Types, Structure, Location, and Functions of Connective Tissue Proper (Loose and Dense)

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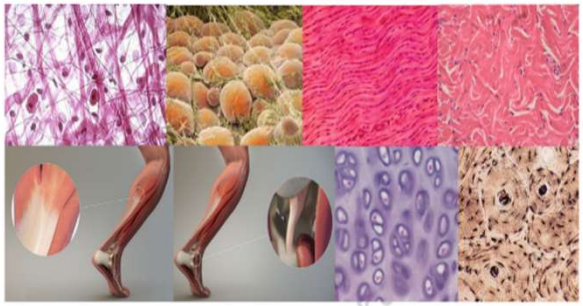
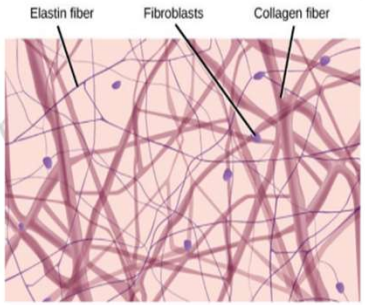
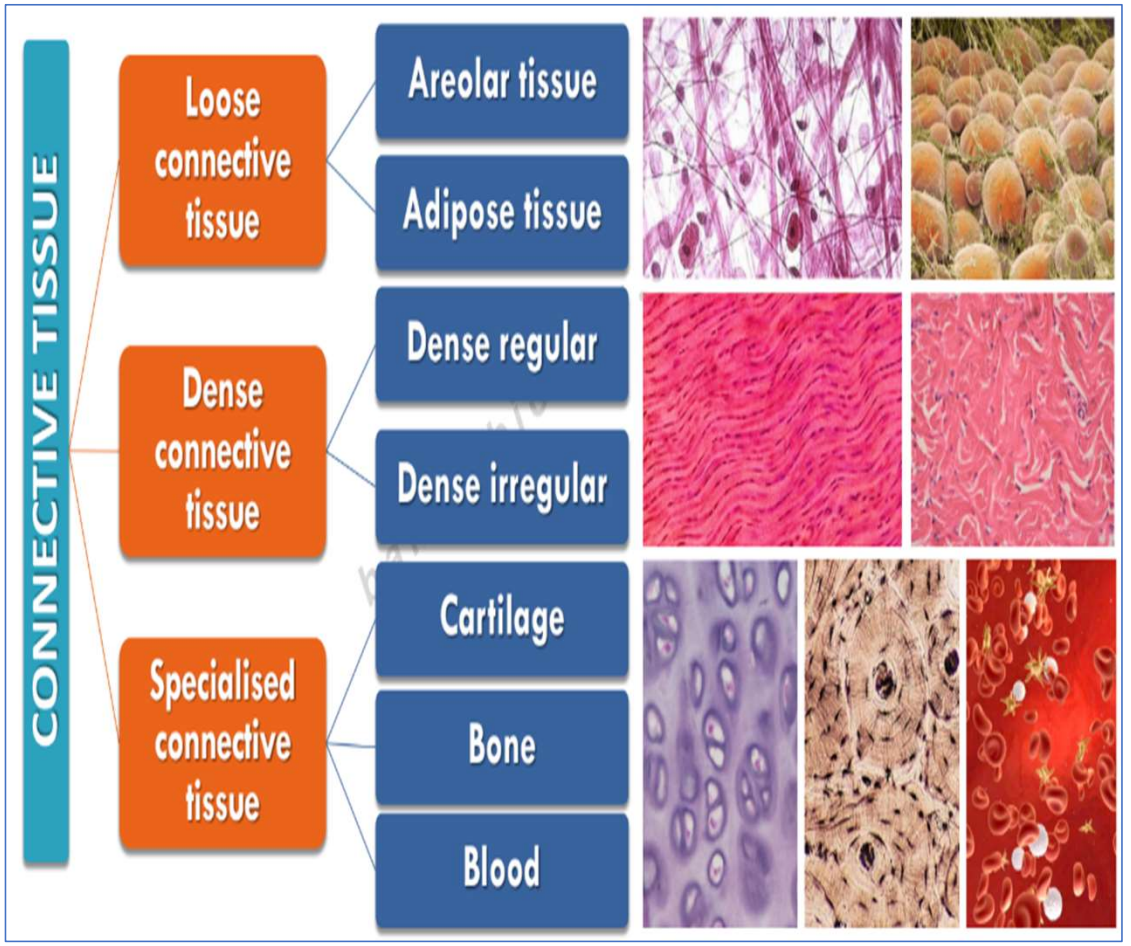
ANIMAL TISSUES

II. CONNECTIVE TISSUE



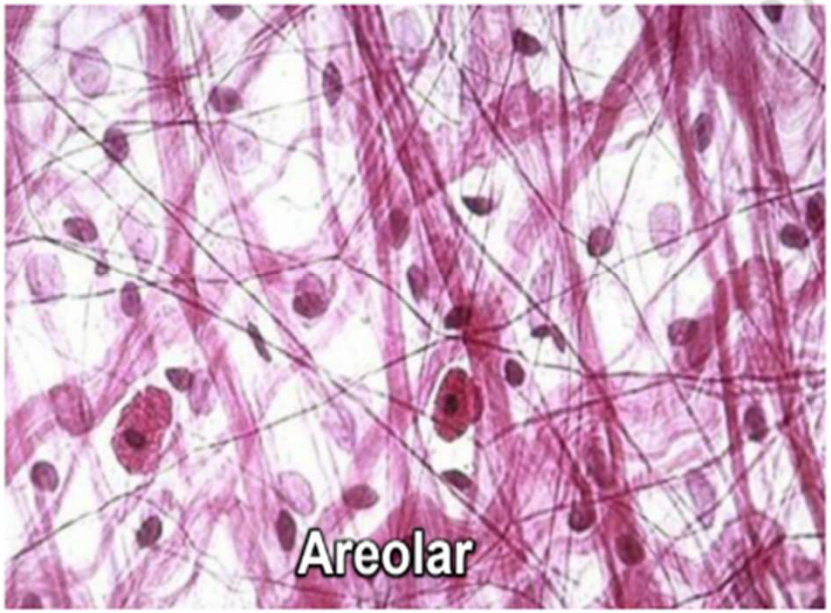


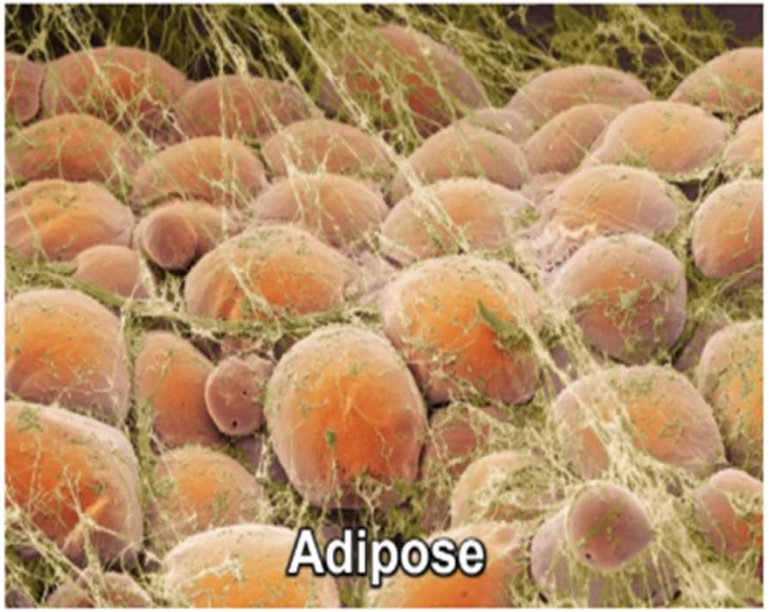
- It **links and supports** other tissues/organs.
- **Most abundant** in complex animals.
- All connective tissues except blood have **fibroblast** cells. They secrete fibrous proteins called **collagen & elastin.** They give **strength, elasticity & flexibility** to tissue.
- The cells also secrete modified **polysaccharides (matrix),** which accumulate between cells and fibres.



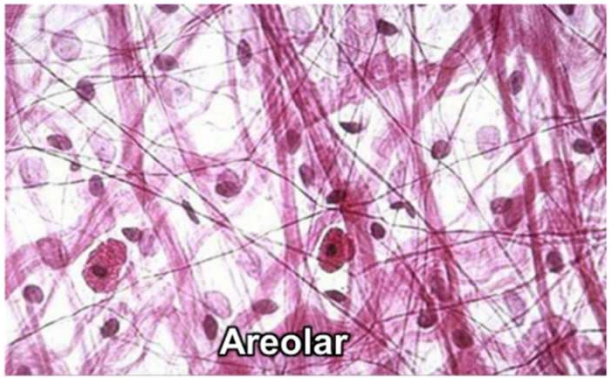
1. Loose Connective Tissue

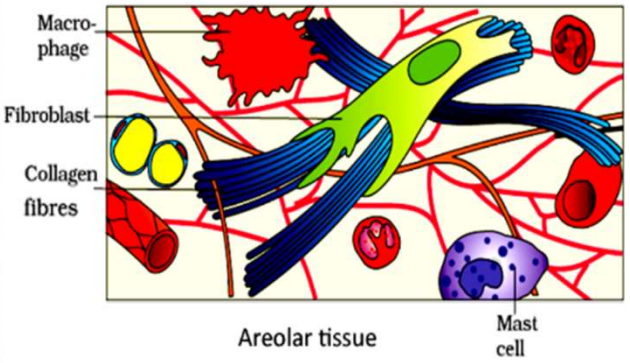
- In this, cells (fibroblasts, macrophages, mast cells etc.) and fibres are loosely arranged in a semi-fluid matrix.
- It is 2 types: Areolar & Adipose.





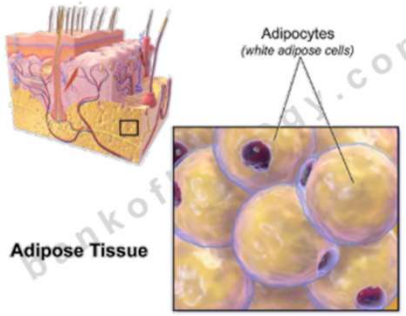
1. Loose Connective Tissue — a. Areolar Tissue

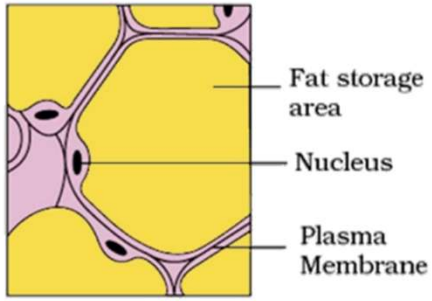




- Present **beneath the skin.**
- It serves as a support framework for epithelium.

1. Loose Connective Tissue — b. Adipose Tissue

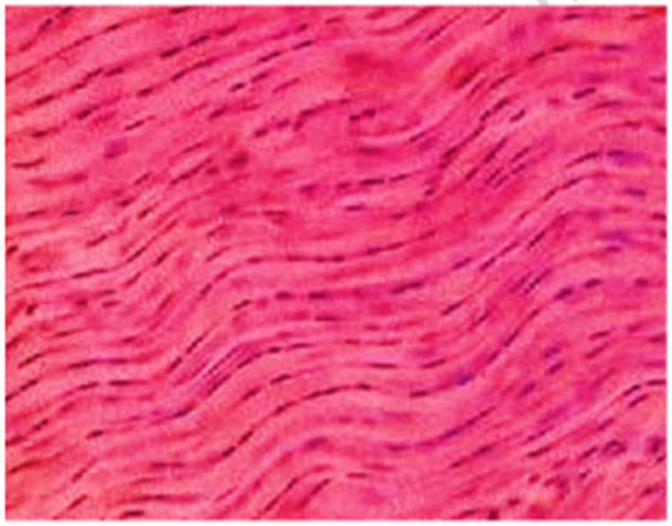


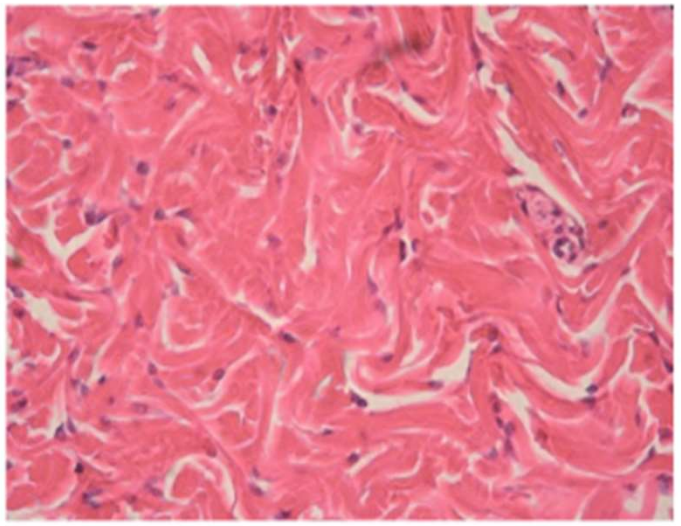


- Seen mainly **beneath skin.**
- Its cells **(adipocytes)** store fats.
- Excess nutrients are converted into fats and stored in this tissue.

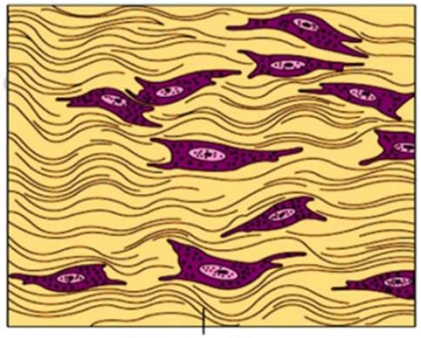
2. Dense Connective Tissue

- Fibres and fibroblasts are compactly packed.
- 2 types:
  - Dense regular connective tissues
  - Dense irregular connective tissues





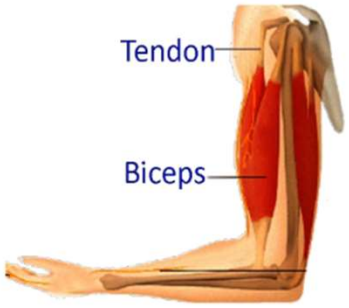
2. Dense Connective Tissue — a. Dense regular



- Show **regular pattern** of fibres.
- Collagen fibres are present in rows between many parallel bundles of fibres.
- E.g. **tendons** and **ligaments.**

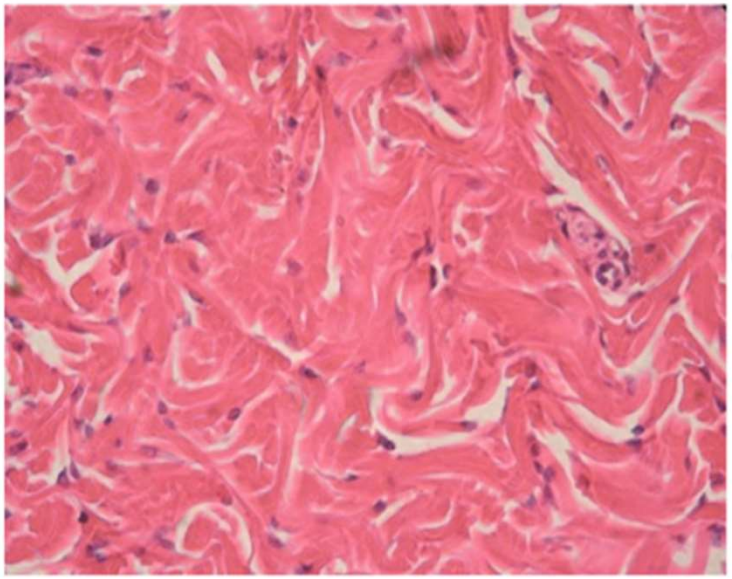
2. Dense Connective Tissue — a. Dense regular

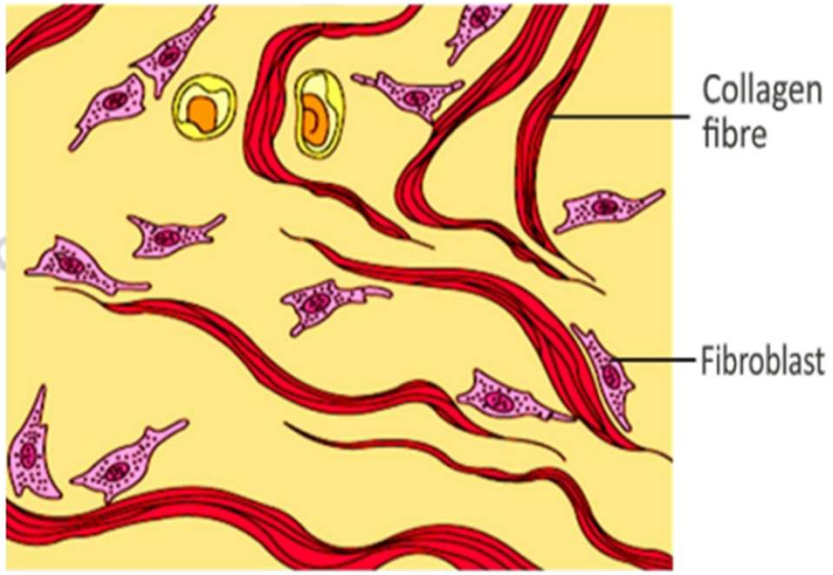
- **Tendons:** Attach skeletal muscles to bones.
- **Ligaments:** Attach one bone to another.



2. Dense Connective Tissue

b. Dense Irregular





- Irregular pattern of fibroblasts and fibres (mostly collagen).
- Present in skin.

Connective tissue is one of the four types of tissues in traditional classifications (the others being, **epithelial, muscle, and nervous tissue**). The main function of the connective tissues is to support the body and to bind or connect together all types of tissue. The connective tissue also provides a **mechanical framework (the skeleton)** which plays an important role in locomotion.

Connective tissues consist of cells and intercellular material. **Fibroblasts** are the most common cell types and are responsible for producing the fibres and other intercellular materials forming the connective tissue. Other cells that occur in the connective tissue generally in the loose connective tissue are adipose cell (adipocytes), mast cells, macrophages, leucocytes, and plasma cells.

The connective tissue exists in a number of forms however all types of connective tissues have three basic structural elements (Fig. 1.7): (i) cells, (ii) non-cellular fibres, and (iii) non-cellular intercellular substance (matrix or ground tissue). The types of fibres that occur in the connective tissue are: (i) collagen (collagenous) and (ii) elastic fibres and (iii) reticular fibres. Collagen fibres are for strength while the elastic ones are for elasticity of the tissue. Reticular fibers are for forming delicate structural framework. The consistency of matrix is highly variable from gelatin-like to a much more rigid material and so may be liquid (e.g. blood), semi-solid (e.g. connective tissue) or solid (e.g. bone). The other characteristic feature of all or most connective tissues is that they are:

- Involved in structure and support.
- Usually derived from mesoderm (middle layer of the embryonic layer).
- Characterized largely by the traits of non-living tissue.

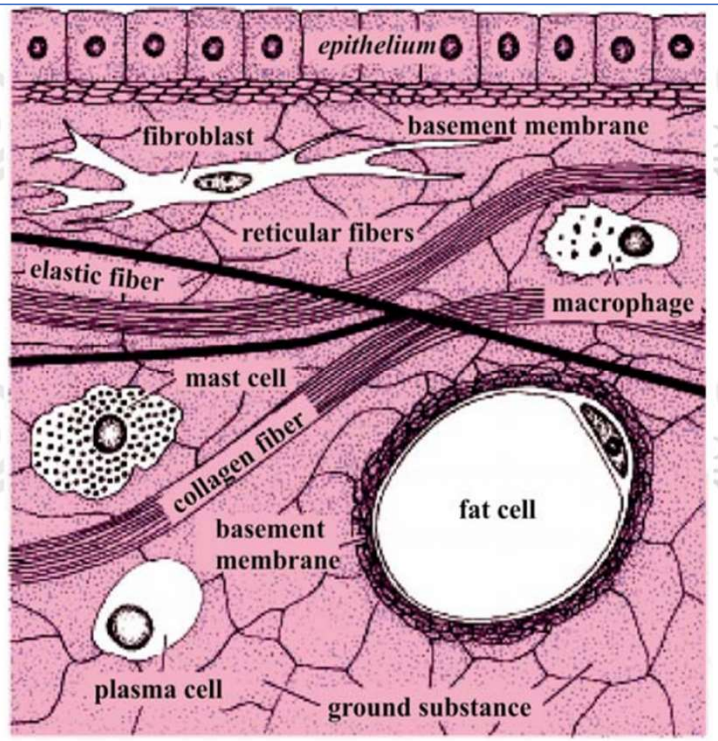
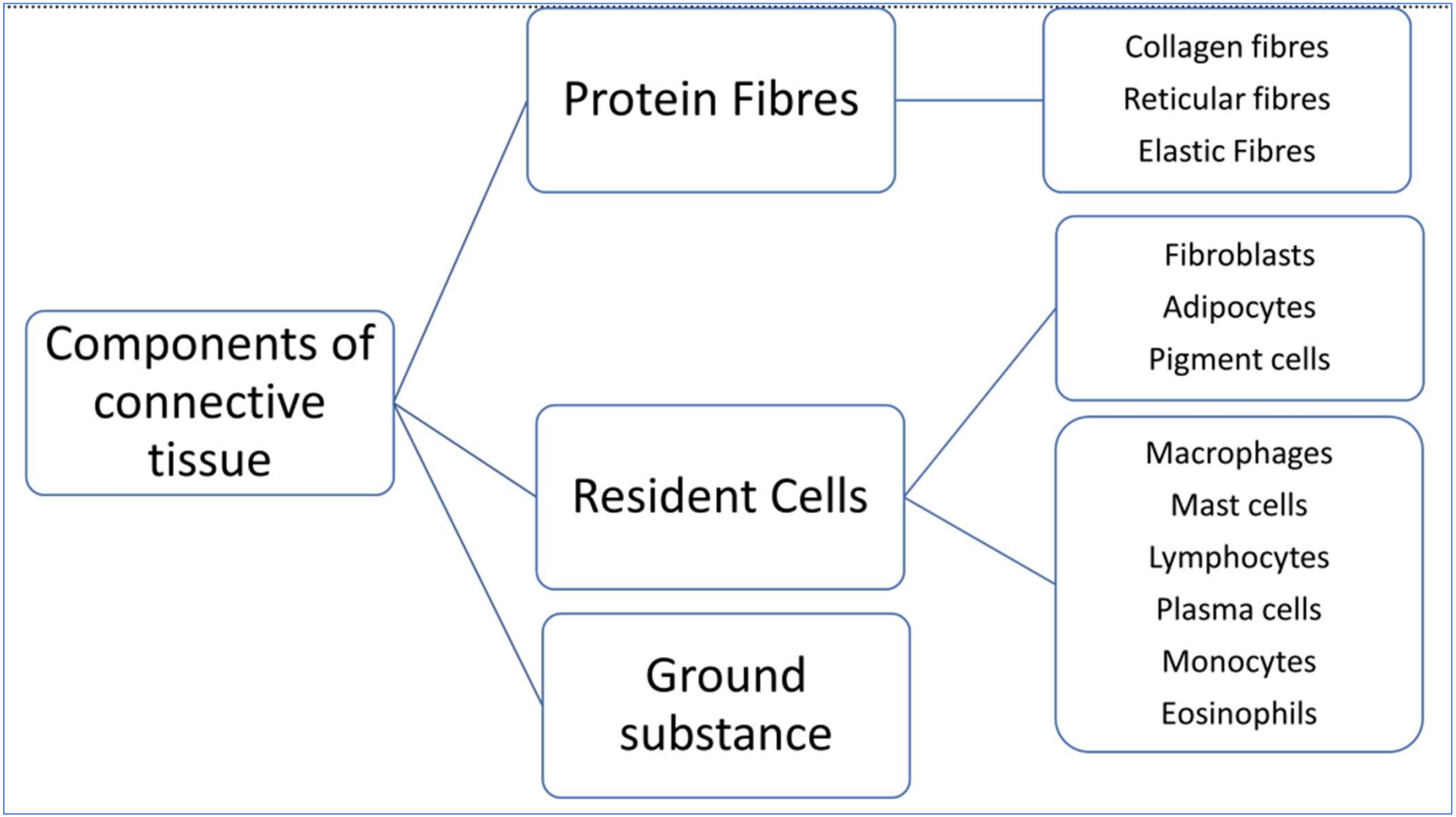


Fig.1.7: A generalized structure of connective tissue showing its various components


Components of connective tissue
Protein Fibres
Collagen fibres
Reticular fibres
Elastic Fibres
Resident Cells
Fibroblasts
Adipocytes
Pigment cells
Macrophages
Mast cells
Lymphocytes
Plasma cells
Monocytes
Eosinophils
Ground substance

ECM is a large network of proteins and other molecules that surround, support, and give structure to cells and tissues in the body. The extracellular matrix helps cells attach to, and communicate with, nearby cells, and plays an important role in cell growth, cell movement, and other cell functions. It is also involved in repairing damaged tissue. Abnormal changes in the extracellular matrix may lead to the development of certain diseases, such as cancer. The extracellular matrix of cancer cells can affect how they grow and spread.The ECM also supports the cells and contains the fluid transporting nutrients to the cells, and carrying away their wastes and secretory products. It acts as an exchange between cells and the blood supply.

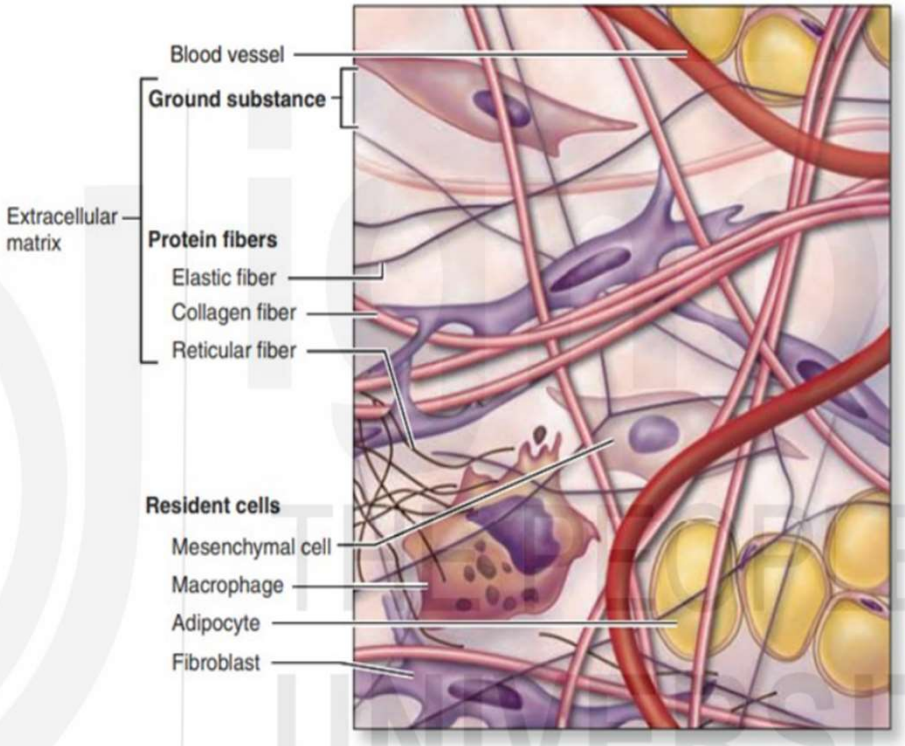


Fig. 1.4 : Connective tissue is composed of fibroblasts and other cells and an extracellular matrix (ECM) of various protein fibres, all ofwhich are surrounded by watery ground substance. In all types ofconnective tissue, the extracellular volume exceeds that of the cells. Adapted

Composition of ECM

The ECM is a heterogenous meshwork composed of various macromolecules, broadly classified into three major groups (Fig. 1.4)

Fibrous proteins: Primarily composed of **collagens**, the most abundant protein in the human body, offering structural support and tensile strength to tissues. Different collagen types exist, each with a unique amino acid composition and distribution pattern (e.g., collagen type I in bones and tendons). **Elastin**, another fibrous protein, provides elasticity and resilience to tissues like blood vessels and lungs.

Adhesion proteins: Facilitate cell attachment, migration, and communication within the ECM. **Fibronectin** plays a crucial role in cell adhesion and migration, while **laminin** forms a crucial component of the basal lamina, a specialized ECM layer underlying epithelial tissues.

Glycosaminoglycans (GAGs): Long, unbranched polysaccharides with attached sulphate groups, contributing to the ECM's negative charge and attracting water, creating a gel-like environment.Examples include **hyaluronic acid** in the skin and cartilage, and **heparan sulphate** in basement membranes.

Ground substance: This is water bound component of ECMand also a mixture of three major macromolecules.**Glycosmainoglycans(GAGs)** are long polymers of repeating disaccharide units (hexosamine and uronic acid , having molecular weight from 100s to 1000s of kDa).**Proteoglycan Aggregates:** The core protein to which the smaller (10-40 kDa GAGs and sulphated and covalently bound . These large, negatively charged molecules attract water, creating a highly hydrated gel-like matrix that provides lubrication, shock absorption, and a space for diffusion of solutes and nutrients

Adhesion protein network is of are large molecules with branched oligosaccharide chains and allow adhesion of cells to their substrate. Fibronectin, laminins and other adhesion proteins intertwine, forming an intricate network that allows cells to attach, migrate, and interact with the surrounding ECM and other cells.

This complex interplay of structural elements creates a dynamic and adaptable microenvironment that caters to the specific needs of each tissue.

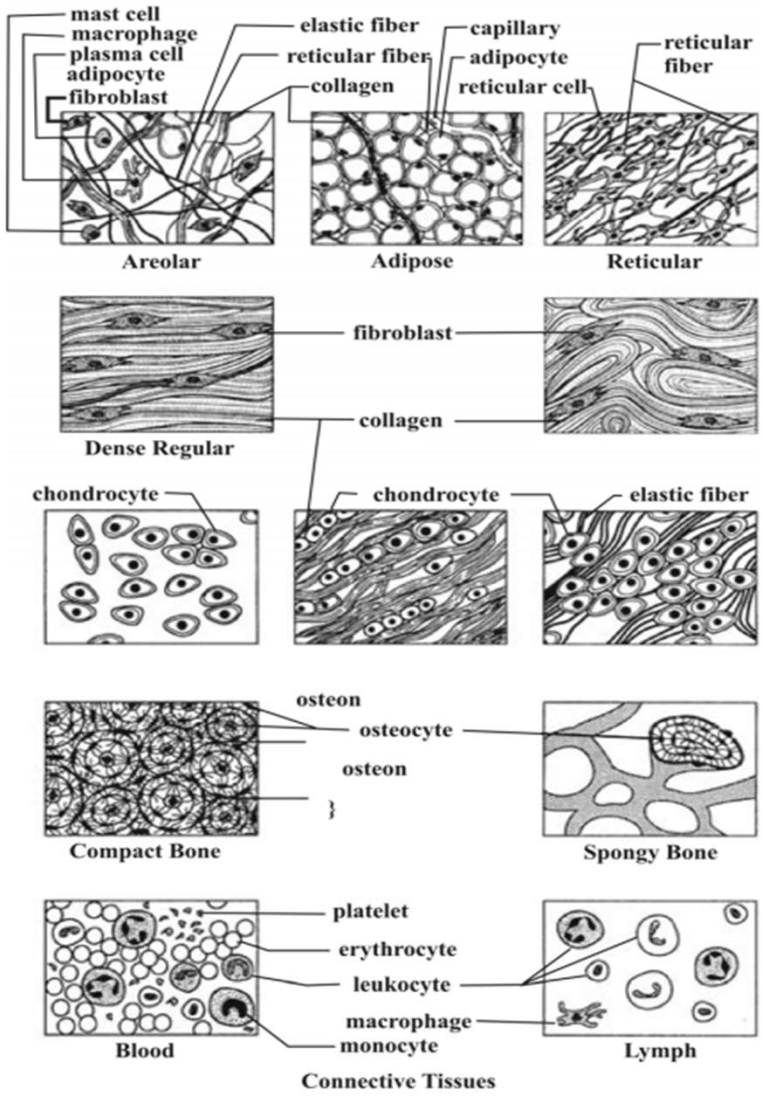


Fig.1.8: The various kinds of connective tissues

I) **Loose Connective Tissue**

Loose connective tissue has abundant cells among few or loosely arranged fibers and a sparse to abundant gelatinous ground substance. Loose connective tissue is the most common type of connective tissue. It occurs beneath the epithelium in skin and in many internal organs such as lungs, arteries and the urinary bladder. This type of tissue also forms a protective layer over muscles, nerves and blood vessels. The loose connective tissues is furthermore classified into

i) Areolar tissue
ii) Adipose tisse, and
iii) Reticular tissue

i) **Areolar Tissue**

Areolar connective tissue holds organs and epithelia in place and consists of matrix, within which lie two kinds of **proteinaceous fibers:** (a) white or collagenous fibres, and (b) yellow or elastic fiber. These fibers intercross, thus making a network. The space within the network is occupied by the matrix and various types of cells such as fibroblasts, histiocytes, basophils, plasma cells, pigment cells, mast cells, lymphocytes, etc.

ii) **Adipose Tissue**

Adipose tissue is a fairly loose connective tissue, containing large numbers of round shaped, fat-storing cells called **adipocytes** which make up 90% of the tissue. Adipose tissue has a rich supply of blood and a high metabolic activity. Adipose Tissue may develop anywhere, but it tends to accumulate beneath the skin, where it can act as a shock-absorber and insulator. Women tend to have more adipose tissue than men.

There are two types of adipose tissue, white adipose tissue (WAT) which is composed mainly of white fat cells and brown adipose tissue (BAT) composed primarily of brown fat cells.

iii) **Reticular Tissue**

Reticular tissue consists of loosely arranged, branching, very thin, white, reticular, collagen fibres with a glycogen coating, present in a gelatinous ground substance. Reticular connective tissue is moderately rich in ground substance, and often has numerous undifferentiated, mesenchymal cells. Reticular tissue provides a delicate structural framework for organ stroma (e.g. bone marrow, lymph nodes, spleen).

II) **Dense Connective Tissue**

Dense connective tissue is also called **dense fibrous tissue**. It has collagen fibers as its main matrix element. Dense connective tissue contains relatively few cells with much greater numbers of collagen fibers. It is divided into two sub-categories:

Dense irregular connective tissue which has bundles of collagen fibers that appears to be fairly randomly orientated (as in the dermis).

Dense regular connective tissue that consists of closely-packed densely-arranged fiber bundles with clear orientation (such as in tendons) and relatively few cell.

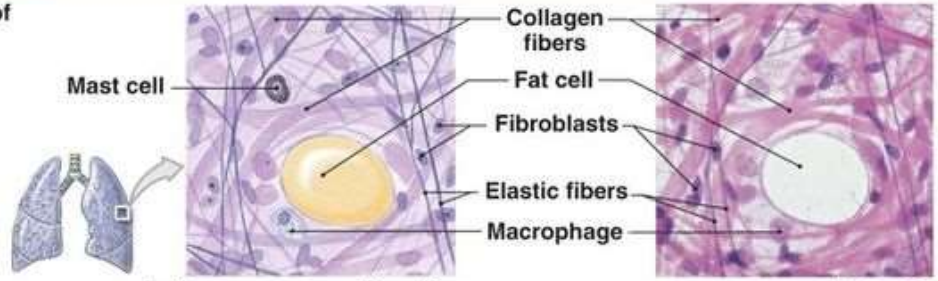
Elastic

Elastic connective tissue is rich in parallel bundles of elastic fibers, and is found in specialized sites (e.g. yellow ligaments of vertebral column, vocal chords).

LOOSE CONNECTIVE TISSUE

LOCATIONS: Beneath dermis of skin, digestive tract, respiratory and urinary tracts; between muscles; around blood vessels, nerves, and around joints

FUNCTIONS: Cushions organs; provides support but permits independent movement; phagocytic cells provide defense against pathogens

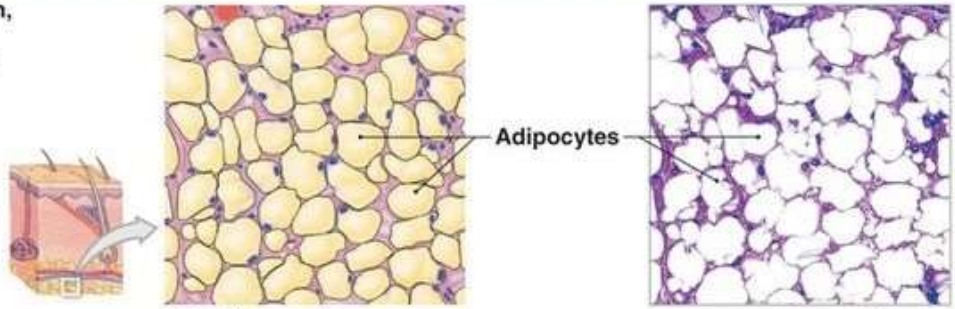


(a) Loose connective tissue — LM × 400

ADIPOSE TISSUE

LOCATIONS: Deep to the skin, especially at sides, buttocks, breasts; padding around eyes and kidneys

FUNCTIONS: Provides padding and cushions shocks; insulates (reduces heat loss); stores energy reserves

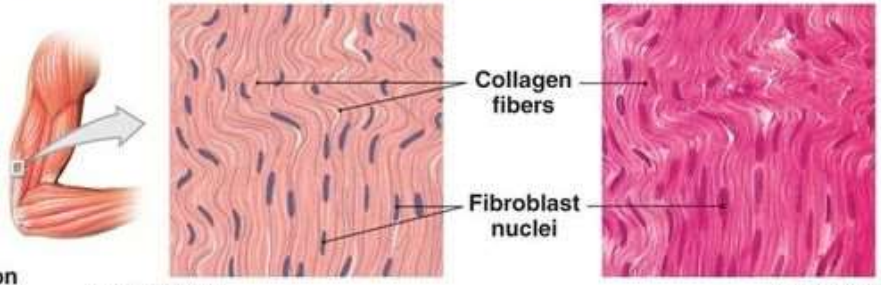


(b) Adipose tissue — LM × 133

DENSE CONNECTIVE TISSUES

LOCATIONS: Between skeletal muscles and skeleton (tendons); between bones (ligaments); covering skeletal muscles; capsules of internal organs

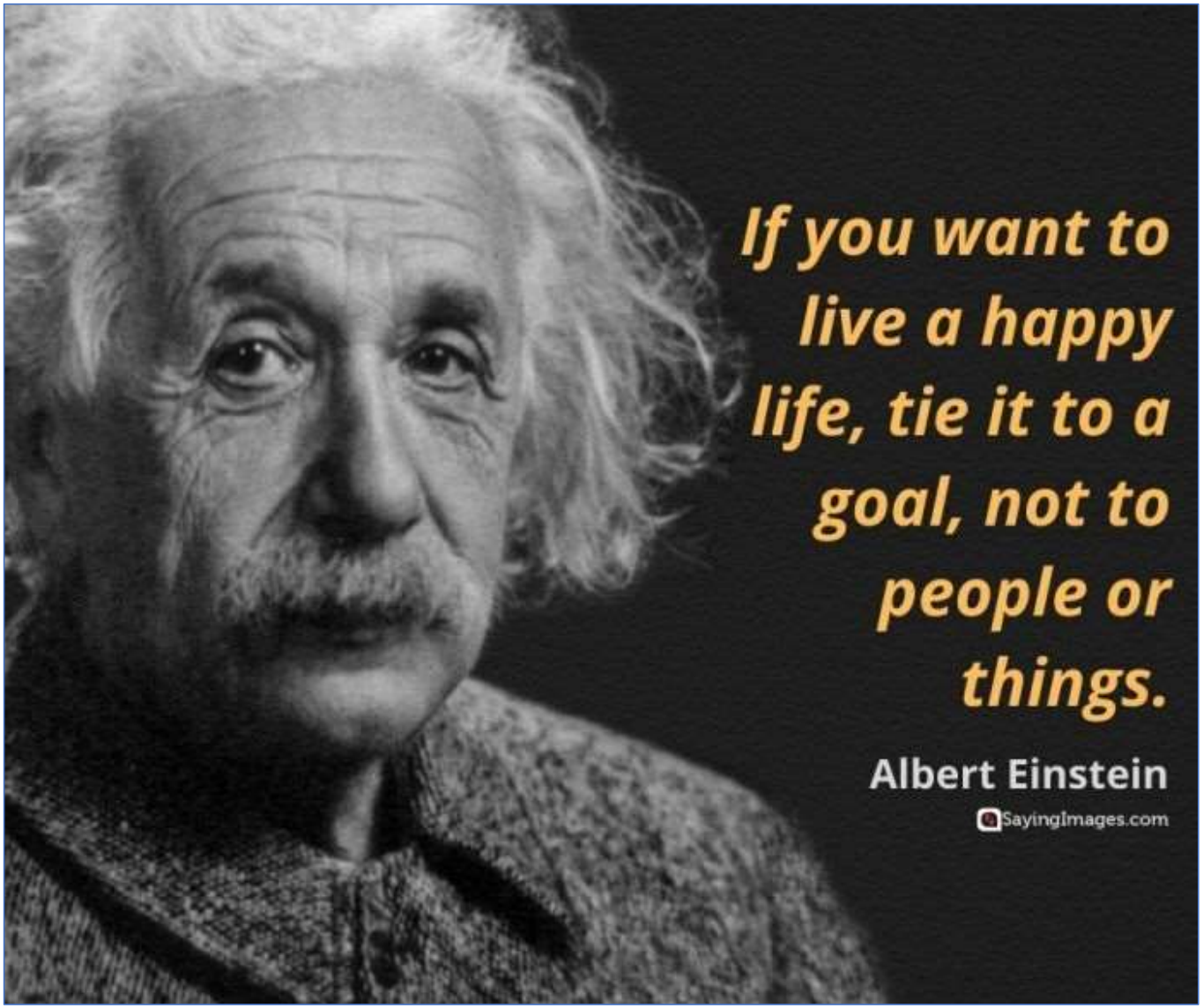
FUNCTIONS: Provides firm attachment; conducts pull of muscles; reduces friction between muscles; stabilizes relative positions of bones; helps prevent overexpansion of organs (such as the urinary bladder)



(c) Tendon — LM × 440

FUNCTIONS OF CONNECTIVE TISSUE

- Providing a medium for oxygen and nutrients to diffuse from capillaries to cells.
- Wraps around and cushions and protects organs
- Stores nutrients
- Internal support for organs
- As tendon and ligaments, it protects joints and attaches muscles to bone and each other
- Runs through organ capsules and in deep layers of skin giving strength


If you want to live a happy life, tie it to a goal, not to people or things.
Albert Einstein
SayingImages.com