- **Leukocytes:**
- The white blood cells (lymphocytes, eosinophilis, and basophilis) are commonly found in connective tissue. They migrate from the blood vessels to the connective tissue, especially to sites of injury or inflammation.
- **Undifferentiated mesenchymal cells (cells of regeneration):**
- These cells have ability to give rise any kind of cells, it form osteoblasts, chondrocytes, adipocytes, they are smaller than fibroblast but have the same appearance, so it characterized by small cell body, with few cytoplasmic processes, large round nucleus with a prominent nucleolus.


Foetal Kidney H&E
mesenchymal cells
collagen fibres
cell processes

Extracellular matrix

I-Ground Substance:

- amorphous, transparent and colorless extracellular matrix, a semifluid gel and a high water content. It is binding cells to the fibers of connective tissue.

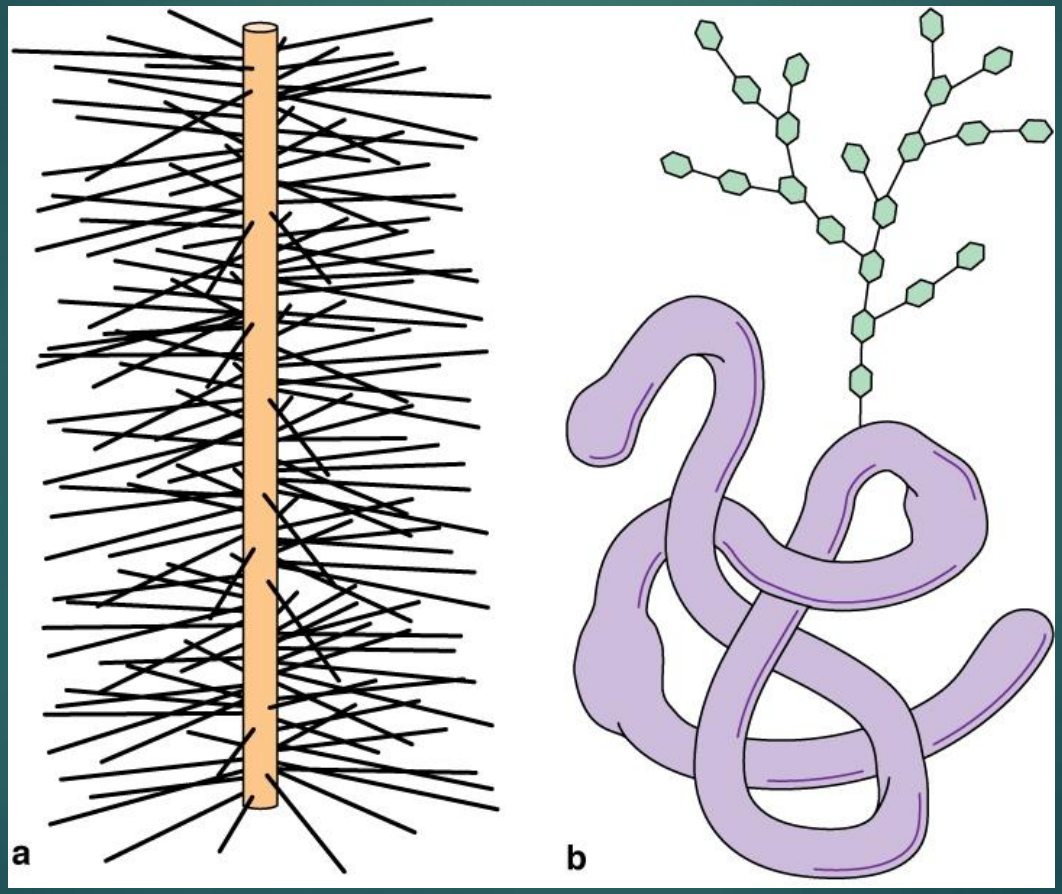
Ground substance composed of:

- **glycosaminoglycans**.
- **proteoglycans**.
- **adhesive glycoproteins**.
- The **glycosaminoglycan** are unbranched polysaccharide molecules of 5 types:
- 1. Hyaluronan (or hyaluronic acid) is the dominant
  2. The remaining 4 are chondroitin sulfate, dermatan sulfate, keratan sulfate and heparan sulfate.

- Except for hyaluronic acid, the other 4 glycosaminoglycans are bound to a core protein to form much larger molecules called **proteoglycan aggregates**. These proteoglycans attract large amounts of water, which forms the hydrated gel of the ground substance.

- The third class of ground substance constituents is **adhesive glycoproteins** responsible for linking the components of the matrix both to one another and to the surfaces of cells. These includes:
- Fibronectin
- Laminin
- Such laminin glycoprotein are the major structural components of the cell basement membrane. This protein binds epithelial cells to the basal lamina.

a proteoglycan
b glycoprotein



- In addition to the hydrated ground substance, there is small quantity of free fluid called interstitial or tissue fluid that is similar to blood plasma in its content of ions and diffusible substances, tissue fluid contain small percentage of plasma proteins that pass through the capillary walls as a result of the hydrostatic pressure of the blood.
- Edema result from accumulation of water in the extracellular space in many pathological conditions. Edema may result from venous or lymphatic obstruction or from a decrease in venous blood flow (e.g, congestive heart failure). It may also be caused by the obstruction of lymphatic vessels due to parasitic plugs or tumor cells and chronic starvation; protein deficiency results in a lack of plasma proteins and a decrease in colloid osmotic pressure. Water therefore accumulates in the connective tissue and is not drawn back into the capillaries.
- Another possible cause of edema is increased permeability of the blood capillary endothelium resulting from chemical or mechanical injury or the release of certain substances produced in the body (eg, histamine).

II-Fibers:

- **Collagen fibers (white fibers):**
- They are the most numerous and strongest fibers in the body derived from connective tissue cells called fibroblasts.
- colorless
- they give the tissue white color when grouped in great no. e.g. in tendon.
- These fibers are straight or wavy, unbranched consist of protein called collagen.
- Collagen fibers always run parallel to each other forming bundles, which branched and anastomose.
-

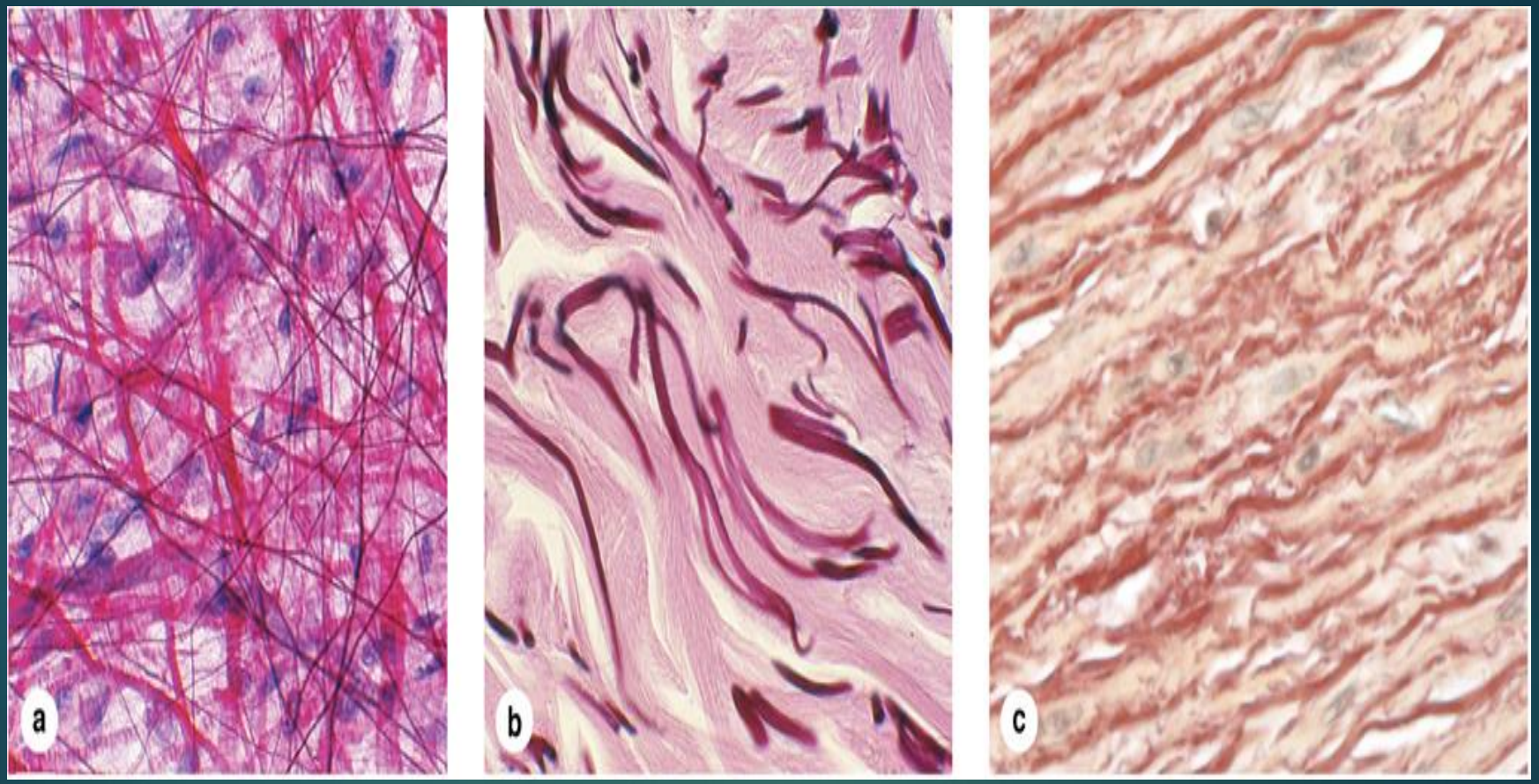
- there are several types of collagen fibers (currently named type I to XXI)

MEDICAL APPLICATION

- Keloid
- Vitamin C (ascorbic acid) deficiency

Elastic fibers (yellow fibers):

- abundant in organs that regularly stretch and then return to their original shape .
- composed principally of a protein called elastin
- thinner than the white fibers, they branched and unite with one another forming irregular network,
- when they present in great quantity they appear yellow,
- the fibers run individually and not in bundle.
- They are not stained with heamatoxylin-eosin, but stain with special stain orcein, they are generally formed by fibroblasts.
  - **Medical application:**
  - **Marfan syndrome**


a
b
c

- **Reticular fibers:**
- Reticular fibers are another form of collagen (Type III). They are arranged as a loose meshwork of thin fibers providing supportive scaffolding for the specialized cells of various organs as well as blood vessels.
- They are formed from collagen, and they are not stained with heamatoxylin-eosin, but stained with silver stain and appear black, they are associated with special cells called reticular cells.

- **Clinical Correlation:**
- **Sun Exposure and Molecular Changes in Photoaged Skin**
- **Chronological aging** of the skin
- **photoaging.**

Connective tissue classification

- Connective tissue proper

1. Dense
   - Regular
   - Irregular
2. Loose

- Connective tissue with special properties

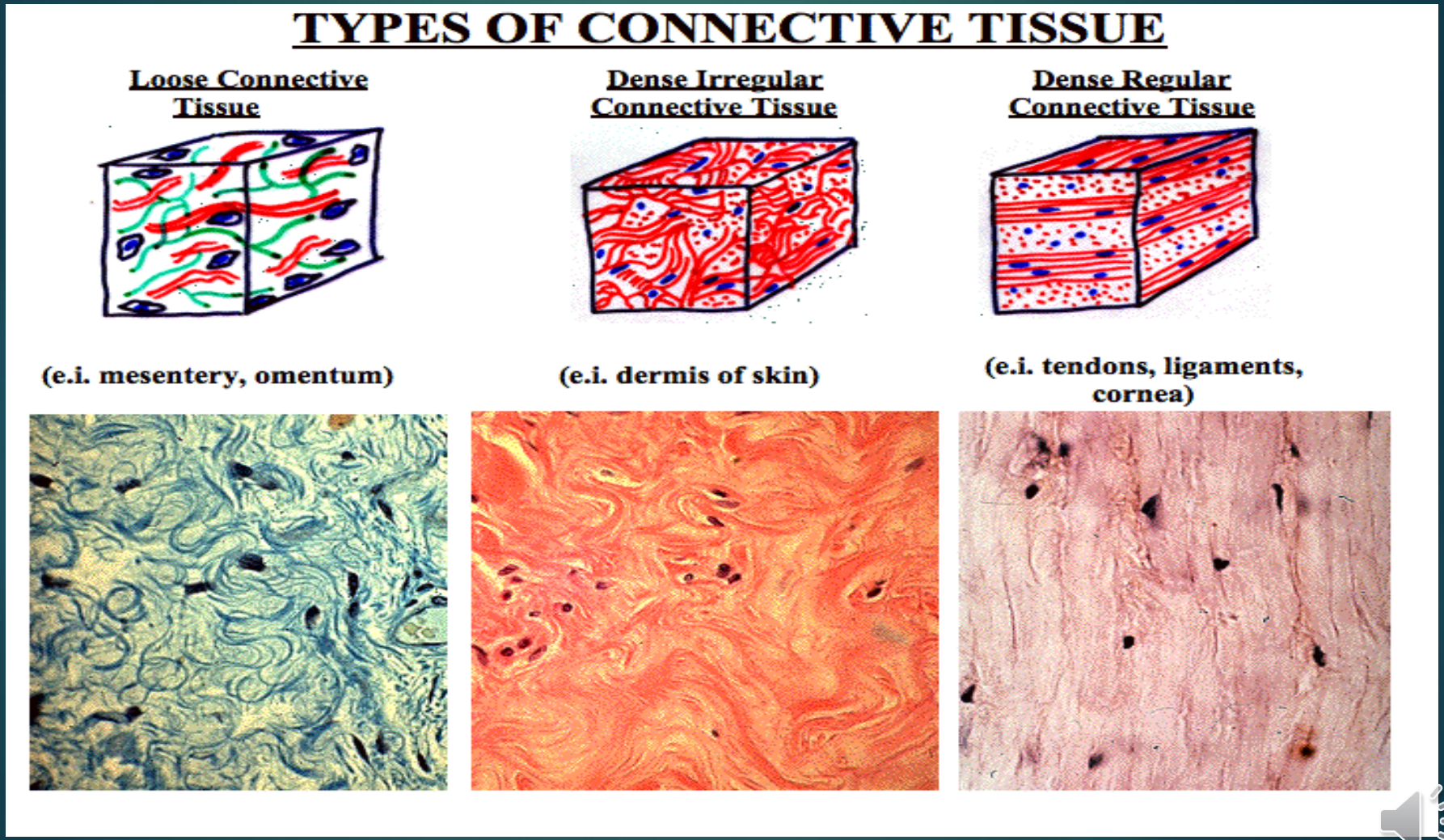
1. Adipose tissue
2. Mucous tissue
3. Hematopoietic (lymphatic and myeloid)
4. Elastic tissue

- Supporting connective tissues

1. Cartilage
2. Bone

I-connective tissue proper:

- a-Loose Connective Tissue:



II- Connective tissue with special properties:

- **Elastic tissue:**

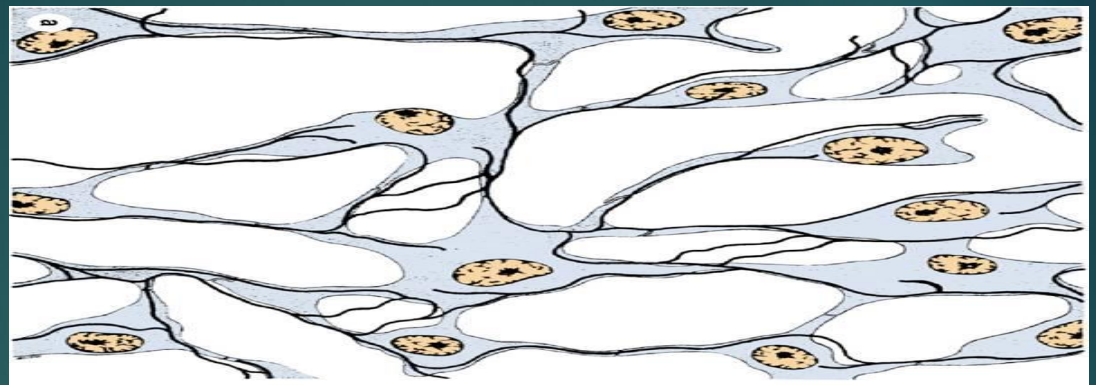
  Elastic tissue is composed of bundles of thick, parallel elastic fibers. The space between these fibers is occupied by thin collagen fibers and flattened fibroblasts.

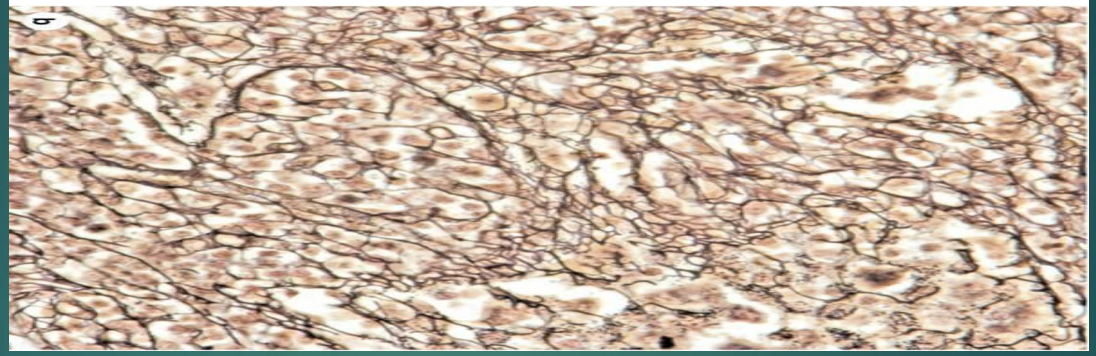
- **Mucous tissue:**

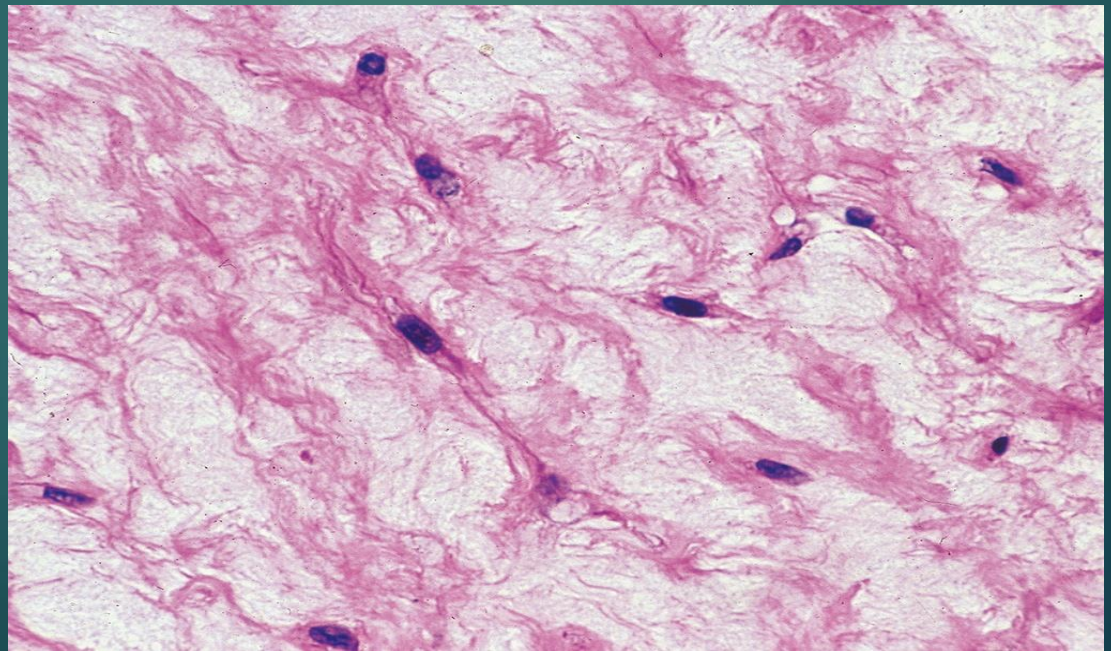
  This is found in the umbilical cord (Wharton's jelly). It is a loose connective tissue composed of fibroblasts

- **Reticular tissue:**

  The very delicate reticular tissue forms three dimensional net-works that support cells. Reticular tissue is a specialized loose connective tissue consisting of reticular fibers initially associated with specialized fibroblast called reticular cells.







- **Mesenchymal tissue:**
- Is the connective tissue of embryo, consists of mesenchymal cells in a gel like amorphous ground substance containing scattered reticular fibers.

Home work

- Q1: what is the function of the following connective tissue cells:
- A. fibroblast
- B. plasma cell
- C. mesenchymal cell

Thank you