Medical Biology

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Connective Tissue

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

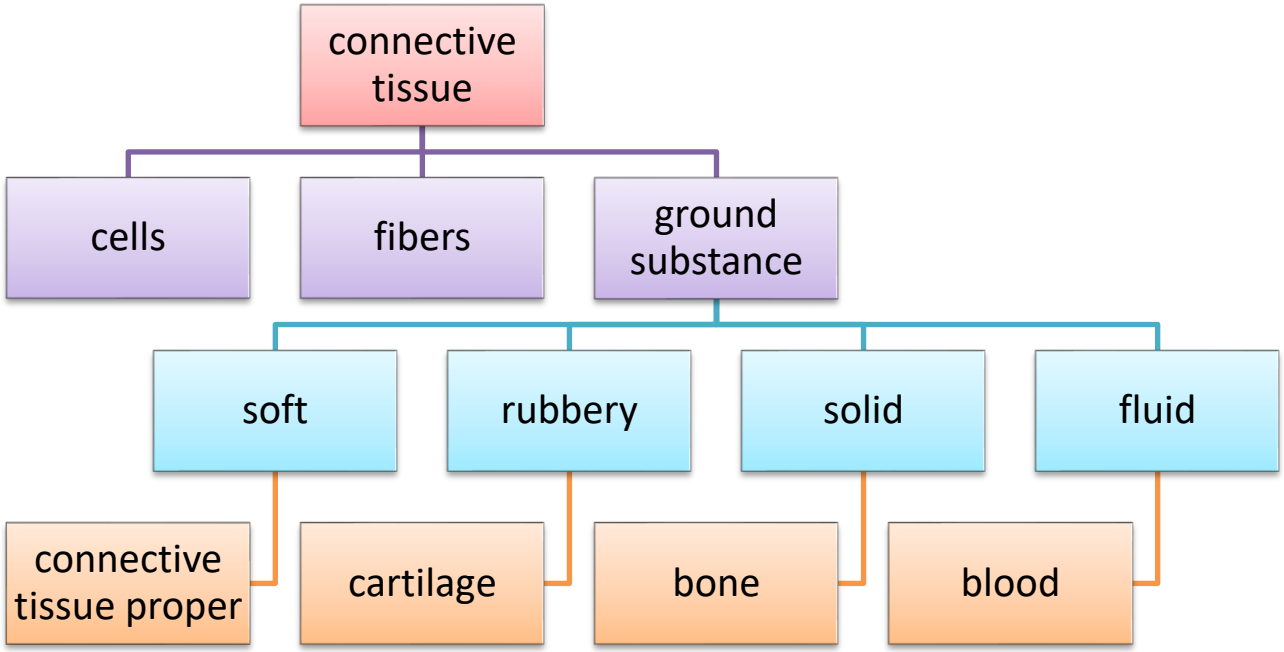
1. binding and supporting the organs.
2. It is vascular except for the cartilage.
3. It is derived from the mesoderm layer.
4. Cells are widely separated (large amount of matrix).

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 as a nutritive role.

3-Storing energy reserves:

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

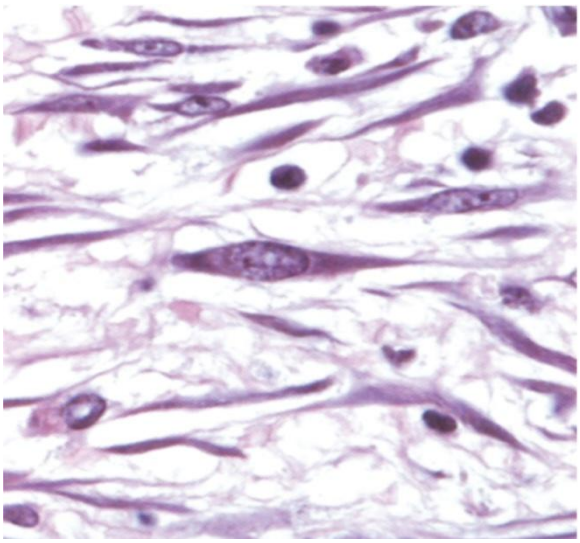
4-Defending the body from microorganisms:

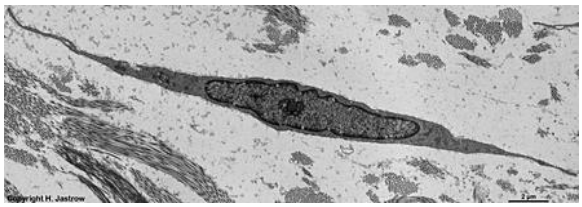
Various components of the connective tissue play roles in the defense or protection of the body including many of the components of the vascular and immune systems (plasma cells, lymphocytes, neutrophils, eosinophils, basophils, mast cells). The various macrophages of the body are also categorized as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

Connective tissue component

1) Cells:

- **Fibroblasts:**





Fibroblasts are the most common cell type found in connective tissue. 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*".

Origin: They are derived from undifferentiated mesenchymal cells.

Histology: Fibroblasts are elongated, spindle-shaped cells with many cell processes. They have oval, pale-staining, regular nuclei with prominent nucleoli. The fibrocytes (inactive fibroblast) are smaller than active fibroblast. The nucleus is small, elongated and more deeply stained

Function: Fibroblasts synthesize collagen, reticular and elastic fibers, and the amorphous extracellular substance.

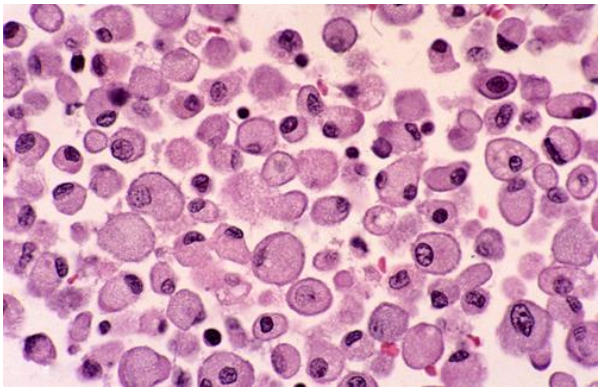
Medical Application:

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 (e.g., 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:**



Origin: Macrophages originate from monocytes, which migrate to connective tissue via blood and differentiate into tissue macrophages. There are different populations of macrophages in different tissues. 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.

Histology: The macrophages usually appear round with slightly irregular cell outlines and eosinophilic

cytoplasm with scattered inclusion bodies, the nucleus is small but stained darker than the nucleus of the fibroblast and it is eccentric.

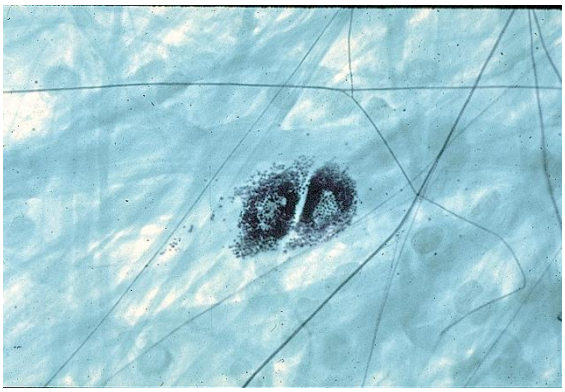
Function:

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

Medical Application:

When adequately stimulated, macrophages may increase in size and are arranged in clusters forming **epithelioid cells** (named for their vague resemblance to epithelial cells), or several may fuse to form **multinuclear giant cells**. Both cell types are usually found only in pathological conditions.

- **Mast cells:**



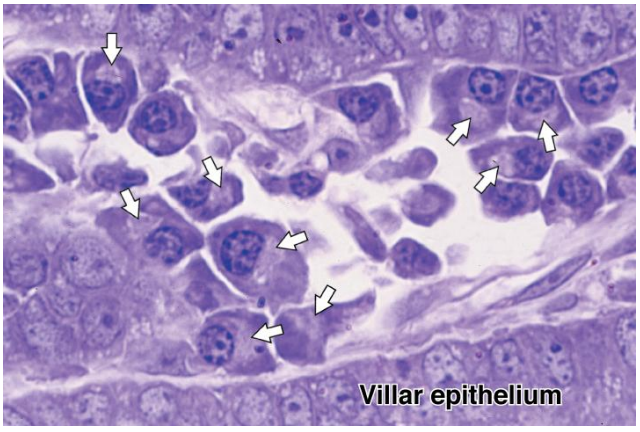
Origin: It originates from cells present in bone marrow.

Histology: Mast cells are oval or round cells characterized by cytoplasm packed with large round basophilic granules and centrally located nucleus.

Function: 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.

The surface of mast cells 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:**



Origin: Plasma cells are derived from B lymphocytes.

Histology: These large cells have eccentric nuclei, basophilic cytoplasm (much rough endoplasmic reticulum associated with protein synthesis) and well-developed Golgi bodies. 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.

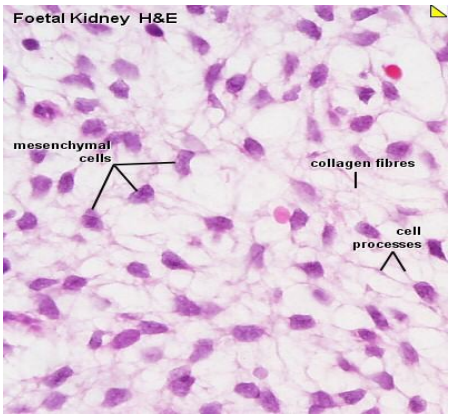
Function: Plasma cells are responsible for the synthesis of antibodies. Plasma cells are relatively short-lived and are found in sites of chronic inflammation or sites of high risk of invasion by bacteria or foreign proteins (such as the lamina propria of the intestinal and respiratory tracts).

Medical Application:
Antibodies are immunoglobulins produced in response to penetration by antigens. Each antibody is specific to the one antigen that gave rise to its production and reacts specifically with molecules possessing similar epitopes. The results of the antibody-antigen reaction are variable. The capacity of the reaction to neutralize harmful effects caused by antigens is important. An antigen that is a toxin (e.g., tetanus, diphtheria) may lose its capacity to do harm when it combines with its respective antibody.

- **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):**



Histology: They are smaller than fibroblast but have the same appearance, so it is characterized by small cell body, with few cytoplasmic processes, large round nucleus with a prominent nucleolus.
Function: These cells have the ability to give rise to any kind of cells, they form fibroblast, osteoblasts, chondrocytes and adipocytes,
Medical Application:
Some cells in mesenchyme are multipotent stem cells potentially useful in regenerative medicine after grafting to replace damaged tissue in certain patients. Mesenchyme-like cells remain present in some adult connective tissues, including that of tooth pulp and some adipose tissue, and are being investigated as possible sources of stem cells for therapeutic repair and organ regeneration.