CONNECTIVE TISSUE

Connective tissue stands as the most abundant and ubiquitously distributed tissue within the animal body. This intricate tissue comprises living cells ensconced within a substantial non-living intercellular matrix. The primary role of connective tissue is to establish connections between different tissues or organs, offering structural support to various components of the animal body. Additionally, it acts as a protective packing around organs, preventing displacement during bodily movements.

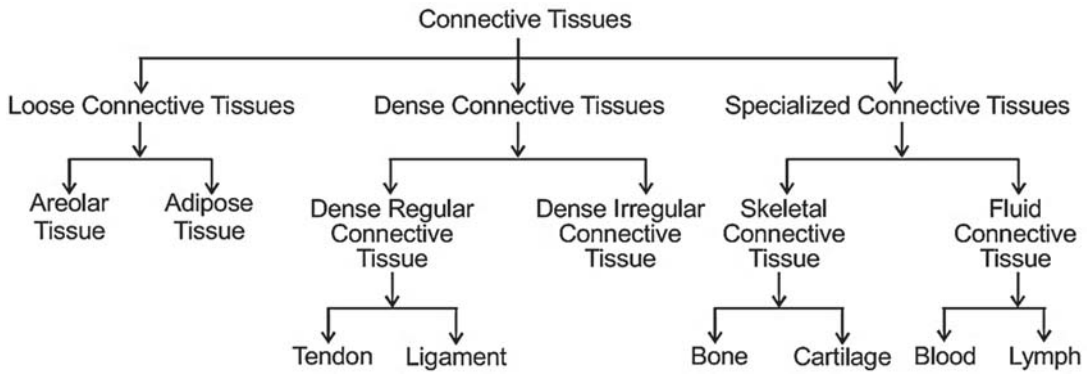
Structure: Connective tissue manifests a tripartite structure, featuring matrix, cells, and fibers. The matrix, also known as ground substance, primarily constitutes a blend of modified polysaccharides and proteins. These matrix components are secreted by the cells inherent to the tissue. Various cell types, including fibroblasts, macrophages, mast cells, and adipose cells, coexist within the matrix. In all connective tissues, except blood, cells contribute to the secretion of fibers composed of structural proteins, namely collagen or elastin. These fibers impart strength, elasticity, and flexibility to the connective tissue.

Types of Connective Tissues:

Connective tissues exhibit diversity, and they can be categorized into three principal types:

- Loose Connective Tissues
- Dense Connective Tissues
- Specialized Connective Tissues

Each type is further divisible into sub-types



Loose Connective Tissue

Loose connective tissue is a type of tissue where cells and fibers are loosely arranged in a semi-fluid matrix. Examples of loose connective tissues include Areolar tissue and Adipose tissue.

- **Areolar Tissue:** Areolar tissue is the most widely distributed connective tissue in the animal body. It is located beneath the skin and often serves as a supportive framework for the epithelium. This tissue connects the skin to muscles, fills spaces inside organs, and surrounds muscles, blood vessels, and nerves.

  Structure: Areolar tissue consists of a ground substance, or matrix, made up of modified polysaccharides (mucopolysaccharides) and proteins (glycoproteins). Scattered within the matrix are various irregular cells, each performing specific functions in the body. Examples of these cells include:

  Fibroblasts: These cells produce and secrete fibers and matrix.

  Macrophages or Histiocytes: They ingest cell debris, bacteria, and foreign matter.

  Mast Cells: These produce histamine (which dilates blood vessel walls), heparin (which prevents Blood clotting), and serotonin (which constricts blood vessels).

  Plasma Cells: They produce antibodies.

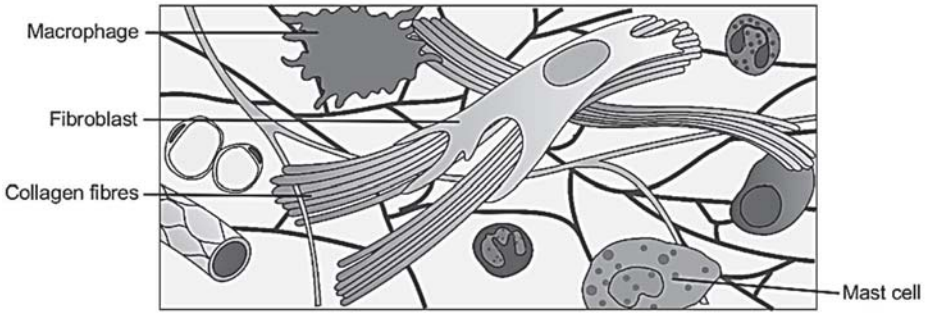


Fig.: Areolar tissue

The matrix also contains two types of protein fibers:

White Collagen Fibers: These unbranched and inelastic fibers are made of collagen protein. Boiling collagen fibers yields gelatin.

Yellow Elastic Fibers: These branched and elastic fibers are made of elastin protein and remain unaffected by boiling.

Function:

Acts as supporting and packing tissue between organs in the body cavity.

Aids in tissue repair after an injury.

- **Adipose Tissue:** Adipose tissue is a connective tissue that stores fat.

  Structure: Adipose tissue is primarily a collection of fat cells or adipocytes. Each fat cell is rounded or oval and contains a large droplet of fat. Excess nutrients not immediately used are converted into fats and stored in this tissue. The protein fibers are limited and form a loose network to support the fat-laden cells.

  Location: Adipose tissue is mainly located beneath the skin and around organs like the heart, kidneys, and eyeballs, serving as a storage site for fat. It is also found in specific animal structures, such as the blubber of whales, elephants, the hump of camels, and the fat bodies of frogs.

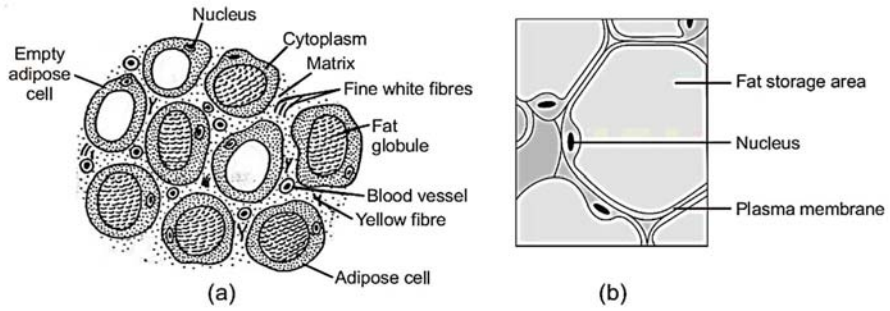


Fig.: (a) Adipose tissue, **(b)** Adipose tissue consisting of adipocytes

Function:

Serves as a fat reservoir.

Provides a shock-absorbing cushion around the eyeballs and kidneys.

Acts as an insulator, reducing heat loss from the body due to its poor heat conductivity.

Dense Connective Tissue:

Dense connective tissue is composed of densely packed fibers and fibroblast cells within the matrix. It serves as a crucial component in tendons and ligaments.

- The arrangement of fibers in the matrix exhibits either a regular or irregular pattern, resulting in two types of dense connective tissue: (i) Dense regular and (ii) Dense irregular connective tissue.

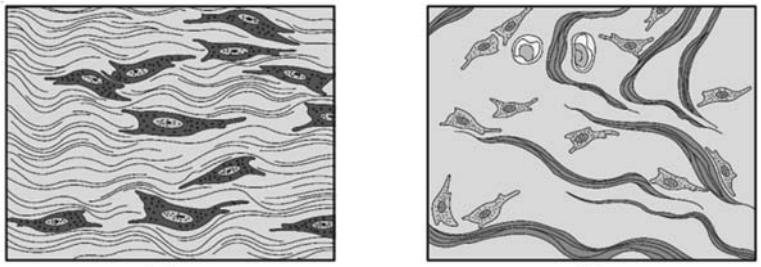


Fig.: Dense connective tissue:
(a) Dense regular, **(b)** Dense irregular

- **Dense Regular Connective Tissue:** In dense regular connective tissue, collagen fibers are organized in rows between numerous parallel bundles of fibers. Examples of tissues falling under this category are tendons and ligaments.
  Tendons: Tendons are robust, cord-like structures that lack elasticity. They connect skeletal muscles to bones and are comprised of parallel bundles of collagen fibers.
  Ligaments: Ligaments are structures that link bone to bone. They predominantly consist of collagen fibers arranged in bundles, with fibroblasts positioned in rows between these bundles. Additionally, elastin fibers are present, providing some elasticity to the tissue.

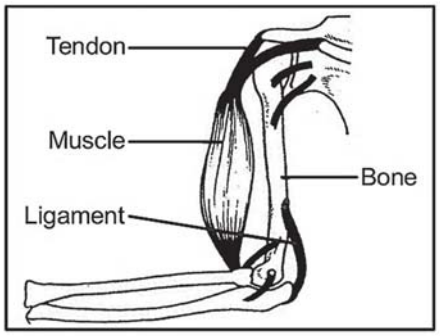


Fig.: Attachment of tendons and ligaments

Differences between Tendon and Ligament	
Tendon	**Ligament**
Inelastic in nature.	Elastic in nature.
Join muscle to bone.	Connect bone to bone.
Made up of white collagen fibres.	Made up of bundles of collagen fibres and few elastin fibres.

- **Dense Irregular Connective Tissue:** Dense irregular connective tissue contains fibroblasts and a multitude of fibers, primarily collagen, oriented in different directions. This type of tissue is found in the dermis of the skin.

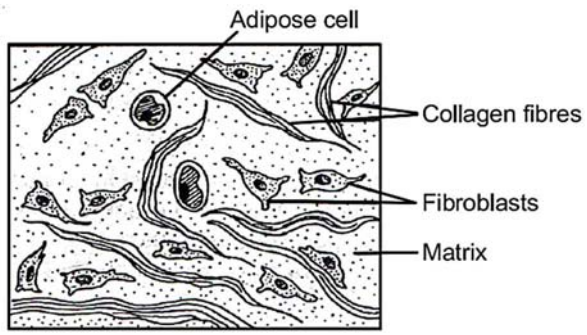


Fig.: Dense irregular connective tissue

Specialized Connective Tissue

Specialized connective tissue encompasses skeletal connective tissue, including cartilage and bone, and fluid connective tissue, such as blood and lymph.

- **Skeletal Connective Tissue:** Skeletal connective tissue, with a solid extracellular ground substance, forms the internal framework or endoskeleton of vertebrates. It provides support, protects organs, and facilitates locomotion. This category includes cartilage and bone.
- **Cartilage:** Cartilage is an elastic tissue, firmer than dense connective tissue but softer than bone. It is more abundant in vertebrate embryos, as many adult bones initially form as cartilage. In adults, cartilage is found in the nose tip, outer ear, joints, and between adjacent vertebral column bones and limb and hand bones.

  Structure: The matrix of cartilage is solid, pliable, and resistant to compression. Fluid-filled spaces, called lacunae, house cartilage-forming cells called chondrocytes. The matrix is produced and maintained by these cells.

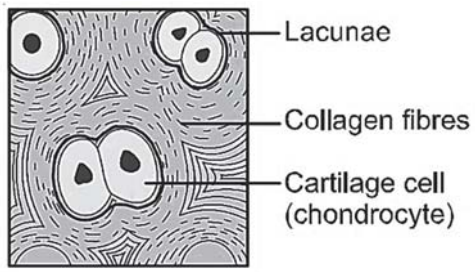


Fig.: Cartilage

Function:

Provides support and flexibility to body parts, resisting compression.

Smoothens joint surfaces, preventing bone wear and tear due to friction.

- **Bone:** Bone is a hard connective tissue, strong and non-flexible, composed of 70% inorganic matter and 30% organic matter. It consists of salts like calcium phosphate, calcium carbonate, ossein, and collagen fibers.

  Structure: The matrix is hard and non-pliable due to calcium salts and collagen fibers, giving bone strength. Longitudinal canals, haversian canals, contain blood vessels, lymph vessels, nerves, and bone cells. Layers, lamellae, with ring-shaped fluid-filled spaces, lacunae, and house bone cells called osteocytes. Some bones contain a bone marrow cavity filled with soft, semisolid fatty tissue, serving as a site for blood cell production.

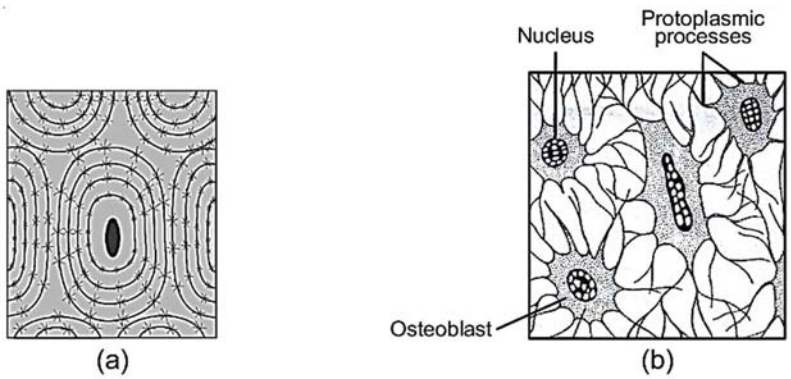


Fig.: (a) Bone, (b) Osteoblasts and their processes

Function:

Provides a structural framework to the body.
Supports and protects softer tissues and organs.
Offers surfaces for muscle attachment, aiding in movement.
Acts as a storage site for calcium and phosphate.

- **Fluid Connective Tissue:** Fluid connective tissue consists of a fiber-free fluid matrix and specialized non-dividing cells. It circulates in the body, facilitating the transportation of various materials. Blood and lymph are the two main fluid connective tissues.
  Blood: Comprising plasma and formed elements like RBCs, WBCs, and platelets, blood circulates to transport nutrients, gases, excretory products, hormones, etc.