اللهم فرج عن المستعضفين في غزة يا رب العالمين , اللهم نصرك الذي وعدت للأهلنا في غزة وفي كل بقاع الأرض يا عزيز يا جبار يا قادر يا مدبر يا من بيده ملكوت كل شيء.
والحمد لك يا ربنا يا من أجرى على من حمده أجراً وسبحانك تعاليت في ملكوتك وسموت بحكمتك , فإنا قاصرون عن فهم حكمتك لكن نطلب رضاك و عافيتك فحاشى ان تردنا وأنت الكريم العظيم المنعم المتفضل ونحن في أفضل الأشهر فيه الأفضل الليالي وفيه نزل خير كتاب على خير خلقك وحبيبك محمد صلى الله عليه وآله وصحبه وسلم .

Ahmad Abu Aisha

Connective Tissue

General Features

At macroscopic level: The bone and cartilages are formed of connective tissue , and they do give support to the whole body .

At microscopic level: connective tissue support other types of tissue (ex: lamina propria under the epithelium)

- Connective tissue provides a matrix that supports and physically connects other tissues and cells together to form the organs of the body.
- The interstitial fluid of connective tissue gives metabolic support to cells as the medium for diffusion of nutrients and waste products.
- Composed of cells (fixed and wandering), fibers and ground substance.
- Variable vascularity.
- Variable regenerative power.

It is usually very will vascularized, but it depends on the type
ex: the cartilages are Avascular vs the bone which is well

Regenerative power is some what related to vascularity, cause the existence of more blood → more nutrients → higher regeneration ability .
however there are exceptions to this rule : epithelium is an example it is Avascular however it has high regeneration power.

Together fibers & ground substance are called matrix.

In the epithelium the cells were similar, meanwhile here in connective tissue the cells making the tissue differs according to:
physiological state.
pathological state.
*The same applies for the fibers& ground substance.
so they differ in amount & type.

Functions

- Structural framework for body. Ex: bones & cartilages
- Transportation of fluids and dissolved substances. Ex: blood, it is special type of CT
- Protection of delicate organs. Ex: capsules surrounding glands
- Supports, surrounds, and connects other tissues. Ex: ligaments , the fascia
- Storage of energy in the form of lipids. Ex: Fat cells (adipocytes) , it is a type of loose CT
- Defend the body against microorganisms. Ex: white blood cells

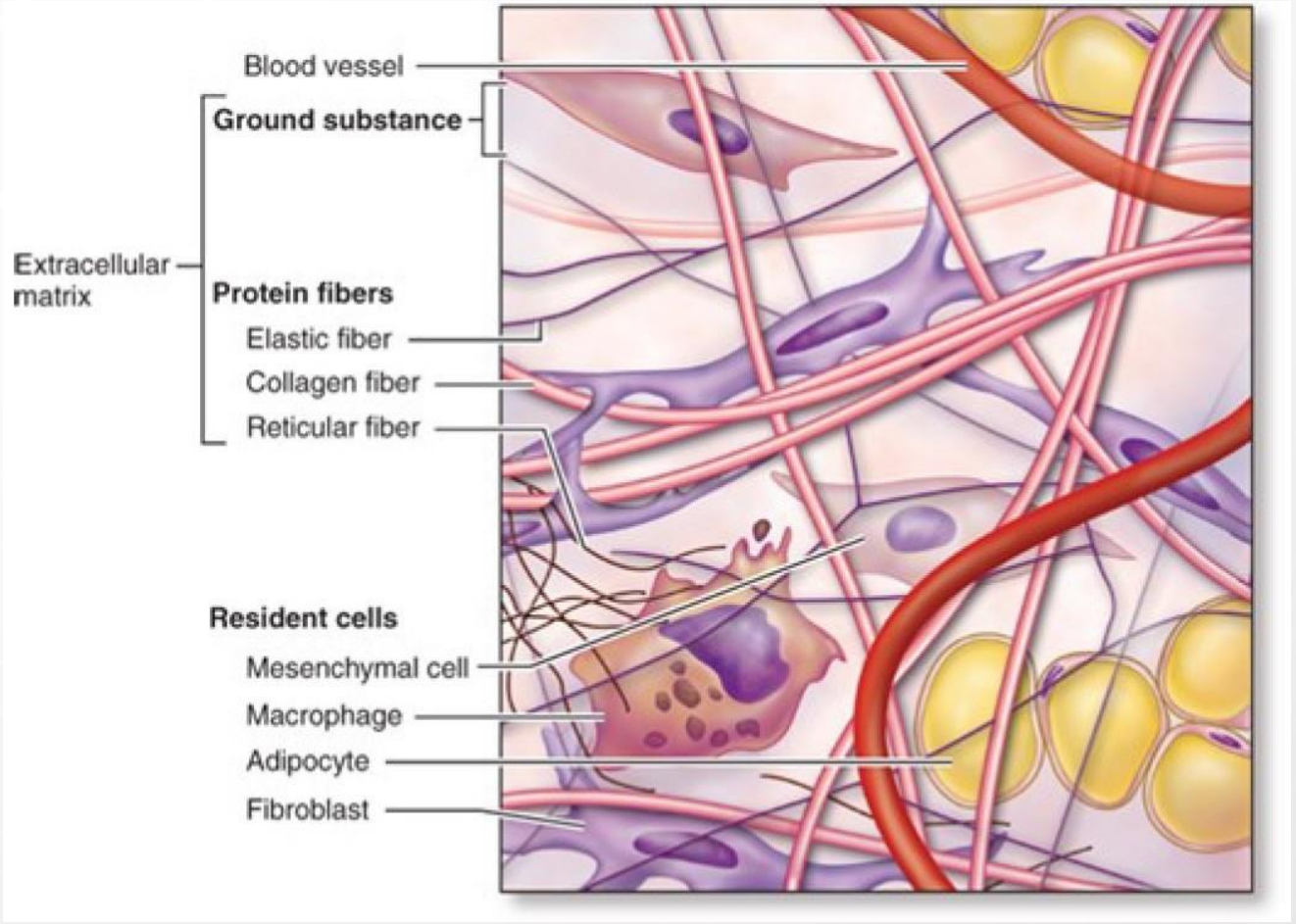
Origin

- All connective tissues originate from embryonic mesenchyme, a tissue developing mainly from the middle layer of the embryo, the mesoderm.
- Mesenchyme consists largely of viscous ground substance with few collagen fibers.
- Mesenchymal cells are undifferentiated and have large nuclei, with prominent nucleoli and fine chromatin.
- Mesenchymal cells are spindle-shaped---- with their scant cytoplasm extended as two or more thin cytoplasmic processes.

Components

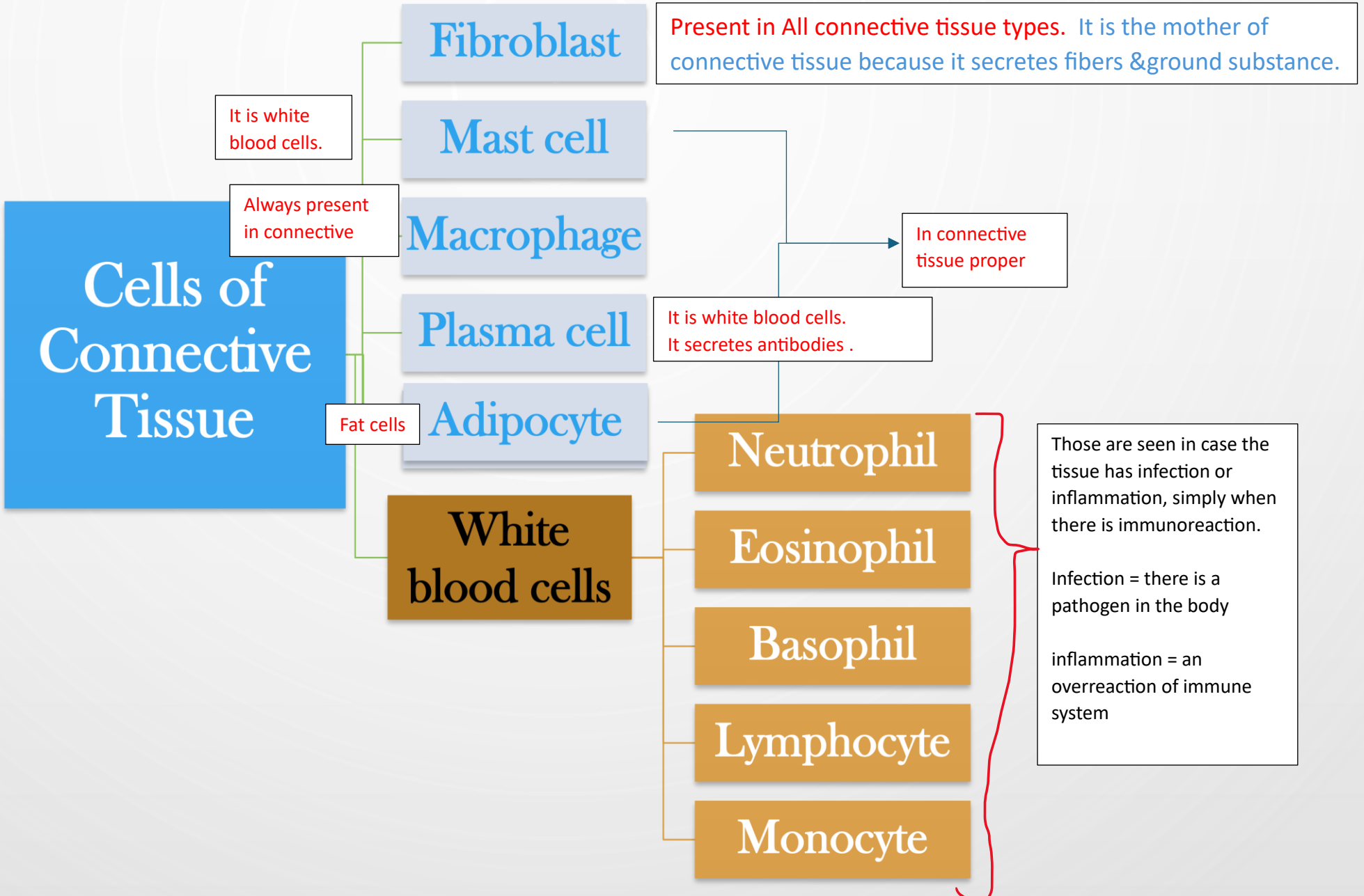
- Cells
- Fibers
- Ground substance.

Matrix



Ground substance.

- Ground substance is a complex of anionic, hydrophilic proteoglycans, glycosaminoglycans (GAGs), and multiadhesive glycoproteins (laminin, fibronectin, etc.)

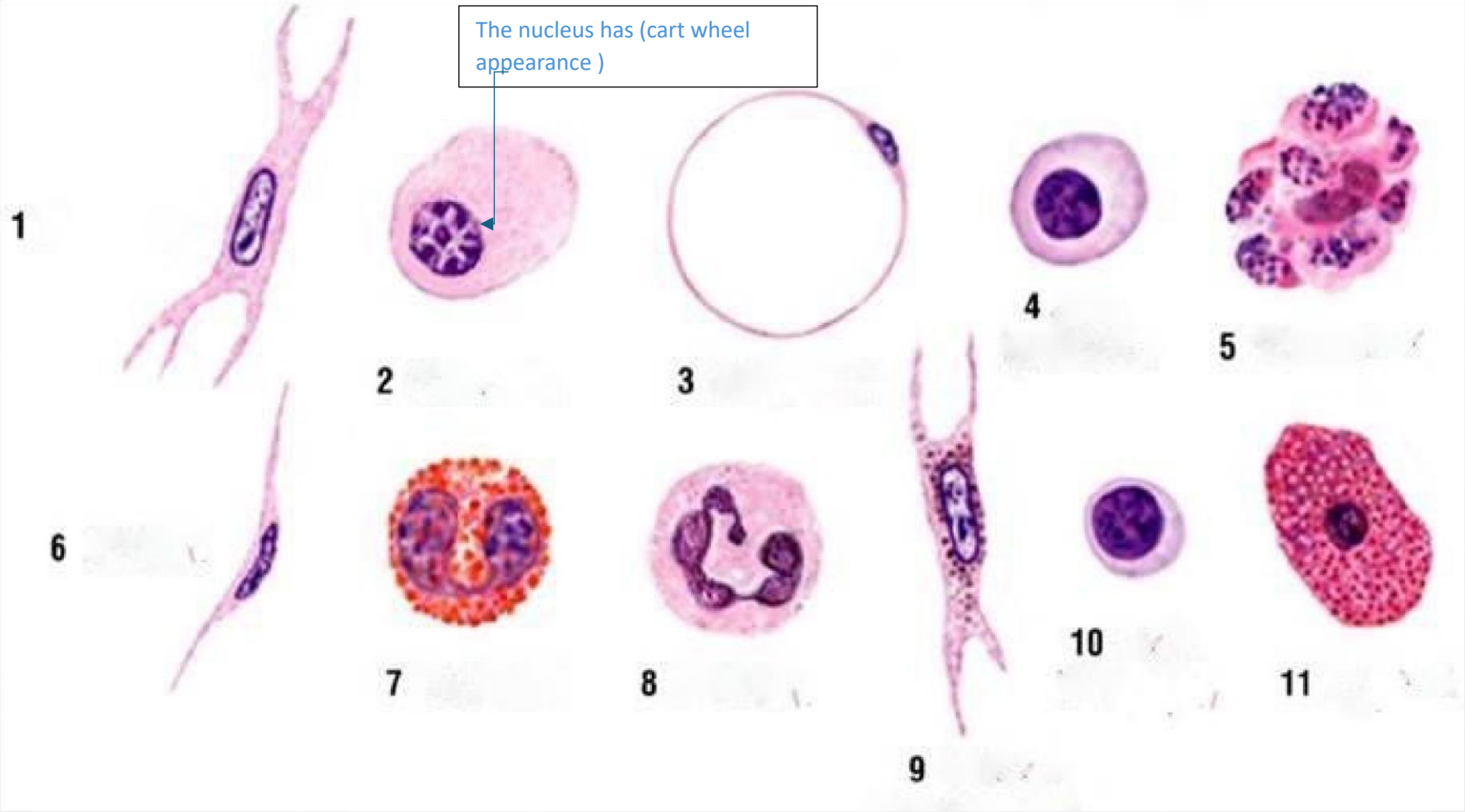

Cells of Connective Tissue
Fibroblast
Present in All connective tissue types. It is the mother of connective tissue because it secretes fibers &ground substance.
Mast cell
It is white blood cells.
Macrophage
Always present in connective
In connective tissue proper
Plasma cell
It is white blood cells.
It secretes antibodies .
Adipocyte
Fat cells
White blood cells
Neutrophil
Eosinophil
Basophil
Lymphocyte
Monocyte
Those are seen in case the tissue has infection or inflammation, simply when there is immunoreaction.
Infection = there is a pathogen in the body
inflammation = an overreaction of immune system

Blast → expresses active cells

Fibrocytes→ expresses dormant(sleeping cell).

ex:
osteoblast (active bone cells)

osteocytes (dormant cells)



1. **Fibroblast**
2. Plasma cell
3. Adipocyte
4. large lymphocyte
5. Macrophage
6. Fibrocyte
7. Eosinophil
8. Neutrophil
9. Cell with pigment granules
10. Small lymphocyte
11. Mast cell

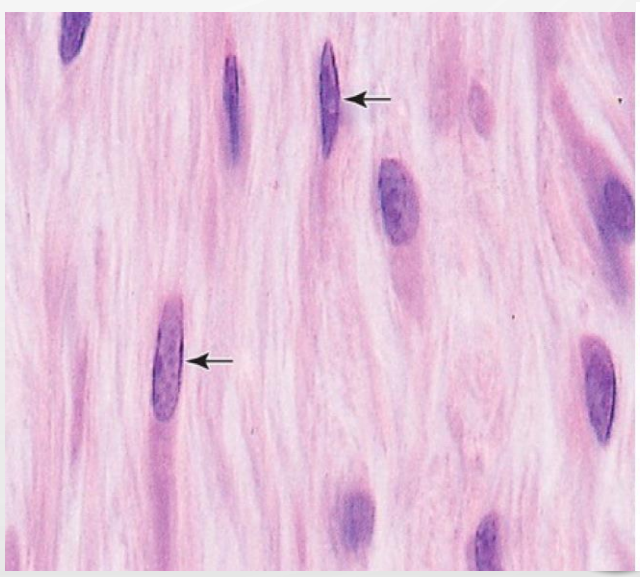
Connective tissue cells

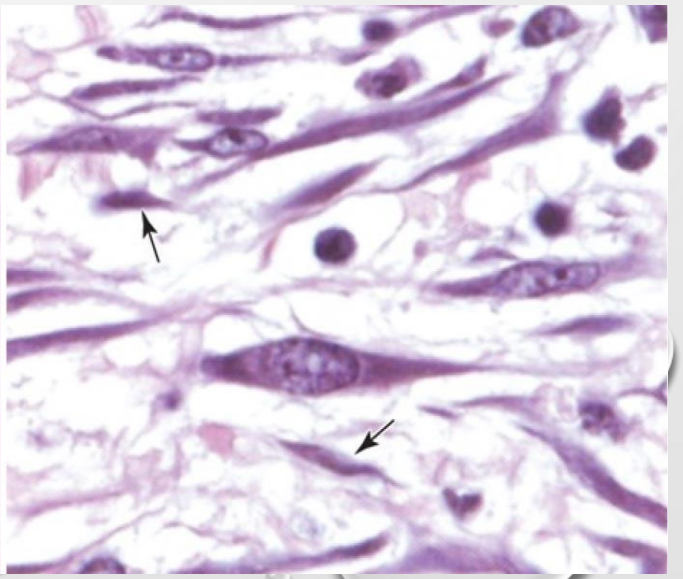
Cell Type	Major Product or Activity
Fibroblasts (fibrocytes)	Extracellular fibers and ground substance
Plasma cells	Antibodies
Lymphocytes (several types)	Various immune/defense functions
Eosinophilic leukocytes	Modulate allergic/vasoactive reactions and defense against parasites
Neutrophilic leukocytes	Phagocytosis of bacteria
Macrophages	Phagocytosis of ECM components and debris; antigen processing and presentation to immune cells; secretion of growth factors, cytokines, and other agents
Mast cells and basophilic leukocytes	Pharmacologically active molecules (eg, histamine)
Adipocytes	Storage of neutral fats

Fibroblast

- The most common cells in connective tissue proper
- Produce and maintain most of the tissue's extracellular components.
- Most of the secreted ECM components undergo further modification outside the cell before assembling as a matrix.

Fibroblast **Fibrocyte**

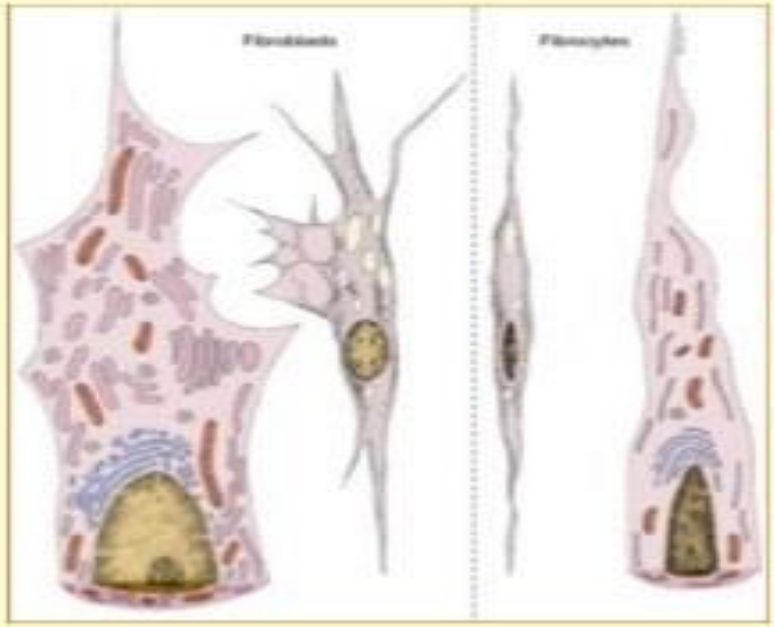




Fibroblasts _ Fibrocytes

✓ Fibroblasts

- the most common cells in connective tissue
- cells responsible for the synthesis of extracelullar matrix components
- an abundant and irregularly branched cytoplasm
- ovoid, large and pale staining nucleus with nucleolus
- rich in RER and well developed Golgi complex
- produce the growth factors → influence growth and cells differentiation
- proliferate when the additional fibroblasts are required



✓ Fibrocytes

- smaller than fibroblasts
- fewer processes
- smaller, darker, elongated nucleus
- small amount of RER

Two stages of activity

The active cells → Fibroblasts

The quiescent cells → Fibrocytes

Fibroblast	Fibrocyte
• has more abundant and irregularly branched cytoplasm • large, ovoid, euchromatic nucleus and a prominent nucleolus • containing much rough endoplasmic reticulum (RER) and well-developed Golgi apparatus. euchromatin: less condensed (so stains poorly) , gene-rich, and more accessibleto transcription	• smaller than the active fibroblast usually • spindle-shaped with fewer processes. • Has much less RER • Has darker and more heterochromatic nucleus. heterochromatin: highly condensed (so stains darkly), gene-poor, and transcriptionally silent. *they aren't dead cells , they are sleeping cells so they can be activated if needed , to give fibroblast.

Macrophage

- Macrophages have highly developed phagocytic ability and specialize in turnover of protein fibers and removal of apoptotic cells, tissue debris, or other particulate material
- Being especially abundant at sites of inflammation.
- Size and shape vary considerably, corresponding to their state of functional activity.
- A typical macrophage measures between 10 and 30 μm in diameter and has an eccentrically located, oval or kidney-shaped nucleus.
- They generally have well developed Golgi complexes and many lysosomes.

Macrophages are simply white blood cells were called (monocytes), but they have left the blood and resided some where else so it acquires new features so the function and the shape differs , The transformation from monocytes to macrophages in connective tissue involves increases in cell size, increased protein synthesis, and increases in the number of Golgi complexes and lysosomes .

similar thing happen when monocytes resides some where else other than connective tissue . It will differentiate to more mature cells called together (mononuclear phagocytosis the)

Mononuclear Phagocyte System

Immune related function

Cell Type	Major Location	Main Function
Monocyte	Blood	Precursor of macrophages
Macrophage	Connective tissue, lymphoid organs, lungs, bone marrow, pleural and peritoneal cavities	Production of cytokines, chemotactic factors, and several other molecules that participate in inflammation (defense), antigen processing, and presentation
Kupffer cell	Liver (perisinusoidal)	Same as macrophages
Microglial cell	Central nervous system	Same as macrophages
Langerhans cell	Epidermis of skin	Antigen processing and presentation
Dendritic cell	Lymph nodes, spleen	Antigen processing and presentation
Osteoclast (from fusion of several macrophages)	Bone	Localized digestion of bone matrix
Multinuclear giant cell (several fused macrophages)	In connective tissue under various pathological conditions	Segregation and digestion of foreign bodies

Not immune related

This is not pathological, because the bone is In constant stat of remolding.
The osteoclast helps liberating calcium from bones when needed

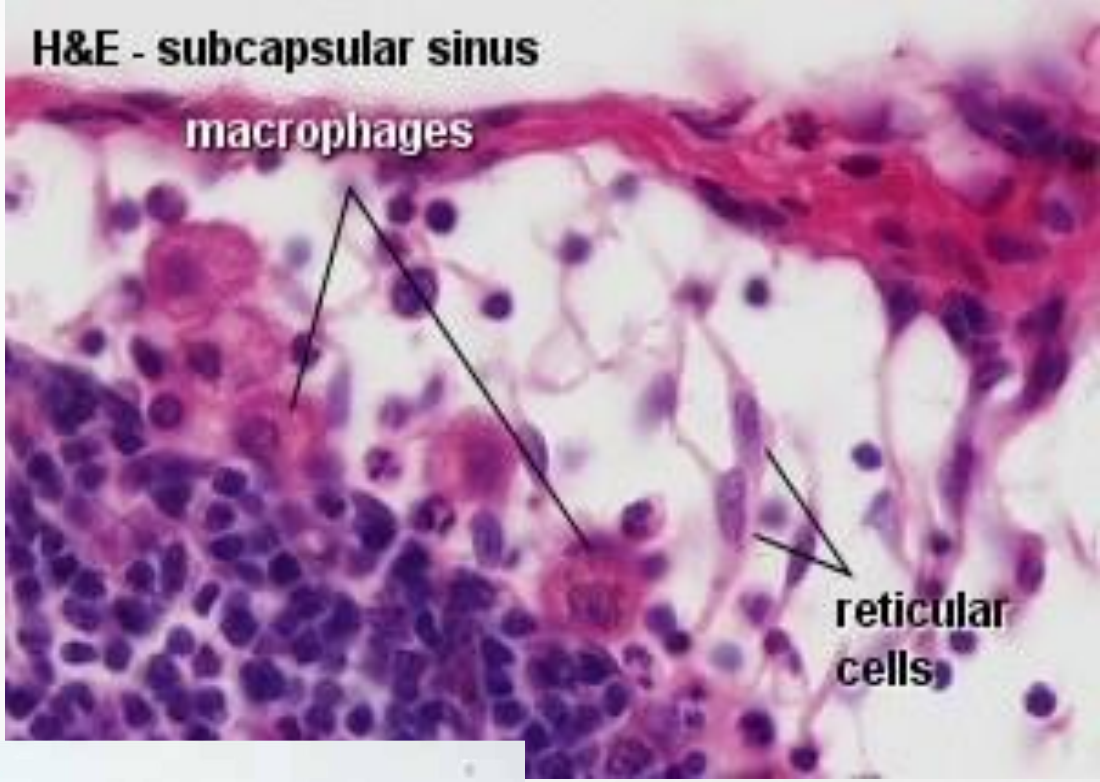
Immune related

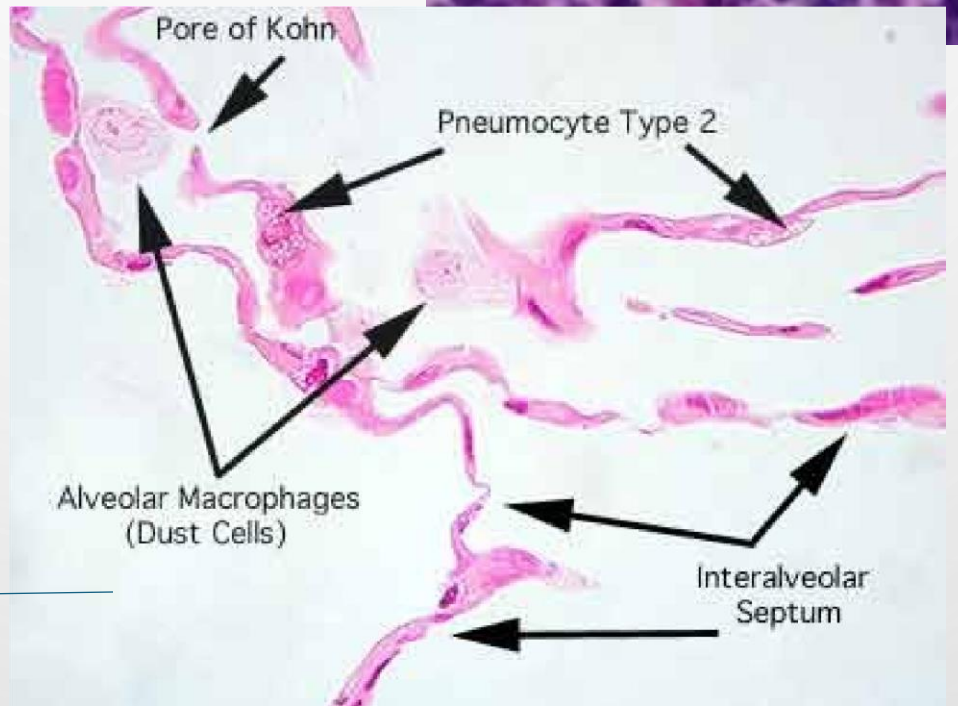
Number of monocytes fuses to form one of these giant cells, which can be distinguished by having many nuclei

This is a section from the liver , so the microphages there are called (Kupffer cells) , They line sinusoidal spaces. And anything that runs in the blood that needs to be picked up, they will pick it and they will store it inside.

macrophages will recognize the ink as a foreign material. They will engulf it and bring it inside And that's how we recognize their location.

Microphages in Sinus (الجيوب الانفية)
which are usually large





They are found in the lungs ,they can engulf the particles that we inhale.

Mast Cell

They are white blood cells (immune cells)
found in the connective tissue.
They are permanent residents in CT , but their amount differs depending on whether the tissue is at immune reaction (so many mast cells will be there), or not

- Mast cells are oval or irregularly shaped cells of connective tissue,
- Filled with basophilic secretory granules that often obscure the central nucleus
- Mast cells function in the localized release of many bioactive substances, includes the following:

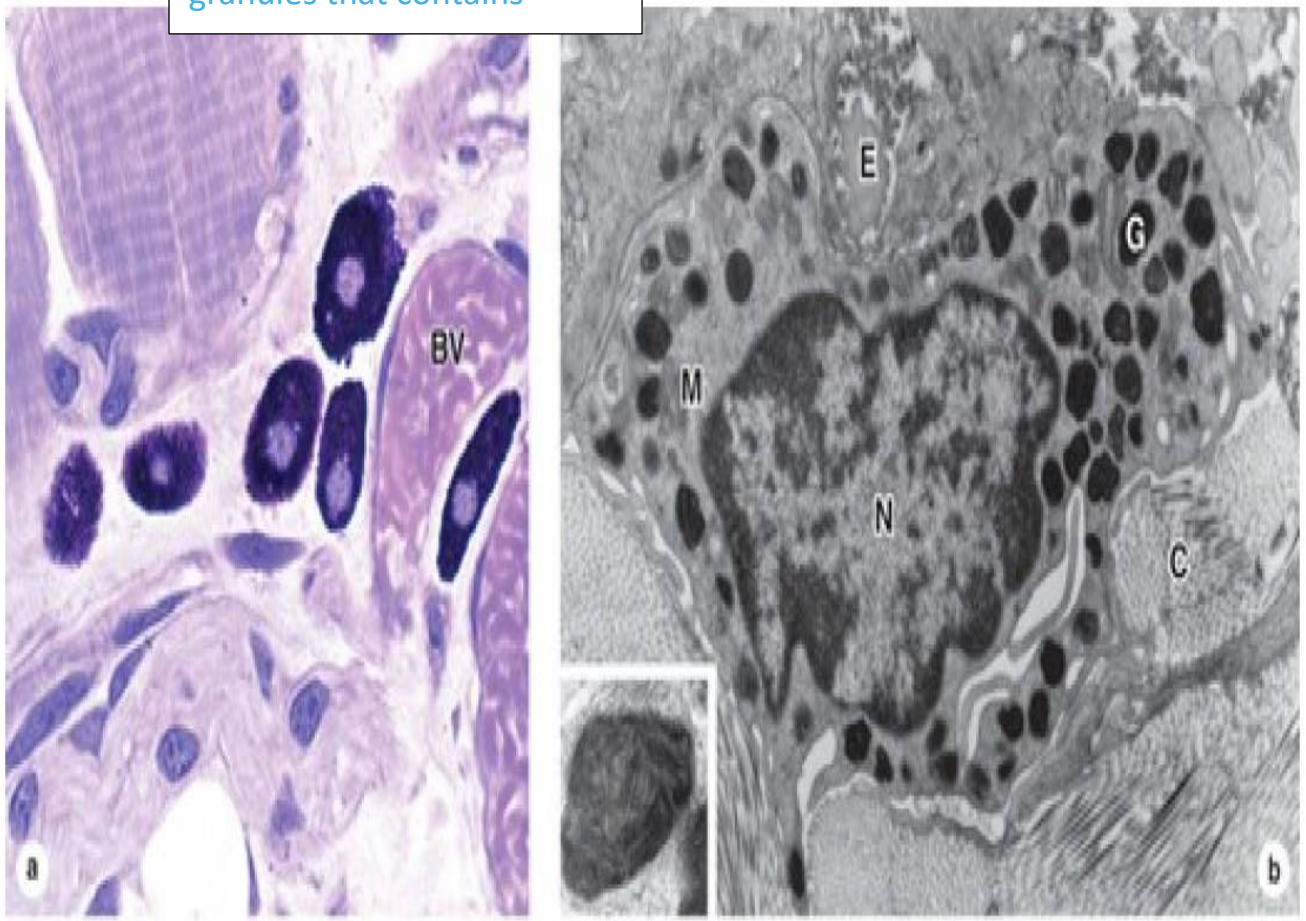
That explains the effects on breathing by allergies. Where mast cells release histamine that increase the contraction of smooth muscles around the airways

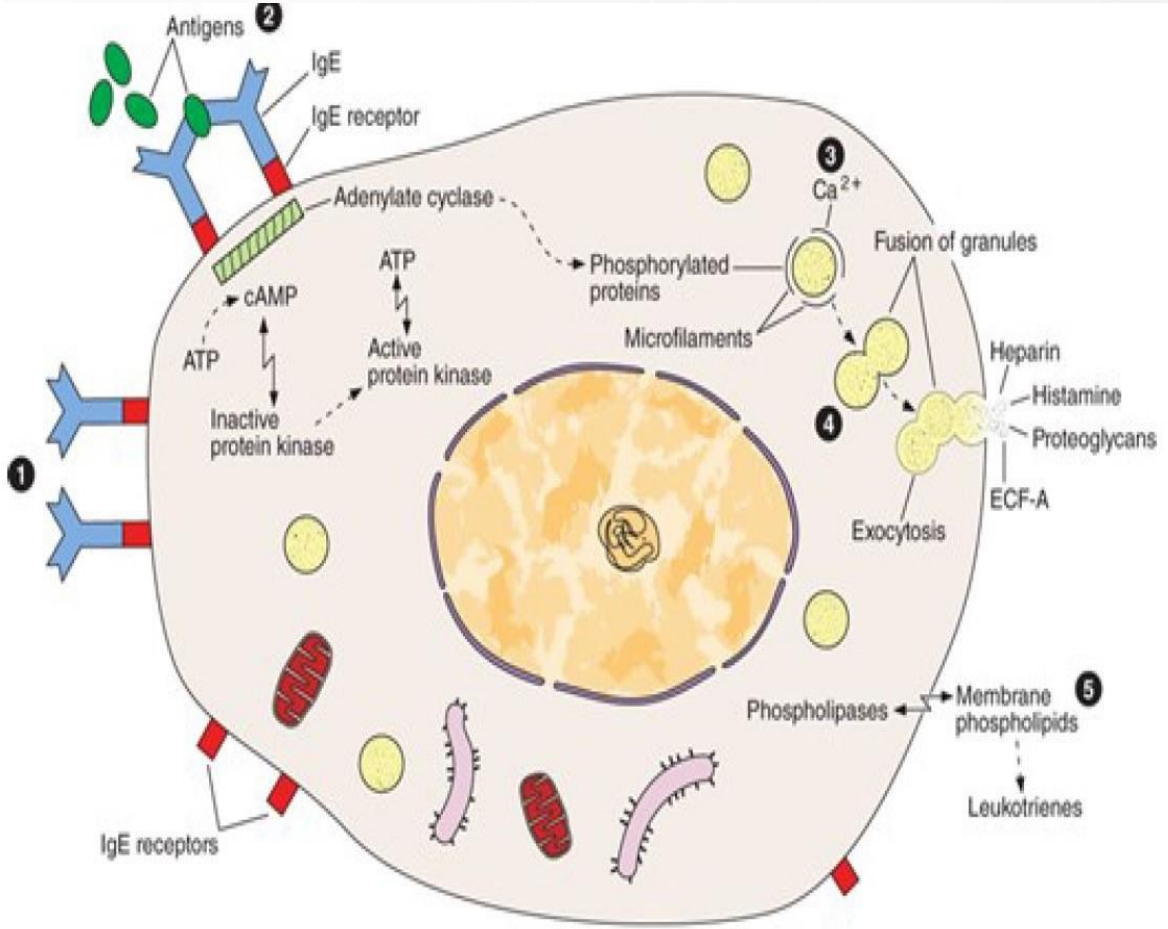
1. Heparin, a sulfated GAG that acts locally as an anticoagulant.
2. Histamine: promotes increased vascular permeability and smooth muscle contraction.
3. Serine proteases: activate various mediators of inflammation
4. Eosinophil and neutrophil chemotactic factors: attract those leukocytes
5. Phospholipid precursors: converted to other important lipid mediators of the inflammatory reaction.

The blood vessels aren't usually permeable
so histamine makes the capillaries more leaky , increasing the blood flow , which explains the redness & warmness of the

MAST CELL

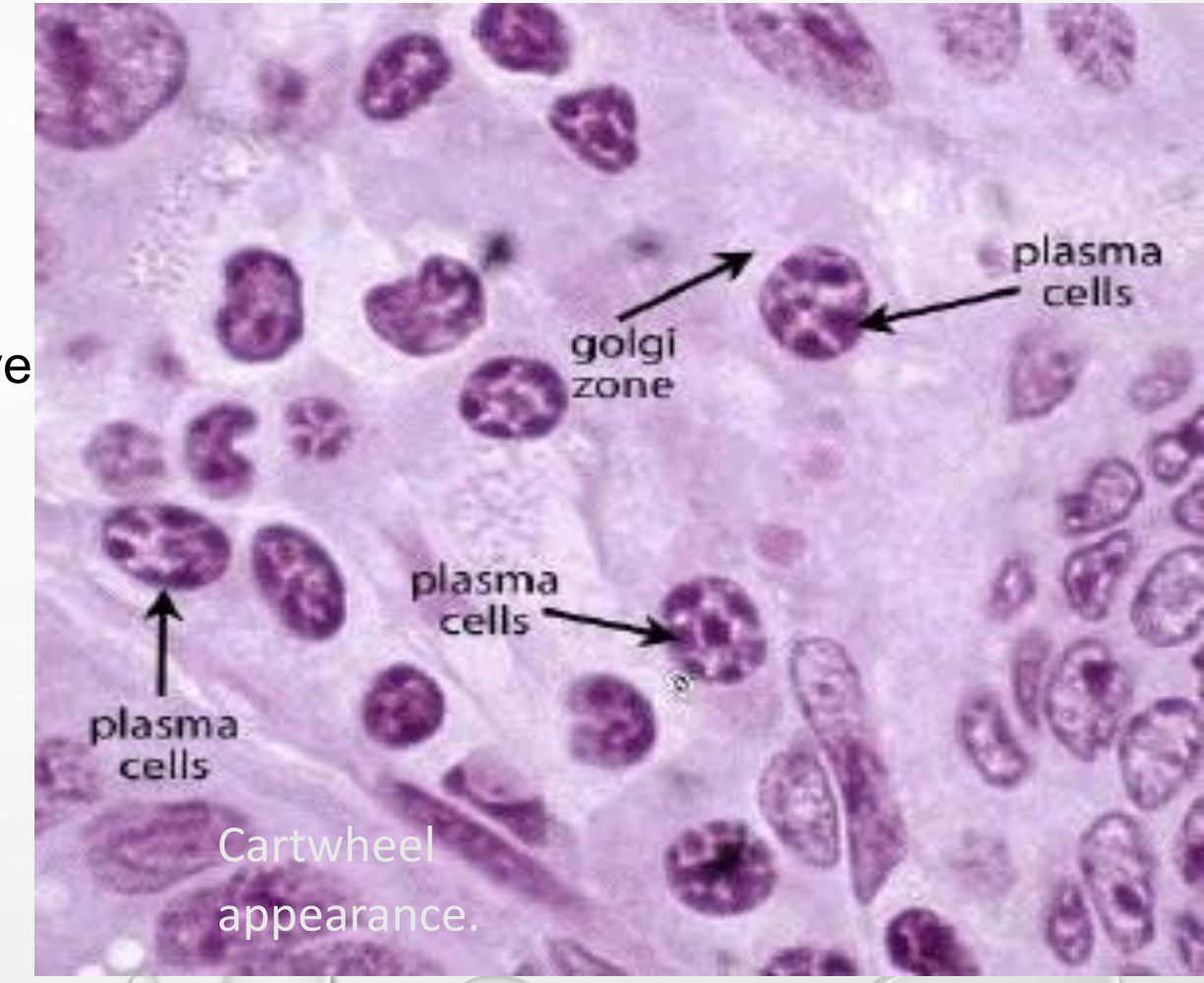
This is toluidine blue staining:
cause they are full with granules that contains



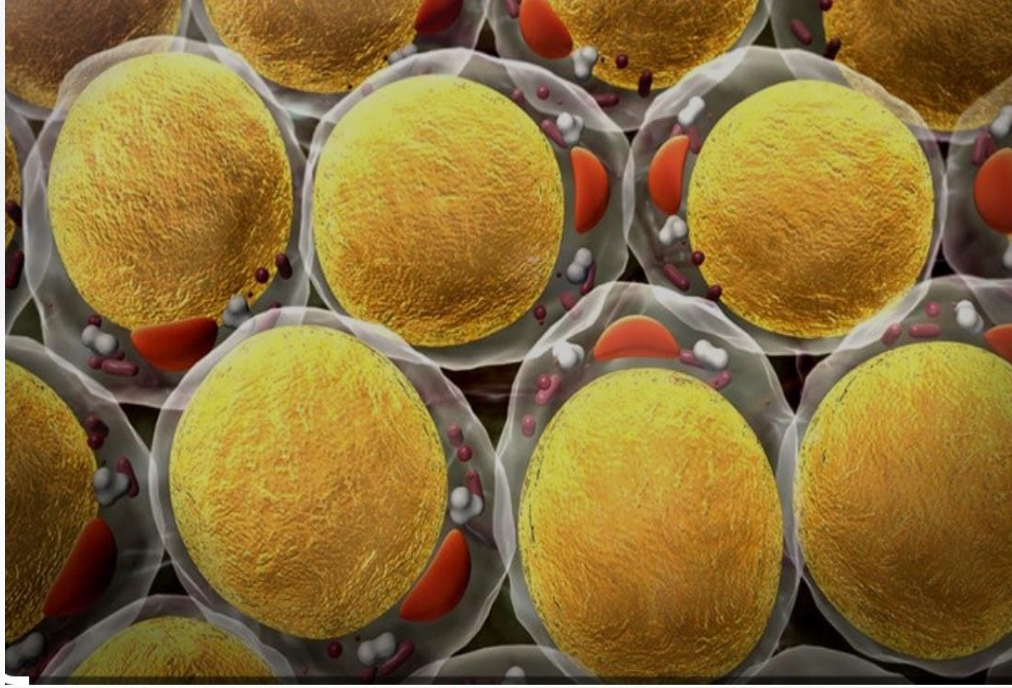


Plasma Cell

- Plasma cells are B lymphocyte derived, antibody-producing cells.
- Relatively large(compared to the lymphocyte), ovoid cells have cytoplasm rich in RER.
- Large Golgi apparatus near the nucleus that may appear pale in routine histologic preparations



Adipose Cells



- Fat cells
- Found in the connective tissue of many organs.
- Large, mesenchymal derived cells are specialized for cytoplasmic storage of lipid as neutral fats, or less commonly for the production of heat.
- Tissue with a large population of adipocytes, called adipose connective tissue, serves to cushion and insulate the skin and other organs.

They are usually found in the loose connective tissu
, and almost everywhere , but if there is too much
them in a single tissue it is not called (loose) any
more , rather it is called adipose connective tissue

Since it is full with fat, the nucleus & the cytoplasm are pushed to the periphery and the cell will have the signet ring appearance.