

# Connective tissue

## Definition:

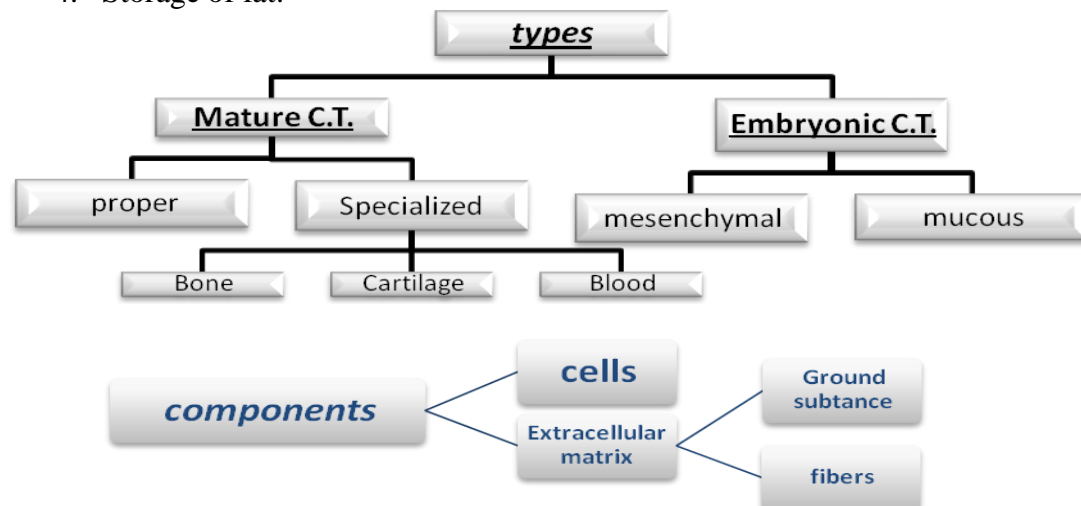
It is a basic type of tissue which provides structural and metabolic support for tissues and organs.

## Characteristics:

- ◆ Vascular, except dense C.T.
- ◆ Cells are widely separated.
- ◆ Few cells with abundant extracellular matrix.
- ◆ Originates from mesenchyme (an embryonic tissue) which develops mainly from mesoderm.

## Functions:

1. Structural Support (Physical and mechanical).
2. Medium for exchange.
3. Defense & protection of the body.
4. Storage of fat.



## Extracellular matrix:

### A. Ground substance:

- ◆ Hydrated , amorphous material .
- Composed of :
1. **Glycosaminoglycans (GAGs):**
    - ◆ -ve charged rod-shaped long unbranched polymers of disaccharides.
    - ◆ Have capability of binding large quantities of water.
    - ◆ Can be sulfated or non-sulfated. *E.g.* hyaluronic
  2. **Proteoglycans:** protein core binds to GAG covalently to form macromolecule.
    - ◆ GAGs represent 80-90% (e.g. Heparan sulfate,, Heparin).
  3. Adhesive **Glycoproteins:**
    - ◆ large macromolecules.
    - ◆ Attach various components of the extracellular matrix to each other.
    - ◆ Attach components with integrins of the cell membrane that facilitate the attachment of cells to the extracellular matrix.
    - ◆ Ex.: Fibronectin, Laminin,

**B. Fibers:**

(Collagen + Elastin)

**Collagen:**

- Inelastic and possesses a great tensile strength, unbranched
- Composed of tropocollagen.
- Acidophilic.
- Under EM the fibers show cross-banding at regular intervals.

**Synthesis:**

- By fibroblast.
- Preprocollagen → Procollagen → Tropocollagen → Fibrils
- Fibrillar collagens include type I, II, III, V and VII.
- Fibrillar structure is absent in type IV collagen.

**Types:**

- Type I.** Acidophilic thick fibers, most common. e.g.: bone.
- Type II.** Forms slender fibers E.g. Hyaline & elastic cartilage.
- Type III.** Known as ***reticular fibers***. e.g. red bone marrow.  
Stained with silver or PAS
- Type IV.** Meshwork procollagen e.g.: lamina densa of the basal lamina.
- Type V.** Forms thin fibers associate with type I e.g.: placenta.
- Type VII.** Attach lamina to lamina reticularis.

**Elastic fibers:**

- Composed of elastin and microfibrils of fibrillin.
- Highly elastic, branching.
- Amorphous material.
- Weak acidophilic
- May form coarser bundles, e.g.: ligaments, or fenestrated sheets, e.g.: aorta.
- Formed by fibroblasts and smooth muscle.
- Origin:
  - Proelastin from fibroblast (or from smooth muscle cells of blood vessels)
  - Microfibrils is composed of fibrillin (glycoprotein) which is formed first.

**Cellular components:****Fixed cells:** cells remain in place within the connective tissue (long lived):

1. Fibroblasts .
2. Adipose cells.
3. Pericytes.
4. Mast cells.
5. Macrophages.

**Transient cells:** originate from bone marrow and circulate the blood stream:

1. Plasma cells.
2. Leucocytes
3. Macrophages.

**Fixed cells:****Fibroblasts:**

- Most abundant in the connective tissue.
- Originate from undifferentiated mesenchymal cells.
- Synthesize the extracellular matrix of the connective tissue.
- Helps in healing of wounds.
- They can differentiate into osteoblasts, chondrocytes, fat cells.
- May undergo cell division.
- May occur in active or inactive state:



Fibroblast

**Cont. Fibroblasts****1. Active:**

- Under L/M:
  - Basophilic.
  - Elongated, fusiform cells.
  - Nucleus: dark-stained, large, granular, ovoid.
- Under E/M:
  - Prominent golgi apparatus.
  - Abundant RER.

**2. Inactive = Fibrocyte**

- Under L/M:
  - Acidophilic.
  - Smaller, more ovoid cell.
  - Small nucleus.
- Under E/M:
  - Sparse (scattered) RER.
  - Abundant free ribosomes.

**Myofibroblast:**

- ◆ Similar to fibroblast by L/M.
- ◆ Have bundles of actin.
- ◆ Basal lamina is absent.
- ◆ Abundant in areas undergoing wound healing.

**Adipose cells:**

- ◆ Derived from undifferentiated mesenchymal cells.
- ◆ Do not undergo cell division.
- ◆ Function: synthesize and storage of triglycerides.
- ◆ They are two types:

**Unilocular fat cells:**

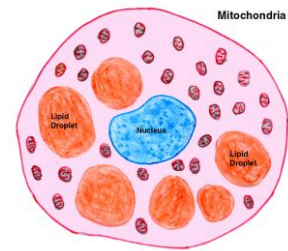
- Under L/M
  - Large, polyhedral cells (50-120)
  - Store fat in the form of single droplet.
  - Cytoplasm and nucleus are peripheral (signet ring)
- Under E/M
  - Small golgi apparatus, thinly spread RER, abundance of free ribosomes, sER.
  - The fat droplet is not bounded by membrane.
  - Each cell is surrounded by basal lamina-like substance & supported by reticular fibers



Adipocyte

**Multilocular fat cells:**

- Form brown adipose tissue.
- ◆ Under L/M
  - Smaller than unilocular, and more polygonal.
  - Fat is stored in several small droplets.
  - Spherical, central nucleus.
- ◆ Under E/M
  - They have SER, but lack RER
  - More mitochondria with abundant long cristea
  - fewer free ribosomes.
  - Receive direct sympathetic innervations
- ◆ **Site:** Human embryo and new born (see multilocular adipose tissue below)
- ◆ **Function:** production of heat



### Pericytes:

- ◆ Derived from undifferentiated mesenchymal cells.
- ◆ Surround endothelial cells of capillaries and small venules.
- ◆ Surrounded by its own basal lamina.
- ◆ May differentiate into other cells.
- ◆ Have long primary and secondary processes

### Mast cells:

- ◆ Oval cells.
- ◆ can divide.
- ◆ Derived from precursor in the bone marrow.
- ◆ Numerous, membrane bounded granules in the cytoplasm.
- ◆ contains heparin and histamine.
- ◆ They are concentrated along small blood vessels, subepithelial connective tissue of the respiratory system.
- ◆ Largest of the fixed cells.
- ◆ Nucleus: center, spherical.



### Macrophages:

- Fixed or free.
- Under L/M:
  - Basophilic.
  - Have many vacuoles & small dense granules.
  - Nucleus: small, eccentric, dark, and kidney-shaped.
    - Nucleolus: usually don't appear.
  - Irregular outline, have filopodia (projections from the cell) that fold in active cells.
- Under E/M:
  - Well-developed golgi apparatus.
  - Prominent of RER.
  - Prominent phagosomes (phagocytic vacuoles).
  - Abundance of lysosomes.
- Function:
  - ◆ Phagocytosis.
  - ◆ Antigen processing and presentation.
  - ◆ Production of cytokines and chemotactic factors.
- Origin: monocytes.
- They can divide.
- They have certain regions in the body Ex.: kupffer cells of the liver, dust cells of the lung, langerhans cells of the skin.
- Life span: ~ 2 months.

## Transient cells

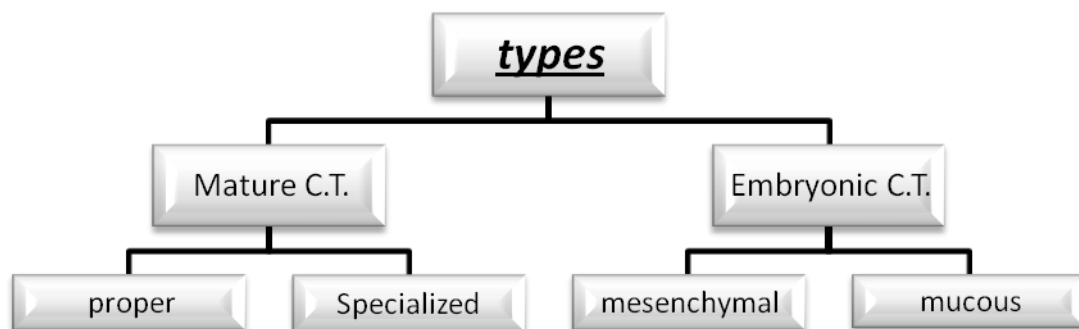
### Plasma Cells

- Under L/M:
  - Basophilic
  - Negative golgi apparatus.
  - Nucleus: spherical, eccentric & clock-face appearance.
  - Large (20 um), ovoid cells
- Under E/M:
  - Abundant RER.
  - Well-developed Golgi complex.
  - Few mitochondria.
- Function:
  - Synthesis & release antibodies.
  - ◆ Derived from B lymphocytes.
  - ◆ N: Possesses heterochromatin radiating out of the center it gives (clock-face) (spoken) appearance.
  - ◆ Pair of centriols.



### Leukocytes

- ◆ white blood cells that circulate in the blood stream.
- ◆ They divide to:
  1. eosinophil
  2. basophil
  3. lymphocytes
  4. monocytes
  5. neutrophil



### Embryonic C.T.

#### Mesenchymal C.T.

- Present in embryo.
- Under L/M:
  1. Mesenchymal cells:
    - Basophilic cytoplasm with small processes.
    - Nucleus is oval with prominent nucleolus.
  2. Ground substance:
    - Gel-like & amorphous.
  3. Scattered reticular fibers.
    - ◆ Prominent nucleoli.

#### Mucous C.T.

- Under L/M:

- Ground substance (Hyaluronic Acid).
- Few fibers (Type I & III collagen fibers)
- Fibroblasts.
- Found in:
  - Umbilical cord.
  - Subdermal C.T. of the embryo.
  - Pulp of young teeth.
- ◆ Known as wharton's jelly

## Mature C.T.

### C.T. Proper:

#### 1- Loose (Areolar) C.T.:

- Sites:
  - Papillary layer of the dermis.
  - Hypodermis
  - Serosa (peritoneum, pleura)
  - Lamina propria
  - Tunica Adventitia of blood cells.
- Under L/M:
  - Contain all the main components C.T.P., (with no predominant element).
  - Fibroblasts & macrophages are the most numerous cells.
  - Loose C.T of mucous membranes (as in the alimentary canal) is called the lamina propria.
  - Abundant ground substance and tissue fluid housing the fixed cells and some undifferentiated cells.
  - Scattered collagen, reticular, elastic fibers.

#### 2- Dense C.T.:

- Under L/M:
  - Fewer cells (few fibroblasts), more fibers.
  - If collagen fibers are arranged randomly, it's called *dense irregular C.T*
  - If it's arranged parallel to each other it's called *dense regular C.T* and can be *collagenous* or *elastic*.
- Types:
  - ◆ **Dense Irregular C.T:**
    - ◆ Randomly arranged collagen fibers which form a meshwork that resists stress.
    - ◆ Few ground substances.
    - ◆ fibroblasts scattering between collagen fibers.
    - ◆ E.g.: the dermis of the skin, capsules of testes, ovary, kidney, nerve sheath.
  - ◆ **Dense regular collagenous C.T:**
    - ◆ Composed of collagen bundles packed parallel to each other.
    - ◆ Few ground substances and fibroblasts between collagen bundles.
    - ◆ E.g.: tendons, ligaments, aponeuroses.
  - ◆ **Dense regular elastic C.T:**
    - ◆ Coarse branching elastic fibers with few collagen fibers.
    - ◆ Fibroblasts are scatters throughout the interstitial space.
    - ◆ Elastic fibers form thin sheets or fenestrated (having windows) membranes, as in large blood vessels, ligamenta flava of the vertebral column.

#### 3-Reticular Tissue:

- Under L/M:

- Type III collagen is the major component
- Collagen forms a mesh-like network interspersed with Fibroblasts and macrophages.
- It forms the architectural framework of liver sinusoids, bone marrow, lymph nodes, spleen, smooth muscle.

#### **4-Adipose Tissue:**

*Classified into two types:*

##### **1. white (unilocular) adipose tissue:**

- Under L/M
  - Formed of unilocular adipose cells.
  - Heavily supplied with blood vessels.
- Function
  - Synthesis, Storage & release of fat
  - Thermal insulator
  - Shock absorber
- Sites
  - Subcutaneous layer (especially in buttock and hips)
  - Abdominal wall.
  - Female breast.
  - Around the kidney.
- N.B. It appears only after birth.

##### **2. Brown (multilocular) adipose tissue**

- Under L/M
  - Formed of multilocular adipose cells.
  - Heavily supplied with blood vessels. (that's why brown)
  - Numerous mitochondria. (that's why brown as well)
- Function
  - Synthesis, Storage & release of fat
  - Thermal insulator
  - Shock absorber
    - ✓ Present in infants of most mammals.