Connective tissue

Connective tissue provides structural support for the body by binding cells and tissues together to form organs. It also provides metabolic support by creating a hydrophilic environment that mediates the exchange of substances between the blood and tissue. Connective tissue is of mesodermal origin and consists of a mixture of cells, fibers, and ground substance.

The hydrophilic ground substance occupies the spaces around cells and fibers. Fibers (collagen, elastic, and reticular) and the ground substances constitute the extracellular matrix of connective tissue. The classification and function of connective tissue are based on the differences in the composition and amounts of cells, fibers, and ground substance.

Connective Tissue Cells

1-Fibroblasts, are the most common cells in connective tissue. Their nuclei are ovoid or spindle shaped and can be large or small in size depending on their stage of cellular activity.

They have pale-staining cytoplasm and contain well- developed rough endoplasmic reticulum (RER) and rich Golgi complexes. They are responsible for the synthesis of all components of the extracellular matrix (fibers and ground substance) of connective tissue .

2-Macrophages, also called tissue histiocytes, are highly phagocytic cells that are derived from blood monocytes. With conventional staining, macrophages are very difficult to identify unless they show visible ingested material inside their cytoplasm. Macrophages may be named differently in certain organs

removal of cell debris and the ingestion of foreign substances; they also aid in antigen presentation to the immune system.

3-Mast cells, are of bone marrow origin and are distributed chiefly around small blood vessels. They are oval to round in shape, with a centrally placed nucleus, large basophilic purple staining granules are visible in their cytoplasm. These granules contain and release heparin, histamines, and various chemotactic mediators, which are involved in inflammatory responses.

4-Plasma cells, are derived from B lymphocytes and are responsible for the production of antibodies in the immune response.. They are oval shaped and have the ability to secrete antibodies that are antigen specific. Their histological features include an eccentrically placed nucleus, a cartwheel pattern of chromatin in the nucleus, and basophilic-staining cytoplasm due to the presence of abundant RER and a small, clear area near the nucleus. This cytoplasmic clear area (Golgi zone [GZ]) marks the position of the Golgi apparatus.

5-Leukocytes, white blood cells, are considered the transient cells of connective tissue. They migrate from the blood vessels into connective tissue by the process of diapedesis. This process increases greatly during various inflammatory conditions.

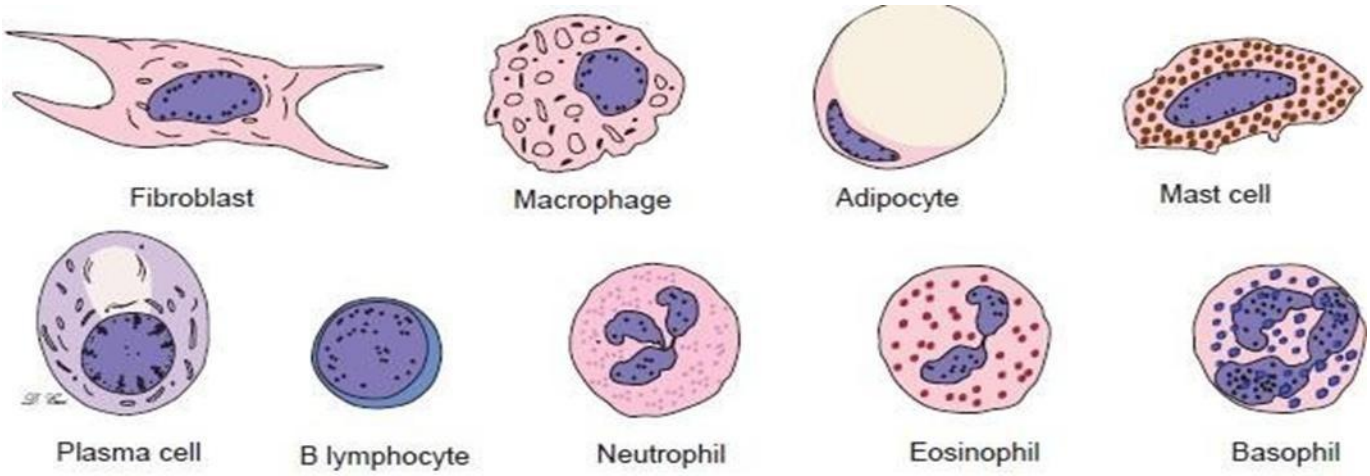
The following leukocytes are commonly found in connective tissue:

(1) Lymphocytes: have a round or bean-shaped nucleus and are often located in the subepithelial connective tissue.

(2) Neutrophils (polymorphs): has a multilobed nucleus and functions in the defense against infection.

(3) Eosinophils: has a bilobed nucleus and reddish granules in the cytoplasm. They have antiparasitic activity and moderate the allergic reaction function.

(4) Basophils: These cells are not easy to find in normal tissues. Their primary function is similar to that of mast cells



6-Adipocytes (fat cells), arise from undifferentiated mesenchymal cells of connective tissue. They gradually accumulate cytoplasmic fat, which results in a significant flattening of the nucleus in the periphery of the cell. Adipocytes are found throughout the body, particularly in loose connective tissue. Their function is to store energy in the form of triglycerides and to synthesize hormones such as leptin.

Connective Tissue Fibers

Three types of fibers are found in connective tissue: collagen, elastic, and reticular. These three fibers all consist of proteins that form elongated structures, which, although produced primarily by fibroblasts, may be produced by other cell types in certain locations.

1-Collagen fibers, are the most common and widespread fibers in connective tissue and are composed primarily of type I collagen. Collagen fibers stain readily with acidic and some basic dyes.

2. Elastic fibers, stain glassy red with H&E but are best demonstrated with a stain specifically for elastic fibers, such as aldehyde fuchsin. Elastic fibers have a very resilient nature (stretch and recoil), which is important in areas like the lungs, aorta, and skin.

.3. Reticular fibers, are small-diameter fibers that can only be adequately visualized with silver stains; they are called argyrophilic fibers because they appear black after exposure to silver salts. They are produced by modified fibroblasts (reticular cells) and are composed of type III collagen.

Types of Connective Tissues

1-Connective tissue proper Dense

can be divided into:-

1-**Dense irregular connective tissue** consists of few connective tissue cells and many connective tissue fibers, the majority being type I collagen fibers, interlaced

with a few elastic and reticular fibers. These fibers are arranged in bundles without a definite orientation.

2- Dense regular connective tissue also consists of fewer cells and more fibers, with a predominance of type I collagen fibers like the dense irregular connective tissue. Here, the fibers are arranged into a definite linear pattern. Fibroblasts are arranged linearly in the same orientation.

2-Loose Connective Tissue,

1- areolar connective tissue, is characterized by abundant ground substance, with numerous connective tissue cells and fewer fibers (more cells and fewer fibers) compared to dense connective tissue. It provides protection, suspension, and support for the tissue.

2-Adipose Tissue is a special form of connective tissue, consisting predominantly of adipocytes that are the primary site for fat storage and are specialized for heat production. It has a rich neurovascular supply. Adipose tissue can be divided into white adipose tissue and brown adipose tissue. White adipose tissue is composed of unilocular adipose cells. White adipose tissue is found throughout the adult human body . Brown adipose tissue, in contrast, is composed of multilocular adipose cells . Brown adipose tissue is more abundant in hibernating animals and is also found in the human embryo, in infants, and in the perirenal region in adults.

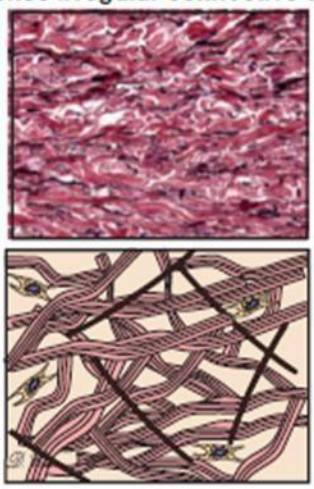
3-Reticular Tissue is a specialized loose connective tissue that contains a network of branched reticular fibers, reticulocytes (specialized fibroblasts), macrophages, and parenchymal cells, such as pancreatic cells and hepatocytes. Reticular fibers are very fine and much smaller than collagen type 1 and elastic fibers.

4-Mesenchymal Connective Tissue is found in the embryo and fetus and contains considerable ground substance. It contains scattered reticular fibers and star-shaped mesenchymal cells that have pale-staining cytoplasm with small processes .

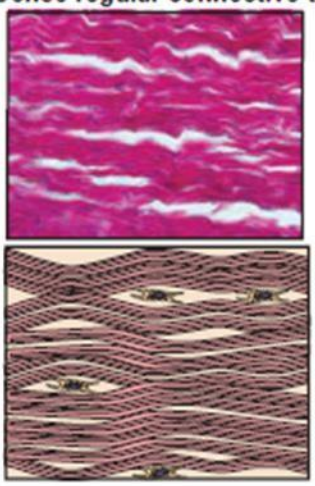
Mesenchymal connective tissue is capable of differentiating into different types of connective tissues .

5-Mucous Connective Tissue exhibits a jellylike matrix with some collagen fibers and stellate-shaped fibroblasts. Mucous tissue is the main constituent of the umbilical cord and is called Wharton jelly . It is mainly found in developing structures, such as the umbilical cord, subdermal connective tissue of the fetus, and dental pulp of the developing teeth.

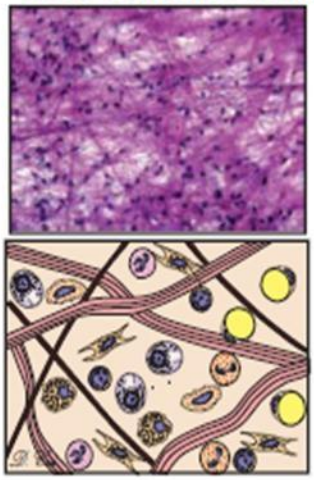
Dense irregular connective tissue



Dense regular connective tissue

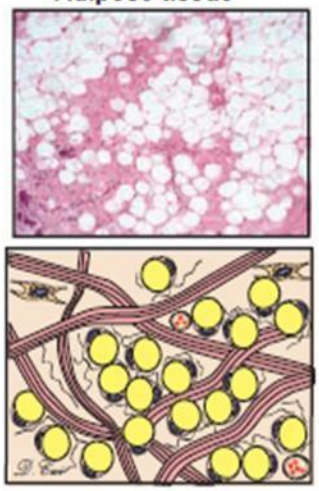


Loose connective tissue

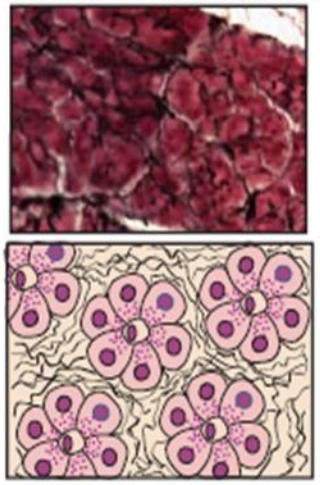


Specialized Connective Tissue

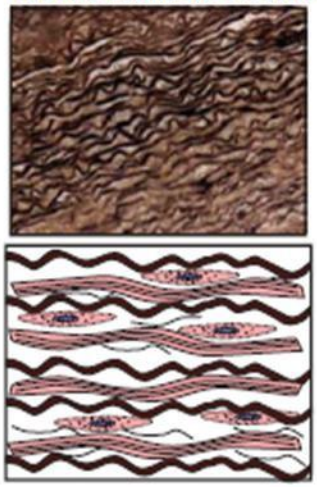
Adipose tissue



Reticular connective tissue

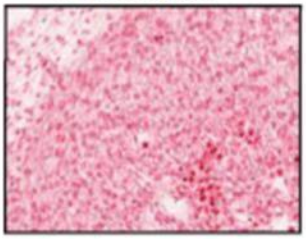


Elastic connective tissue



Embryonic Connective Tissue

Mesenchyme



Mucous connective tissue