

الجمهورية الجزائرية الديمقراطية الشعبية

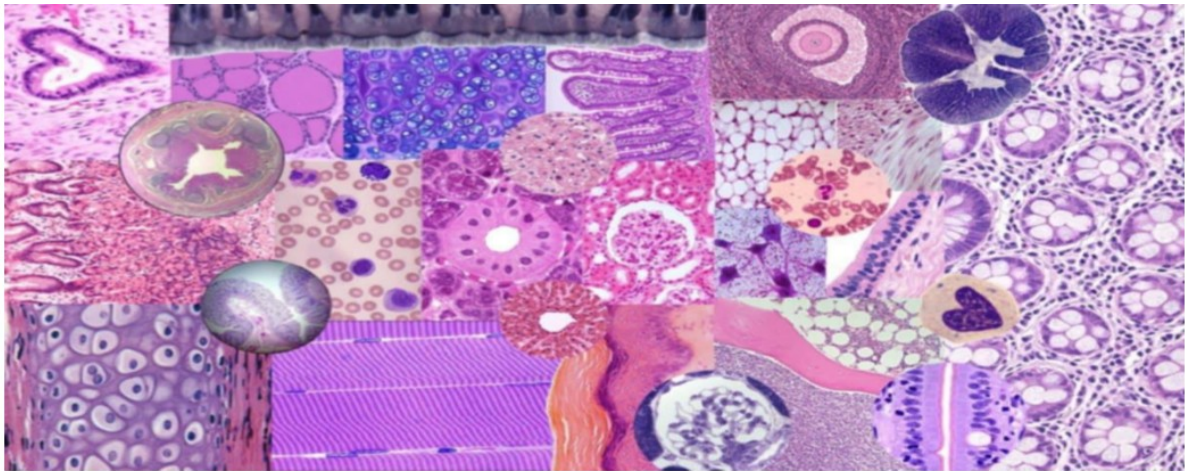


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HISTOLOGY



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CONNECTIVE TISSUE

Definition

It is the most widespread tissue in the body; it is composed of a mixture, in variable proportions, of cells, fibers, and ground substance.

Connective tissue (CT) = Cells + Fibers + Ground substance

Embryonic Origin

Mesenchymal cells = connective cells, of mesodermal (mesoblastic) origin, which have retained their embryonic characteristics, i.e., they are multipotent.

They are found in various tissues of the body in a stellate form and appear to be interconnected via their cytoplasmic projections.

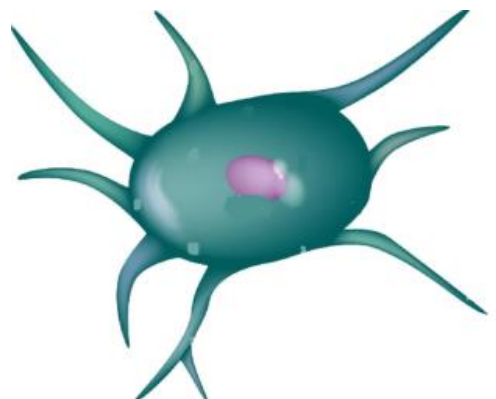
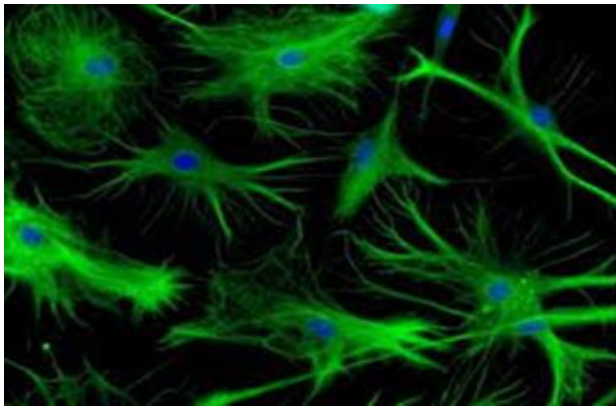


Figure 1

Following stimulation, mesenchymal cells differentiate and become capable of synthesizing the molecules of the extracellular matrix:

Fibroblasts ■■■■■■■■ Connective tissue proper

Chondroblasts ■■■■ Cartilaginous tissue

Osteoblasts ■■■■■■■■ Osseous (bone) tissue

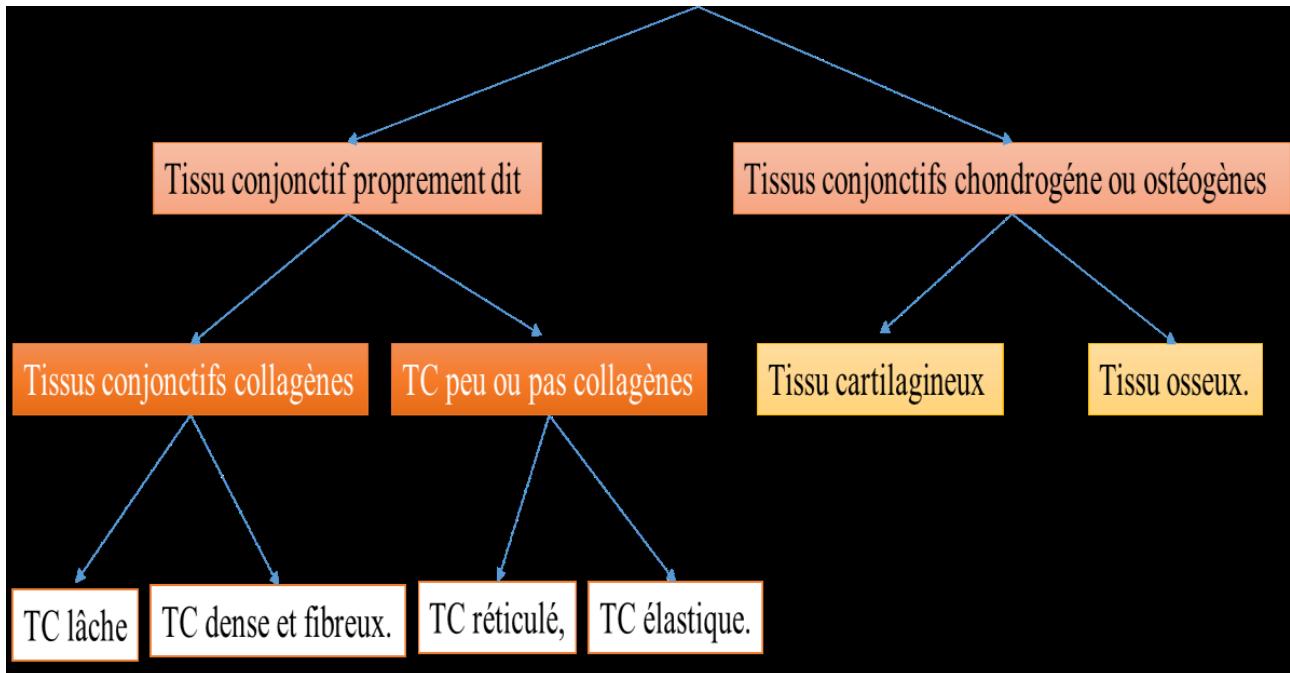
Roles and Functions

- Connection between organs (e.g., tendons and vascular pathways)
- Encapsulation (capsules and structural frameworks)
- Nutrition (site of passage for interstitial fluid)

❖ In pathology: connective tissue is the site of inflammation.

Classification

Based on the proportions of the constituent elements, the following types can be distinguished:



The Ground Substance

It fills the space between the cells of the connective tissue and the fibers. Its consistency is variable (and it contains H₂O derived from plasma):

- **Connective tissue proper** ■■■■■■■■ semi-solid or loose ([H₂O] ↑)
- **Cartilaginous tissue** ■■■■■■■■ solid and elastic ([H₂O] ↓)
- **Osseous tissue** ■■■■■■■■ solid and rigid ([H₂O] ↓ + [Ca] ↑)

Connective Tissue Proper

It is a non-specialized tissue and the most widespread in the human body.

- Location: around and within organs
- Its connective cells are not in direct contact with each other
- Roles: defense, transport, storage, and repair
- It is vascularized
- It varies morphologically and functionally: cells, fibers, and ground substance vary both qualitatively and quantitatively

1. Cells

a) Autochthonous cells (fixed and mobile).

→ **In normal connective tissue proper:** these are fixed cells of mesenchymal origin, such as the fibroblast, fibrocyte, histiocyte, and adipocyte.

→ **In irritated connective tissue proper:** these are inflammatory (mobile) cells, such as the plasma cell, mast cell, macrophage, and giant cells of irritation (Langhans cells).

b) **Immigrant cells:** blood cells transiently present in the connective tissue proper. This includes leukocytes such as granulocytes, monocytes, and lymphocytes.

Fibroblast

Derived from mesenchymal cells; present in all connective tissue proper (CTP).

Role:

- Intense synthesis of protein precursors, fibers, and ground substance
- Synthesis of ECM molecules, cytokines, and interferon-beta, which plays an important role in antiviral defense.

Fibrocyte

Spindle-shaped without cytoplasmic projections.

Nucleus: weakly mitotic.

Cytoplasm: weakly basophilic; poor in rough endoplasmic reticulum (RER) and ribosomes.

Role: weak synthesis of protein precursors, fibers, and ground substance.

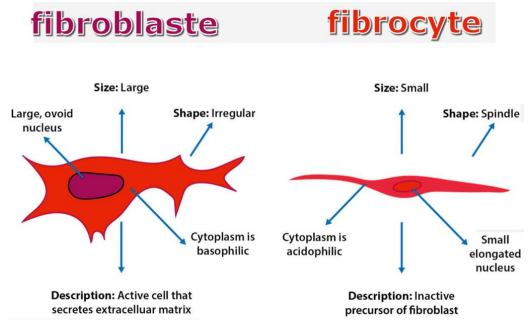


Figure 2

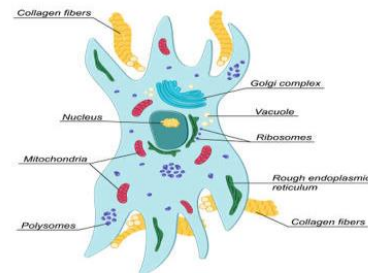


Figure 3

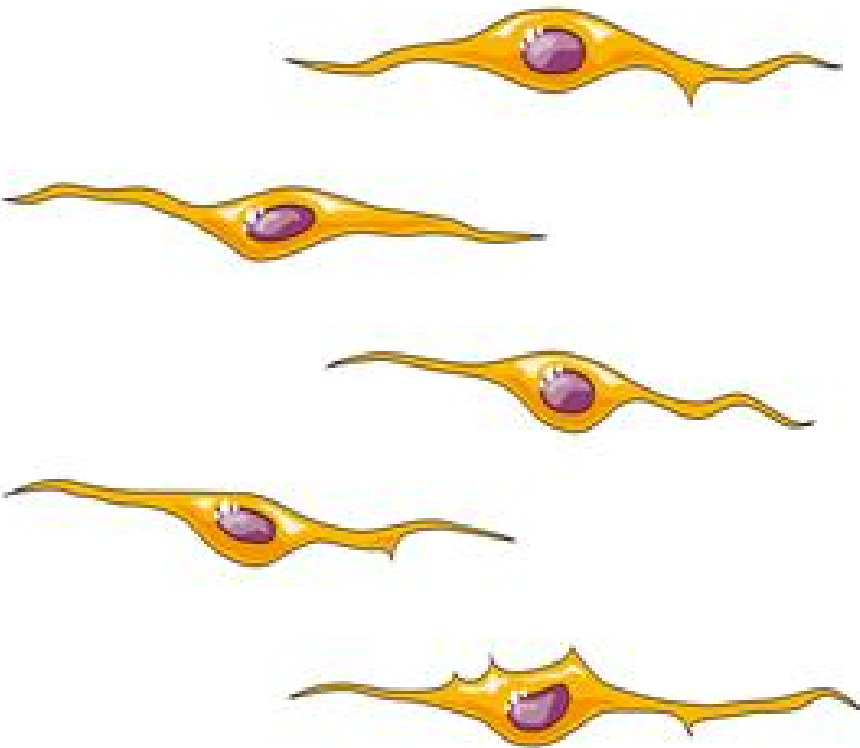


Figure 4

Adipocytes

Specialized in lipid storage; present either isolated or in groups.

WHITE ADIPOSE TISSUE ADIPOCYTE

- Location: hypodermis of adults
- Shape: ovoid and spherical
- Size: large
- Nucleus: eccentric
- Lipid vacuoles: single
- Mitochondria: few in number

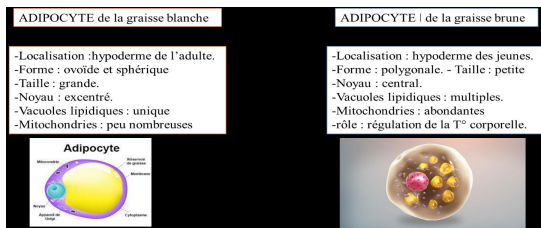


Figure 5

BROWN ADIPOSE TISSUE ADIPOCYTE

- Location: hypodermis of young individuals
- Shape: polygonal
- Size: small
- Nucleus: central
- Lipid vacuoles: multiple
- Mitochondria: abundant
- Role: regulation of body temperature

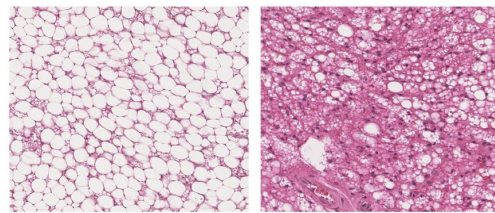
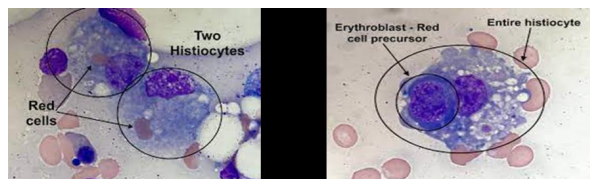


Figure 6



Figures 7 & 8

Histiocyte

- A quiescent-type cell (highly metabolically active and capable of dividing at any time).
- Contains vacuoles and inclusions (reserve material).
- Fate: in the event of inflammation of the CTP, it transforms into a macrophage.



Figure 9

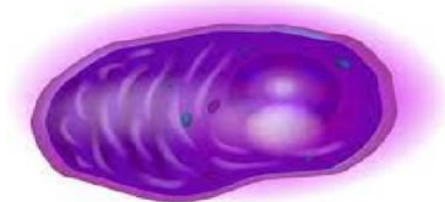


Figure 10

Macrophage

Structural appearance related to the degree of activity: the surface displays numerous microvilli and pseudopods (for amoeboid movements); the cytoplasm is acidophilic and rich in lysosomes; the Golgi apparatus is well developed; the nucleus is eccentric.

- It belongs to the mononuclear phagocyte system.
- Its structural appearance is linked to its degree of activity.
- It has a high phagocytic capacity toward microorganisms and cellular debris present in the CTP.

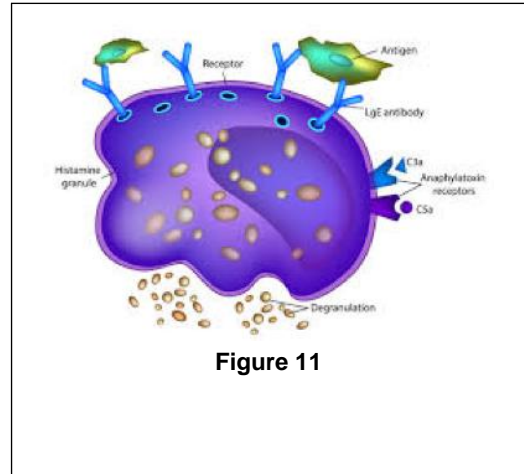


Figure 11

Plasma Cell

Characteristic of irritated CTP during chronic infections.

- It is an immune agent derived from the B lymphocyte.
- Location: scar tissues, around grafts or metastases.
- Oval, sometimes pyriform and voluminous shape.
- Eccentric nucleus; chromatin arranged in a cartwheel (clock-face) pattern.
- Cytoplasm very basophilic; abundant in ribosomes and RER for antibody synthesis.

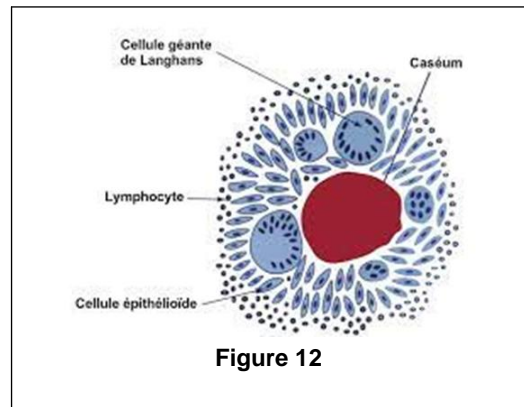


Figure 12

Mast Cell

Shape: rounded or oval.

The cell surface is covered with microvilli.

The central nucleus is spherical.

Its basophilic cytoplasm is rich in vesicles containing heparin, histamine, and hyaluronic acid.

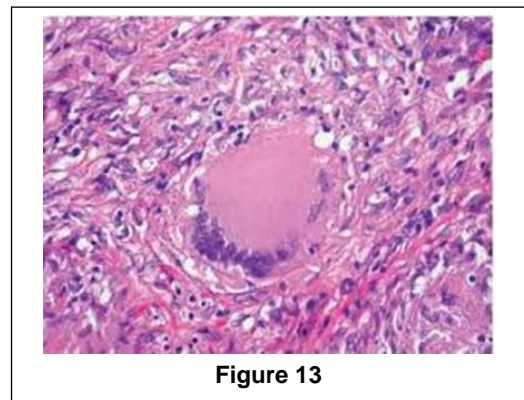


Figure 13

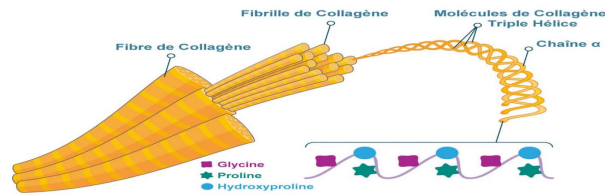
The Giant Cell of Irritation

When the particle to be digested is very large, macrophages fuse to form giant cells of irritation.

Size: large, with an acidophilic cytoplasm rich in lysosomes.

Multinucleated (nuclei arranged in a horseshoe or necklace pattern).

Example: Langhans giant cells, found in tuberculosis.



Figures 14 & 15

2. Connective Fibers

Precursors: procollagen (for collagen fibers and reticulin fibers) and proelastin (for elastic fibers).

Site of precursor synthesis: fibroblast and fibrocyte.

Site of assembly: extracellular matrix.

❖ Collagen Fibers

This is a tissue with transverse striations showing alternating light and dark bands.

Under EM (electron microscopy): they are the thickest of the connective fibers.

They are extensible but not elastic.

Role: resistance of CTP to mechanical forces + structural strength.

Collagenogenesis

- This is the process of collagen fiber formation.
- Precursors = AAs (including proline, lysine, glycine, hydroxyproline, and hydroxylysine).

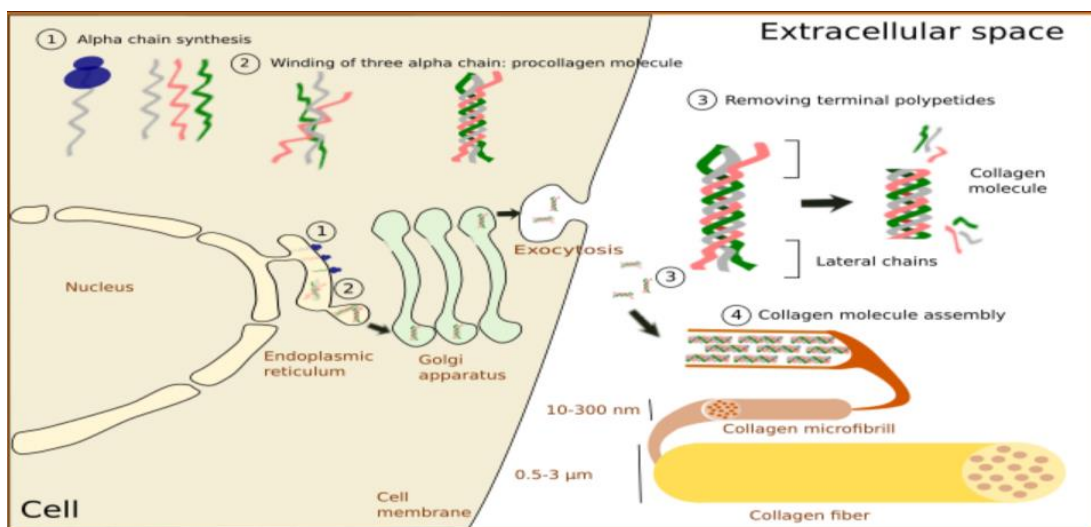


Figure 16

Stages of Collagen Formation

- Alpha chain subunits are synthesized by the fibroblast and assembled into groups of 3 → procollagen molecules.
- Following exocytosis, a processing step (involving enzymes such as matrix metalloproteinases, MMP) removes the N- and C-terminal ends of the alpha chains → tropocollagen molecules.
- The primary structure of tropocollagen (an elongated, multi-domain protein) enables oriented extracellular self-assembly → collagen fibrils.
- These fibrils associate in parallel to form collagen fibers, with a 70 nm overlap (representing the overlap between tropocollagens from two adjacent fibrils).



Figure 17

Types of Collagen

Determined by their amino acid composition and the physicochemical properties of their tropocollagens:

- **Type I:** the most abundant. Found in the dermis, tendons, bone tissue, dentine, and fibrocartilage.
- **Type II:** Cartilage; mature hyaline cartilage.
- **Type III:** specific to reticulin fibers at the level of blood vessels and adipose tissue.
- **Type IV:** specific to basement membranes and immature hyaline cartilage.

❖ Reticulin Fibers

These are collagen fibrils to which a glycan complex is bound, preventing any further association.

They are thinner than collagen fibers.

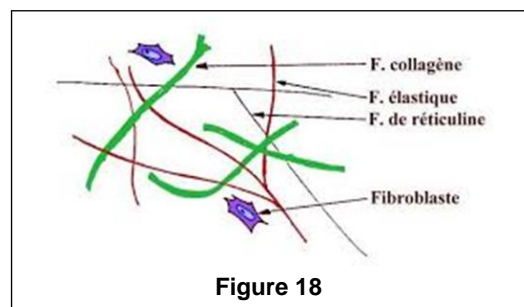


Figure 18

❖ Elastic Fibers

These are the thinnest fibers. They are anastomosed and branched (forming a network rather than bundles) and are elastic.

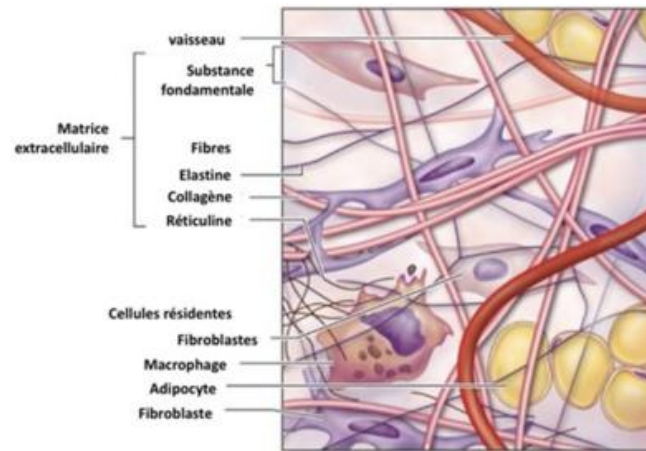


Figure 19

3. Ground Substance of the CTP:

- It occupies the spaces between fibers and cells.
- Consistency: semi-solid, amorphous, homogeneous.
- Origin: from fibroblasts, or of vascular origin via plasma filtration.
- Chemical composition: water (in very abundant amounts).
- Of endogenous origin (derived from cell lysis).

VARIETIES OF CONNECTIVE TISSUE PROPER

Based on the proportions of the constituent elements and their properties:

➤ Loose Connective Tissue Proper

- The proportion of fibers, cells, and ground substance is balanced.
- It is very widespread in the body: subcutaneous cellular tissue (dermis and hypodermis), lamina propria of mucous membranes, and alveoli of spongy bone.
- Role: filling

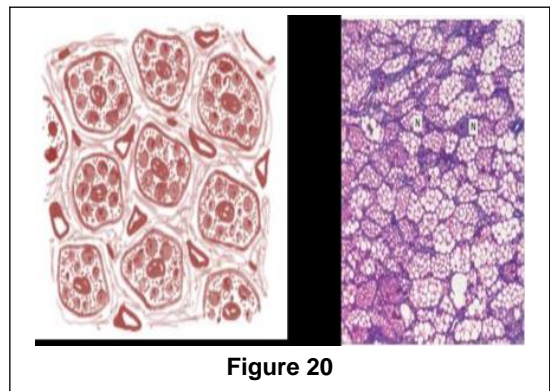


Figure 20

➤ Primary Adipose Connective Tissue Proper

- Located at the level of brown fat, with a high content of type I adipocytes, mitochondria, and rich vascularization.
- The role of type I adipocytes is the regulation of body temperature.

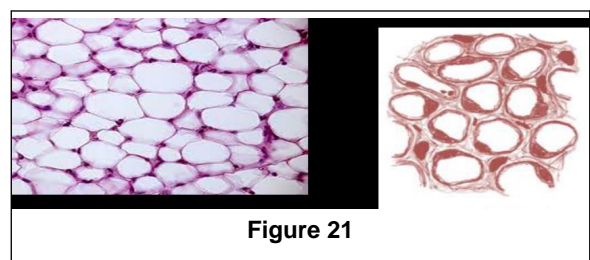


Figure 21

➤ **Secondary Adipose Connective Tissue Proper**

Present at the level of white fat, with a predominance of highly active type II adipocytes.

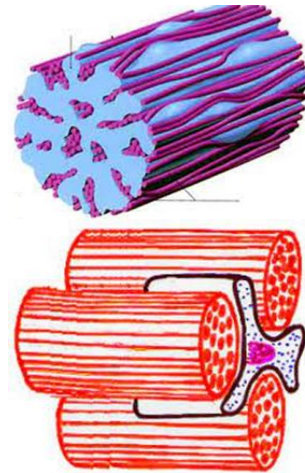


Figure 22

➤ **Decidual Connective Tissue Proper**

It forms during pregnancy under the influence of progesterone.

The cells of the uterine mucosa swell with water (edema) and accumulate glycogen.

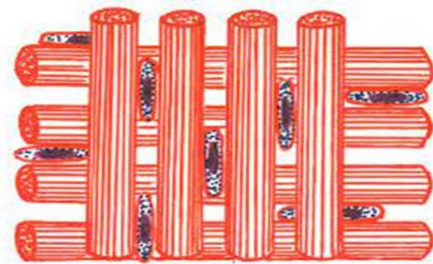


Figure 23

➤ **Dense (Fibrous) Uniaxially Oriented Connective Tissue Proper**

Collagen fibers predominate (as in tendons and ligaments).

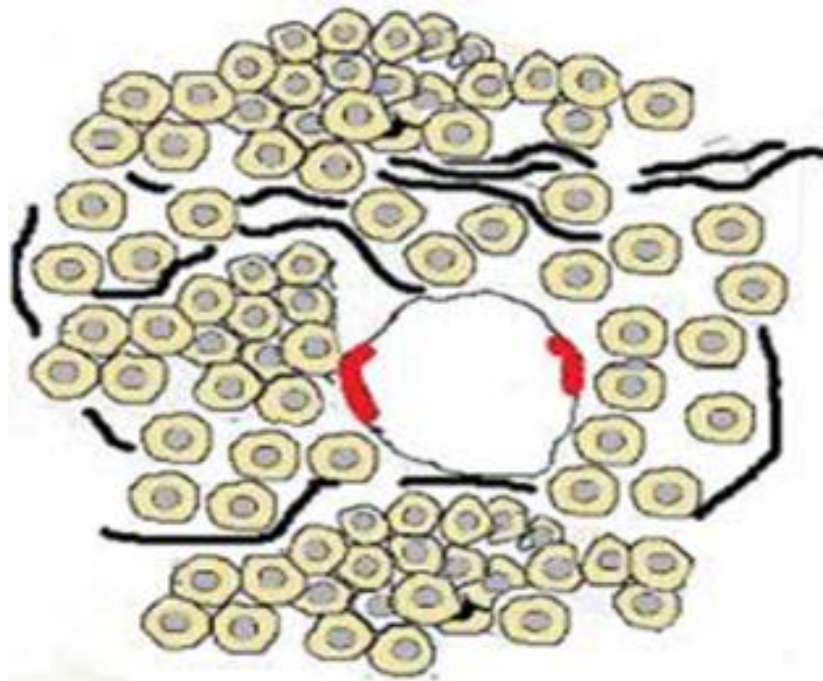


Figure 24

➤ **Dense (Fibrous) Biaxially Oriented Connective Tissue Proper**

Predominance of collagen fibers (located at the level of the corneal dermis).

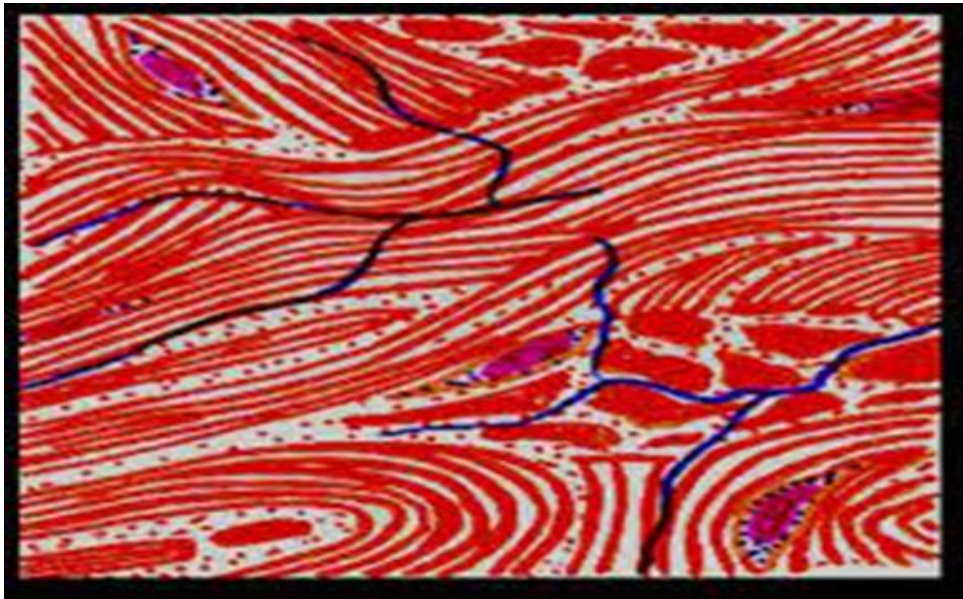


Figure 25

► **Dense (Fibrous) Non-Oriented Connective Tissue Proper**

Composed of numerous voluminous collagen fibers (organ capsules).

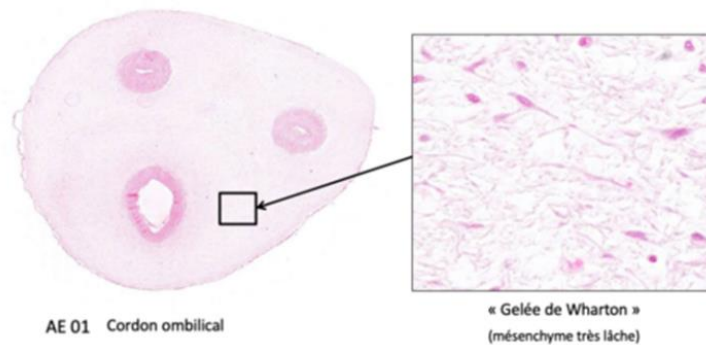
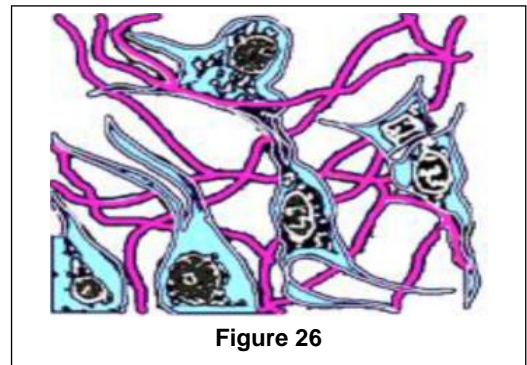


Figure 25

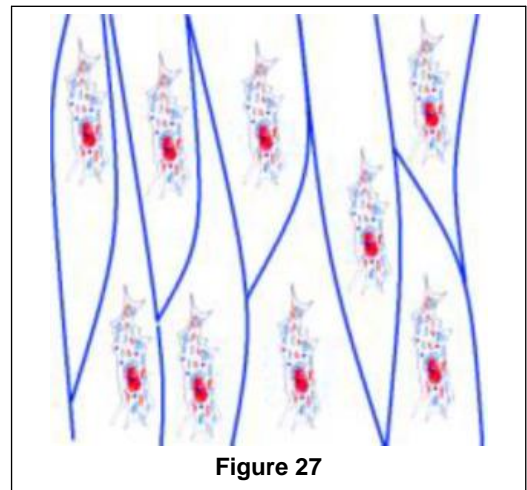
► **Reticular Connective Tissue Proper**

Predominant reticulin fibers are anastomosed in a very tightly meshed network. Located within the framework of hematopoietic organs.



► **Elastic Connective Tissue Proper**

Elastic fibers predominate. Found at the level of the tunica media of large arteries.



► **Mucous Connective Tissue Proper**

Characterized by the abundance of its viscous (gelatinous) ground substance; found at the level of Wharton's jelly of the umbilical cord.

[Figure 28 — Histological section of Wharton's jelly (umbilical cord): AE01 umbilical cord cross-section showing loosely arranged mesenchyme]