

in contact with each other

Epithelium

- numerous
- **Cells:** closely aggregated, tight by junctional complexes
- **Intercellular substance:** **very little**
- **No fibers in the ground substance**
- **Blood vessels:** **avascular**
- **Origin:** **ectodermal, endodermal, mesodermal**
- **Function:** covering or secretion (glands)

rich in nerve supply

high renewal rate



nutrition from the underlying connective tissue

does not in contact with each other

Connective T.

- **Cells:** few, **widely separated**
- **Intercellular substance:** abundant
- **fibers are present in the ground substance**
- **Blood vessels:** rich
- **Origin:** **mesodermal**
- **Function:** **support, defence and nutrition**



General Properties of Connective Tissue

- Connectoprotection
- Form capsule ~~around~~ in certain place

One of the four basic types of tissues (epithelium, connective tissue, muscle, and nervous tissue)

Composition:

- cells
- Extracellular matrix
- fibers
- ground substance

3. Functions:

- Architectural framework of the body
- Bind together and provide **mechanical support** for other tissue (metabolic, defense, transport, storage)
- **Nutrition**
- **Wound repair**
- **Protection:** **inflammatory response**

Extracellular Matrix (ECM) Ground Substance of the

- 1. **Glycosaminoglycans (GAG)** *glucos + AA + Protein + CHO*
 - **linear (unbranched) polysaccharide**, e.g. heparin sulfate, chondroitin sulfate, keratan sulfate, hyaluronic acid
 - attract sodium & hold water
 - very hydrophilic due to abundant negative charges (*hydrated*)
 - except for hyaluronic acid, are usually bound covalently to protein core as part of a proteoglycan
- 2. **Proteoglycans:** Forms thick gel that slows the spread of pathogens
 - **core protein + GAG side chains (like a bottle brush)**
 - bind cells, other proteins, and/or ECM components
- 3. **Multiadhesive glycoproteins**
 - small glycosylated proteins containing NUMEROUS binding sites to cells, signaling molecules, and other ECM components
 - e.g. **fibronectin** and **laminin**: important for adhesion of epithelial cells to the basal lamina via transmembrane integrin receptors.

Tissue fluid: Similar to blood plasma

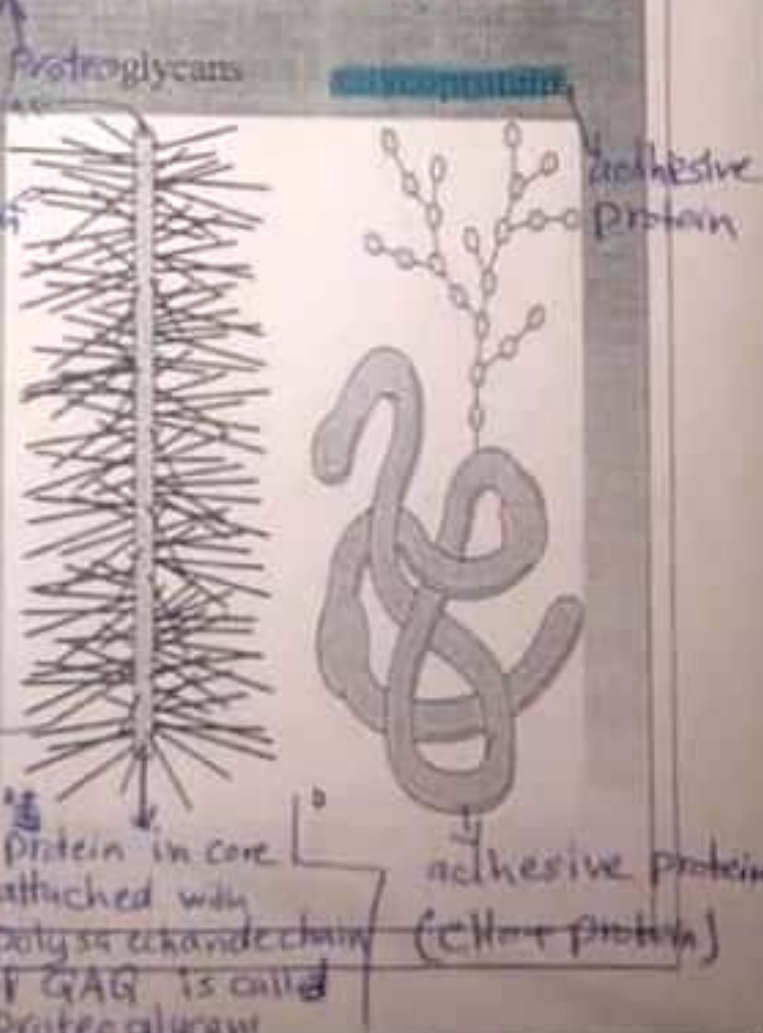
FUNCTION:

- Nutrition
- Barrier to bacterial penetration

Its ground substance jelly like

Ground Substance

- Glycosaminoglycans**
 - GAGs are polysaccharides that contain amino sugars
 - **hyaluronic acid** is the largest GAG
- Proteoglycans:**
 - They are made up of a core protein to which glycosaminoglycans (GAGs) are attached.
- Glycoproteins:**
 - Fibronectin mediates the attachment of cells to the extracellular matrix
 - Laminin - a component of basal laminae that mediates the attachment of epithelial cells.
- Tissue fluids:**
 - plasma proteins of low molecular weight
 - Salts



*يشبه الفرشة التي تتصاقق
لتنظيف الكفاية*

C.T Connective Tissue Fibers

- ① **Collagen** most numerous type
 - most abundant protein in human body
 - Several types: fibril-forming or fibril-associated (in **skin, tendon, cartilage, bone, dentin, blood vessels**); cross-linked networks (in all basement membranes)
- ② **Reticular Fibers** - **specialized type of collagen (Type III; reticulin)** associated with smooth muscle in organs subjected to changes in volume, forms the stroma in lymphatic and hematopoietic organs
- ③ **Elastic Fibers** - thin fibers or fenestrated sheets composed of various glycoproteins, including the protein elastin, providing elastic properties to tissues that experience repeated deformation (in skin, blood vessels, lung, bladder)

Collagen → also called white fiber due to the collagen type appear in white color by naked eye (stain pink with H&E)

collagen type I → is bundle of fibers.

C.T. fibers

The proportion of different fiber types varies depending on the structural needs or function of the particular CT.

- ❖ **Collagen fibers** are the most abundant fiber type. All connective tissues have collagen fibers, but the number and organization varies in different types. They **are flexible** and have **high tensile strength**.
- ❖ **Reticular fibers** means 'network', are especially abundant in arteries, spleen, liver, uterus and intestinal muscle layers, and they form the primary framework for hematopoietic organs, the parenchyma of cellular organs such as liver and endocrine glands. Reticular fibers are also associated with the reticular lamina of basement membrane.
- ❖ **Elastic fibers** are especially abundant in elastic ligaments (ligamenta flava of the vertebral column, ligamentum nuchae of the neck, and vocal folds of the larynx, and in the walls of arteries (where elastic fibers are produced by smooth muscle cells, not fibroblasts))

connective tissue of cells:-

- 1) Fibroblast → In the connective tissue, forms the ground substance and fibers
- 2) chondroblast → of cartilage
- 3) osteoblast → of bone

* any blast cell is highly active cell.

* collagen fibers are made up from collagen protein

* ground substances are made up from GAGs, proteoglycans and glycoprotein.

the cell that contains fibroblast is called protein secreting cell.

which is the most organelles that contain protein secreting cell? ribosomes ~~rough~~ rough endoplasmic reticulum

* يتل في السيتوبلازم طباقة ribosomes و rough endoplasmic reticulum

* ويتصنع بروتين كثير ولو البروتين طباقة لبرا الخلية لازم
تحتوي على (promenent) ~~promenent~~ (golgi) لانها بتفر وتطباقة مباشرة لازم
يعبر ال modification

* Protein secreting cells have a large number of

Ribosome, rough endoplasmic reticulum. which synthesise amino acid. their cytoplasm is basophilic cytoplasm after stained by basic stain

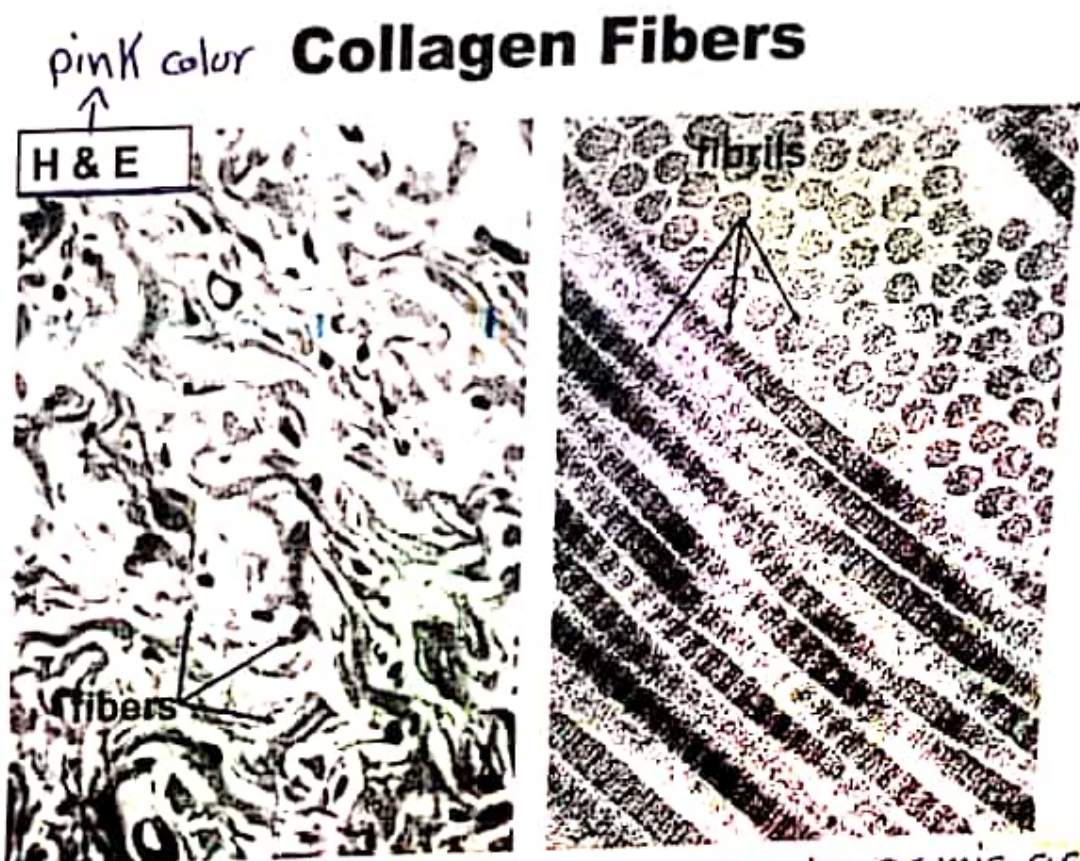
~~when stained the cell by the cytoplasm is~~

* protein secreting cells have active nucleus and basophilic cytoplasm due to having a large number of ribosomes and rough endoplasmic reticulum. that produced amino acid and take the basic dye.

Collagen fibers (white fibers) ^{thick}

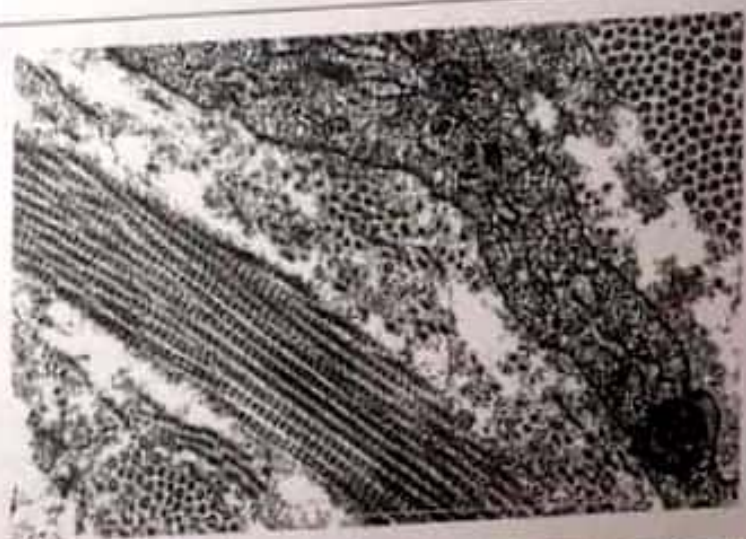
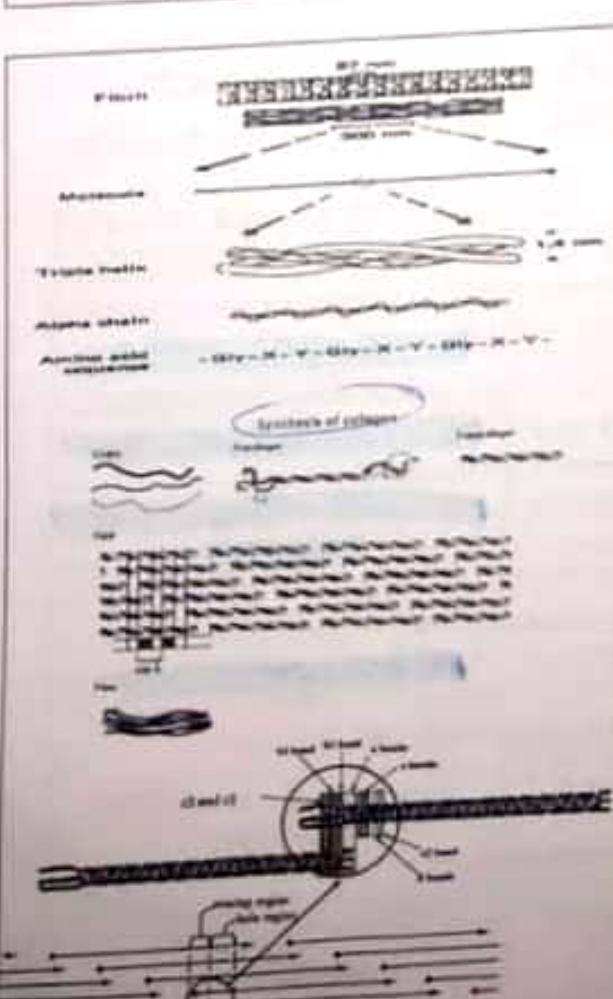
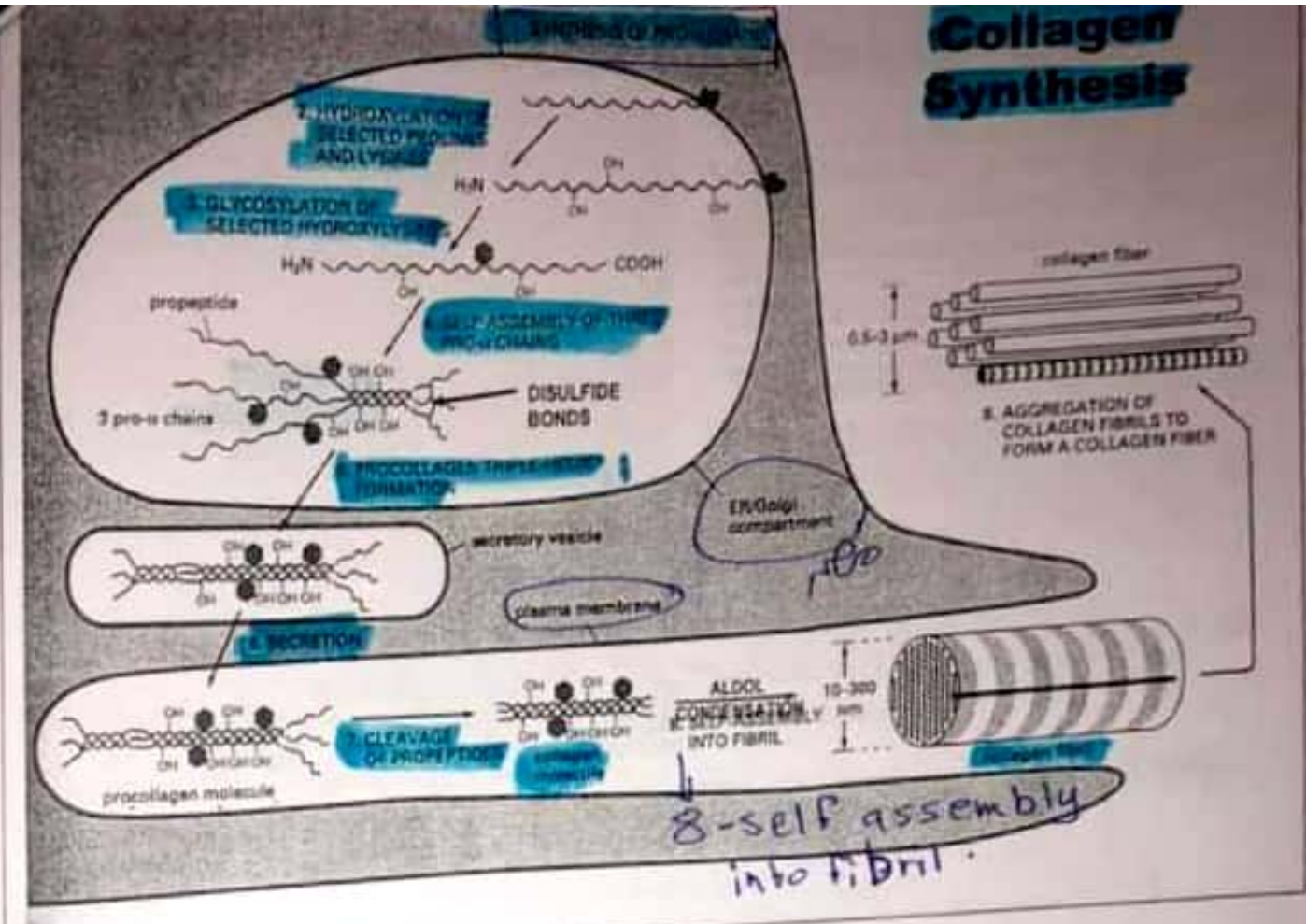
- The most numerous
- are extremely tough.
- Formed of collagen protein
- They are stronger than steel fibers of the same size.
- They provide high **tensile strength**, which is the ability to resist longitudinal stress.
- Since fresh collagen fibers have a glistening white appearance they are sometime called "**white fibers**".
- Fibers do not branch but bundles can do
- **Stain** pink with eosin

trichrome stain is a specialized stain for collagen that give it blue color

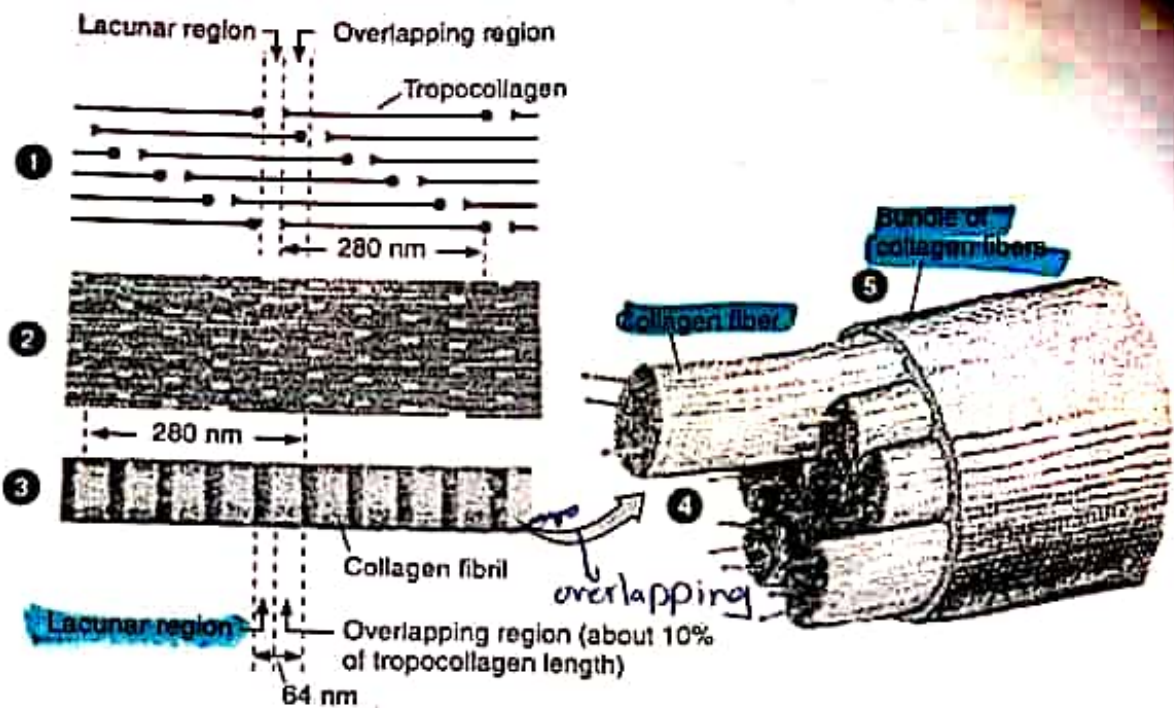


the name of stain in the electron microscope is osmic acid
black color

Collagen Synthesis



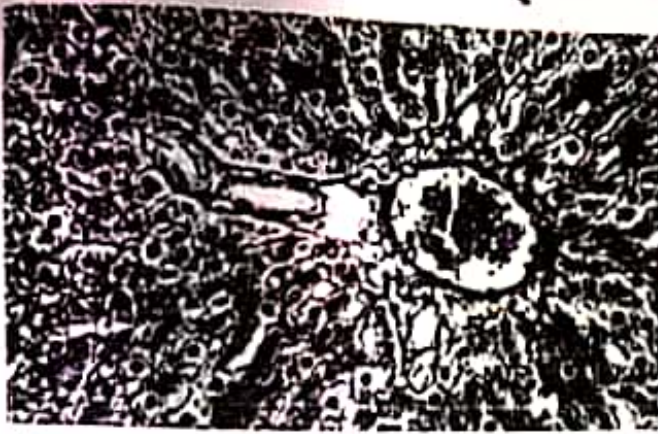
Assembly of collagen fiber bundles



Major Collagen Fiber Types (out of at least 20) According to the chemical composition of collagen molecules

Collagen Type	Tissues	Function
Fibril-forming collagens (these are visible)		
1 I (most abundant)	Skin, tendon, bone, dentin	Resistance to tension
2 II	Cartilage, vitreous of eye	Resistance to pressure
3 III (reticulin)	Skin, muscle, blood vessels, liver, etc.	Structural framework and stability
Network-forming collagens		
4 IV + VII	All basement membranes	Support and filtration
Fibril-associated collagens with interrupted triple helices (FACIT)		
8, 9 VI, IX, X	Assoc. w/ type I and II fibrils	Fibril-fibril / fibril-ECM binding
Anchoring filament collagens		
7 VII	Epithelia	Epidermis to basal lamina

Reticular (Reticulin) Fibers



Cell branching and anastomosing fiber

- Form network
 - Form a delicate supporting framework for highly cellular tissues (**adipose**, **spleen**, **lymph nodes**, **liver**, **bone marrow**, **spleen**, **smooth muscle**).
 - Composed mainly of Type III collagen, with a carbohydrate moiety that reduces Ag⁺ to metallic silver - **argyrophilic**.
 - Special stain: silver impregnation to visualize **argyrophilic**.
 - Thinner than type I collagen (Type III fibrils are 30-40 nm diameter; type I fibrils are ~200 nm diameter)
 - made by **reticular cells** (specialized fibroblasts) and vascular smooth muscle cells
- * not stained by H&E but by silver dye

Elastic Fibers

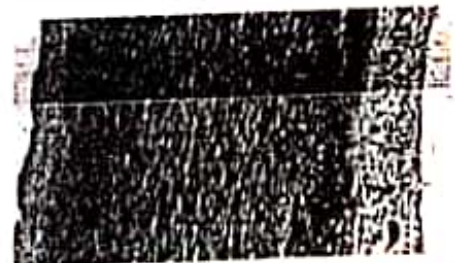
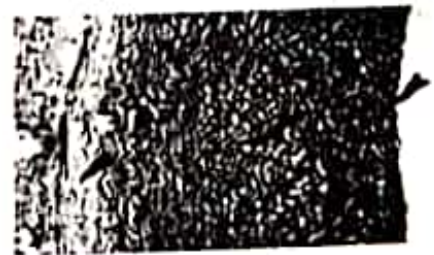
Elastic fibers (**yellow fibers**): can be stretched to one and one-half times their length, but recoil to their initial length when released. Fresh elastic fibers appear yellow and are also called **yellow fibers**.

Stain : H&E , Orcein , VVG

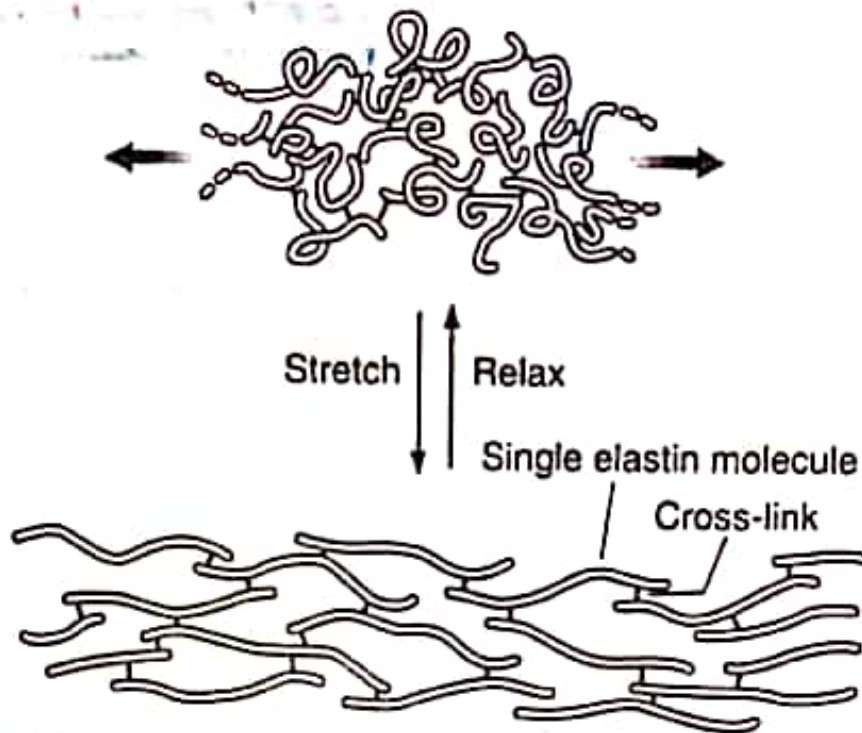
Elastin: is rich in glycine and proline, but it contains little or no hydroxyproline and hydroxylysine . uniquely contains **desmosine** and **isodesmosine**, which are thought to cross-link the molecules into a network of randomly coiled chains. This cross-linking is responsible for its rubber-like properties.

They are found where greater elasticity is needed present in large amounts in ligaments, lung, skin, bladder, and walls of blood vessels.

large elastic artery
(aorta, etc)



Network of elastin molecules can stretch and recoil like a rubber band



collagen



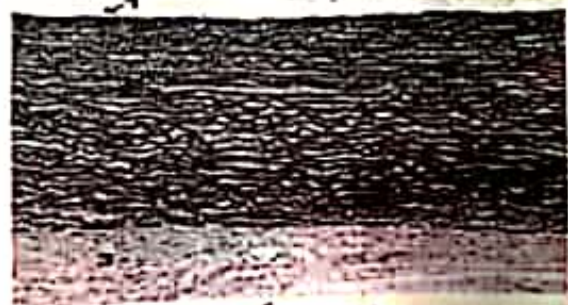
Fibers



- The most **numerous**
- White if in great number (**white fibers**)
- **Strong and flexible**
- Fibers do not branch but bundles can do
- Formed of **collagen** protein
- Stain pink with eosin
- Types of Collagen Fibres

- **Thin branching**
- **Not** stained by H&E
- Stained dark brown with **silver stain**
- Consist of type **III collagen**
- Supportive function

- Yellow if in great number (**Yellow fibers**)
- Elastic and **stretchable**
- Fibers can **branch** and unit
- Formed of **elastin** protein
- Stained weakly by H&E
- Stain brick red by **orcein**
- Stain dark violet with **V.V.G** stain.



Elastic

Fibers

Fiber	Components	Location
<u>Collagenous Fibers</u>	Alpha polypeptide chains	tendon, ligament, skin, cornea, cartilage, bone, blood vessels, gut, and intervertebral disc.
<u>Elastic fibers</u>	elastic microfibril & elastin	extracellular matrix (blood vessels)
<u>Reticular fibers</u>	Type-III collagen	liver, bone marrow, lymphatic organs highly cellular tissue.

Connective Tissue Cells.

Resident cells → c.T cells

1) Fibroblasts 2) Adipocytes

Fixed cell

3) Pigment cells

Immigrant cells :- Free cells

* macrophage of the c.T is called histocytes.

* monocytes → one of WBC, half of life span in blood, 2nd half in tissue

monocytes in tissue is called macrophage.

* macrophage in the lung → alveolar macrophage

* // // // bone → osteoclaste.

* // // // Liver → Kupffer cell

* // // // brain → microglia

- all of these names are called diffused phagocytic cells

لو حركت ال macrophage من ال C.T و صار
عندي Infection يتسوي migration من ال C.T
عشان تأكل phagocytoses

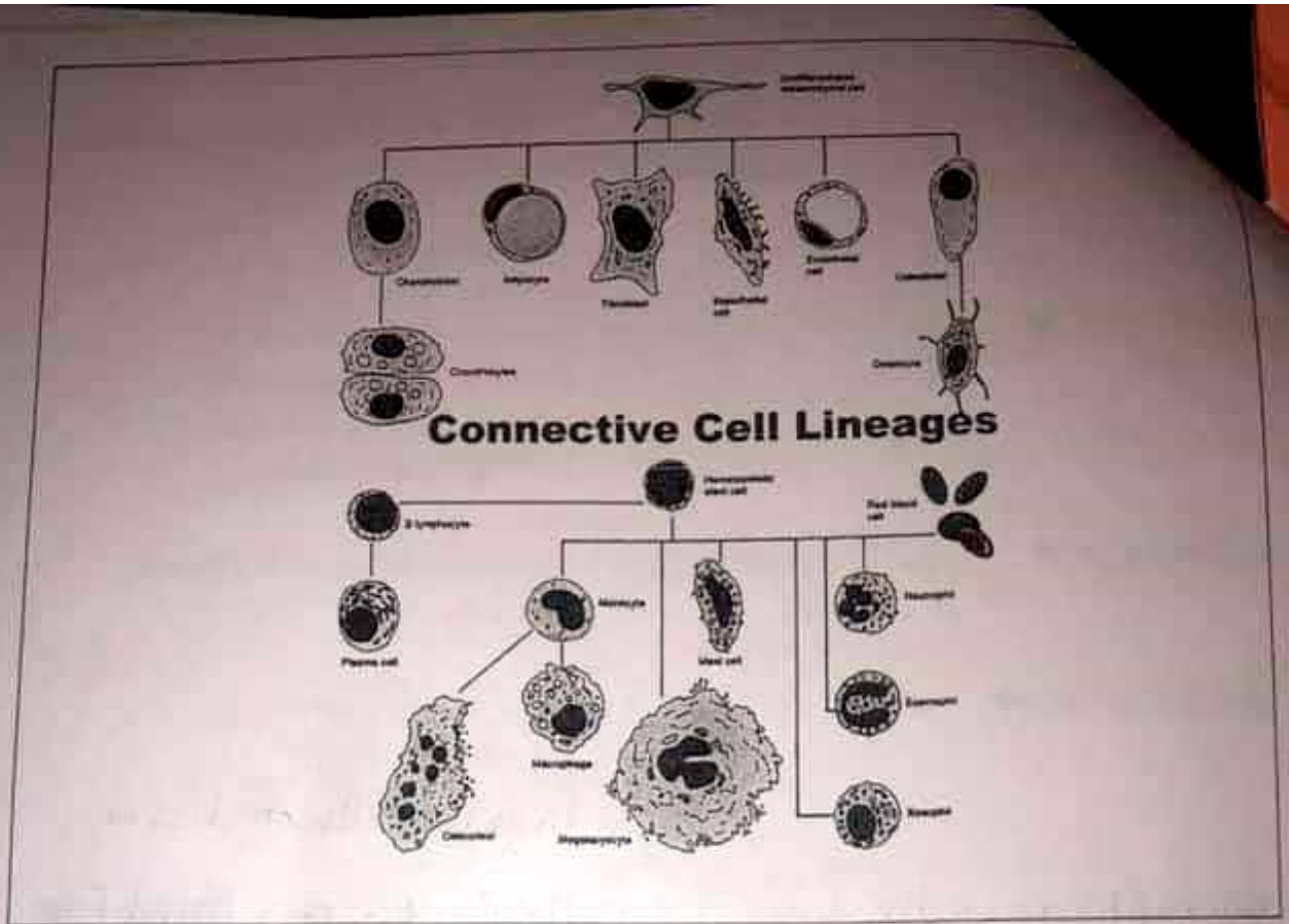
plasmocytes → Plasma cell

* Leucocytes → WBC

- plasmocytes → blood cell (~~lean~~ Lymphocytes)
B-Lymphocytes

If there is infection, B-Lymphocytes are
activated will convert into plasmocytes
and produce antibodies

specialized cells:- in the modified type
of CT



C.T. CELLS

C.T cells

1) Fixed cells

2) Free cells → almost all from blood

monocytes → macrophage

mast cell ~~is~~ its origin from hemopoietic stem cell

- Origin
- Structure
 - LM
 - EM
- Function

Undifferentiated Mesenchymal Cell

- * Stem cell
- Spindle shaped cells
- Many processes
- Oval nucleus
- Basophilic cytoplasm
- Divide and differentiate into other C.T. cells



L.M.

- * proliferated
- * highly active cell
- * active nucleus

- mast cells
- Leucocytes
- macrophages

→ originated from hemopoietic stem cell

other cells originated from undifferentiated mesenchymal cell (UDMC)

F Protein secreting cell
the most common type

▪ **Origin : from UDMC**

▪ **2 types**
Young fibroblast:

- Large in size
- Fusiform with processes
- oval central paler nucleus
- Basophilic cytoplasm

Function

- synthesis of C.T. fibers and matrix + ground substance

mature (Fibrocytes):

- Small in size *Less active*
- Fusiform smaller
- oval central darker nucleus
- acidophilic cytoplasm

