

Biology

Dr. Khalida Ibrahim

Connective Tissue

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

1. binding and supporting the organs.
2. it is vascular except the cartilage.
3. it is derived from mesoderm layer.

Connective tissue is composed of:

- Cells
- Extracellular materials

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:

The most prominent function of connective tissue is structural support to enable maintenance of anatomical form of organs.

2-Transporting fluids and dissolved materials:

The connective tissues serve a nutritive role.

3-Storing energy reserves:

The adipose tissue serves as an energy store and also provides thermal insulation.

4-Defending the body from microorganisms:

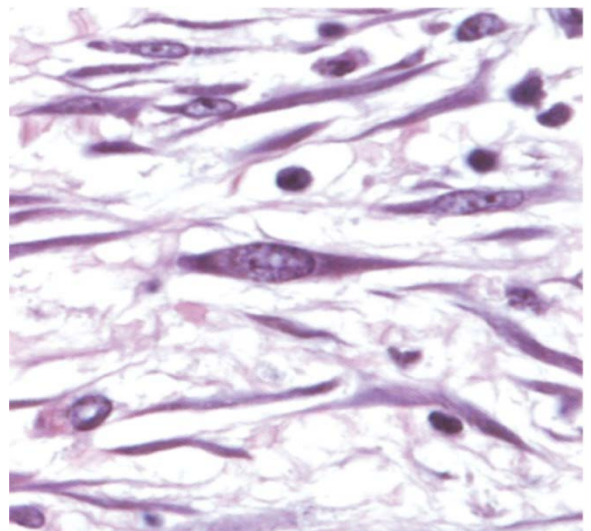
Various components of the connective tissue play roles in the defense or protection of the body including many of the components of the vascular and immune systems (plasma cells, lymphocytes, neutrophils, eosinophils, basophils, mast cells). The various macrophages of the body are also categorized as connective tissue cells.

Connective tissue component

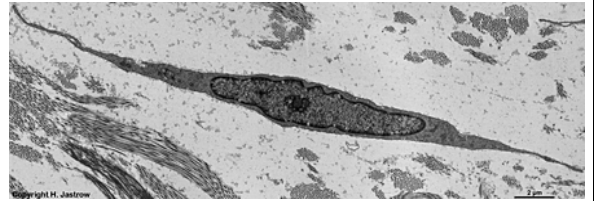
1) Cells:

• Fibroblasts:

Fibroblasts are the most common cell type found in connective tissue. They are derived from undifferentiated mesenchymal cells. The term "fibroblast" is commonly used to describe the active cell type, whereas the more mature form, which shows less active synthetic activity, is commonly described as the "fibrocyte". **Fibroblasts** are elongated, spindle-shaped cells with many cell processes. They have oval, pale-staining, regular nuclei with prominent nucleoli. Fibroblasts synthesize collagen, reticular and elastic fibers and the amorphous extracellular substance.



The **fibrocytes** (inactive fibroblast) is smaller than active fibroblast. The nucleus is small elongated and more deeply stained.



MEDICAL APPLICATION

The regenerative capacity of the connective tissue is clearly observed when tissues are destroyed by inflammation or traumatic injury. In these cases, the spaces left after injury to tissues whose cells do not divide (eg, cardiac muscle) are filled by connective tissue, which forms a scar. The healing of surgical incisions depends on the reparative capacity of connective tissue. The main cell type involved in repair is the fibroblast.

When it is adequately stimulated, such as during wound healing, the fibrocyte reverts to the fibroblast state, and its synthetic activities are reactivated.

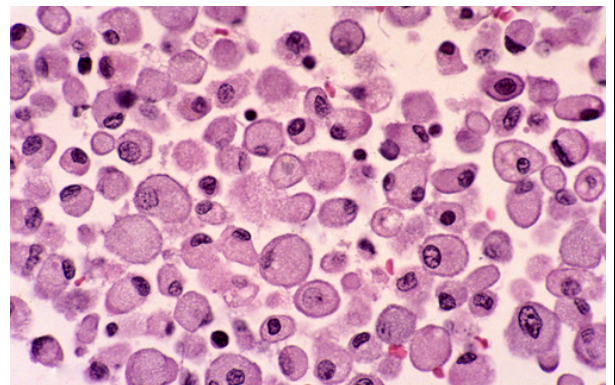
In such instances the cell reassumes the form and appearance of a fibroblast. The **myofibroblast**, a cell with features of both fibroblasts and smooth muscle cells, is also observed during wound healing. These cells have most of the morphological characteristics of fibroblasts but contain increased amounts of actin microfilaments and myosin and behave much like smooth muscle cells. Their activity is responsible for wound closure after tissue injury, a process called **wound contraction**.

• **Macrophages:**

Macrophages originate from monocytes, which migrate to connective tissue via blood and differentiate into tissue macrophages. There, exist different populations of macrophage. These include: Langerhans cells in skin, dendritic cells in lymph nodes, Kupffer cells in the liver, histiocytes in the connective tissue proper, osteoclasts in bone, and microglia in nervous system.

The main functions of macrophages are ingestion by phagocytosis of microorganisms, and they also participate in the breakdown of aged cells including erythrocytes. The intracellular digestion occurs as a result of fusion of lysosomes with the phagosome (ingested body). Other functions include: antigen presentation, removing cell debris e.g. during pregnancy, the increased uterus size is involuted immediately after delivery by action of macrophages. Macrophages also are secretory cells that secrete enzymes and cytokines have defensive functions.

The macrophages usually appear round with slightly irregular cell outlines, the nucleus is small but stained darker than the nucleus of the fibroblast and it is eccentric.



• **Mast cells:**

Mast cells are oval or round cells characterized by cytoplasm packed with large round basophilic granules. Two of the main components of mast cell granules are histamine (vasodilator) and heparin (anticoagulant). The granules of mast cells are released in inflammatory responses.

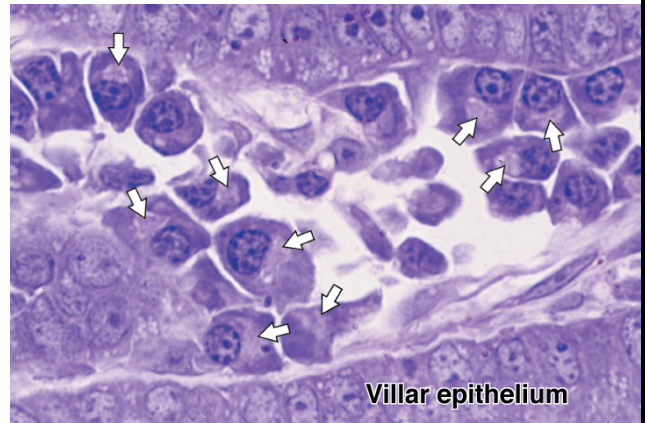


Mast cells are abundant in loose connective tissue (especially adjacent to blood vessels), in the dermis, and in the lamina propria of the respiratory and digestive tracts.

The surface of mast cell contains specific receptors for immunoglobulin E (IgE), a type of immunoglobulin produced by plasma cells. Most IgE molecules are bound to the surface of mast cells and blood basophile.

- **Plasma cells:**

Plasma cells are responsible for antibody production. These large cells have eccentric nuclei, basophilic cytoplasm (much rough endoplasmic reticulum associated with protein synthesis) and well-developed Golgi bodies. Plasma cells are relatively short-lived and are found in sites of chronic inflammation or sites of high risk of invasion by bacteria or foreign proteins (such as the lamina propria of the intestinal and respiratory tracts). The plasma cell is easily recognized by its intensely stained cytoplasm (which is quite basophilic, since these cells are making antibodies at a great rate) and by its characteristic "clock face" pattern of chromatin distribution in the nucleus.



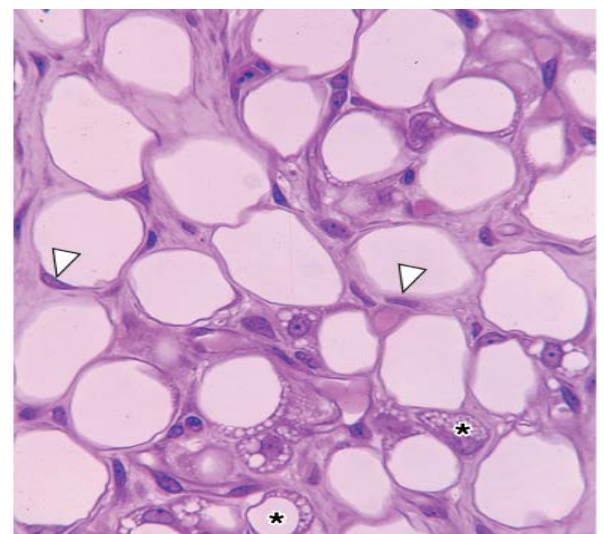
- **Adipose cells:**

Adipocytes are the cells that primarily compose adipose tissue, specialized in storing energy as fat, also act as an endocrine organ to secrete leptin hormone which regulate the appetite under normal condition and so regulate the amount of adipose tissue, defect in its secretion result in obesity.

There are two types of adipose tissue, white adipose tissue and brown adipose tissue.

1. **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.

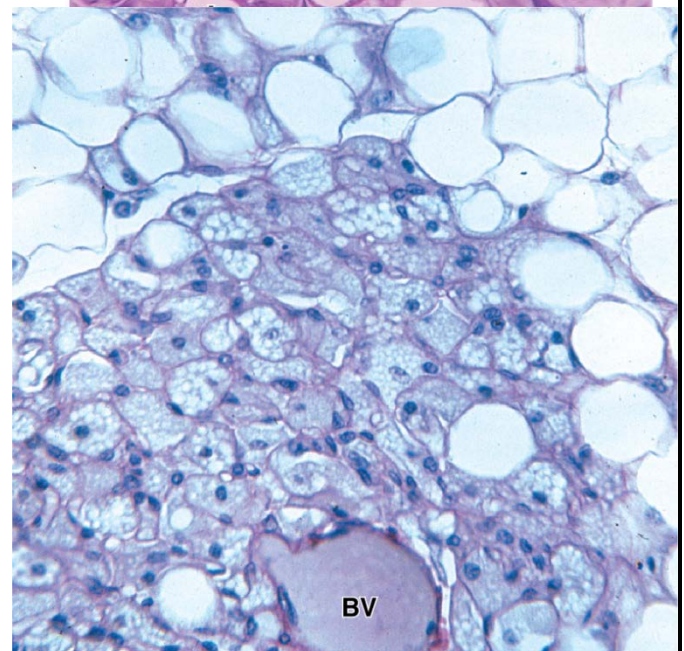


2. **Brown fat cells (multilocular cells):**

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.

- **Leukocytes:**

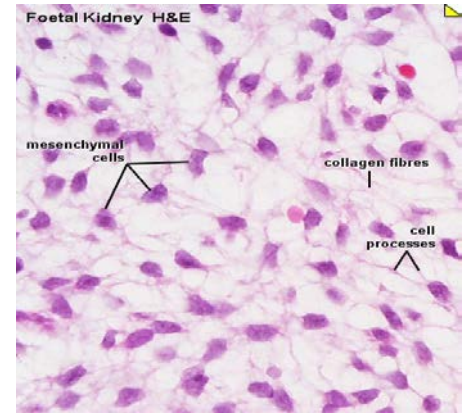
The white blood cells (lymphocytes, eosinophils, and basophils) are commonly found in connective tissue. They migrate from



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.



2) extracellular matrix:

I-Ground Substance:

Ground substance in connective tissue consists primarily of amorphous, transparent and colorless extracellular matrix, which has the properties of a semifluid gel and a high water content. It is binding cells to the fibers of connective tissue.

Ground substance composed of:

1. **glycoaminoglycans.**
2. **proteoglycans.**
3. **adhesive glycoproteins.**

The **glycosaminoglycan** are unbranched polysaccharide molecules of 5 types:

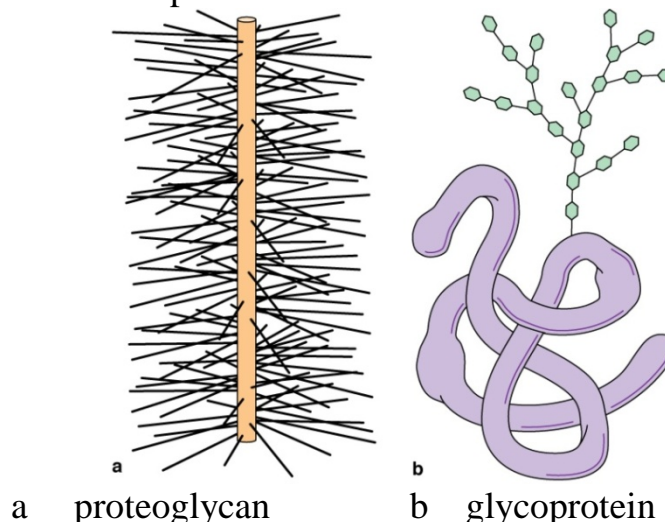
1. Hyaluronan (or hyaluronic acid) is the dominant glycosaminoglycan in connective tissues.
2. The remaining 4 major glycosaminoglycans are chondroitin sulfate, dermatan sulfate, keratan sulfate and heparan sulfate.

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.



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.

Causes of Edema:

1. Edema may result from venous or lymphatic obstruction or from a decrease in venous blood flow (e.g, congestive heart failure).
2. 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.
3. 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 (e.g, histamine).