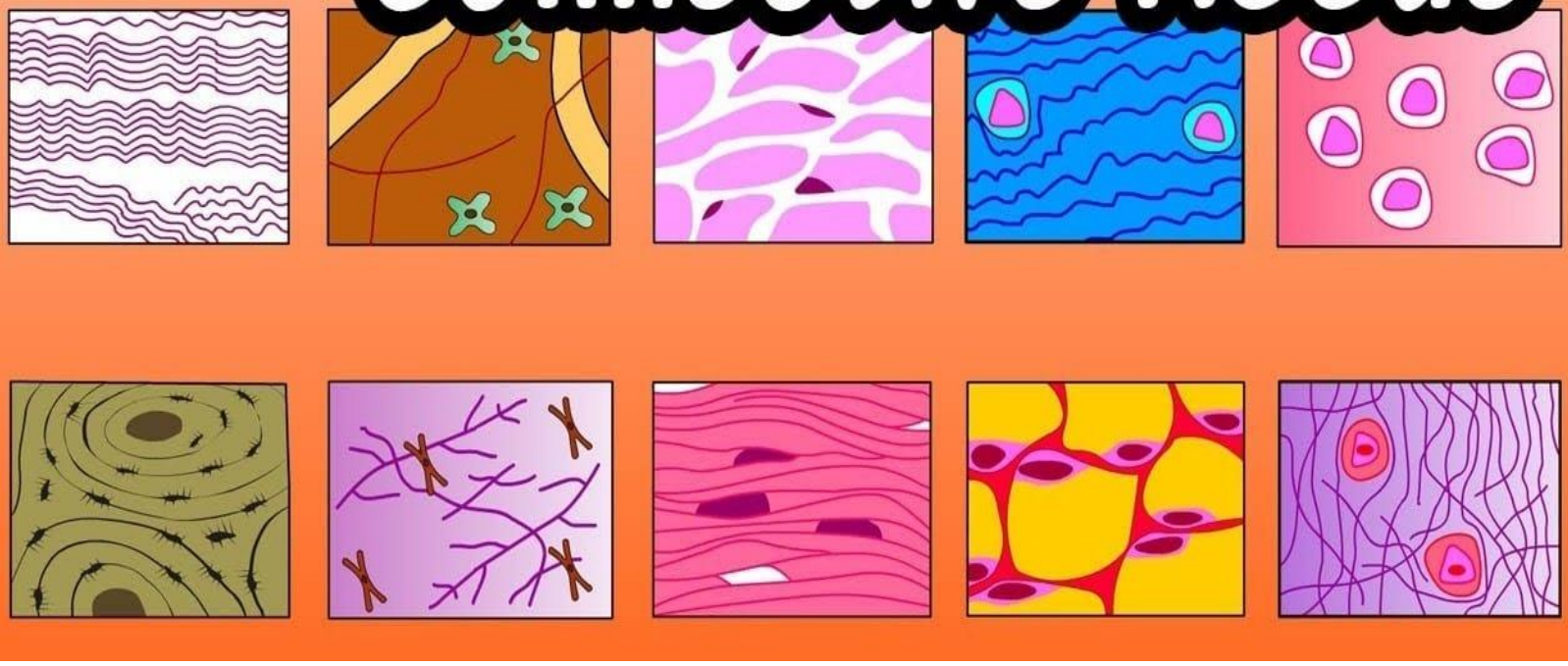
Connective Tissue



By

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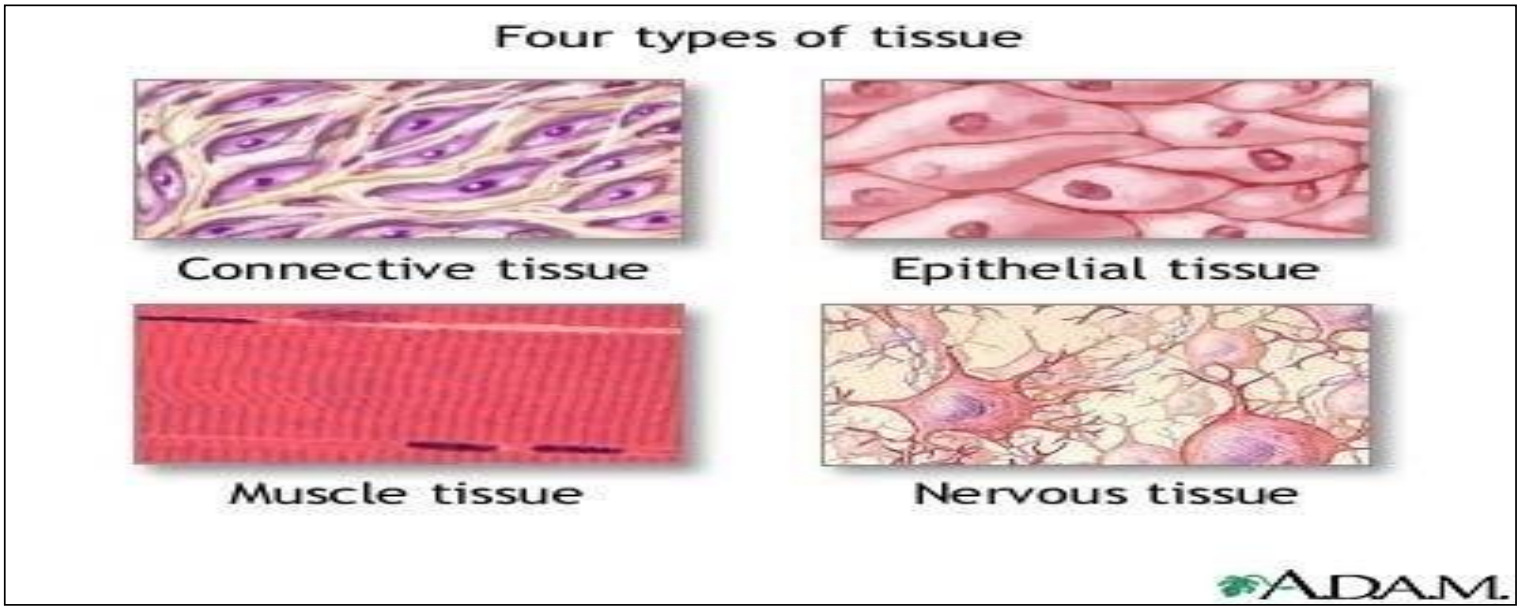
LEARNING OUTCOMES

1. Know the structural characteristics of the connective tissue.
2. Describe connective tissue cells.
3. Identify different types of connective tissue.
4. Differentiate between different types of connective tissue.
5. Relate the composition of connective tissue to its specific function.

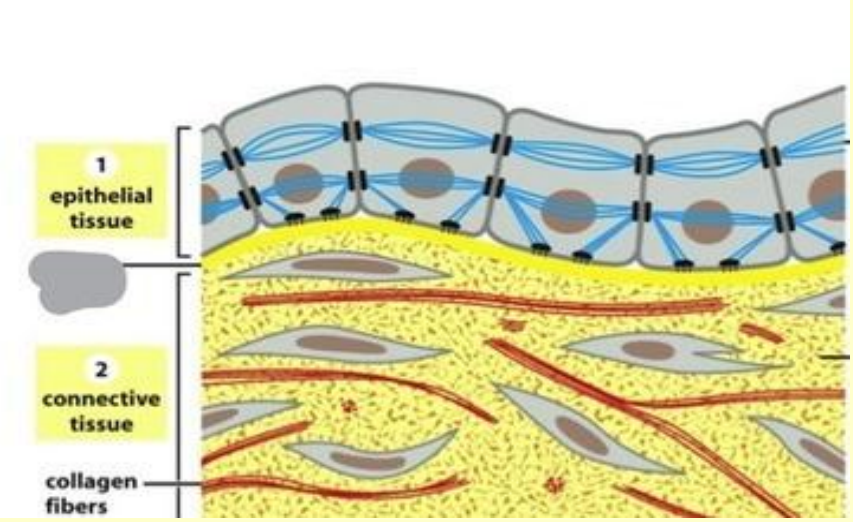
Definition

- It is one of the four basic tissues of the human body.
- The name “connective” is related to the function of *connection* and *binding* *cells* and organs together



In epithelial tissue: cells form sheet with **little** amount of ECM.

In connective tissue: composed **mainly of ECM** with a **few number of cells** that scattered between the matrix.



Connective tissue: that *connect* and *bind cells* and organs together.

-Cells connect to the macromolecules of the matrix by specialized junctions.

ECM is a complex of nonliving macromolecules that synthesizes by *tissues* ***cells*** and exported by them into the extracellular space.

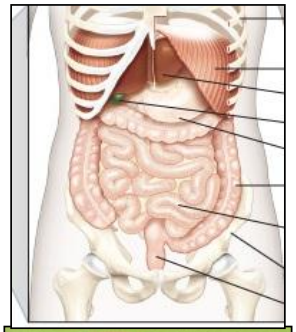
Functions of connective tissue

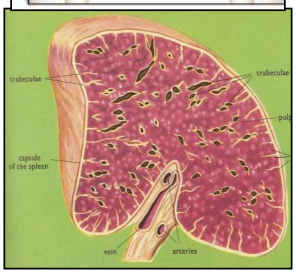
Structural

Defensive

Nutritive

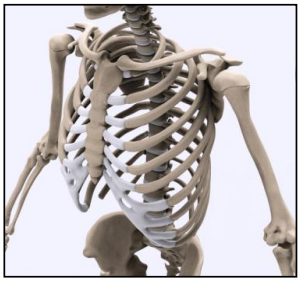
Structural function





1-Loose CT fills spaces between organs

2-Form the capsule & internal architecture of the organs



3-Bone and cartilage support soft tissues.

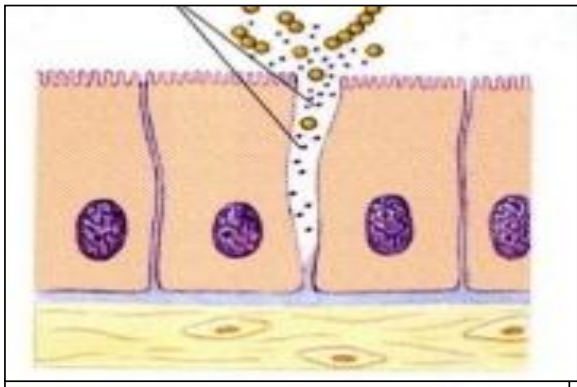
4-Dense CT make up tendons and ligaments

5-Adipose CT stores fat.

Defense function

1-Physical barriers:

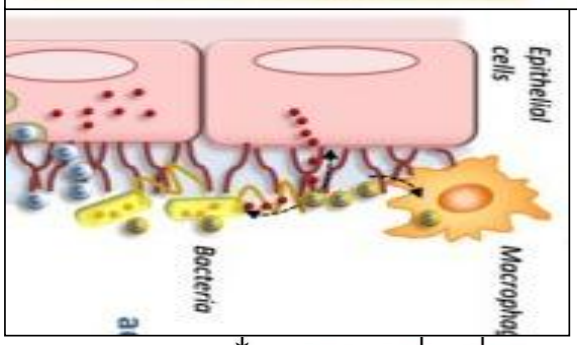
Prevent spread of microorganisms that pass through *epithelia.*



2-Contains immune cells:

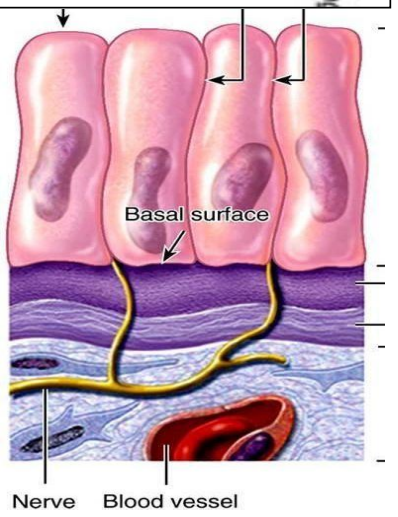
*Phagocytic cells

*Plasma cells



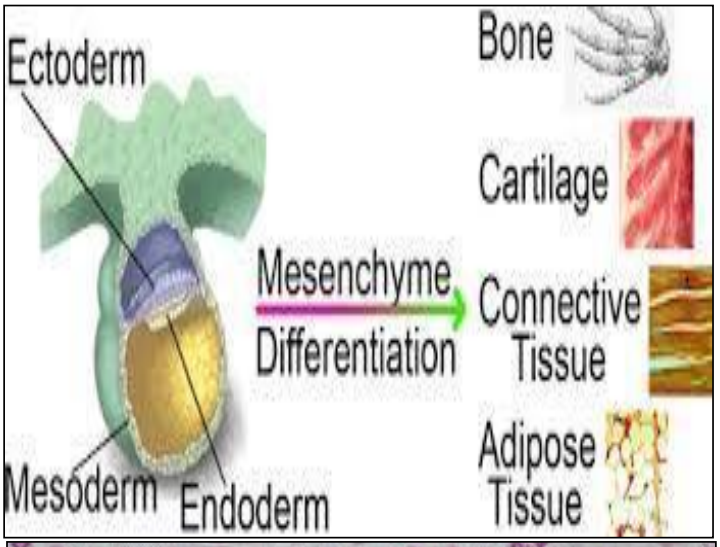
Nutritive Function

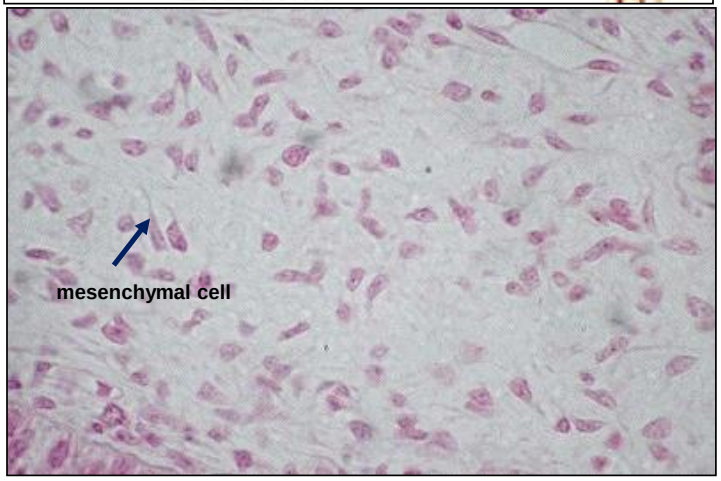
Ground substance of C.T. serves as ***a medium*** through which *nutrients* and *metabolic wastes* can be exchanged between epithelial cells and blood supply.



Development

- C.T. develops from the mesenchyme (*embryonic tissue).*
- The mesenchyme developed from the mesoderm.
- The mesenchyme is formed by *mesenchymal cells.*

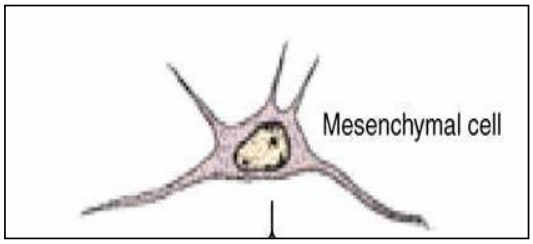




Undifferentiated mesenchymal cell

Shape

Spindle shaped cell having many processes



Size

small

Nucleus

- Oval
-pale
-with prominent nucleoli and fine chromatin.

→ **Active cell**

Cytoplasm

L.M : Small in amount
- Basophilic

E.M:
- Free ribosomes
-Mitochondria

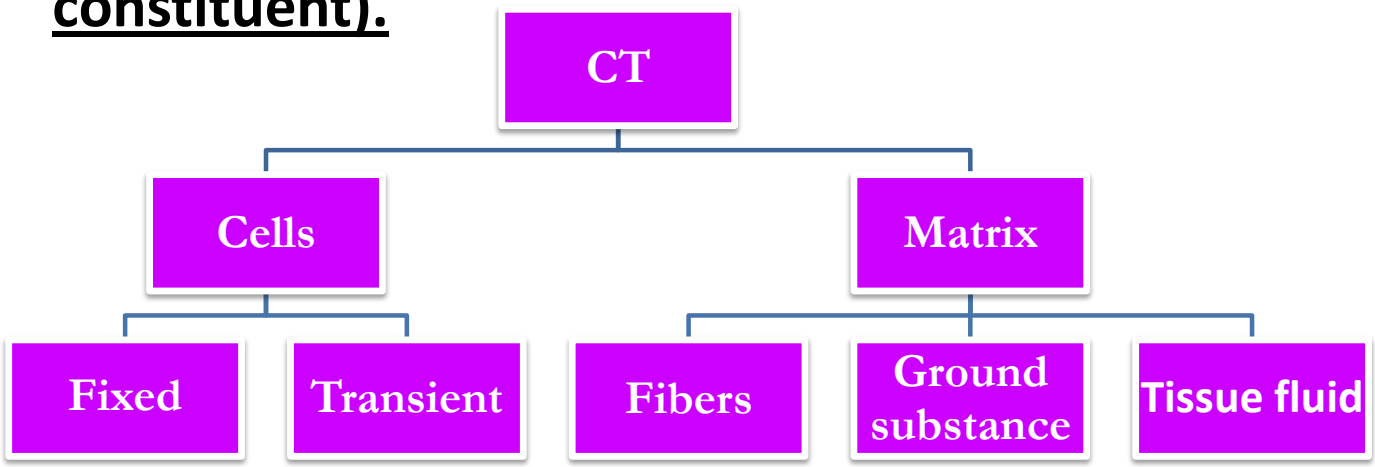
→ **Protein synthesizing cell**

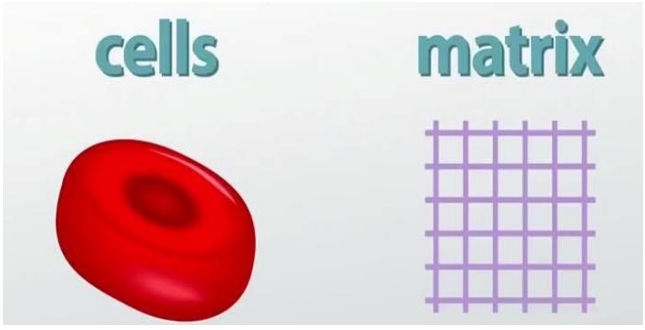
Function

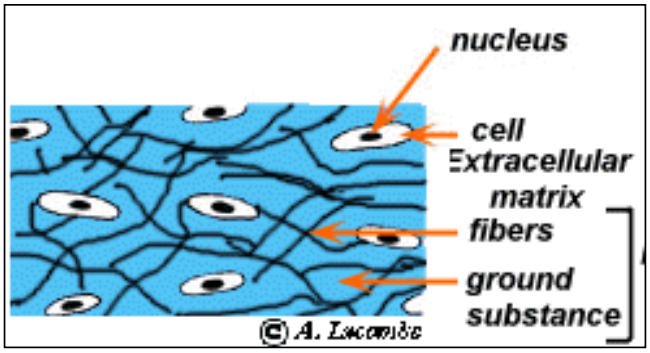
It is the stem cell (Mother cell) of most connective tissue cells.

Composition of C.T.

- **Connective tissue cells (less-widely separated)**
- **Extracellular substance (Matrix) (More- the major constituent).**







Extracellular matrix (ECM)

Secreted by: ***Fibroblasts.***

I- Ground substance

=Water + Macromolecules:

- Glycosaminoglycans
- Proteoglycan
- Glycoproteins

Resist compression

II- Connective tissue fibers

- Collagen fibers
- Elastic fibers
- Reticular fibers

Resist tension

Ground substance

- **Definition:** transparent, homogenous and viscous.
- **Composed of:**

1- **Glycosaminoglycans:** sulphated & non sulphated.

2- **Proteoglycans:** central protein core & sulphated glyccosaminglycans.

3- **Glycoproteins:** globular protein & branched monosaccharides.

- **Stain:** metachromtically (**toluidine blue**).

TISSUE FLUID

- It is very small quantity of fluid contained in the amorphous substance.
- It is similar to plasma in its content of ions and diffusible substances.
- It contains *small* percentage of plasma proteins of low molecular weight that pass through capillary walls.

Connective tissue cells

A- Fixed cells

Developed & remain in CT.

They ***originate locally*** from undifferentiated mesenchymal cells and spend their life in C.T.

- **Fibroblasts**
- **Adipocytes (fat cells)**
- **UMCs**

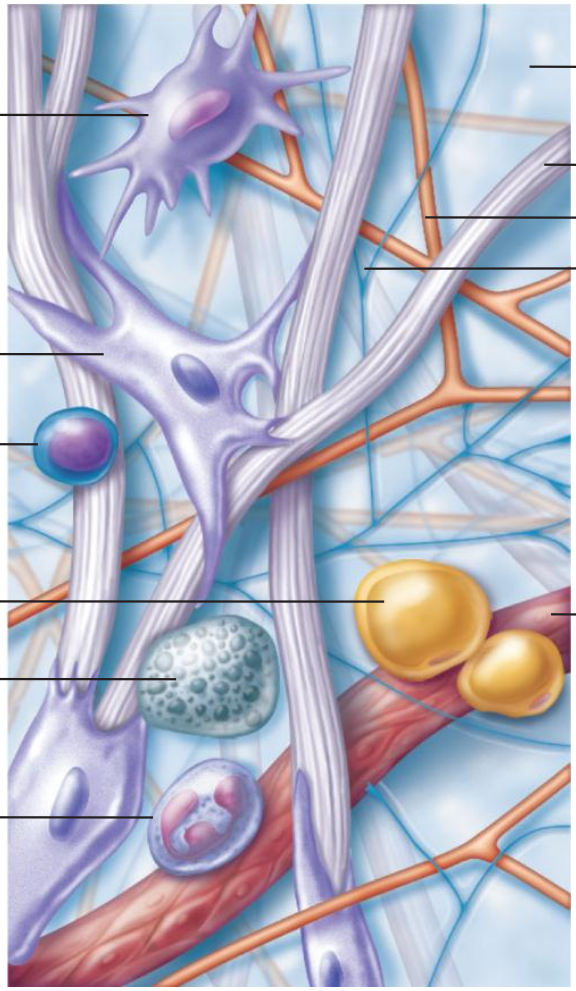
B- Transient cells

- Cells coming ***from outside***
- Come from hematopoietic stem cells in bone marrow
- Circulate in blood and then move into C.T (wondering)

- **Plasma cells**
- **Macrophages**
- **Mast cells**
- **Leukocytes**

Cell types

Extracellular matrix



Connective tissue cells

Shape

Size

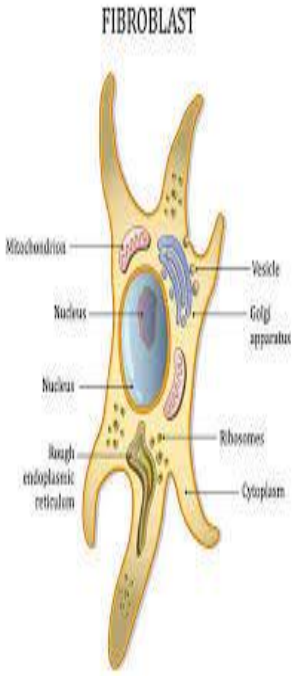
Nucleus

Cytoplasm

Function

Fibroblast

Most common cell in C.T.



Shape

Branched cells with long processes

Size

larger than fibrocyte

Nucleus

-Large ovoid
- Pale staining with fine chromatin
- Prominent nucleolus ⇨ **Active cell**

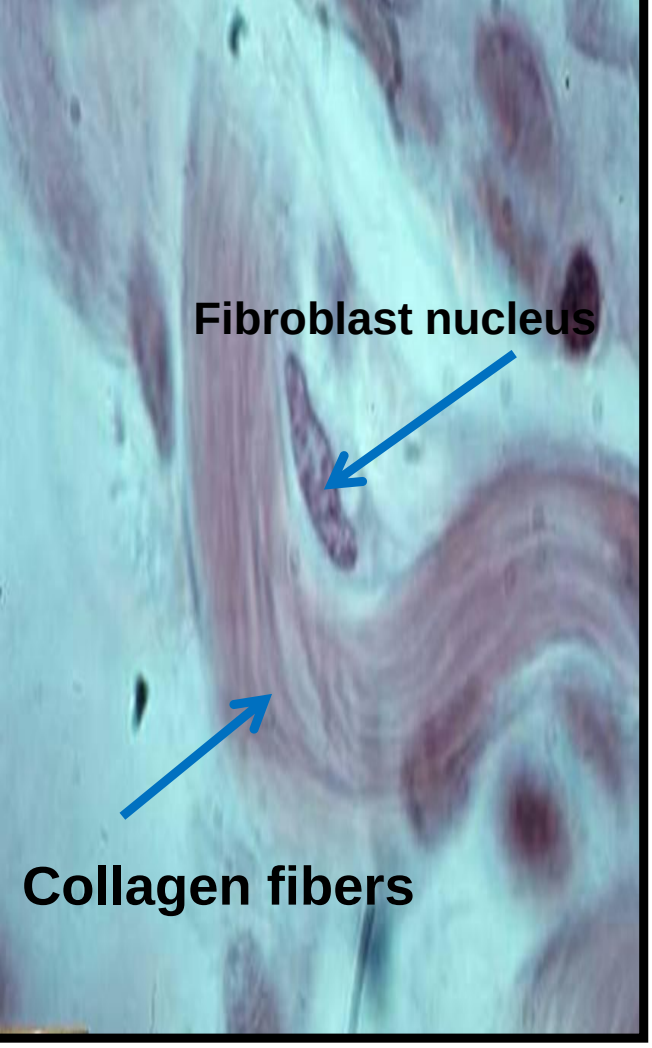
Cytoplasm

L.M: Basophilic
E/M:
- Rich in RER
-Well developed Golgi

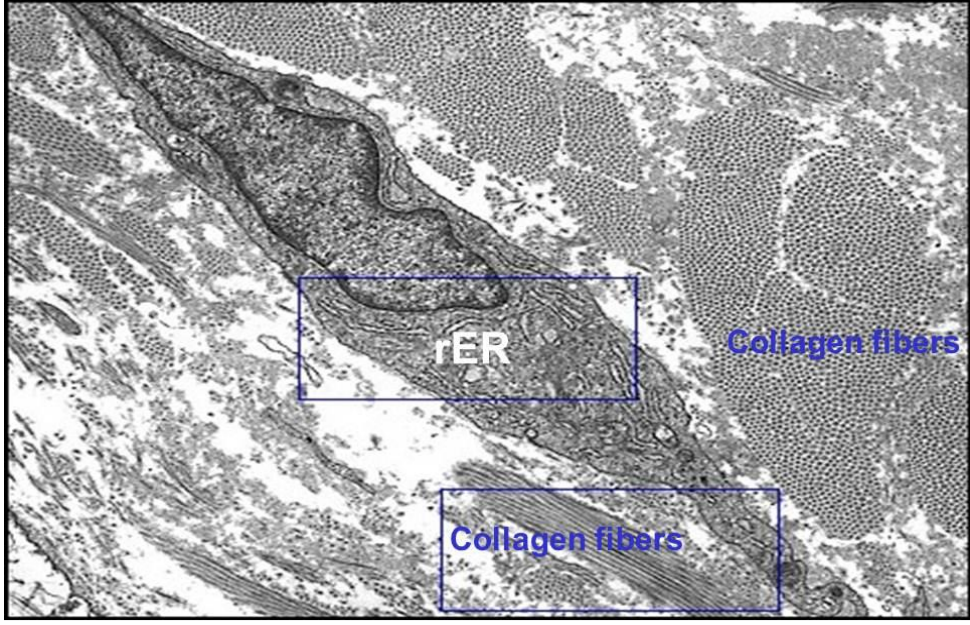
⇨ **Protein synthesizing cell**

Function

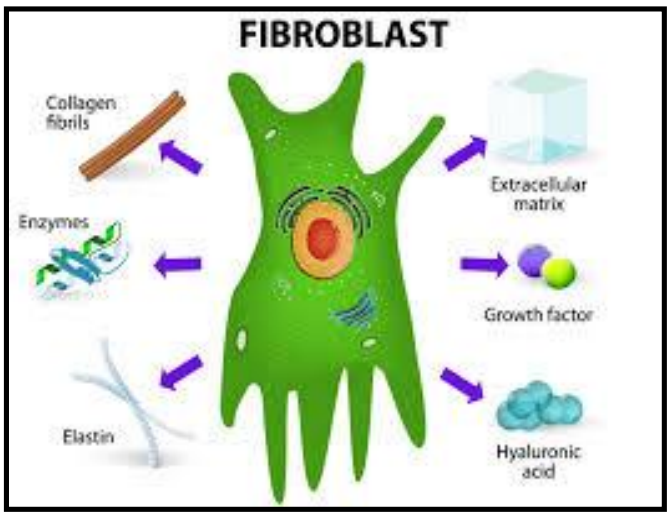
Formation of:
- Components of connective tissue matrix
- Collagenic, elastic and reticular fibers.



Fibroblast and collagen fibers



Fibroblast and collagen fibers



Fibrocyte

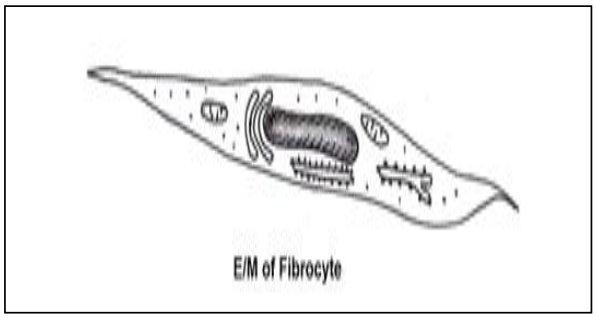
Old or inactive fibroblast

Shape

Spindle shaped with fewer processes.

Size

Smaller than fibroblast



Nucleus

Smaller, dark elongated

Cytoplasm

L.M: Less basophilic (nearly acidophilic)

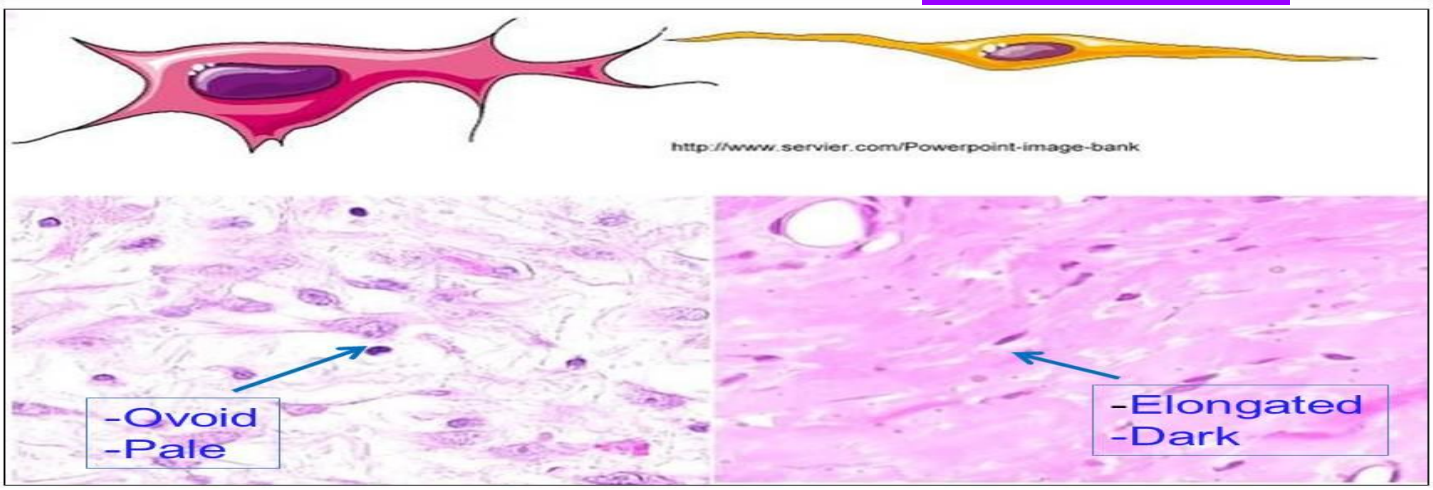
E/M: - Few RER

Function

It **maintains** components of connective tissue

Fibroblast

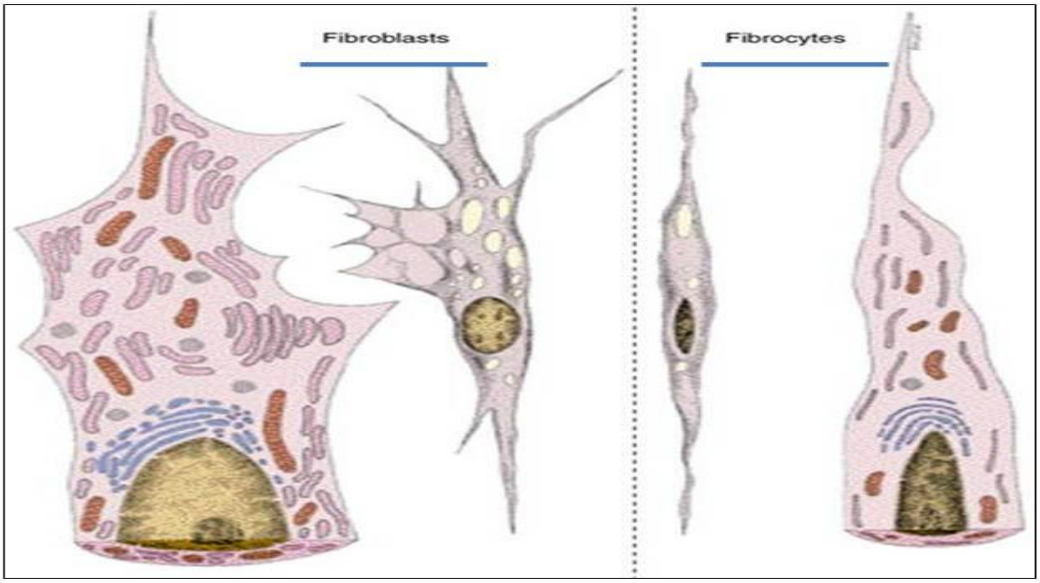
Fibrocyte



Branched

Many rER

Ovoid pale nucleus



Spindle

Few rER

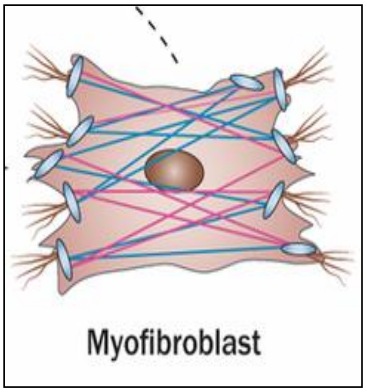
Elongated dark nucleus

Myofibroblast

- They are cells with features of fibroblast and smooth muscle cells.
- Activated during wound healing

Cytoplasm

E/M: It contains increased amount of actin and myosin microfilaments.

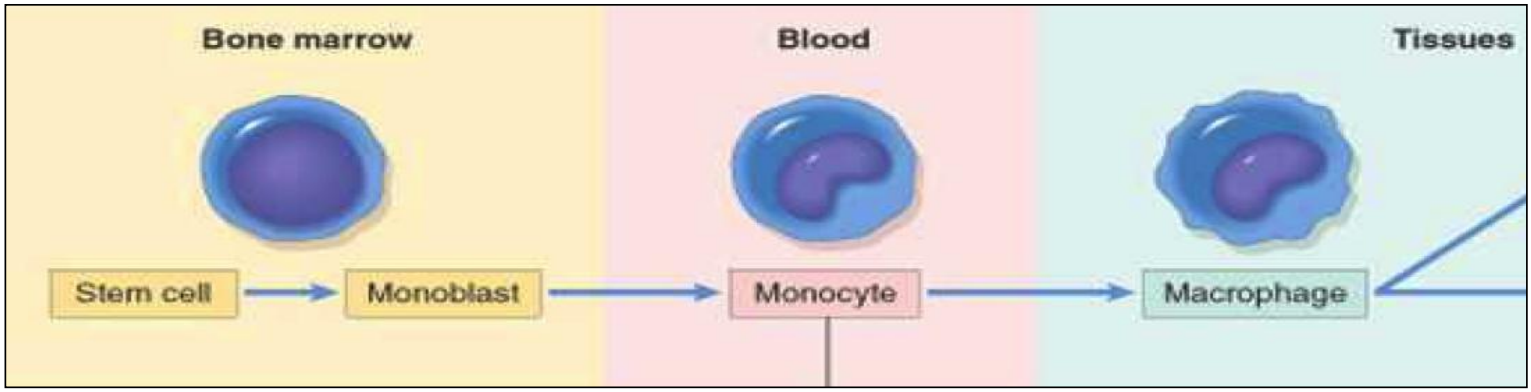


Function

It is responsible for wound closure (wound contraction).

Macrophage

Origin: Derived from bone marrow precursor cell that divide, producing monocyte that circulate in the blood. Then, these cells cross the wall of capillaries to penetrate the connective tissue, where they mature and acquire morphological features of macrophages.



Sites: distributed throughout the body in many organs

Shape:

-Irregular surface with protrusions and indentations.

-if stimulated: it increases in size with more folds in its membrane.

Nucleus :

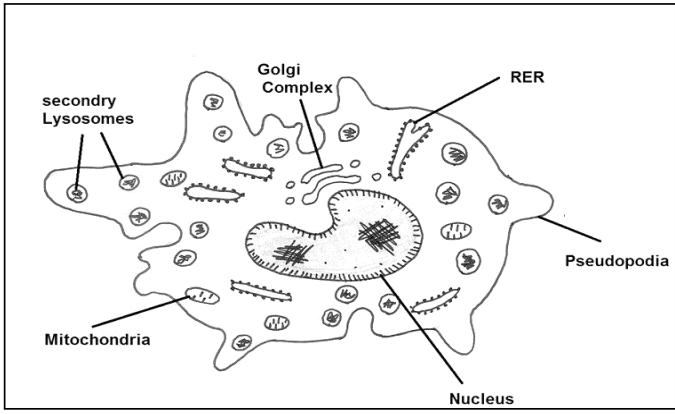
-Eccentric - Oval or kidney shaped.

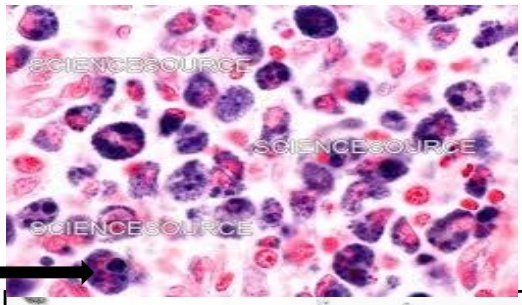
Cytoplasm: L.M: Basophilic

E.M :

- Many lysosomes *(most specific).*
- Well-developed Golgi.
- Prominent RER.

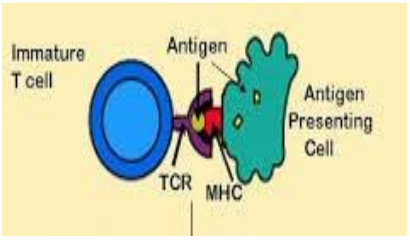
Staining: by injection of vital dye in animals (trypan blue or indian ink): engulf dye and accumulate in its cytoplasm in the form of granules





Function:

1. Ingestion of foreign particles (phagocytosis).
2. Digestion of foreign particles by lysosomes.
3. Antigen processing and presentation.
4. Secretion of substances that participate in defensive functions.



Source: Lichtman MA, Shafer MS, Felgar RE, Wang N: *Lichtman's Atlas of Hematology*: http://www.accessmedicine.com

Mast cell

Origin: **From stem cells in bone marrow.**

Sites: **- Widely distributed in the human body**

- Abundant in skin near to small blood vessels (perivascular mast cell), mucosa of GIT and respiratory tract (mucosal mast cell).

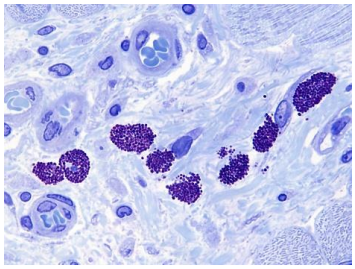
Shape: **Oval to round**

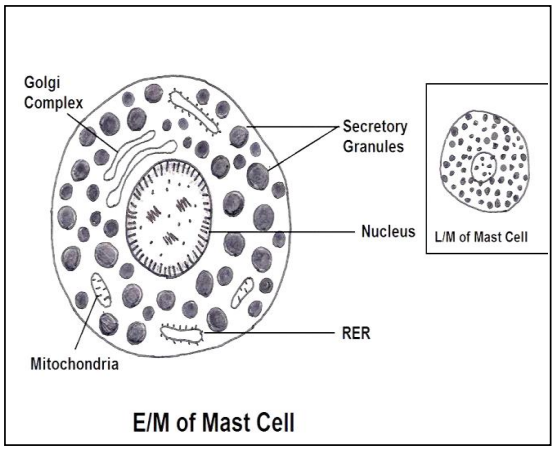
Nucleus :

- Small, spherical

- centrally located.

- Obscured by cytoplasmic granules.





E/M of Mast Cell

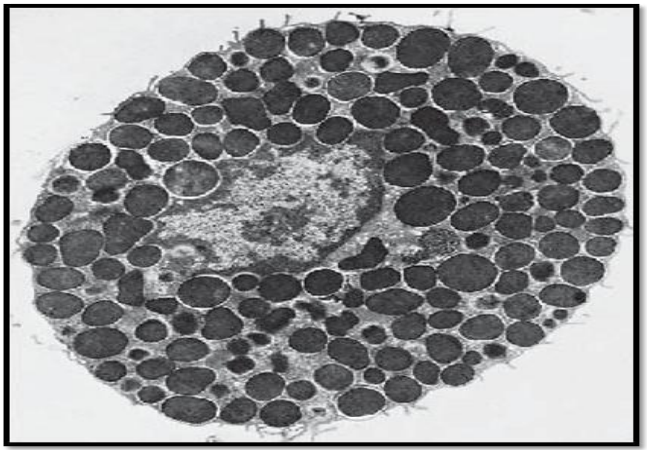
Cytoplasm:

:L.M **coarse granules**

Staining:

The granules are stained metachromatically with toluidine blue.

(they are stained purple instead of blue).



E/M:

-Well developed Golgi.

-Membrane limited heterogeneous granules.

-Few mitochondria.

-RER

Function of Mast cell:

- **Synthesis and storage:**

-Histamine:

a- Dilates blood capillaries and increases their permeability.

b- Causes contraction of smooth muscle (mainly bronchioles).

-Leukotriens:

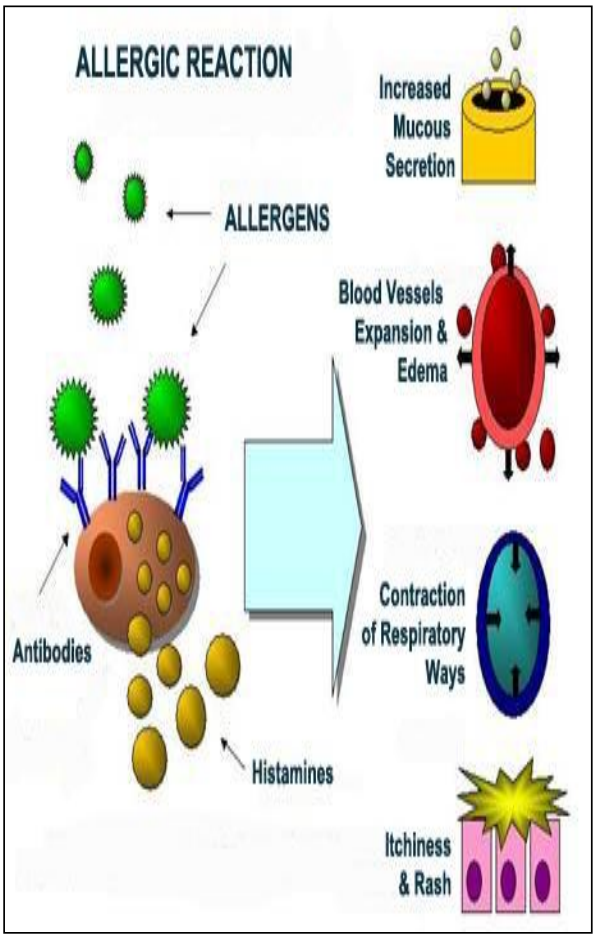
produce slow contraction of smooth muscle.

-Neutrophils Chemotactic Factor (NCF-A):

attracts blood neutrophils.

-Heparin:

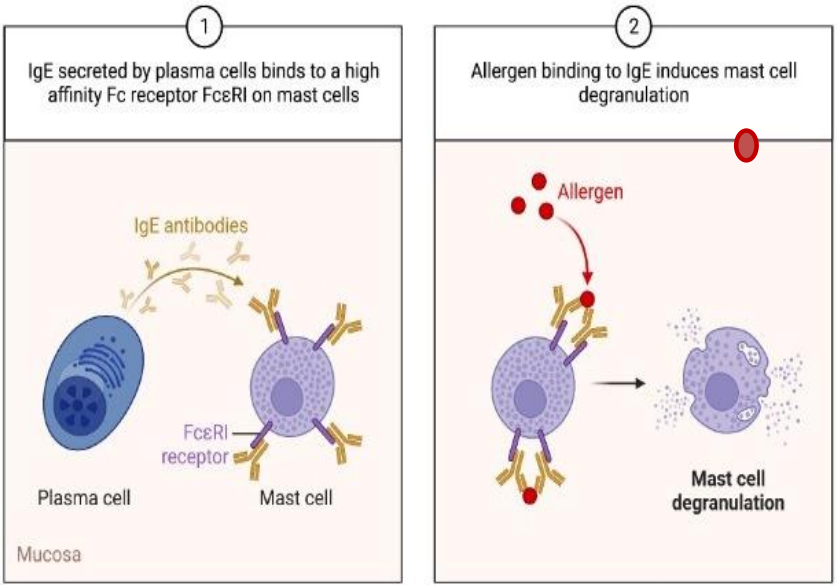
is blood anticoagulant.



- **Initiate allergic and local inflammatory responses by release of the contents of granules**: Release of mast cell content produce allergic reaction known as **immediate hypersensitivity reaction** (the most severe is the **anaphylactic shock**).

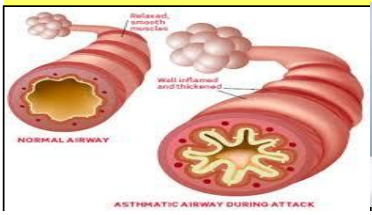
The process of anaphylaxis consists of the following sequential events.

- **The first exposure** to an antigen (allergen) results in production of IgE by plasma cells.
- **IgE** are fixed to specific receptors on surface of mast cells.
- **AT second exposure** to the **same** antigen results in binding of the antigen to IgE on the mast cell.
- **This event** triggers release of mast cell granules liberating histamine, heparin, leukotriens.



An example: Bronchial asthma:

Allergic condition occurs due to secretion of large amount of histamine by mast cells triggered by subsequent exposure the same allergen, Leads to bronchospasm and *difficulty in breathing*.



Plasma cell

Origin:

B-lymphocyte

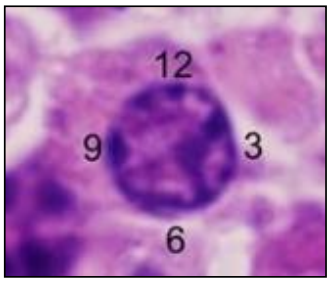
Shape :

Large and oval

Nucleus :

-Spherical

-Eccentrically placed.



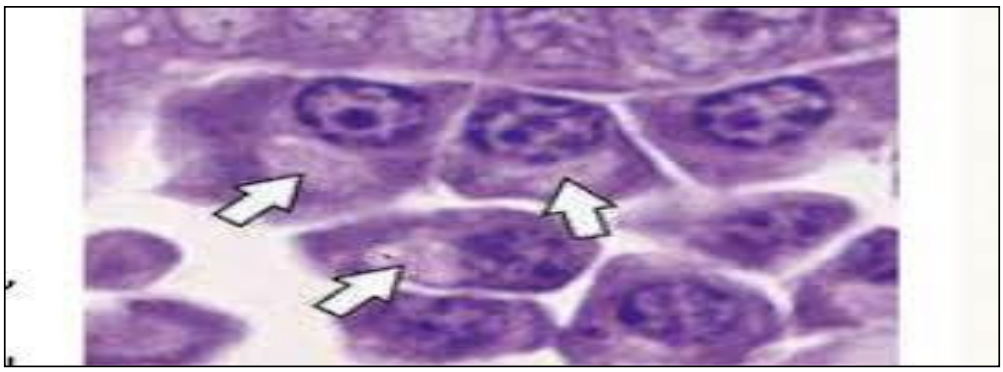
-Contains compact coarse chromatin alternating with light-areas of equal size that gives (clock-face appearance) or (cartwheel)

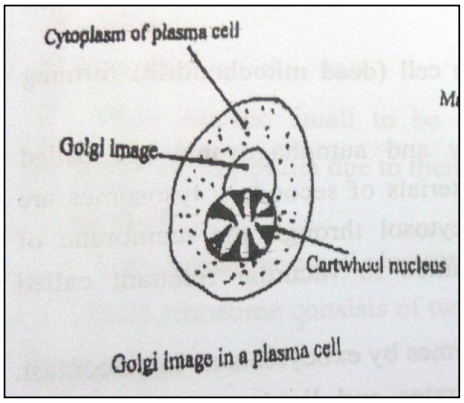
Cytoplasm:

-L.M:

- Basophilic

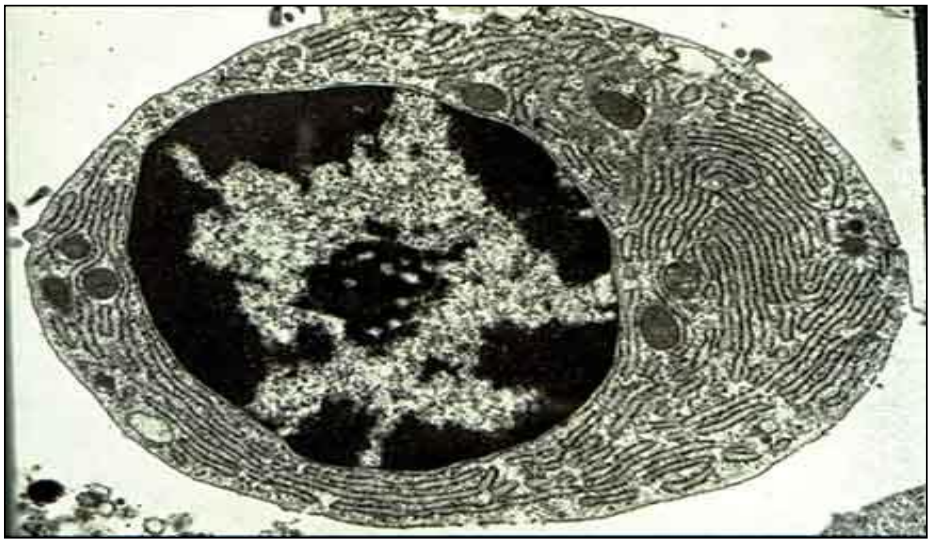
- Contains pale area near the nucleus (- ve Golgi image)

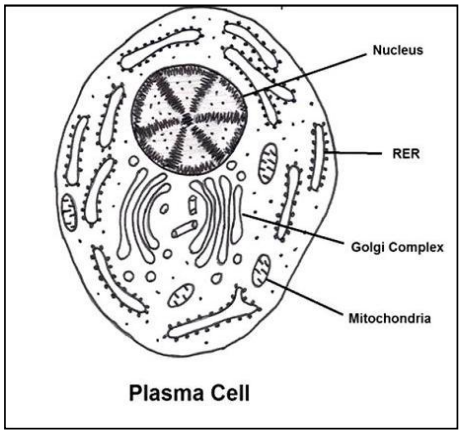




E/M:

- Rich in RER
- Well developed Golgi





Antigen presenting:

Most antigens are partially digested in macrophages then transferred to B-lymphocytes that becomes Plasma cell

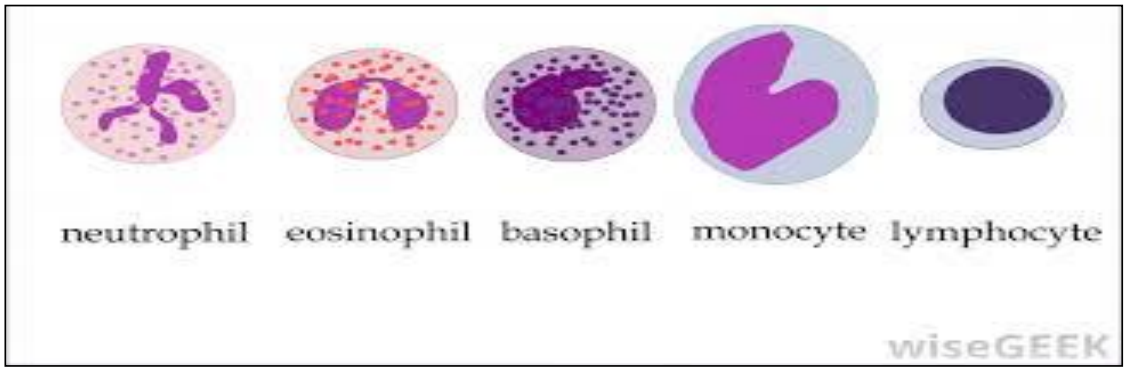
Function :

Production of antibodies

- Specific immunoglobulins produced in response to penetration by antigen.
- Each antibody is specific for one antigen that gives rise to its production

Blood leucocytes

-White blood cells migrate to connective tissue where they perform their functions e.g. lymphocytes and eosinoplils .

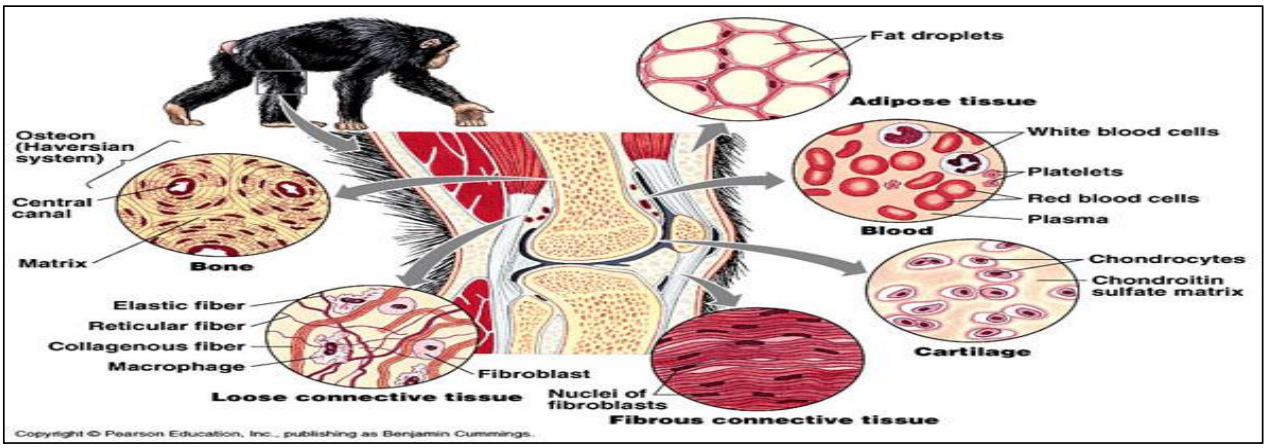


Classification of C.T.

C.T. proper
-Loose C.T.
-Dense C.T

Specialized C.T.
-Adipose
- Reticular
- Mucous
- Elastic
-Hematopoietic

Supporting C.T.
- Bone
- Cartilage

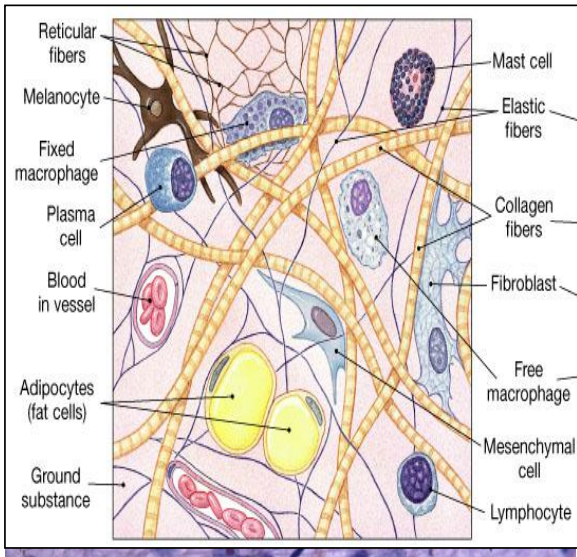


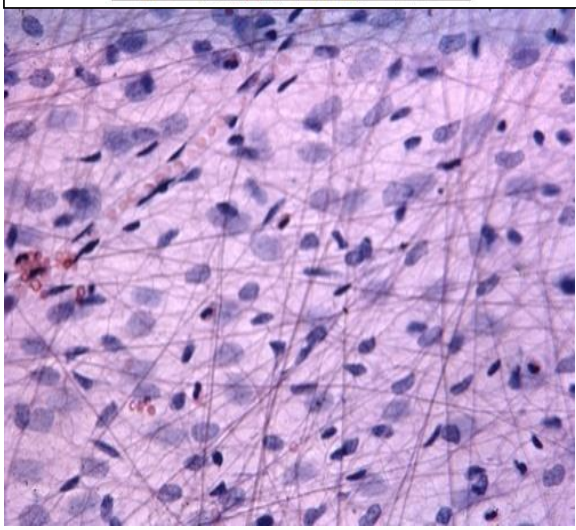
Types of connective tissue

- Structure
  - Cells
  - Fibers
  - GS
- Character
- Sites

I- Connective tissue proper

1-Loose (areolar) connective tissue





Structure:

Cells: all cells are present *(fibroblasts and macrophages are the most numerous cells)* –dispersed

Fibers: all fibers are present, that are loosely arranged.

GS: Large in amount

Character:

-it is the most widely distributed connective tissue in the body.

-It binds body parts together while allowing them to move freely over one another.

-Highly vascular (allow nutrients diffusion)

-Does not resist stress.

Sites

-It fills the spaces between fibers and muscle sheaths.

- It supports epithelial tissue of serous and mucous membranes.

- It is present in papillary layer of dermis.

- It ensheathes the blood and lymphatic vessels.

2- Dense connective tissue

- **Structure:**

Cells: few

Fibers: It is mainly formed of **collagenous fibers**

GS:

Little ground substance

- **Character:**

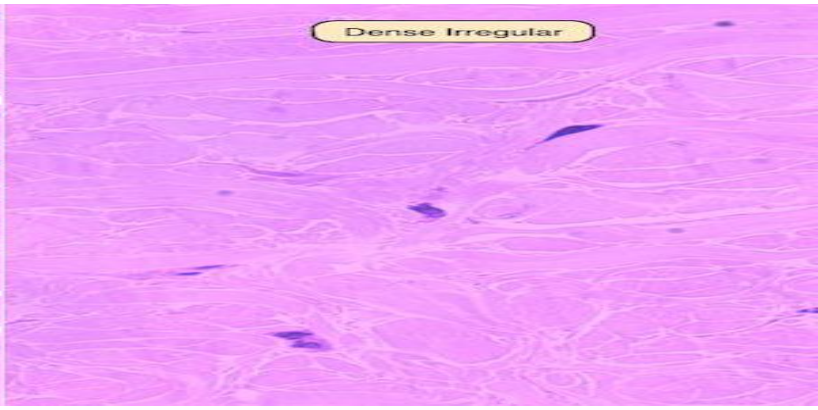
- It is *less flexible*

-Resist stress

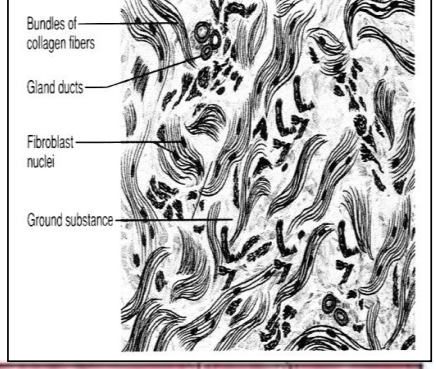
- **Types:**

a**) Dense regular connective tissue**

b) Dense irregular connective tissue



Types of dense connective tissue



1-Dense irregular connective tissue:

Structure:

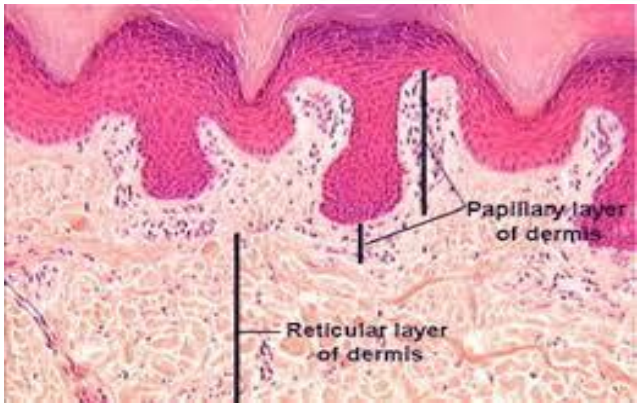
- The collagenous bundles are irregularly arranged without definite orientation and run in different directions.
  - Few C.T cells mainly fibroblasts.
  - Little amount of ground substance.

Function:

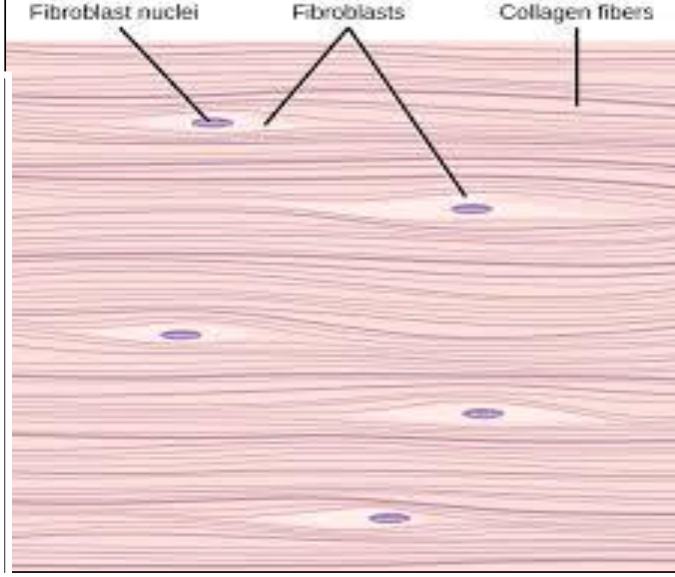
It withstands stress from all directions.

Sites:

- Reticular layer of Dermis of the skin
- Capsules of spleen, lymph nodes and liver.
- Perichondrium and periosteum.



2-Dense regular connective tissue:



Sturcture:

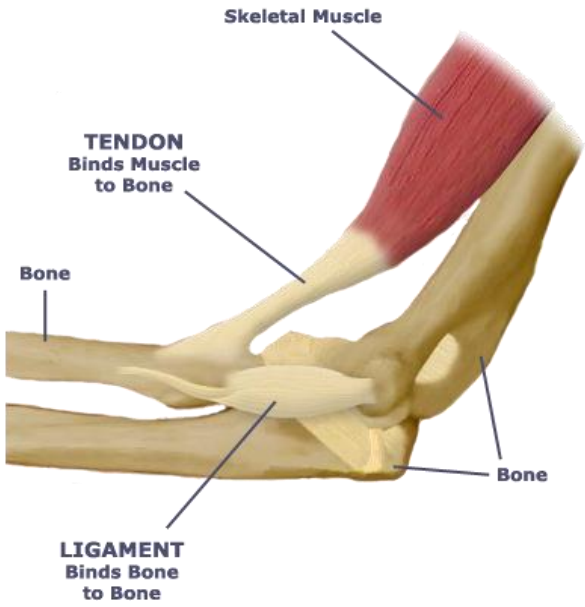
- The collagen bundles are arranged in regular pattern .
- Fibroblast are located between the collagen bundles with their long axis parallel to the bundles
- Little amount of ground substance.

Function:

- It withstand prolonged stress in one direction

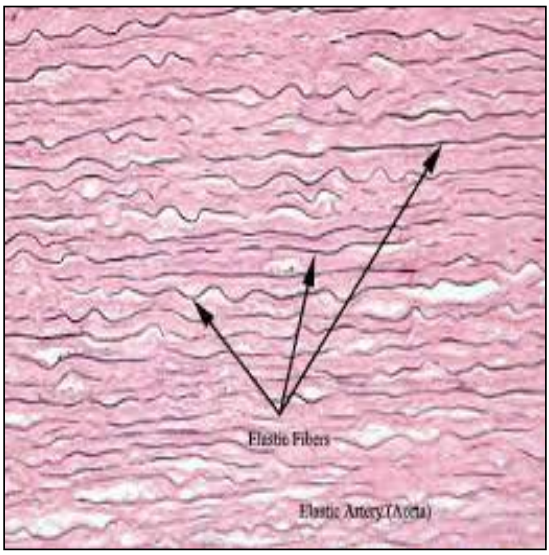
Site:

- **Tendons**
- **Ligaments**



II- Connective tissue with special proporties

Yellow elastic tissue



Structure:

Cells:

Flattened fibroblasts

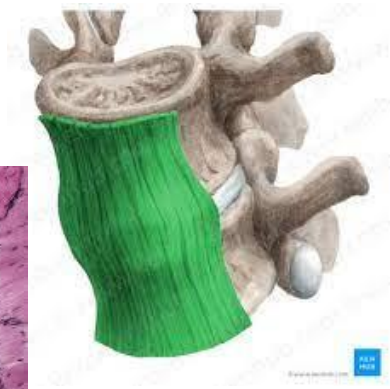
Fibers:

Large number of bundles of thick parallel elastic fibers and thin collagenous fibers

GS:

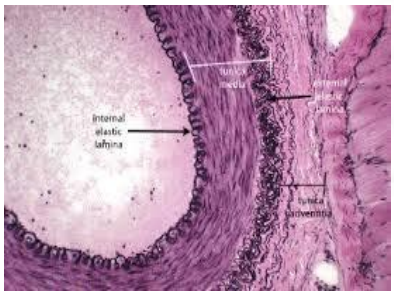
Character :

The abundance of elastic fibers gives the tissue great elasticity and the yellow colour

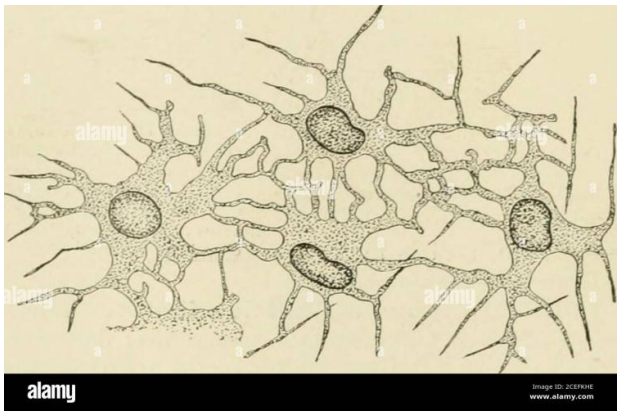


Site:

- Ligaments of vertebral column
- True vocal cords.
- Elastic lamina of arteries.



Reticular connective tissue



Structure:

1- **Reticular cells**

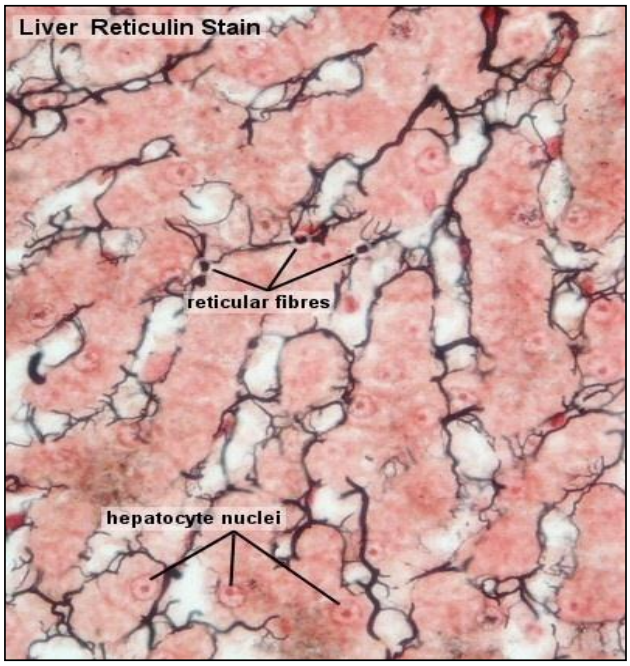
- They are fibroblasts with cytoplasmic processes.
- Specialized for the secretion of reticular fibers.
- Their nuclei are large and pale.

2- **Reticular fibers**

Reticular cells and fibers create **spongy like structure** within which cells and fluids are mobile. It slows flow of material along the **sinus like spaces**.

3- **Ground substance**.

4- **Mononuclear macrophages**

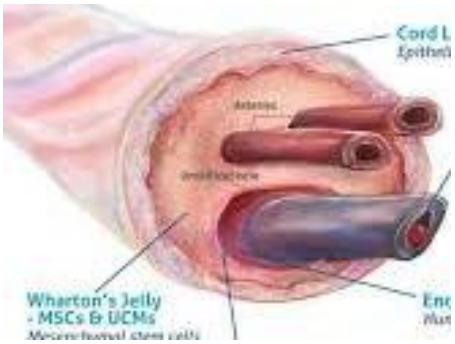


Site:

It forms the framework of all parenchymatous tissues:

- Myeloid tissue (bone marrow)
- Hematopoietic organs.
- Lymphoid organs (lymph node, lymph nodules, spleen)
- Liver.

Mucoid connective tissue



- **Structure:**

- **Cells:**

Mainly fibroblasts.

- **Fibers:**

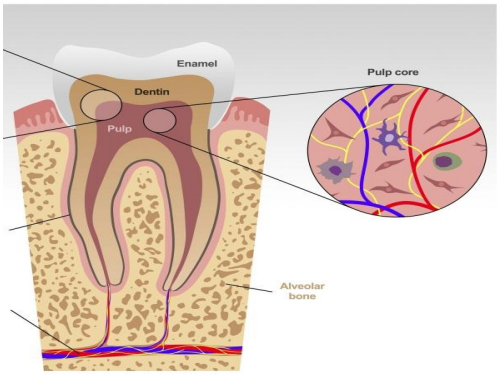
Few collagen, elastic and reticular fibers

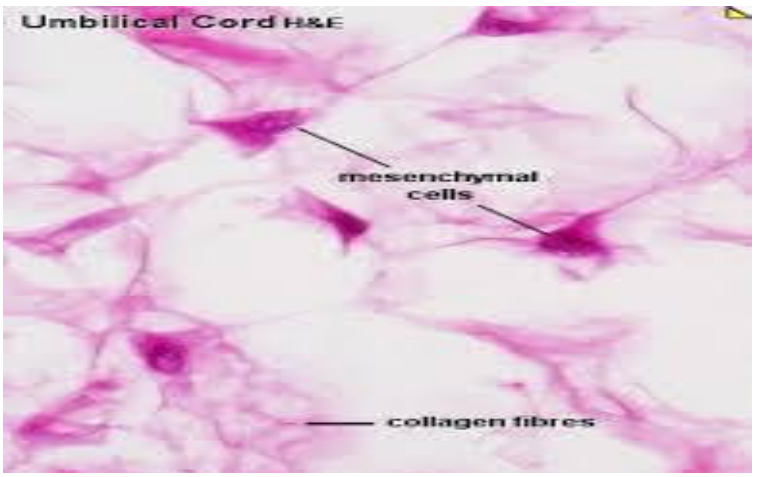
- **GS:**

It has *abundant jelly like matrix* composed mainly of hyaluronic acid

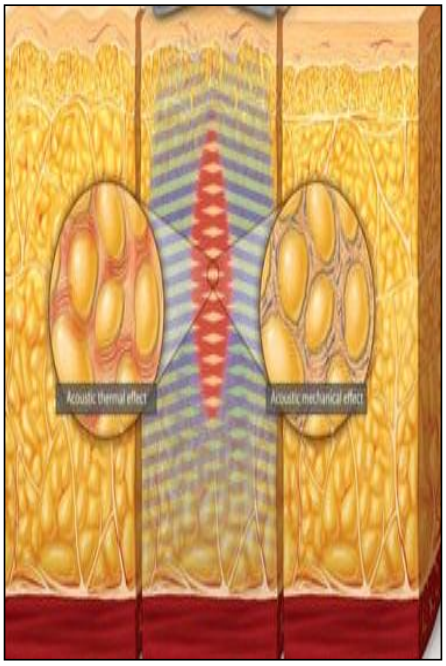
- **Site:**

- Umbilical cord ***(Wharton's jelly).***
- Pulp of young tooth.





Adipose connective tissue



It is a special type of connective tissue in which • *adipocytes predominate* and occur in large aggregates.

- **Functions**

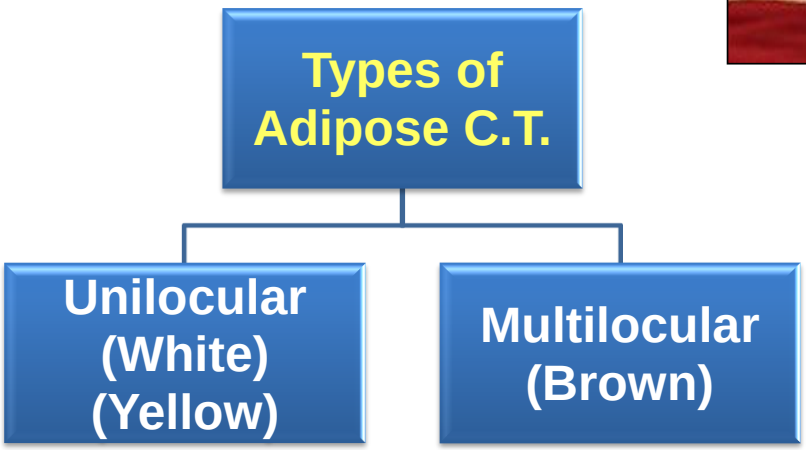
1- Store energy in the form of triglycerides.

2- Shape the surface of the body.

3- Shock absorbers chiefly in soles and palms.

4- Thermal insulators.

5- Fills the spaces between other tissues and keep some organs in position



1- Unilocular (White) adipose tissue

- It is the **common type.**
- it is the **almost only** type in **adult**.

- ***Function:***

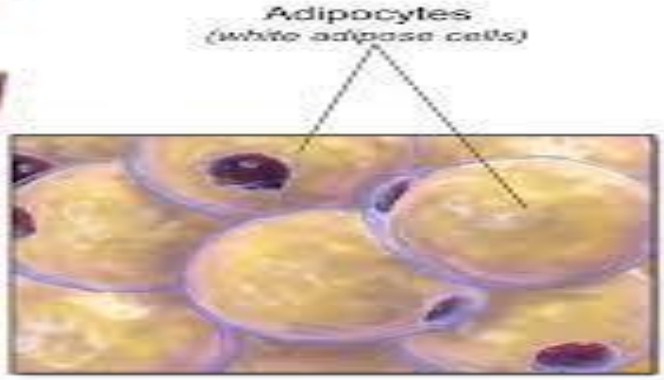
the main energy depot for the organism.

- ***Sites:***

It is present throughout the human body except eyelids, penis, scrotum and auricle of external ear.

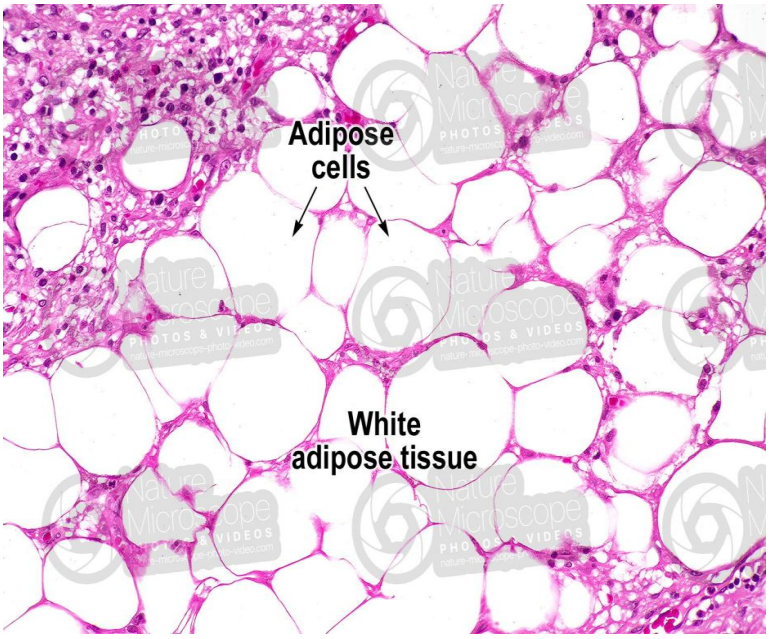
- ***Color:*** **depends on diet, varies from white to yellow due to the dissolved carotenoid in fat droplets.**

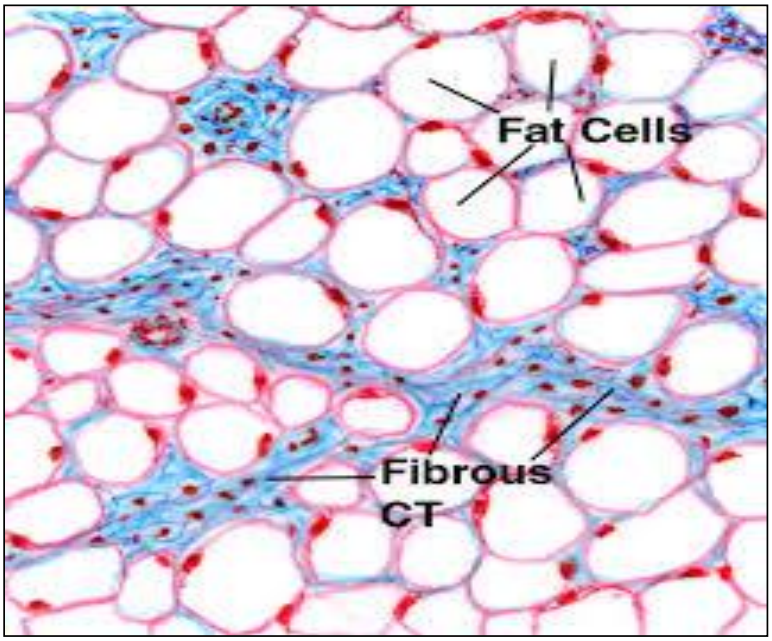
Adipose Tissue



Histological characteristics of the unilocular adipose tissue:

- White adipose tissue is subdivided into incomplete lobules by partitions of connective tissue containing a vascular bed and nerve network.
- Fibroblasts, macrophages, and other cells make up about half the total number of cells.
- Ather half are *Fat cells* that present .in large aggregates





Adipose (fat) cell

- Found isolated or in small groups within the C.T.
- If found in ***large aggregates***, they make up adipose C.T.

Origin: UMC

L.M:

Shape :

- Spherical when single
- Polyhedral in adipose C.T.(closely packed).

Nucleus :

peripheral and flattened

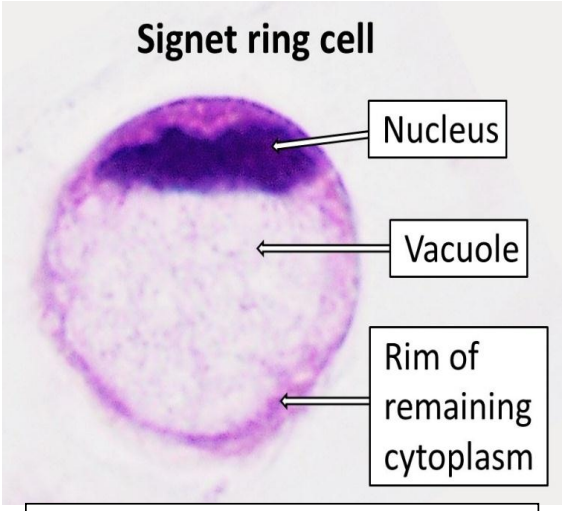
(signet ring appearance).

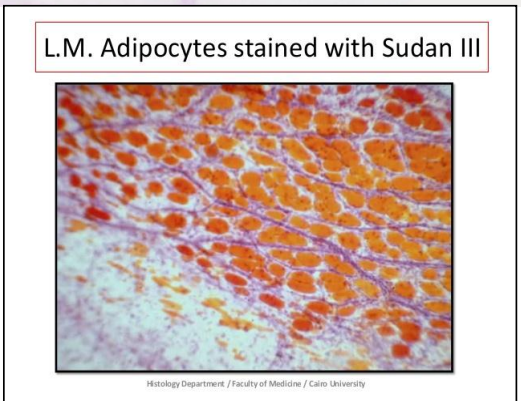
Cytoplasm:

- Hx & E staining.

Appears as thin ring surrounding a dissolved fat vacuole

- Sudan III: orange





E/M:

- Each cell is surrounded by a basal lamina.

- The fat appears as : minute droplets in addition to the single large one, the droplets are not surrounded by a membrane.

- *The thickest potion of the cytoplasm surrounding the nucleus contains:*

1-Golgi complex

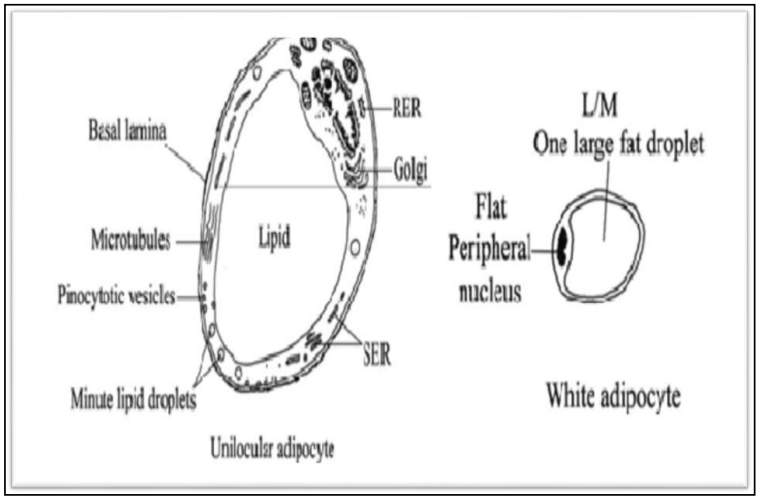
2- Filamentous and ovoid mitochondria

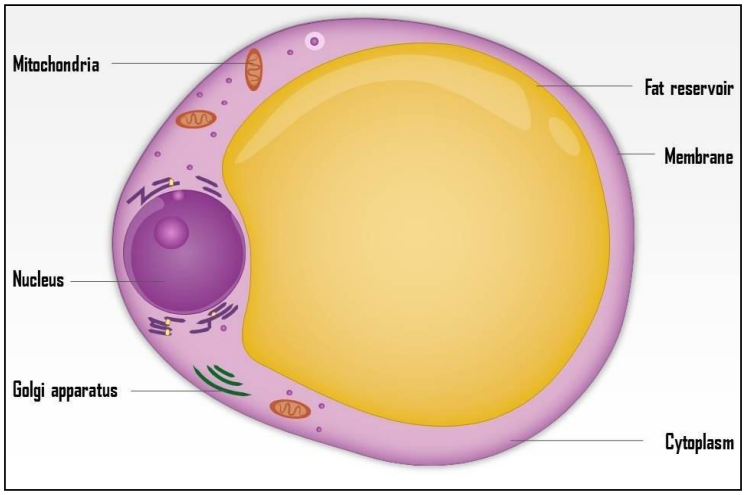
3- Few RER and free polyribosome.

- *The rim of cytoplasm surrounding the lipid droplet contains:*

1-SER

2- Numerous pinocytotic vesicles





2 - Multilocular adipose tissue (brown fat)

- It is greatly reduced in adult.

Sites: - In hibernating animals.

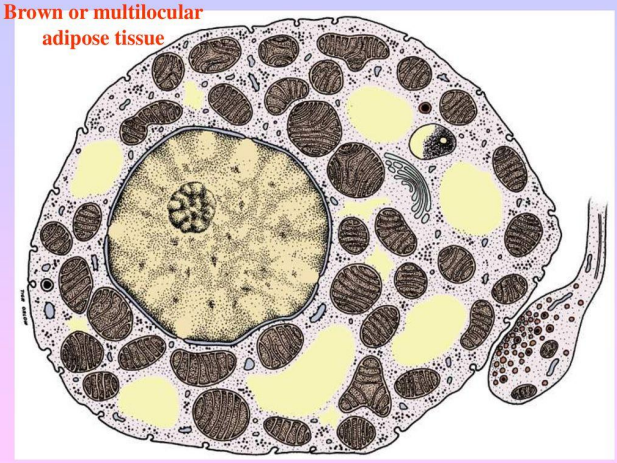
- In human embryo and **newborn,** restricted to neck, axilla, and mediastinum.

Functions:

-In animals It transforms the stored chemical energy to heat when stimulated.

-In human it is important in the first months of postnatal life as it produces heat that protects newborn against cold.

Histological structure: Cell shape:



L/M:

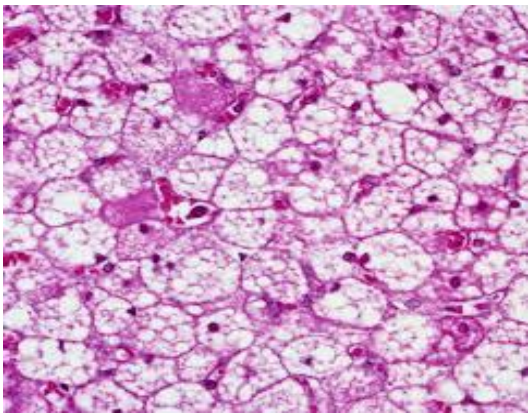
- Polygonal.
- smaller than those of unilocular adipose tissue.
- ***Cytoplasm:*** Several fat vacuoles in Hx & E staining.
- ***Nucleus:*** spherical and eccentric.

E/M:

- Numerous lipid droplets of different sizes.
- The mitochondria are numerous with abundant long cristae. Its color is brown due to:-Large number of blood capillaries.
  -Numerous mitochondria that contain colored cytochrome.

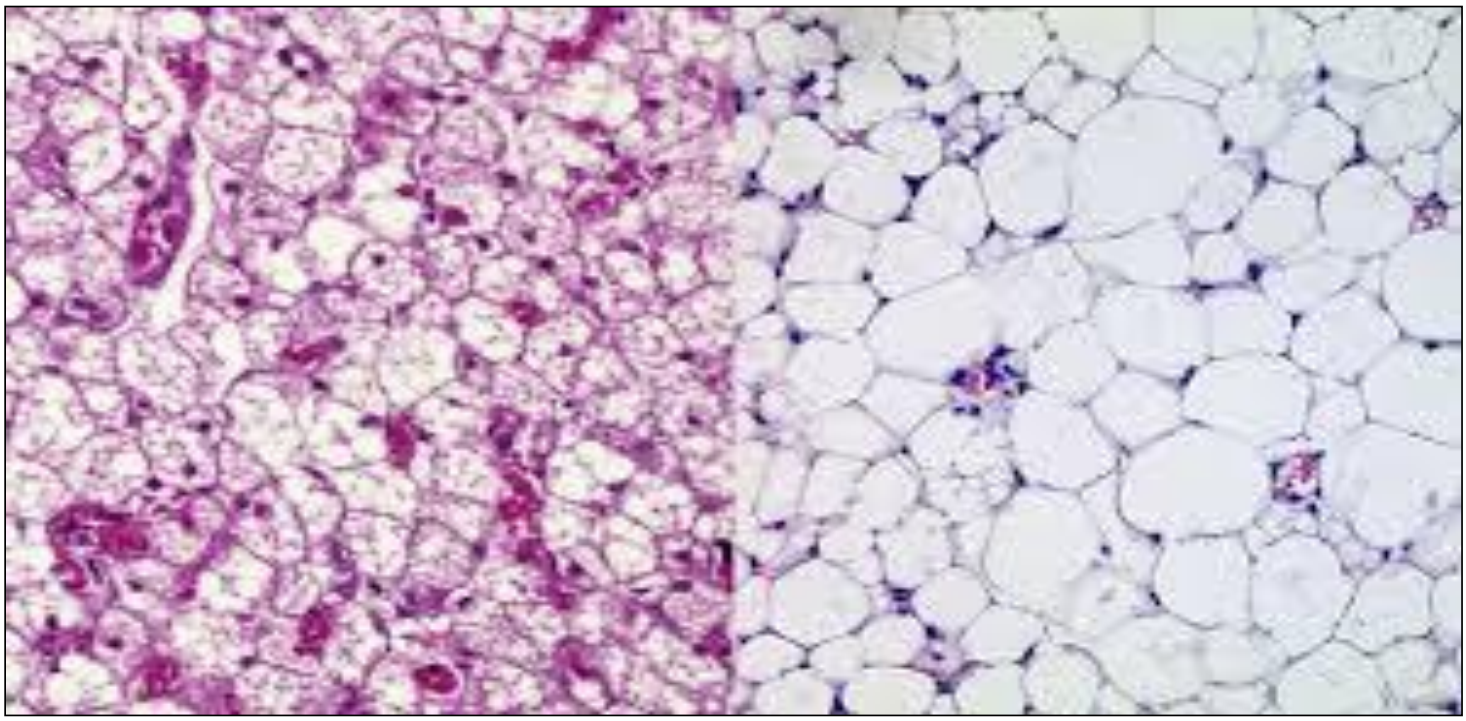
Characteristics of the brown adipose tissue:

-It is subdivided by connective tissue into prominent lobules.
-It is abundant in hibernating animals and resembles endocrine organs as its cells aggregate into closely packed masses associated with blood capillaries.
-Receives direct sympathetic innervation



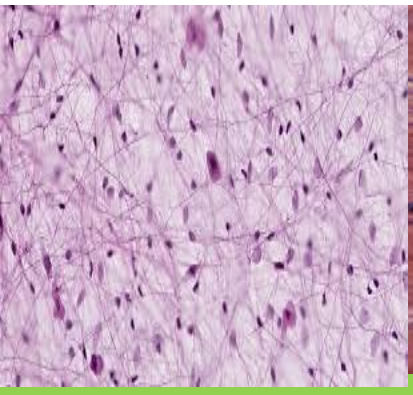
Brown fat

White fat

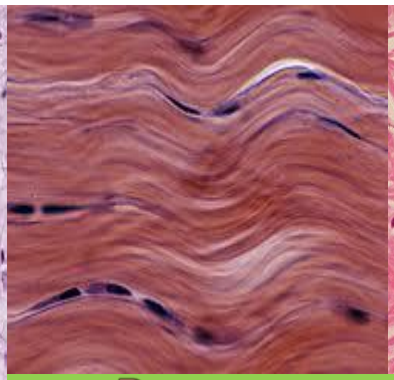


Type of connective tissue	Loose C.T.	Dense regular C.T.	Dense irregular C.T.	Mucoid C.T.	Elastic C.T.	Adipose C.T.
cells	-All	-All -Few	-All -Few	-All -Mainly fibroblasts	-fibroblast	-Mainly adipocytes
Ground substance	-Large amount	-Few	-Few	-Large abundant -Jelly like(Wharton's)	-Few	-Few amount
fibers	-All -Less	- Mainly collagen	-Mainly collagen	-All -Few	-Mainly elastic fibers	-Few amount
Sites in the body	-Dermis -Mucous membranes -pleura	-Tendon -Ligaments	-Dermis -Capsules of spleen	-Umbilical cord -Pulp of young tooth	-ligaments of vertebral column -true vocal cords	

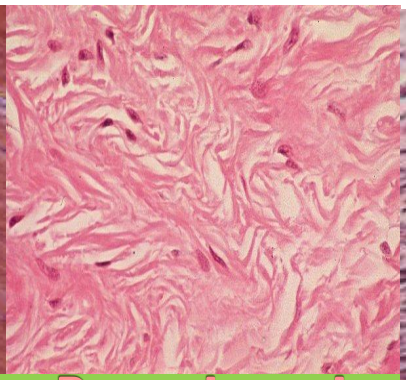
Types of C.T.



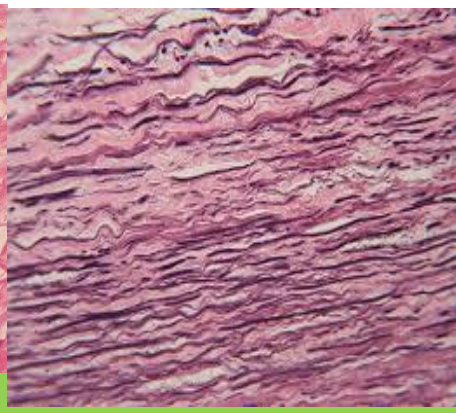
Loose C.T



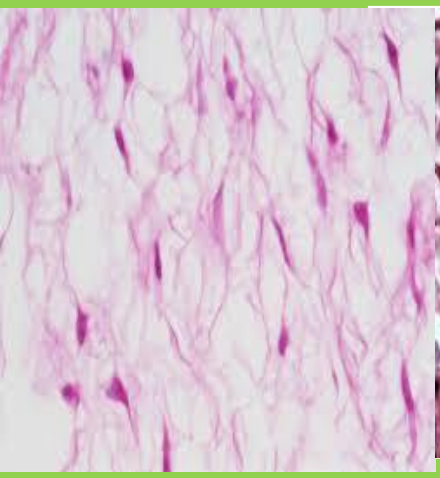
Dense regular C.T.



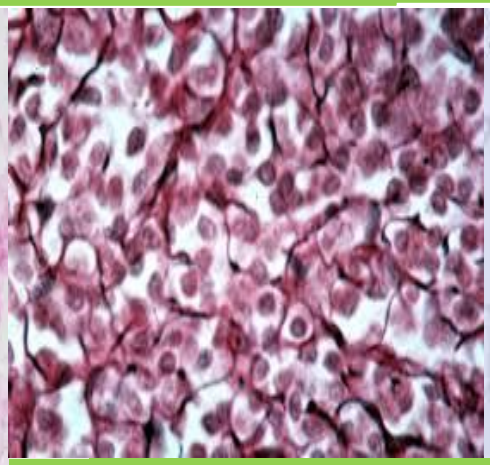
Dense irregular C.T.



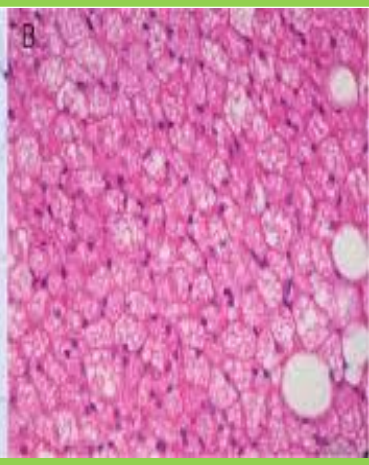
Elastic C.T.



Mucoid C.T.

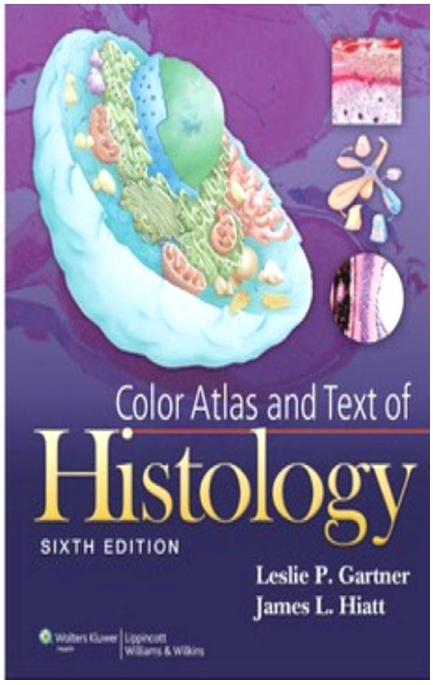


Reticular C.T.



Adipose C.T.

References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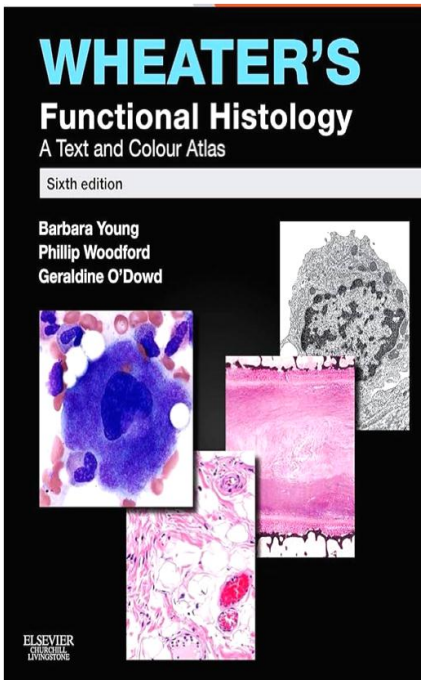
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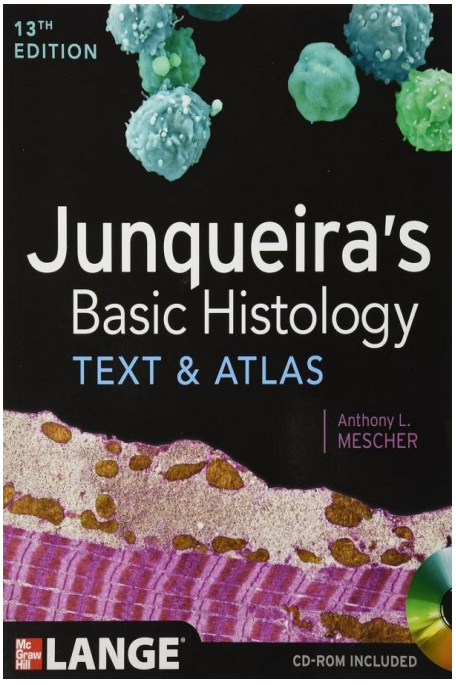
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