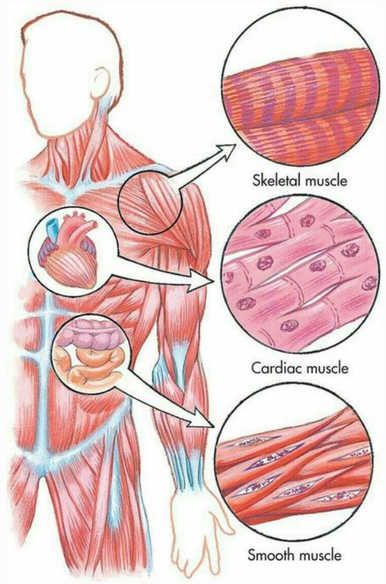
بسم الله الرحمن الرحيم

Histology - Lecture #9

Connective Tissue pt.1



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Connective Tissue

General Features

- Connective tissue provides a matrix that supports and physically connects other tissues and cells together to form the organs of the body.

  It support the epithelial tissue as well as connecting it (epithelium) to underlying structures as in GI tract

- The interstitial fluid of connective tissue gives metabolic support to cells as the medium for diffusion of nutrients and waste products + gases

- Composed of cells (fixed and wandering), fibers and ground substance.

  Fixed cells are always present in connective tissue.
  Wandering cells, like white blood cells, you may see them sometimes and not at other times. If there is an infection, their numbers will increase.

- Variable vascularity.
- Variable regenerative power.

For example, bone is vascular, however, cartilage is avascular. There is a relationship between vascularity and regenerative power, bone is regenerative more then cartilage because it is more vascular.
Tendons and capsules have good vascularity as well as regenerative power.

Functions

1. Structural framework for body. Bone, cartilages, tendons and ligaments.
2. Transportation of fluids and dissolved substances. Blood and Interstitial fluid in connective tissue
3. Protection of delicate organs. Bones and cartilages.
4. Supports, surrounds, and connects other tissues.
5. Storage of energy in the form of lipids. Adipose connective tissue

Loose connective tissue may contain some fat cells(scattered), but if the tissue is filled with fat cells it is called adipose tissue

1. Defend the body against microorganisms. White blood cells

The nucleus of a mesenchymal cell is described as euchromatic, meaning that the genetic material inside it is loosely packed and not condensed, it appears under the microscope Lightly stained or pale when using histological stains, due to the loosely packed chromatin

Origin

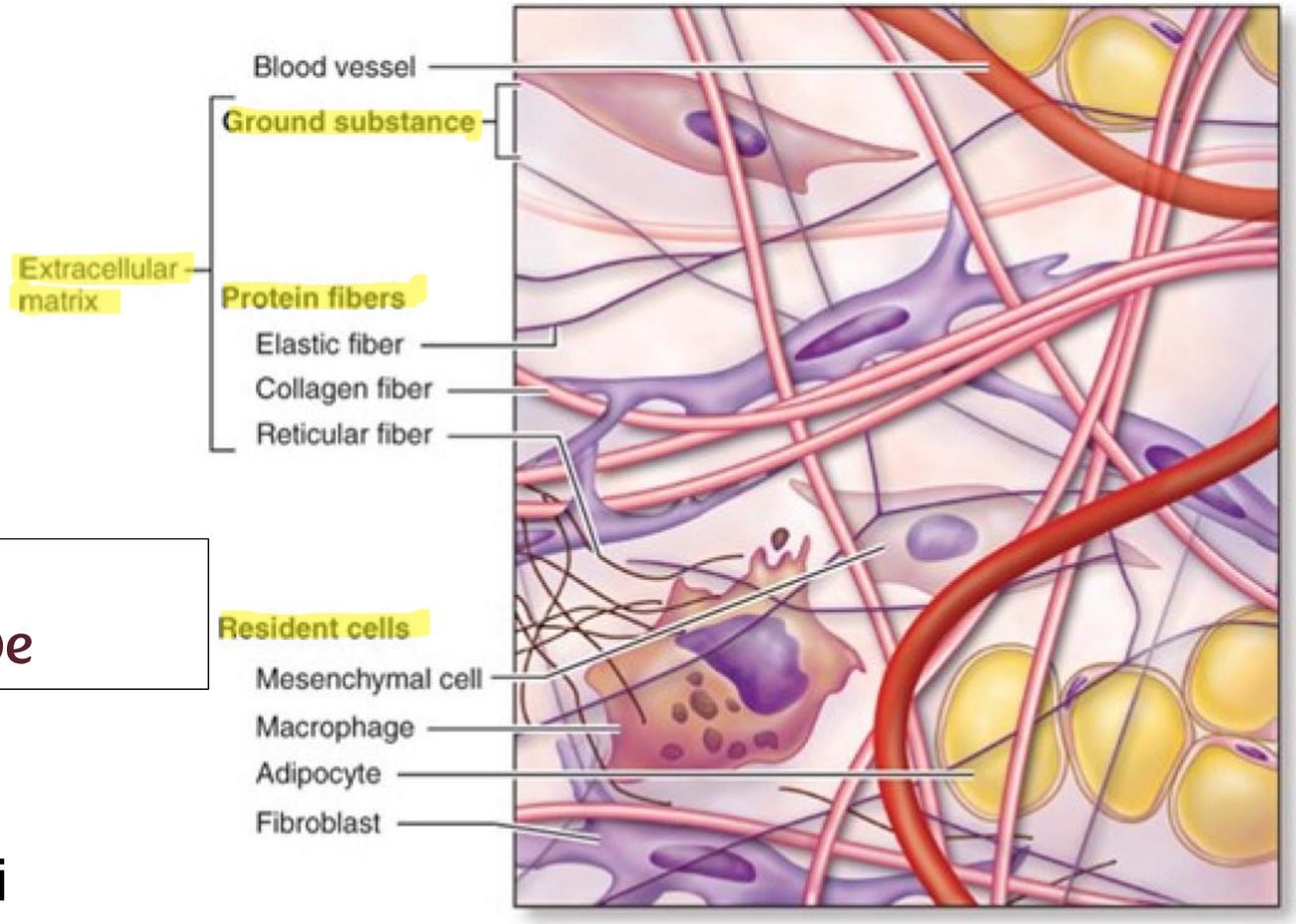
- All connective tissues originate from embryonic mesenchyme, a tissue developing mainly from the middle layer of the embryo, the mesoderm.
- Mesenchyme consists largely of viscous ground substance with few collagen fibers.
- Mesenchymal cells are undifferentiated and have large nuclei, with prominent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

Mesenchyme stem cells differentiate according to location (Bone / dermis / cartilage)

Components

- Cells
- Fibers
- Ground substance

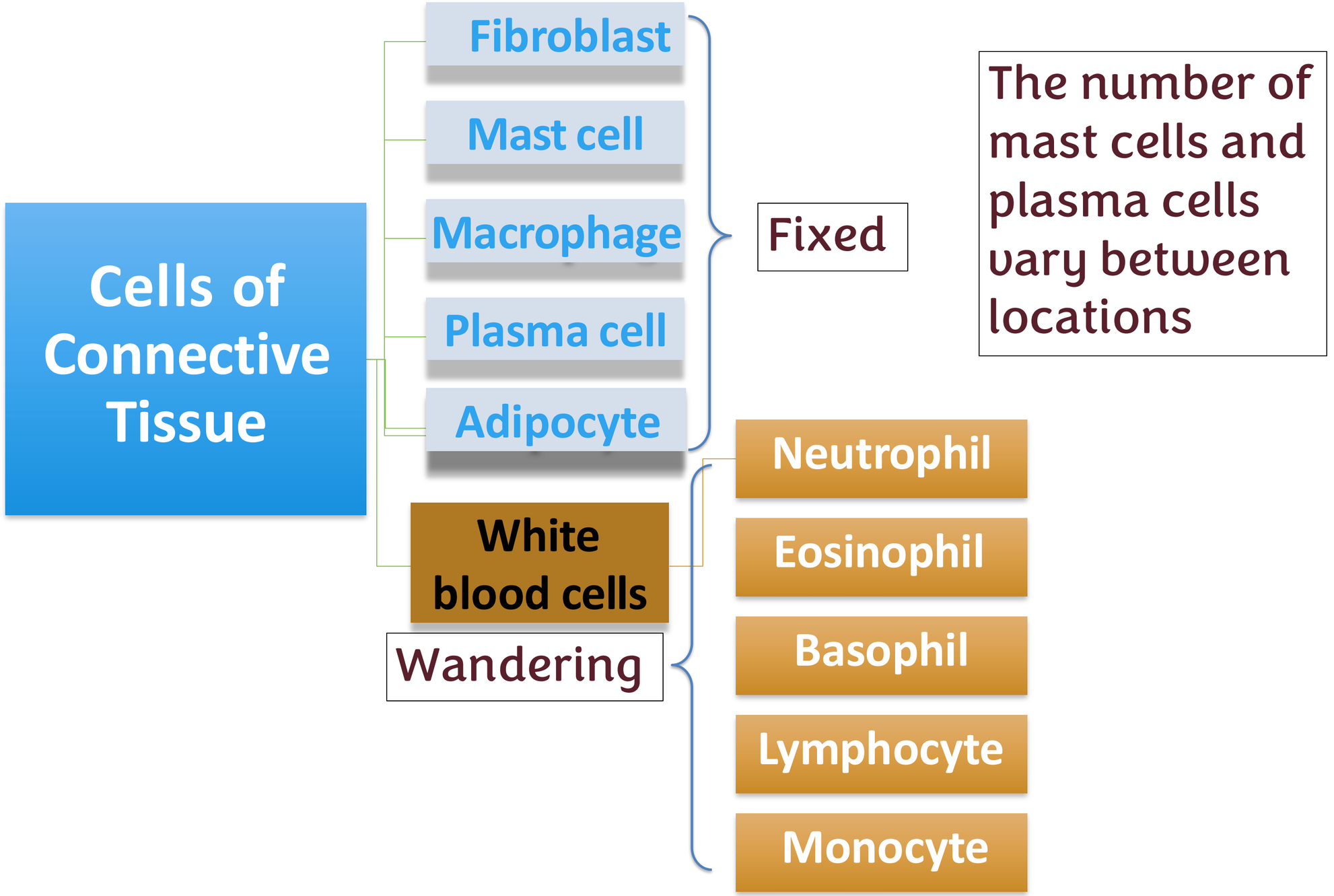
More fibers >> Dense connective tissue
More ground substance >> Loose connective tissue

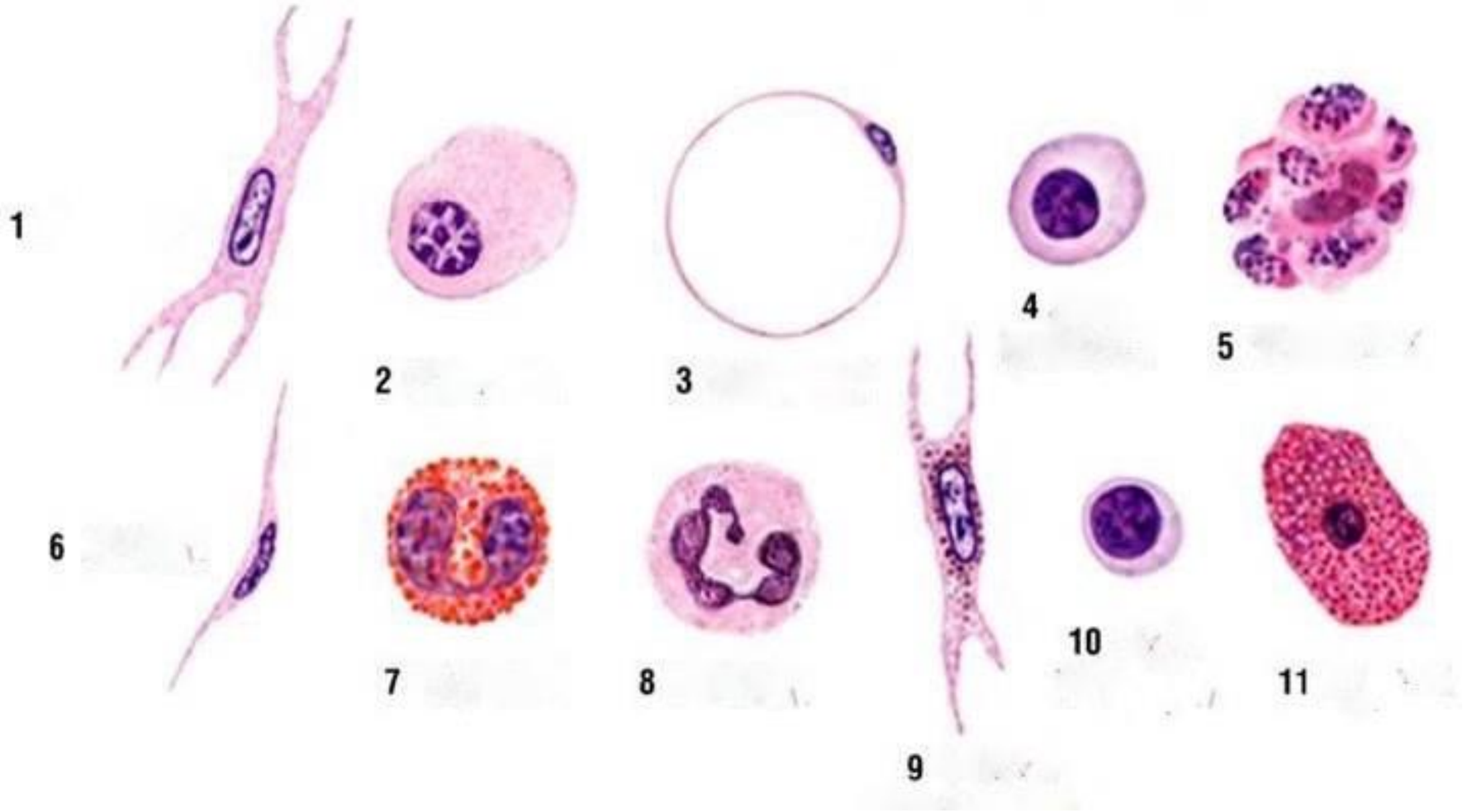


Ground substance

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

Connective tissues have different types of cells unlike other type of tissues


Cells of Connective Tissue
Fibroblast
Mast cell
Macrophage
Plasma cell
Adipocyte
Fixed
The number of mast cells and plasma cells vary between locations
White blood cells
Wandering
Neutrophil
Eosinophil
Basophil
Lymphocyte
Monocyte



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

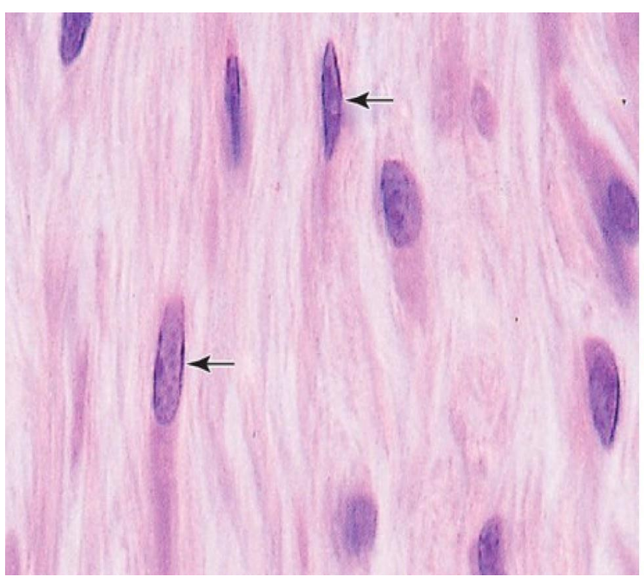
Signaling molecules for cell communication in immune system

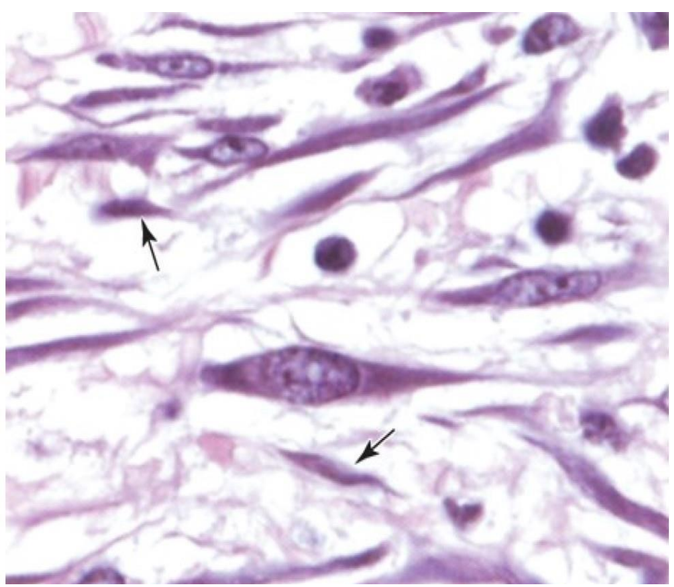
Fibroblast

Mother of the CT

- 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**

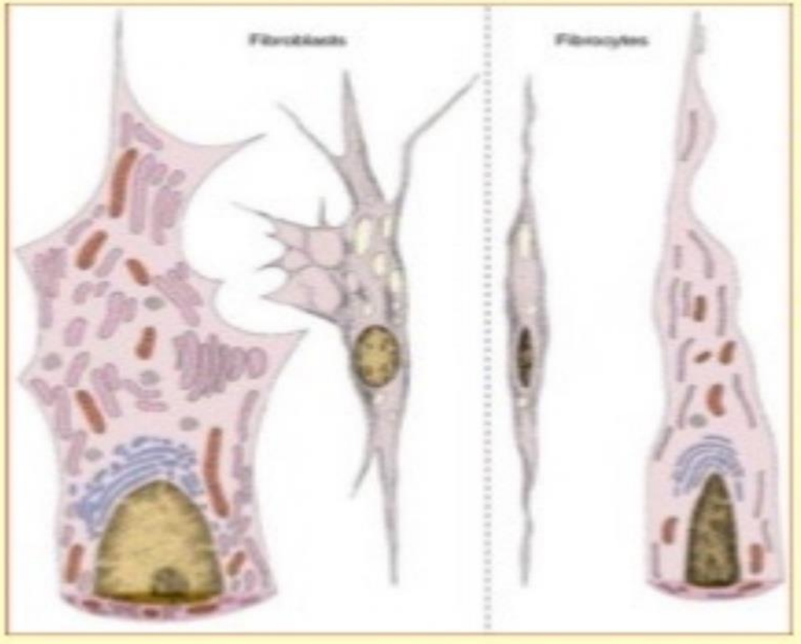




Fibroblasts _ Fibrocytes

✓ 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

Notes about fibroblasts and fibrocytes:

1- Fibrocytes are semiretired, they were fibroblasts and they have done synthesis and release of components.

2- Fibrocytes are not dead cells, they are quiescent.

3- Fibrocyte nucleus compacts and it forms heterochromatic nucleus, in fibroblasts it is called euchromatic.

A heterochromatic nucleus refers to a nucleus in which a large portion of the chromatin is in a highly condensed state

4- If we need fibrocytes due to damage in connective tissue, they will return to active state

5- Cytoplasm is bigger in fibroblasts and it contains more organelles like mitochondria and RER than fibrocytes

6- Fibroblasts can move because they have process, fibrocytes are less motile.

7- We have other examples:

Osteoblasts and Osterocytes in bone

Chondroblasts and Chondrocytes in cartilage

Macrophage

Macrophages are originally monocytes, meaning they are derived from white blood cells, they recycle in the blood until they're needed they migrate into connective tissue.

- Macrophages have highly developed phagocytic ability and specialize in turnover of protein fibers and removal of apoptotic cells, tissue debris, or other particulate material
- 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 can result from the fusion of two or more cells.

Macrophage

- Being especially abundant at sites of inflammation.

When a wound or cut occurs in the skin, microorganisms reach the blood from the surrounding environment (when bleeding occurs, it means that the connective tissue has been reached).

Microphages are very important in areas of inflammation because they specialize in antigen processing and presentation, in addition to secreting growth factors such as cytokines (signaling molecules for communication between cells of immune system).

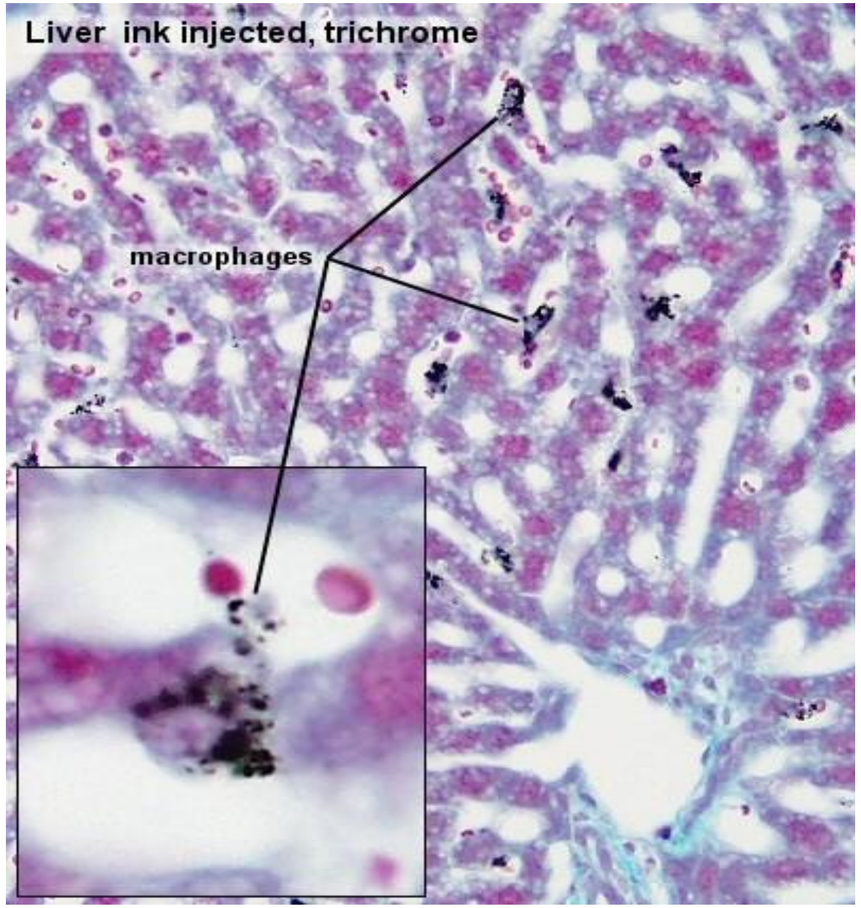
monocytes ← [Mononuclear] Phagocyte System

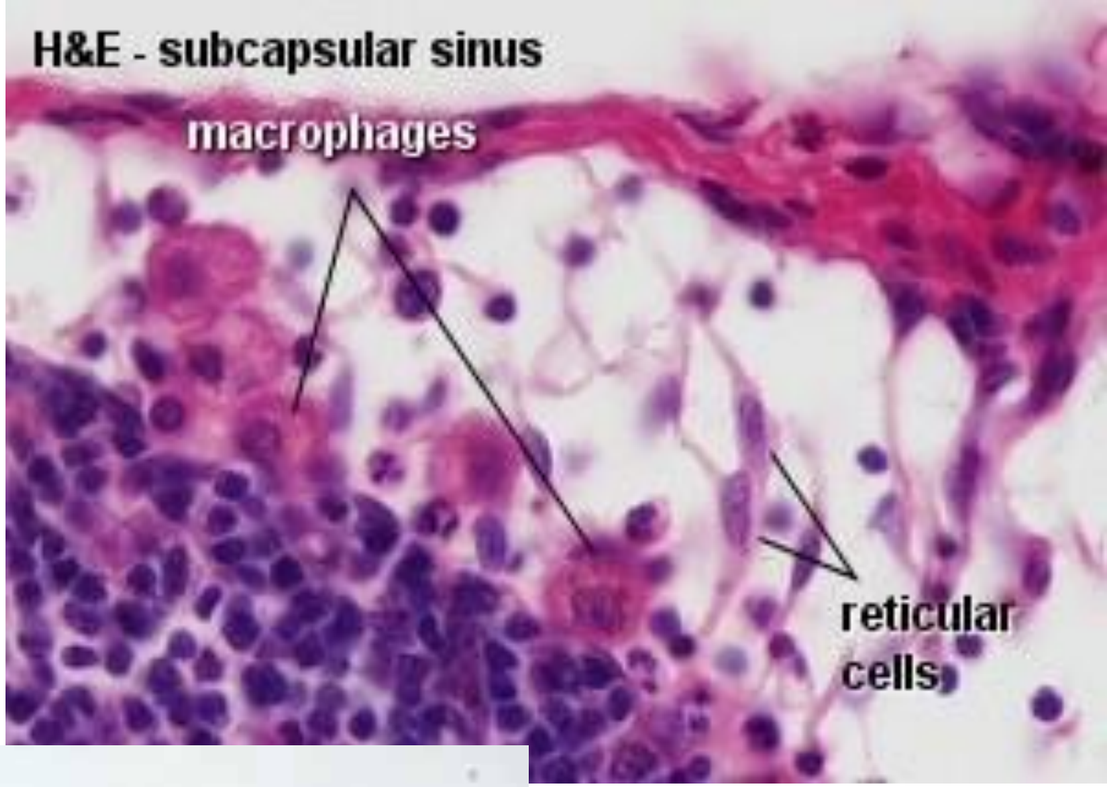
Cell Type	Major Location	Main Function
Monocyte	Blood	Precursor of macrophages
Macrophage	Connective tissue, lymphoid organs, lungs, bone marrow, pleural and peritoneal cavities	Production of cytokines, chemotactic factors, and several other molecules that participate in inflammation (defense), antigen 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

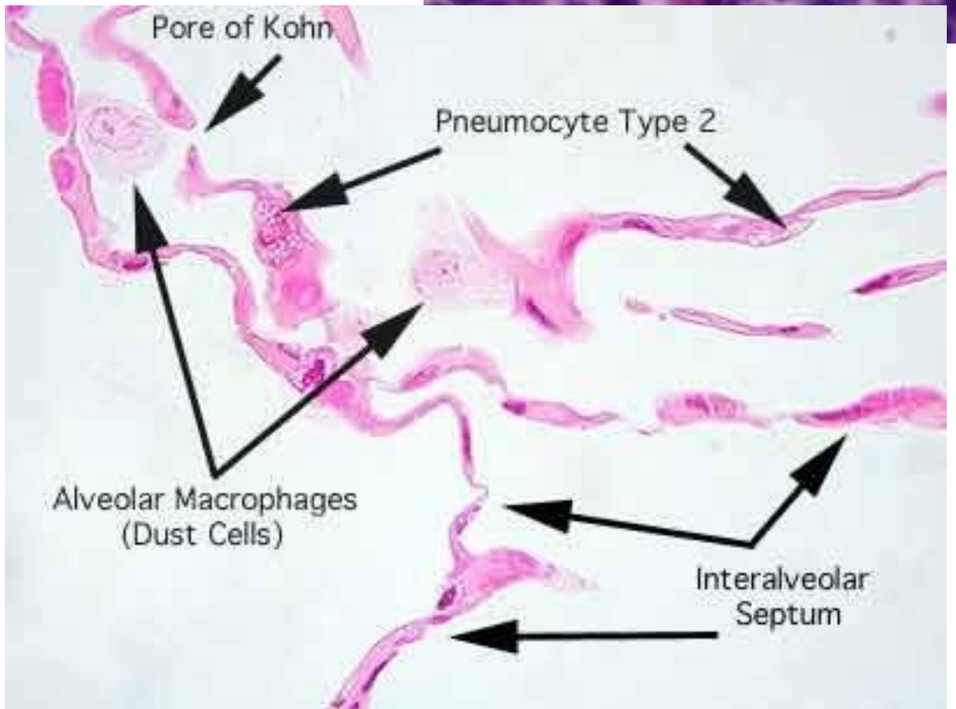
Immune related functions

Career shift

The last way to compensate for the deficiency of calcium ions


Liver ink injected, trichrome
macrophages


H&E - subcapsular sinus
macrophages
reticular cells


Pore of Kohn
Pneumocyte Type 2
Alveolar Macrophages (Dust Cells)
Interalveolar Septum

Mast Cell Highly active

- 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:

➢ Heparin, a sulfated GAG that acts locally as an anticoagulant

➢ Histamine: promotes increased vascular permeability(Vasodilation =heat) and smooth muscle contraction(Reduces the diameter of the bronchial lumen)

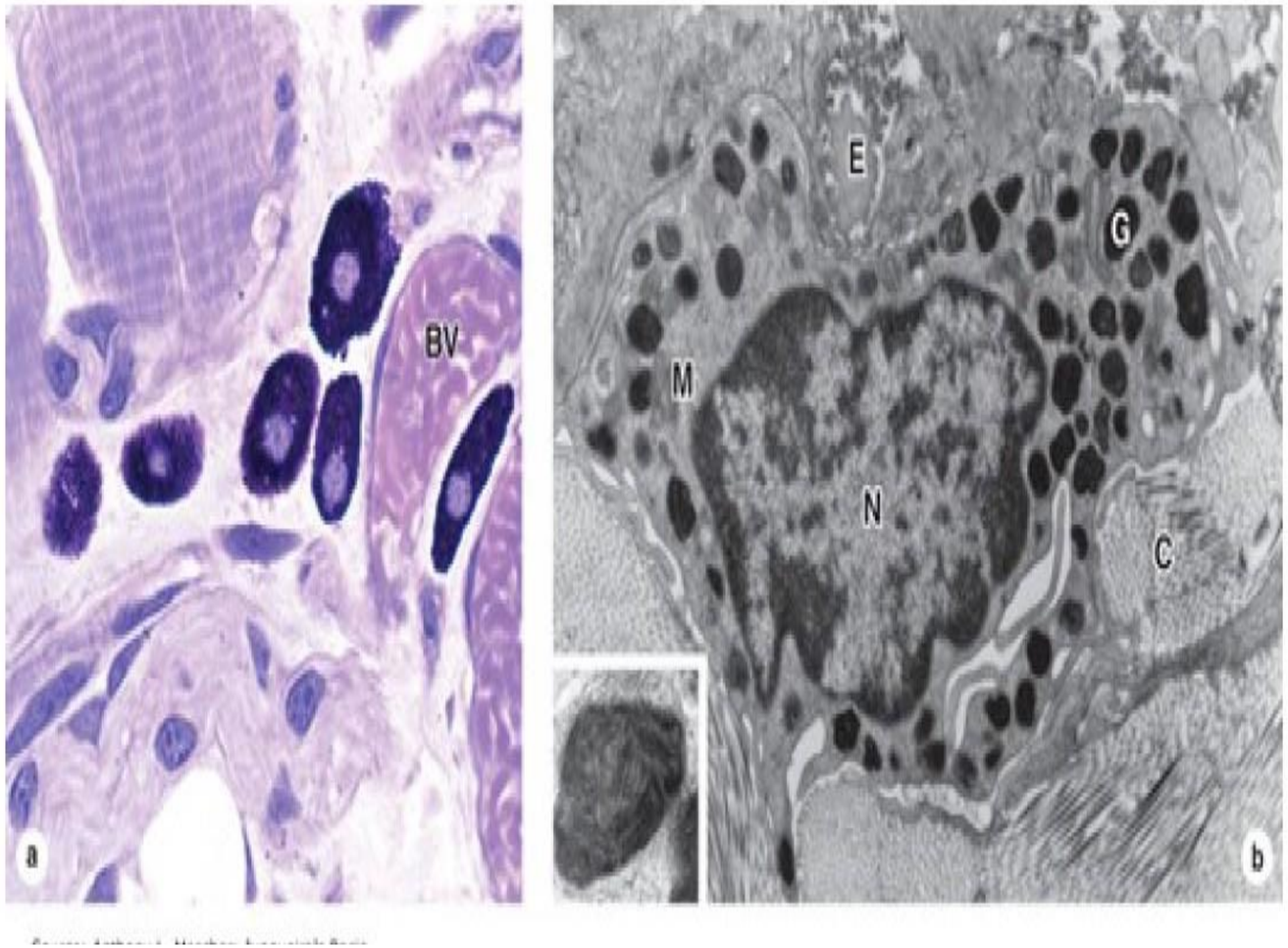
Responsible for allergy symptoms

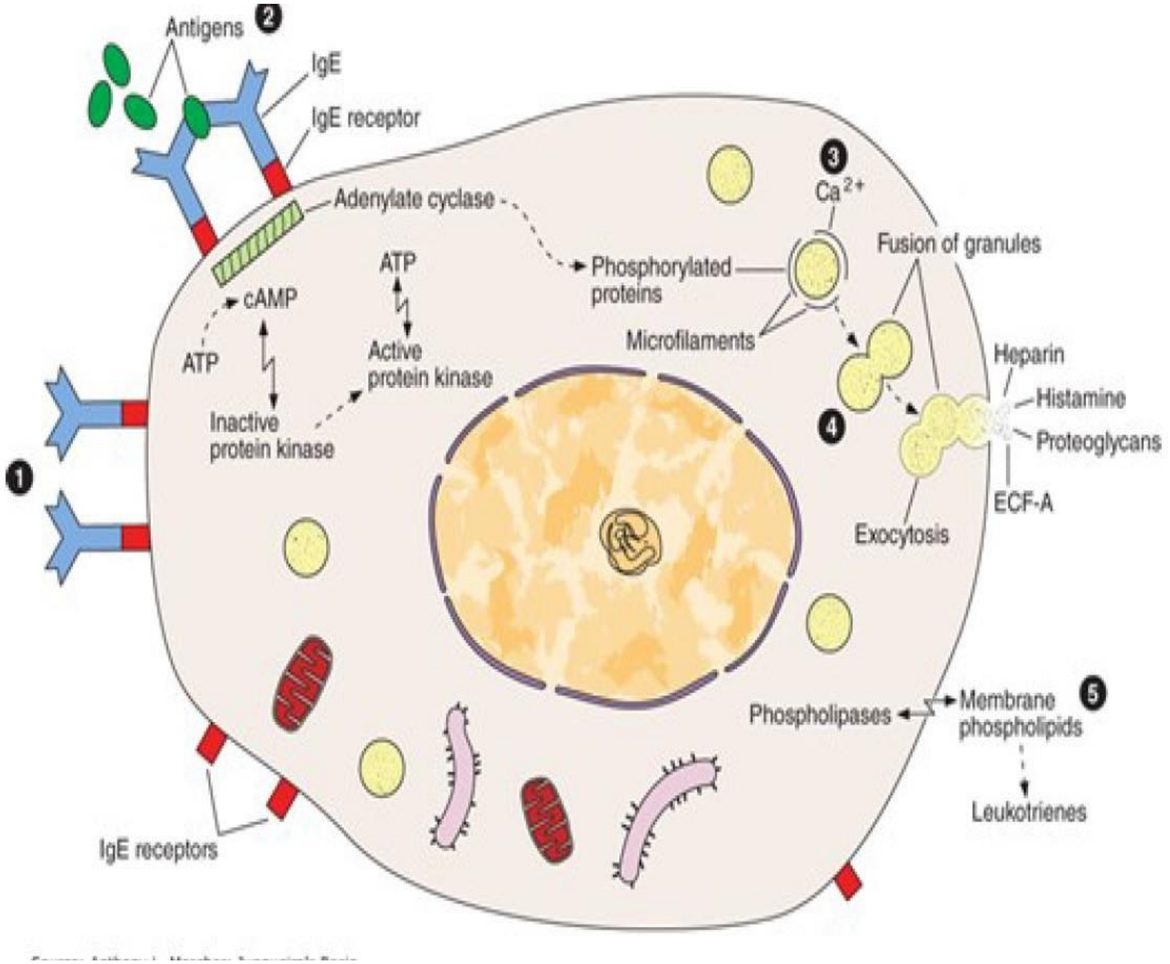
➢Serine proteases: activate various mediators of inflammation

➢Eosinophil and neutrophil chemotactic factors: attract those leukocytes

➢Phospholipid precursors: converted to other important lipid mediators of the inflammatory reaction.

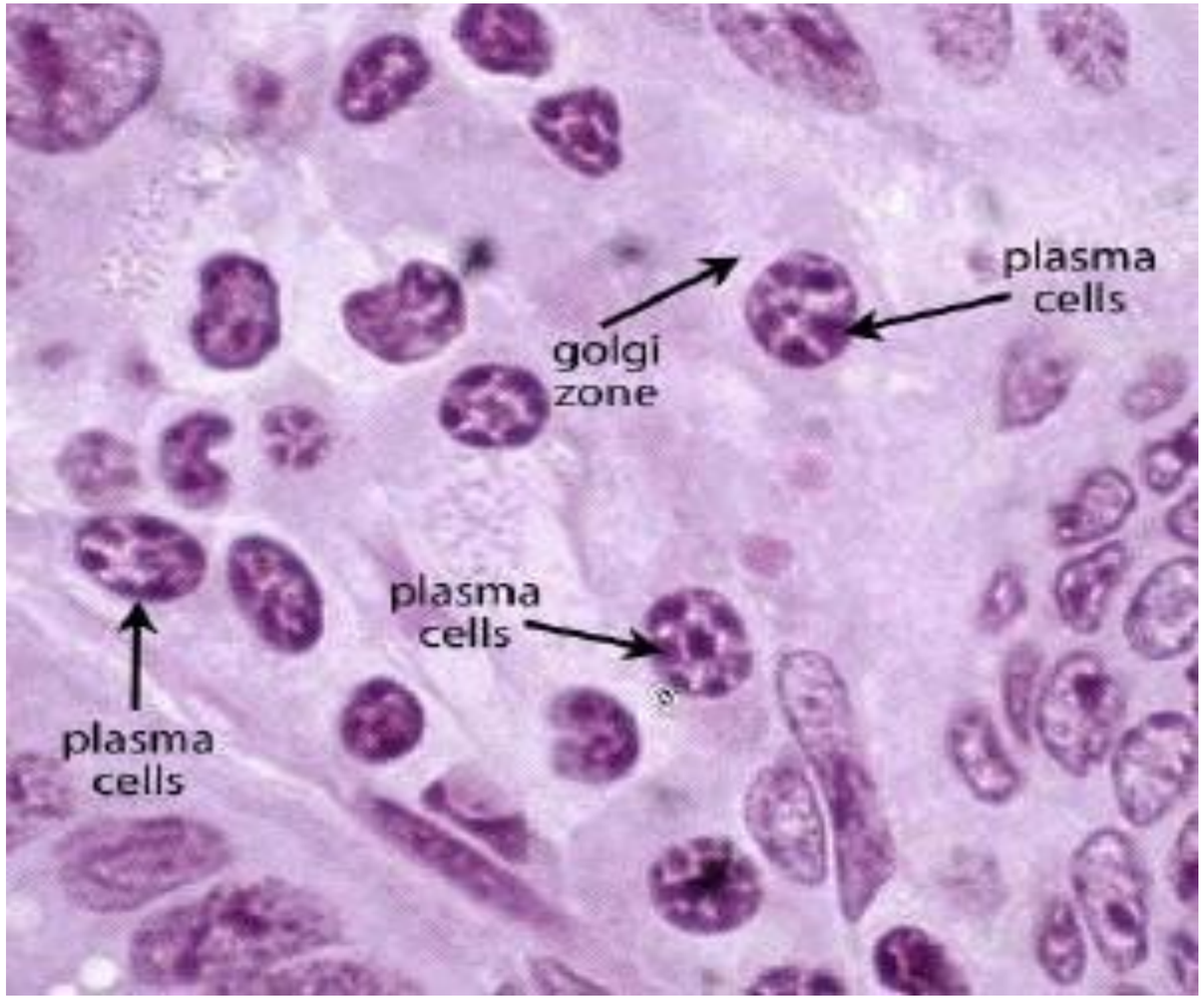
MAST CELL


BV
a
E
G
M
N
C
b


Antigens
2
IgE
IgE receptor
Adenylate cyclase
3
Ca2+
Fusion of granules
ATP
cAMP
Phosphorylated proteins
Microfilaments
ATP
Active protein kinase
Inactive protein kinase
Heparin
Histamine
Proteoglycans
4
ECF-A
Exocytosis
1
Phospholipases
Membrane phospholipids
5
Leukotrienes
IgE receptors

Plasma Cell

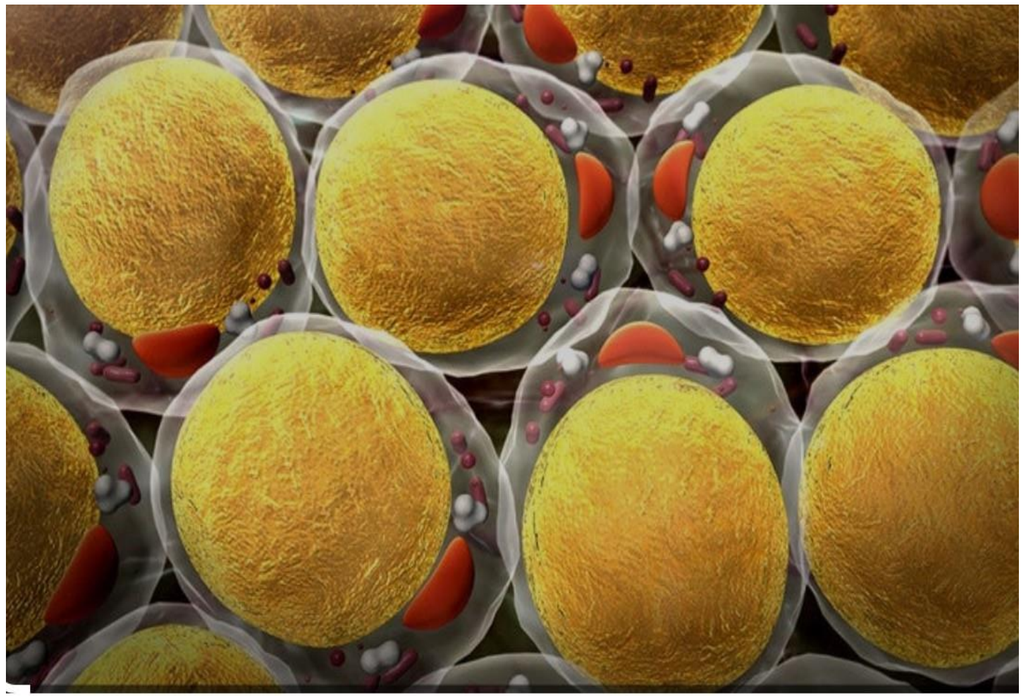
- Plasma cells are B lymphocyte-derived, antibody- producing cells.
- Relatively large, ovoid cells have basophilic cytoplasm rich in RER. **Large cytoplasm**
- Large Golgi apparatus near the nucleus that may appear pale in routine histologic preparations



Adipose Cells

- Fat cells **(Rounded)**
- 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.

The appearance of fat cells is called signet ring because the nucleus is pushed to the periphery.



For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide 12	Fibrocytes can’t move	Fibrocytes are less motile
V1 → V2	Slide 10	Missed	Added

رسالة من الفريق العلمي:

"وَالذَّاكِرِينَ اللَّهَ كَثِيرًا وَالذَّاكِرَاتِ أَعَدَّ اللَّهُ لَهُم مَّغْفِرَةً وَأَجْرًا عَظِيمًا"

[الأحزاب:35]