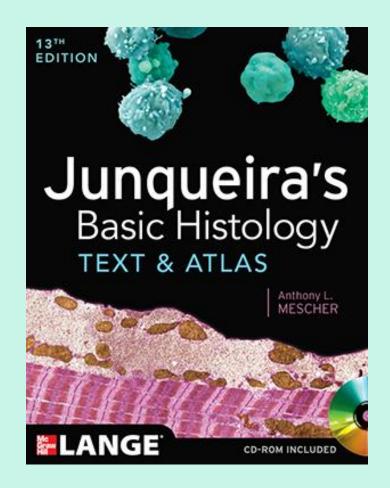
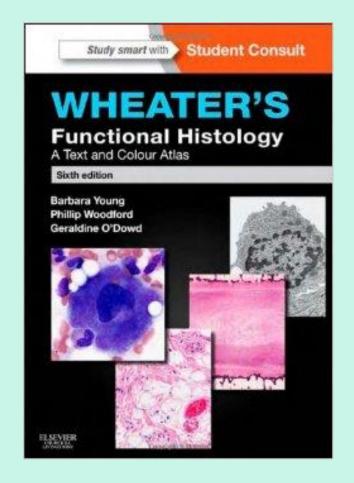
## **CONNECTIVE /SUPPORTING TISSUE**

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Dept of Anatomy
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Ragama



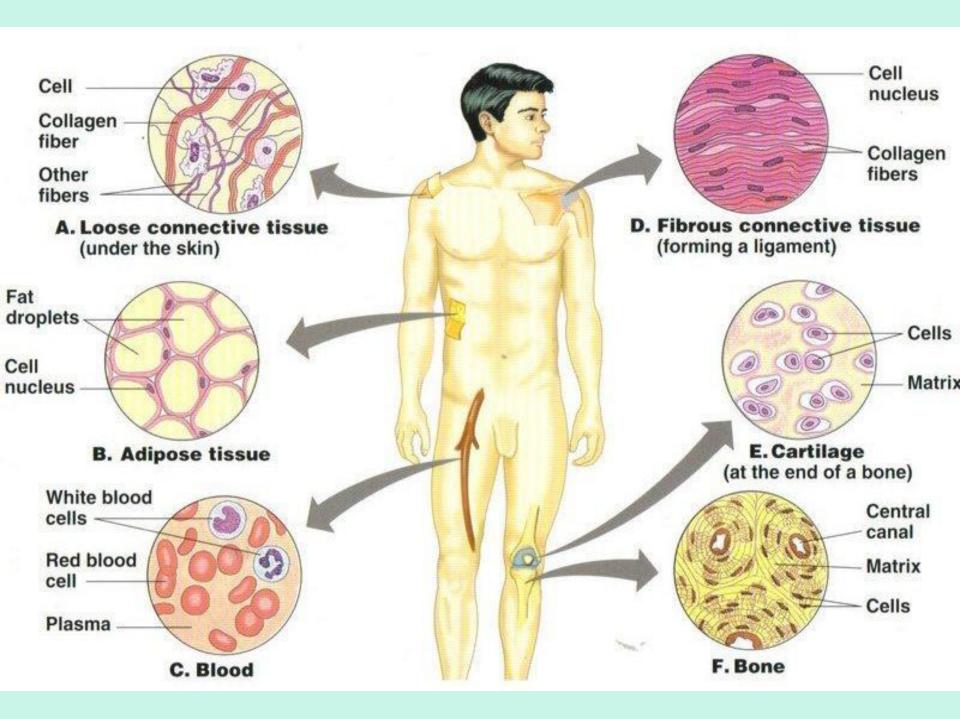


## **Objectives**

- state the general functions of connective tissue
- classify connective tissue
- state the location of each type of connective tissue
- state the functions and staining properties of the following
  - a) areolar tissue
  - b) elastic fibres
  - c) collagen fibres
  - d) adipose tissue
- list the different types of cells in connective tissue

## What is connective Tissue?

- Connective tissue fills the spaces between organs and tissues
- Provides structural and metabolic support for other tissues and organs.

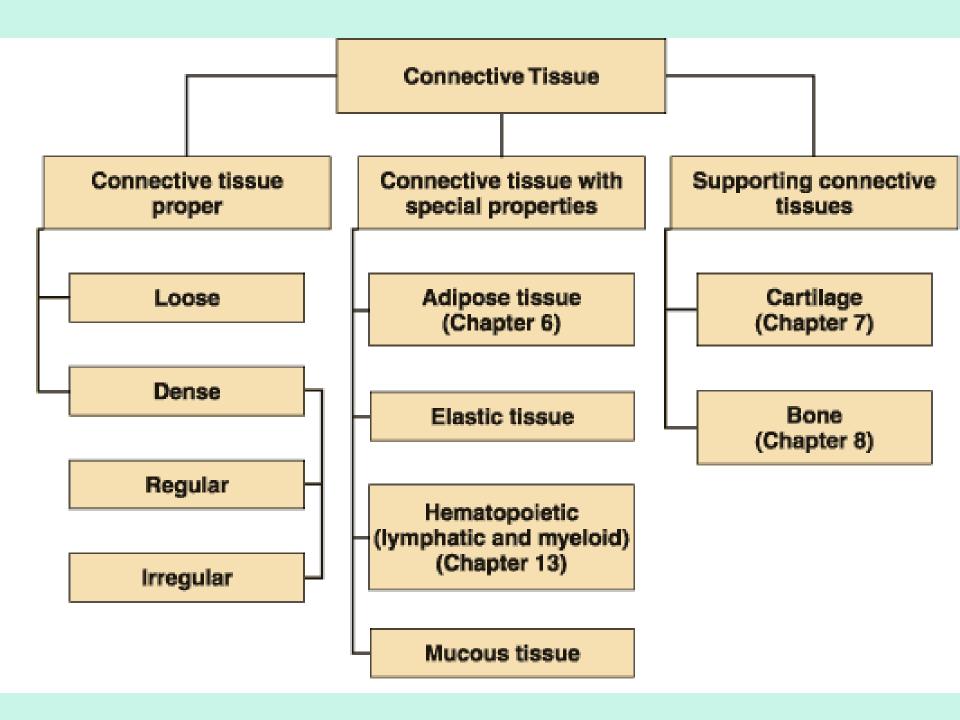


This is a type of supporting tissue which connect .......

- tissues to tissue
- tissues to structures
- tissues to skeleton

### Tissue which provides

- structural and metabolic support
   Tissue which functions as .....
- medium of exchange of nutrients and metabolites



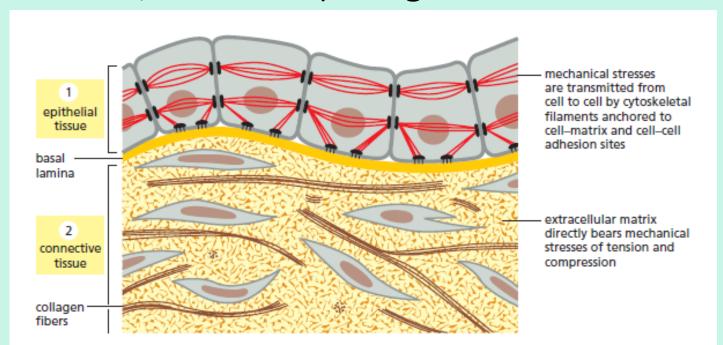
## **General Functions of Connective Tissues**

- 1) <u>To join together</u> the other tissues of the body (tendons and ligaments)
- 2) Support (trachea, bones)
- 3) Protect underlying organs (skull)
- 4) Transport (blood)
- 5) Nutritive Functions (blood)
- 6) Immune Function (lymphocytes/white blood cells)
- 7) Storage sites & insulation (Fat tissue)

## Connective tissue (CT) is formed by...

1.Cells 2.Fibers 3. Ground substance

- -Main component of CT is extracellular matrix-(EC matrix)
- -EC matrix consist of different **protein fibers** (collagen, reticular, and elastic) and **ground substance**.



## Connective tissue (CT) is formed by ...

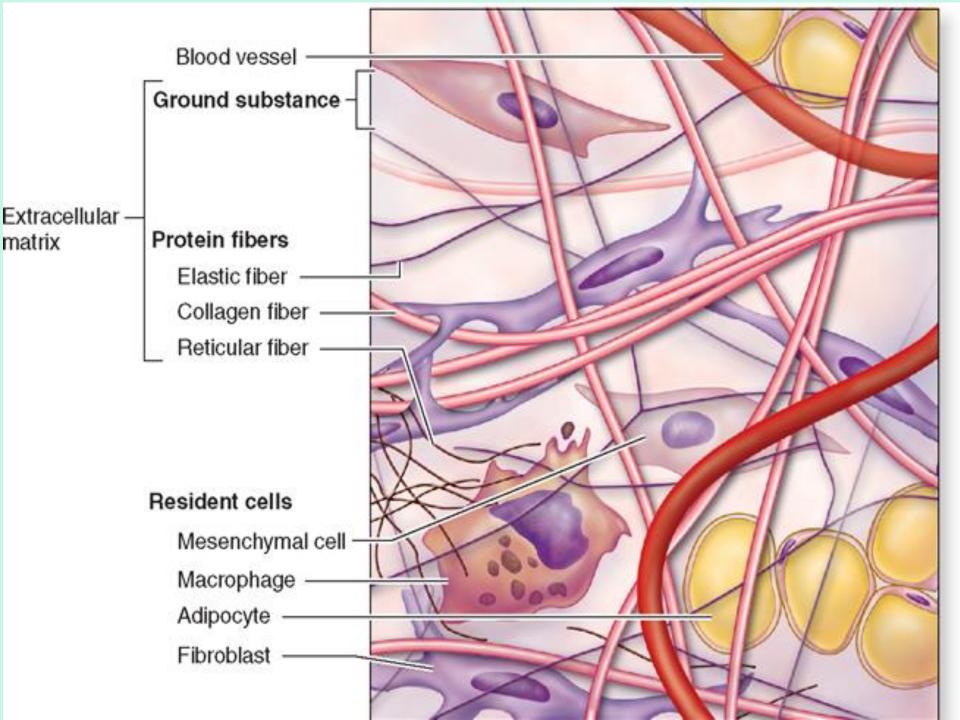
- EC matrix consist of different **protein fibers** (collagen, reticular, and elastic) and **ground substance**.
- EC matrix is the dominant component of certain supporting tissues
- It determines the physical properties of each type.

#### **Ground substance**

- -Gel like arrangement of organic material in EC matrix----
- -Highly hydrophilic
- Embedded a variety of *fibres*

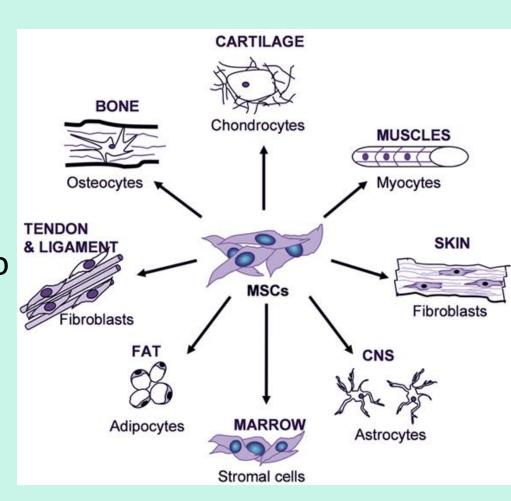
## Home work .....

• List the functions of ground substance (10 marks)

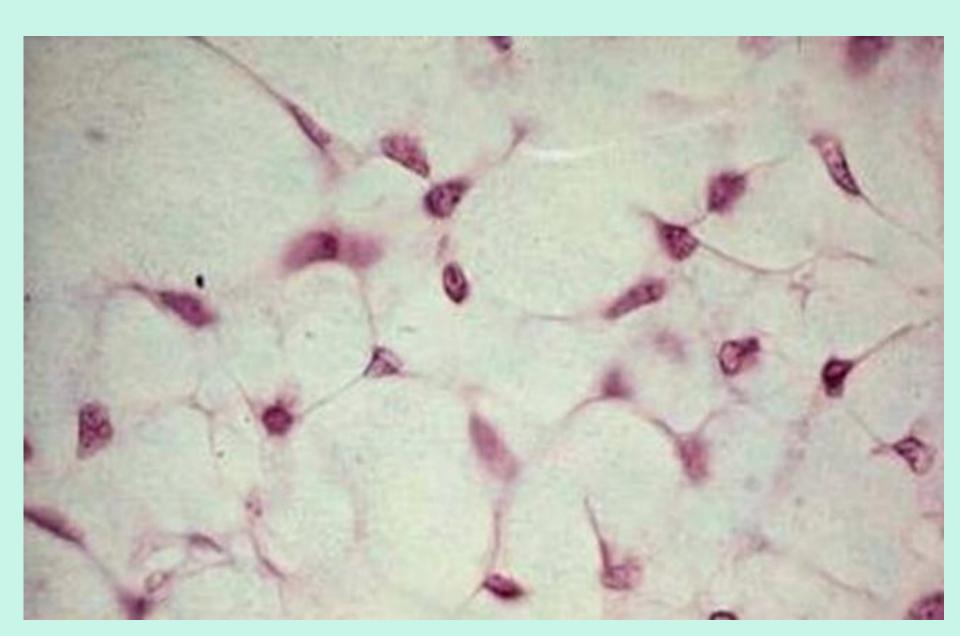


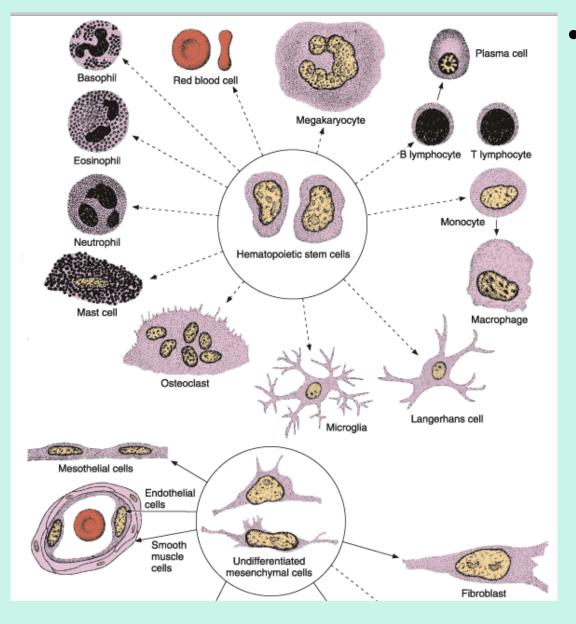
## **Development of Connective tissues**

- Connective tissues originate from the mesenchymal cells
- Elongated cells
- characterized by
  - An oval nucleus
  - Prominent nucleoli
  - Fine chromatin
- Mesodermal cells migrate from their site of origin to developing organs
- Main production is fibroblast



## **Mesenchymal cells**





- Other cells of CT such as
  - mast cells,
  - Macrophages
  - plasma cells

originate from haematopoetic stem cells in bone marrow.

# Three types of cells in CT relation to their basic functions

1.Fibroblasts



2.Tissue macrophages, mast cells and leucocytes –



defense and immune functions

3.Adipocytes



Storage



Metabolism of fats

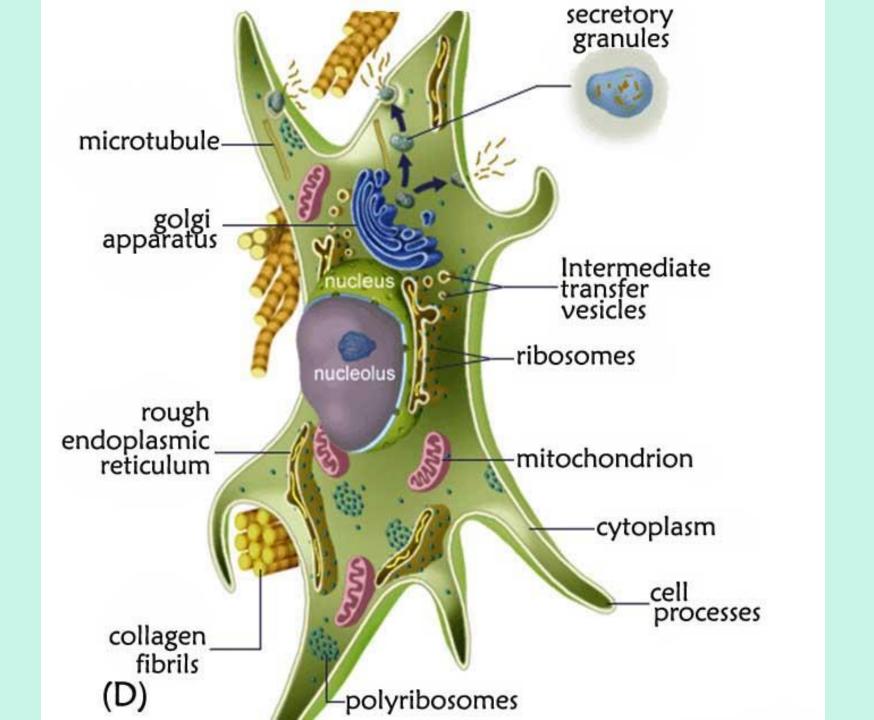
### **Fibroblasts**

- Maintain integrity of supporting tissue
- Most numerous cells.

Main function-Produce -Fibers

-Ground substance of the EC matrix

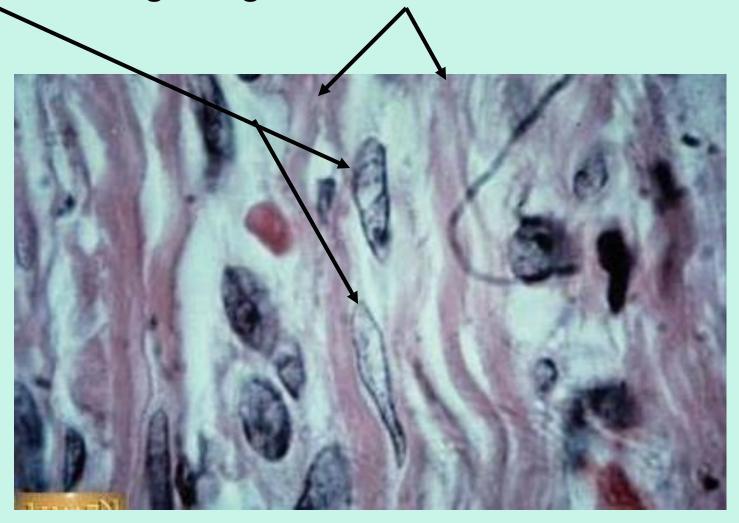
- Large flattened cells with ovoid nuclei
- Long cytoplasmic processes
- When active nucleolus is prominent
  - have fine chromatin granules
- Presence of well developed ribosomes, rER and golgi indicate that the cell is active in protein synthesis
- Secretion influenced by Age & Hormones



# Rough endoplasmic reticulum



• Fibroblsts among collagen fibres

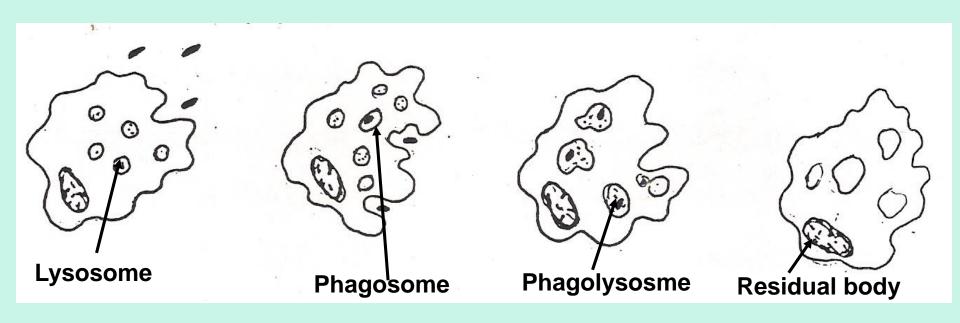




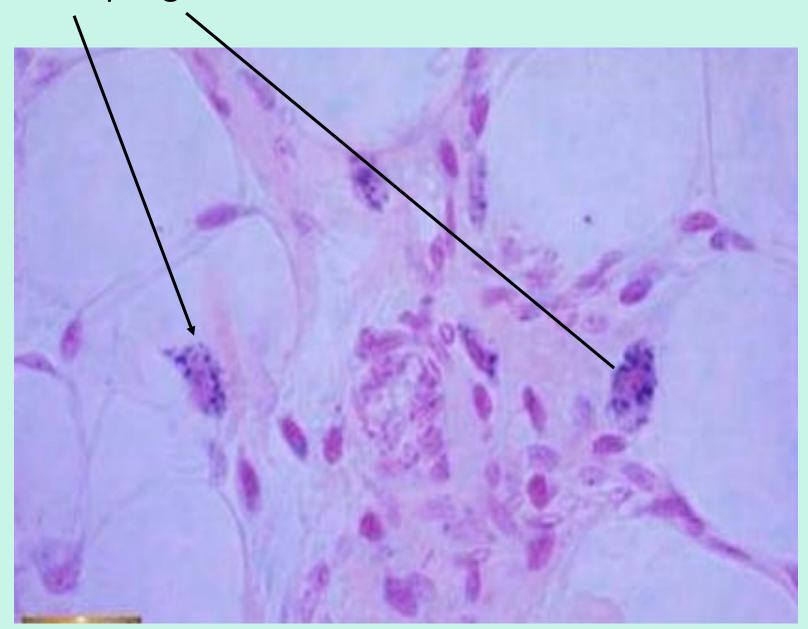
## **Macrophages**

- Macrophages are derived from blood monocytes (A type of white blood cell)
- Monocytes migrate to the peripheral tissue and become macrophages
- Ovoid cells; Oval nucleus indented towards one end
- Contains heterochromatin
- Exhibit intense phagocytic activity
   (Lysosomes/ phagolysosomes /secondary lysosomes, residual bodies)
- Engulf and digest cellular debris, foreign substance, microbes, cancer cells by phagocytosis

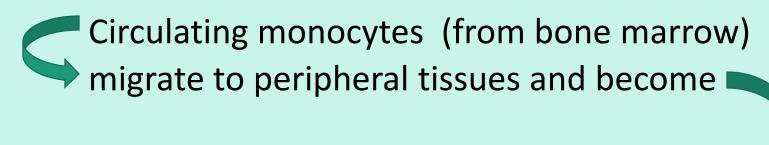
- Active state contain lysosomes in abundance
- Active cells throwing pseudopodia move in amoeboid movement and phagocytose material
- Macrophages take part in the immune mechanism
   Phagocytose bacteria



Macrophages



### Concept of -monocyte macrophage system

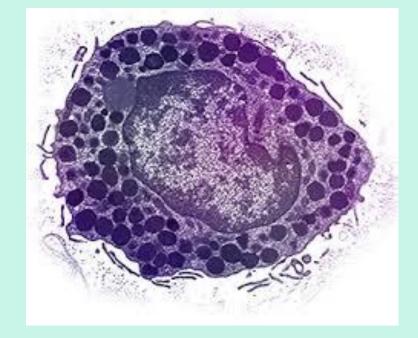


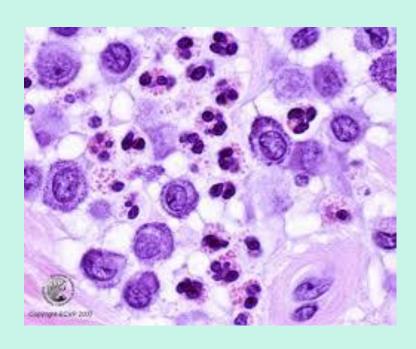
Tissue macrophages

- Includes Kupffer cells of liver
  - Microglia of CNS
  - Langerhan cells of skin
  - Osteoclasts of bone
- During inflammation macrophages increase at site by
  - Cell multiplication
  - Migration of blood monocytes

### **MAST CELLS**

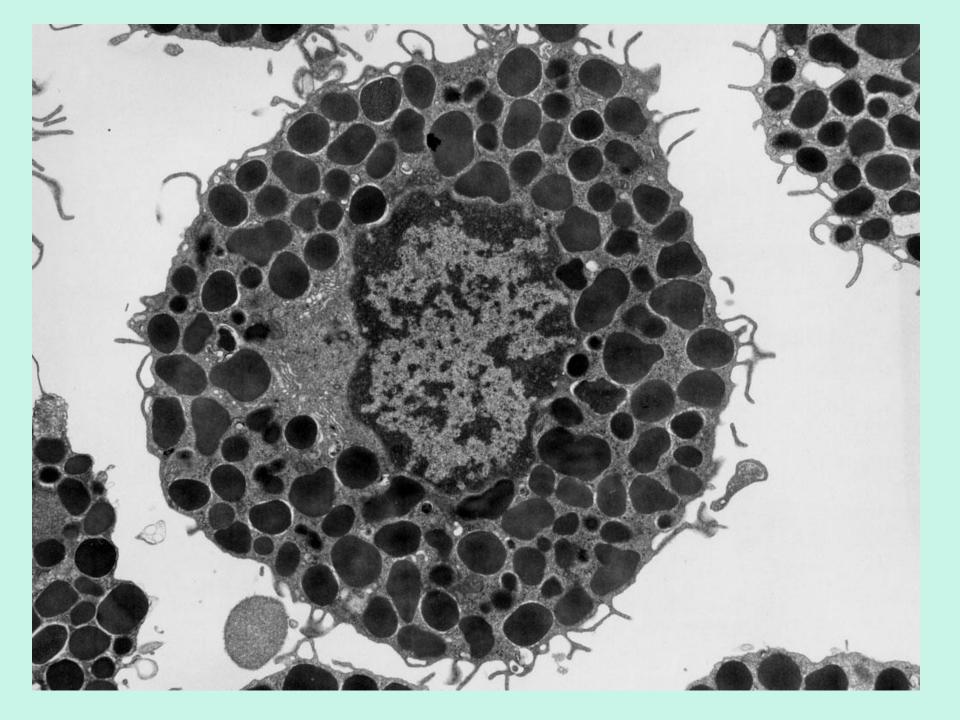
- Found in all types of supporting tissue
- Also beneath the skin
- Deep to the lining of the GI and respiratory tracts
- Around blood vessels
- Similar to basophils
- Extensive cytoplasm
- Large granules (toluidene blue shows granules in red )
- Granules are membrane bound
   Metachromasia





Substance released –
 histamine and other vasoactive substances that
 induce hypersensitivity response – increased
 permeability of capillaries and small venules [e.g urticaria,
 rhinitis, asthma]

#### Components of Inflammation Mast cell Fibroblast Macrophage CONNECTIVE CELLS Smooth muscle Basophil VESSELS leukocyte Lymphocyte Endothelium Basement membrane roteoglycans

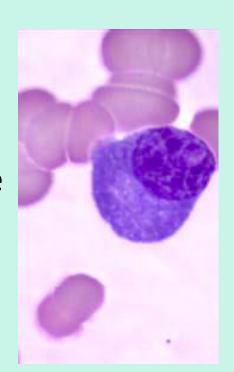


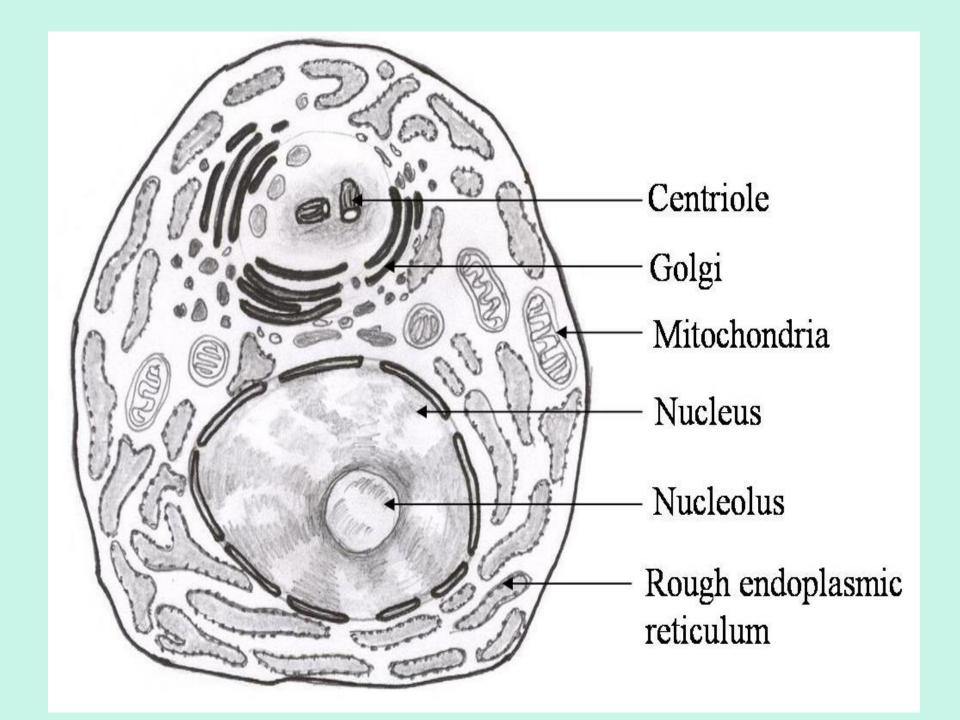
## Leucocytes-Plasma cells

- Extensive basophilic cytoplasm (RER and ribosomes)
- Pale stained Perinuclear area well developed active
   Golgi
- Eccentric nucleus chromatin radiating

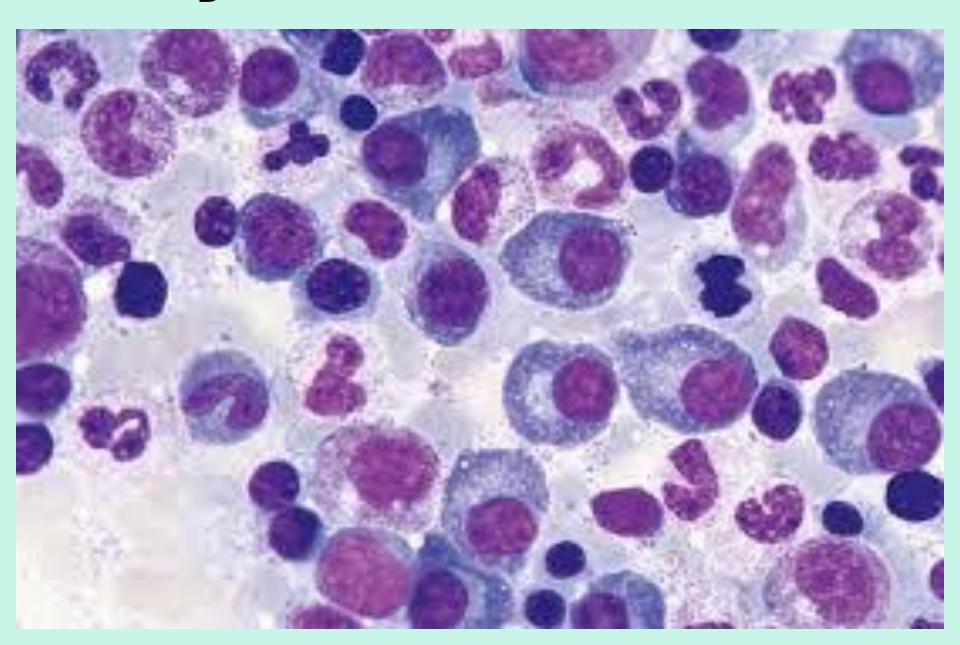


- Immunologically active plasma cells produce antibodies
- Larger than lymphocytes





# Leucocytes-Plasma cells



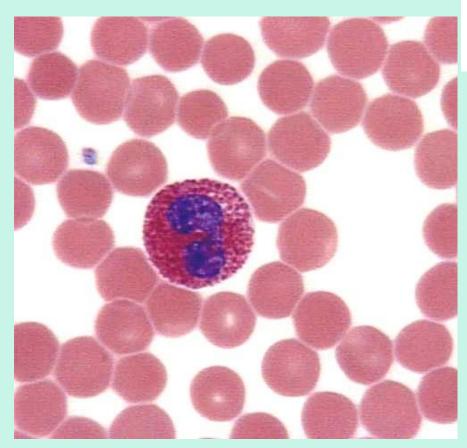
## **Leucocytes - Neutrophils**

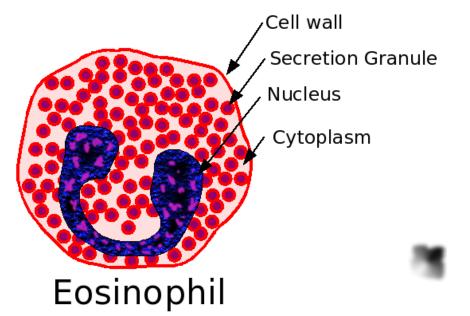
Rare in CT except in acute or chronic inflammation



## **Eosinophils**

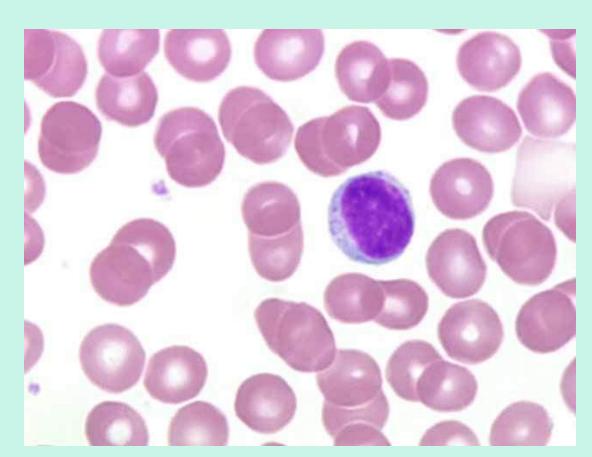
- Present in large numbers
- Bilobed nucleus

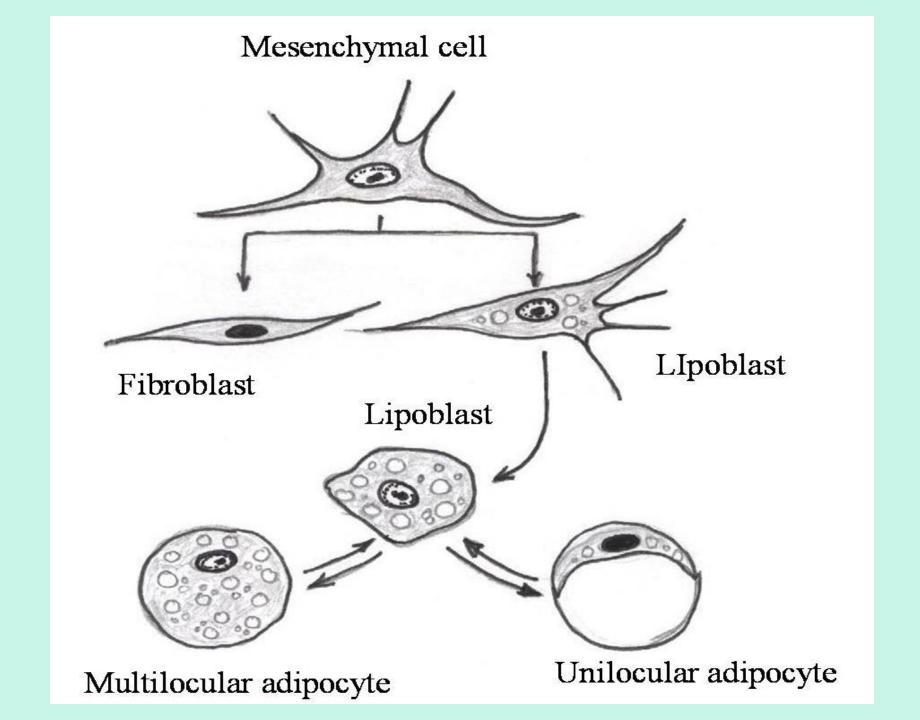




## **Leucocytes -Lymphocytes**

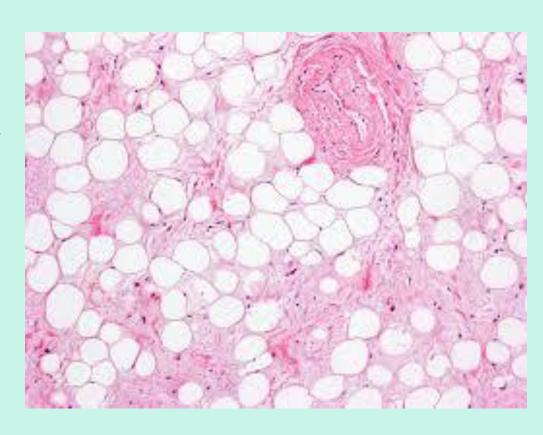
- Recognized by their dense nucleus
- Thin rim of cytoplasm





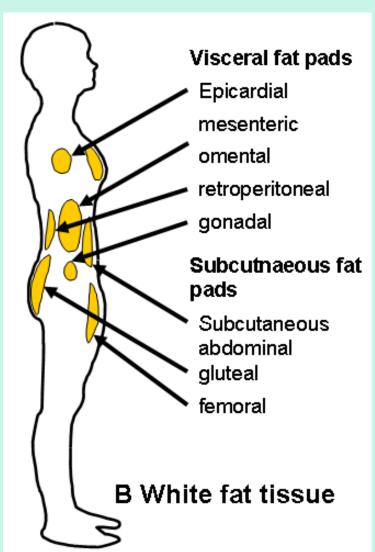
## Adipocytes

- Adapted for the storage of fat
- Found in clusters in loose connective tissue
- Main cell type in adipose tissue
- Two main types-
  - white adipose tissue
  - brown adipose tissue



# White adipose tissue

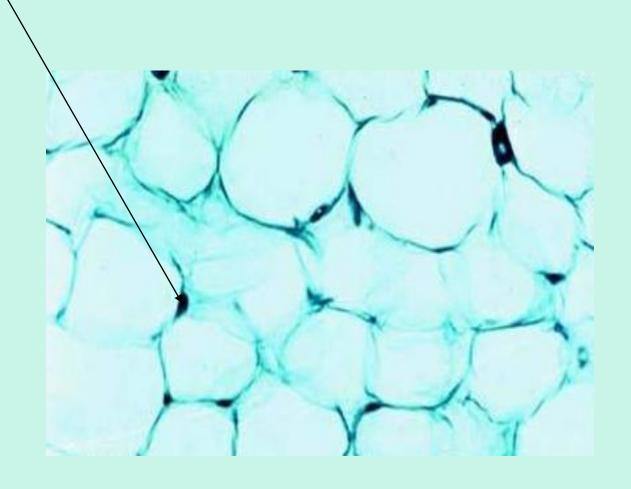
- Found throughout the body in the deep layers of the skin
- Forms an energy store
- An insulator

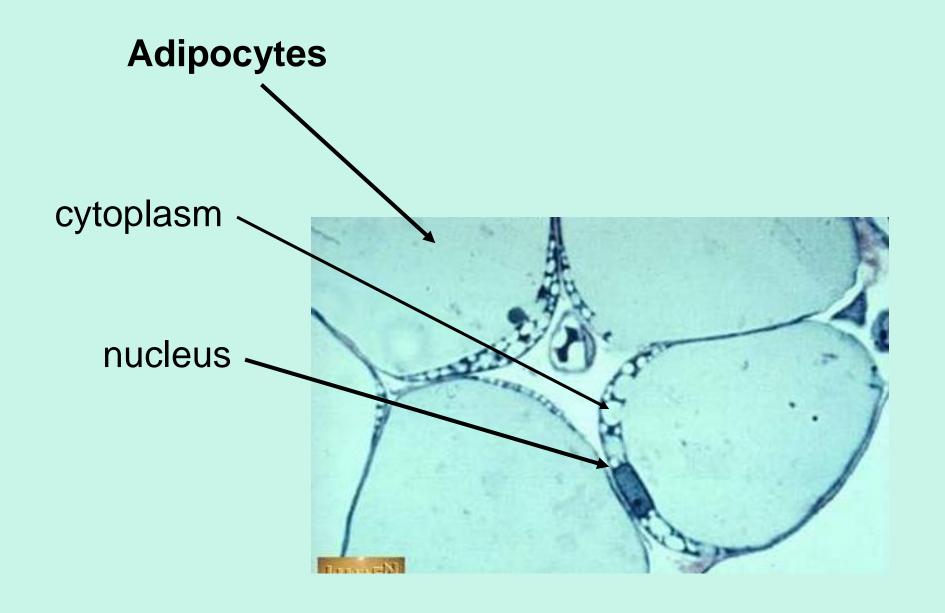


# White adipose tissue

- Fat stored in the form of lipid droplets
- They accumulate and form large droplets in the cytoplasm
- Cytoplasm is reduced to a thin rim nucleus becomes compressed
- EM shows the main droplet with an irregular outline
- smaller droplets are seen in the periphery
- Mitochondria are found in peripheral cytoplasm

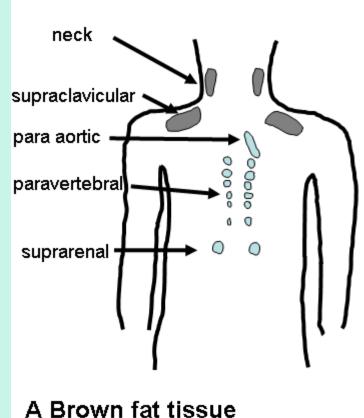
 Nuclei are eccentrically located and are rounded.\





# **Brown adipose tissue**

- highly specialized
- found in newborns
- plays a part in temperature regulation
- arranged in lobules separated by fibrous septa.
- lipid is stored as minute droplets giving rise to multilocular appearance

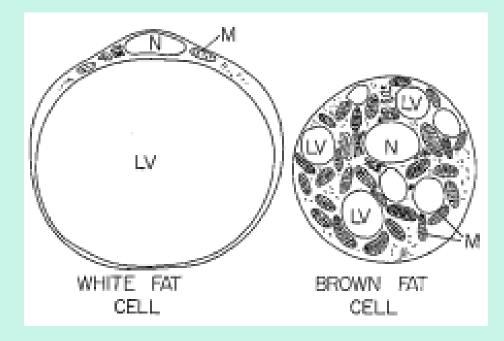


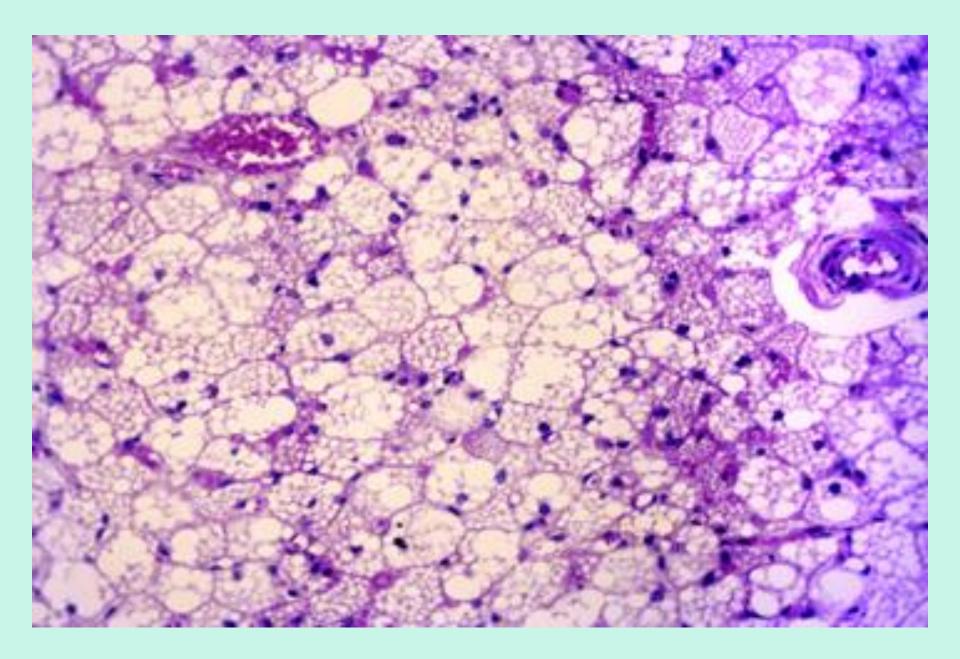
# Brown adipose tissue

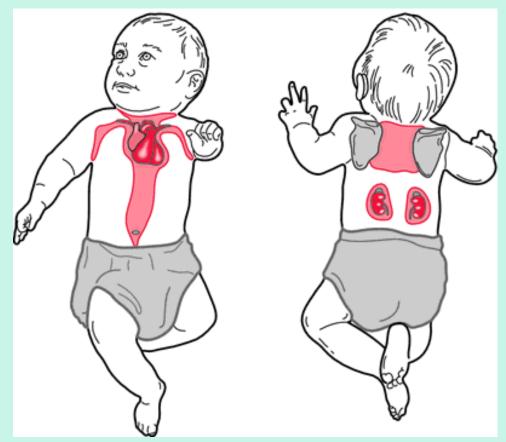
- cytoplasm stains intensely because mitochondria
   with numerous closely packed cristae for cytochromes involved in energy production.
- Undergoes involution in early infancy

• In adults found in small amounts, around the adrenal

gland and great vessels







- located on the back along the upper half of the spine and toward the shoulders
- great importance to avoid lethal cold
- hypothermia is a major death risk for premature neonates

## **Fibres**

#### Two types

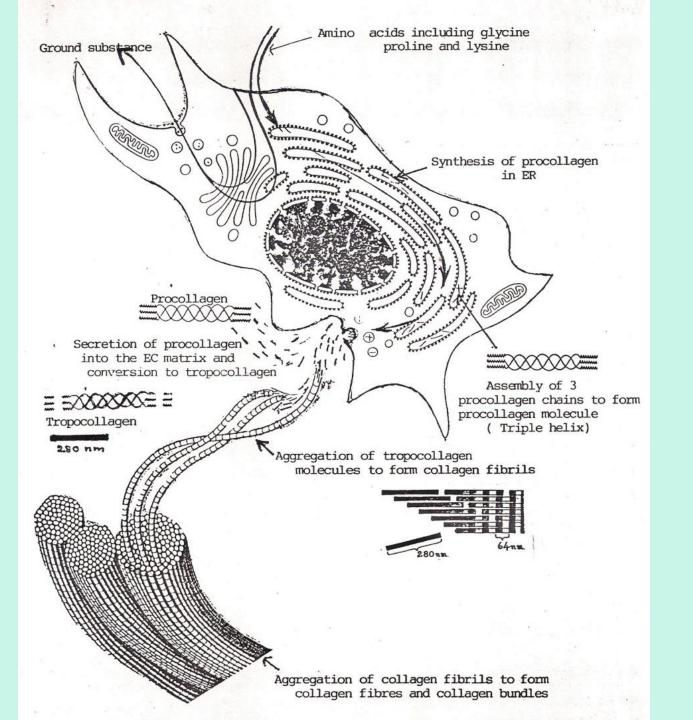
- Elastic (yellow) fibres.
- Collagen (white) fibres

#### Collagen is found in all types of supporting tissue

- Most abundant protein
- Flexible and has a high tensile strength
- Collagen is secreted by fibroblasts as tropocollagen molecules
- secreted to the extracellular matrix
- Coarse collagen fibres are formed by type I tropocollagen

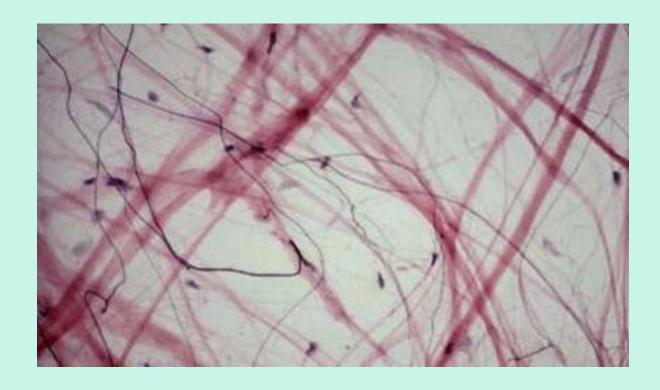
- Several types on the basis of its morphology, amino acid composition and physical properties.
- Type 1 collagen found in loose supporting tissue
  - -in the dermis
  - -in tendons and ligaments
  - -in the bone
- the arrangement varies depending on the mechanical support required
- collagen fibrils are arranged in bundles
- 2-10μm in diameter.

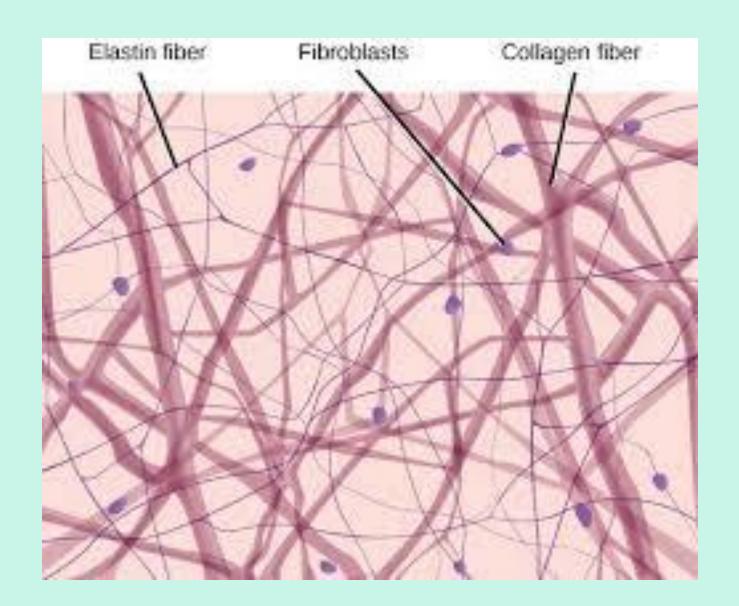
- Type 2 collagen is found as fibrils in <u>hyaline cartilage</u>
- Type 3 collagen are the reticular fibres
- form a branched network in cellular organs
  - Eg liver and lymphoid tissue.
- Type 4 collagen <u>does not form fibrils.</u>
  It is an important constituent of the <u>basement</u> membrane.



#### Areolar connective tissue

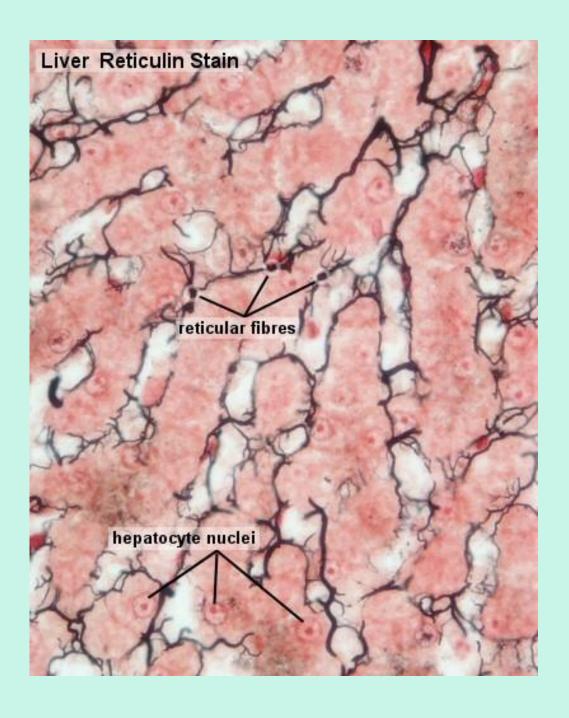
- All pink fibers collagenous fibers.
- Dark, thin, more tortuous fibers elastic fibers
- Most of the nuclei are fibroblasts nuclei





#### **Reticulin fibres** – (Type 3)

- frame work organs ———— liver and lymphoid tissue
- fine network of branching fibres
- anchored to the collagenous capsule
- not clearly seen in H&E sections
- stain black with silver stains
- Reticulin fibres are the earliest collagen fibres to produced



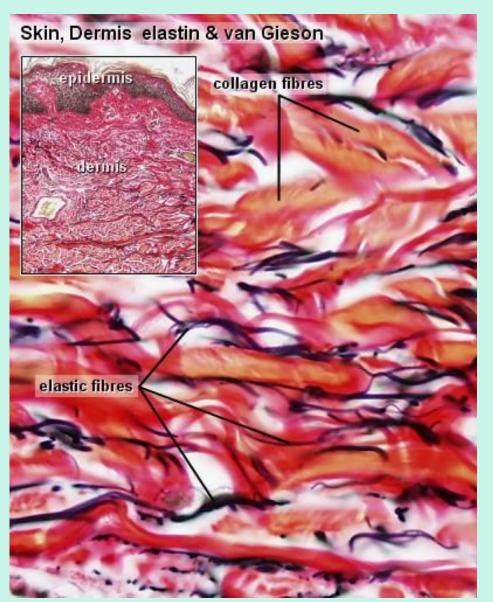
### Home work

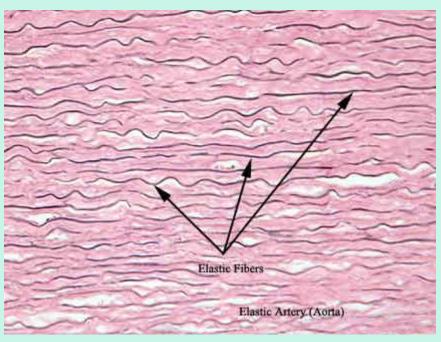
Write short notes on Elastic fibers? (20 Marks)

#### **Elastic fibres**

- thinner than collagen
- no banding.
- short branching fibres form an irregular network
- Electron microscopy shows that elastic fibres consist of individual microfibrils
- are embedded in an amorphous matrix.
- matrix accounts for about 90% of the fibre and is composed of the protein elastin.
- Neither the elastin nor the microfibrils are collagens
- Special stains are necessary to show elastic fibres in tissue sections

#### A - Elastic Fibres





### Home work

• Briefly describe ground substance ? ( 20 marks)

#### **Ground substance -**

- Amorphous transparent material semifluid gel
- Cells and fibres are embedded
- Glycosaminoglycans 
   — mucopolysaccharides
   hyaluronic acid linked with protein molecule to form
   mucoproteins proteoglycans
- Ground substance is a medium of nutrients, gases and metabolites with which exchange of substance occur between cells and capillaries
- Ground substance act as mechanical barrier to prevent bacteria entering the body
- Prevent spread of microorganisms
- Act as a selective barrier containing inorganic ions and charged molecules

#### **Ground substance -**

- Large molecules loosely linked to one another
- Spaces between the molecules and electrostatic charges determine permeability and viscosity
- Attracts large volumes of water and Na ions- EC fluid
- Mechanical properties enhanced by fibrous protein-mediate interaction of cells with other constituents

### Home work

Describe types of supporting tissue? (50 marks)

#### TYPES OF SUPPORTING TISSUE

# 1.Loose irregular ordinary supporting tissue (areolar tissue)

- widely distributed in the body
- a meshwork of thin collagen and elastic fibres
- all cells types are found among the fibres

#### 2. Dense irregular supporting tissue

- dermis, capsules of organs, periosteum.
- a network coarse collagen fibres, few elastic or reticular fibres
- Fibroblasts are few

#### 3. Dense regular supporting tissue-

collagen fibres are densely packed with a regular arrangement

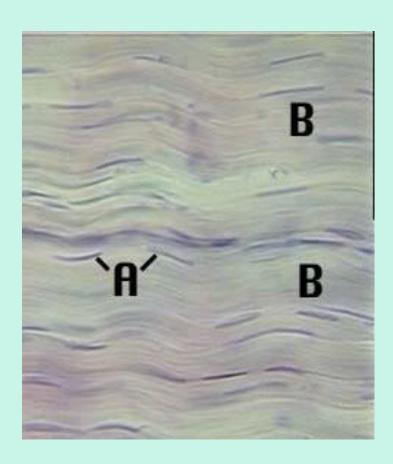
- Tendons
- Aponeuroses
- Ligaments

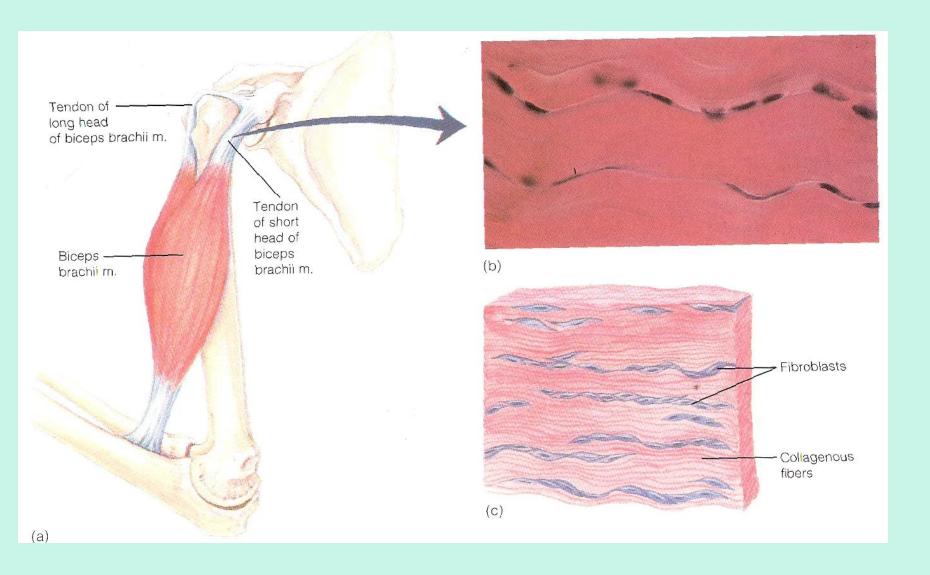
#### In tendons

- collagen fibres arranged as parallel bundles
- only cell type that is fibroblasts
- lie in rows between the bundles.

### B- collagen fibres

### A - fibroblasts





#### **Aponeuroses-**

- collagen fibres arranged as broad sheets
- number of layers
- fibres of one layer running at an angle to the adjacent layer

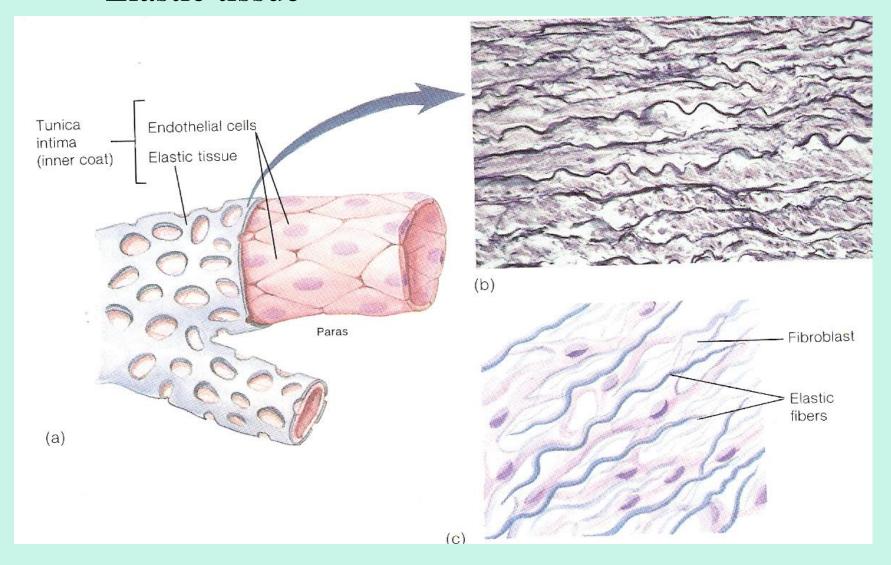
#### In ligaments-

- arrangement of fibres not so regular
- ligamentum nuchae

made of elastic fibres

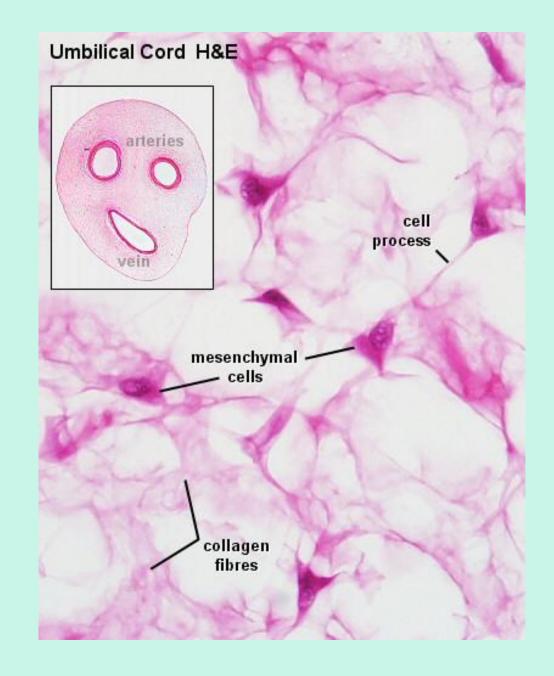
ligamentum flava

#### Elastic tissue



#### 4.Adipose tissue

- **5. Mucoid tissue** is seen in umbilical cord
- known as Wharton's jelly
- ground substance is mucoid
- scanty meshwork of collagen fibres and few cells
- vitreous body in eye is also contain mucoid tissue



- 6. Basal lamina also known as the basement membrane
- is a specialized form of extracellular matrix
- It can be organized in three ways:
- it can surround cells **muscle fibres** have a layer of basal lamina around them
- it lies underneath sheets of epithelial cells

- it separates two sheets of cells, such as the endothelial cells of blood vessels and epithelial cells of another tissue.
- This arrangement is seen in kidney glomerulus, where the basal lamina acts as a permeability barrier or sieve.

### Home work

• Briefly describe Functions of basal lamina? (30 marks)

#### **Functions of Basal lamina**

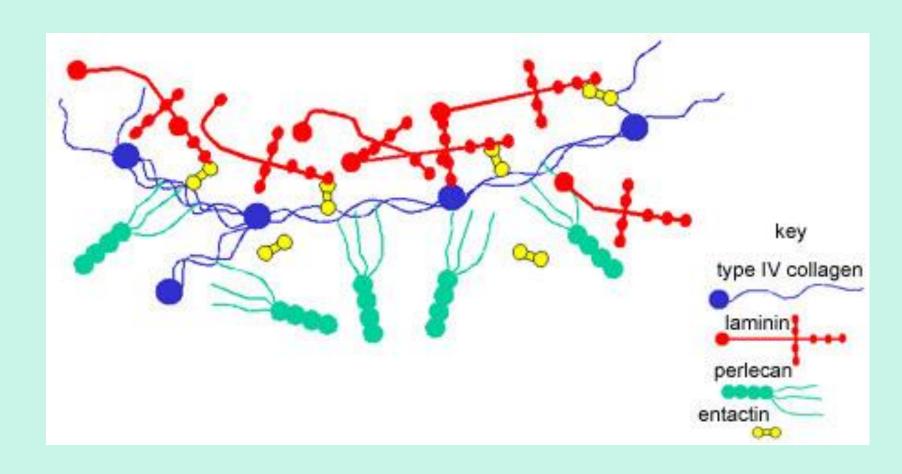
- Exact composition of the **basal lamina** varies between different types of cells
- In the **kidney**, the basal lamina acts as a molecular filter
- At the **neuromuscular junction**, the basal lamina of the muscle cells separates the nerve cell from the muscle cell at the synapse
- helps to regenerate the synapse after injury
- The **basal lamina** provides support to the overlying epithelium
- limits contact between epithelial cells and the other cell types in the underlying tissue

- acts as a filter allowing only water and small molecules to pass through
- If the epithelial cells become 'malignant', they are able to break through the basement membrane and invade the tissues beneath

#### **Components of basal laminae**

• The **basal lamina** consists of a mixture of collagens, laminin (glycoprotein), perlecan (heparan sulphate glycoprotein), entactin (glycoprotein)

• These proteins can bind to each other to make a highly cross linked extracellular matrix as shown in this diagram.



- All epithelia have a **basal lamina** which lies between the cells and the underlying connective tissue.
- This layer is so thin is usually only clearly defined under the electron microscope.
- The **basal lamina** helps to attach and anchor the cells to the underlying connective tissue.
- Proteins (integrins and proteoglycans) in the cell membranes attach to proteins in the basal lamina
- in turn is linked to the extracellular matrix of connective tissue

- three distinct layers of the basal lamina can be described:
- lamina lucida electron lucent (very little staining in the EM).
- lamina densa electron dense.
- lamina reticularis can be associated with reticular fibres of the underlying connective tissue.

