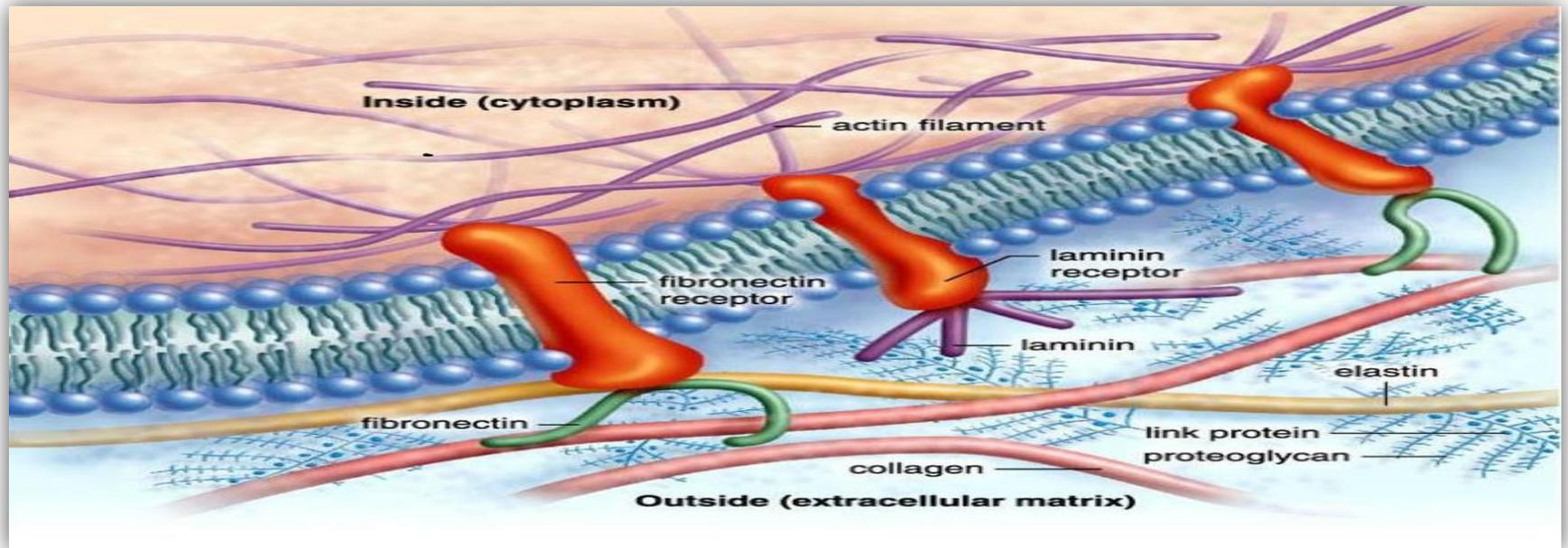


EXTRACELLULAR MATRIX



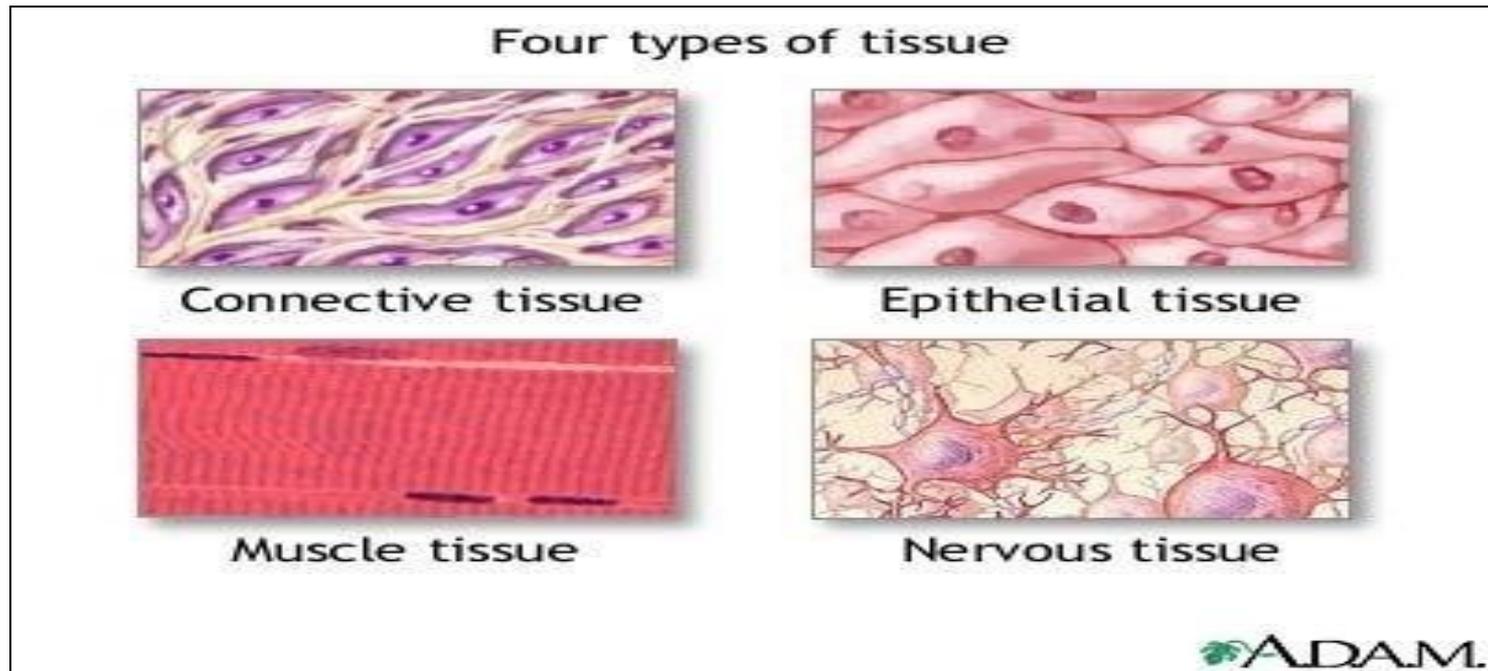
By
Dr. Heba Sharaf Eldin

Associate Professor of Histology & Cell Biology

OUTCOMES

1. Define the extracellular matrix (ECM).
2. Know the components of the extracellular matrix.
3. Enumerate the function of the specific molecules of ECM .
4. Identify the different types of ECM fibers.
5. Know the molecular structure and the characteristic properties of different ECM fibers.

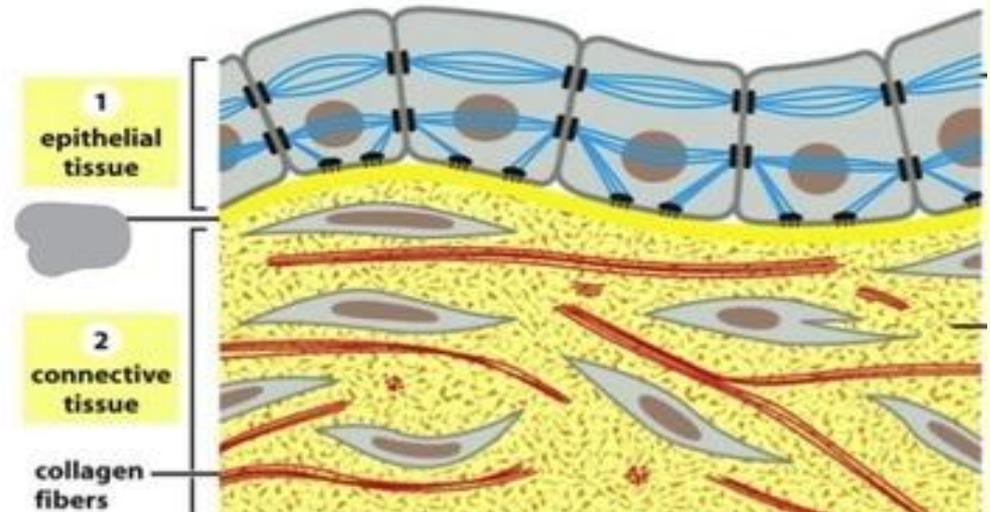
- **Cells** form structural and functional associations called **tissues**.
- They are 4 basic tissues in the human body.



- All tissues are composed of **cells** & **extracellular matrix**.

In epithelial tissue: cells form sheet with **little** amount of ECM.

In connective tissue: composed **mainly of ECM** with a **few number of cells** that scattered between the matrix.



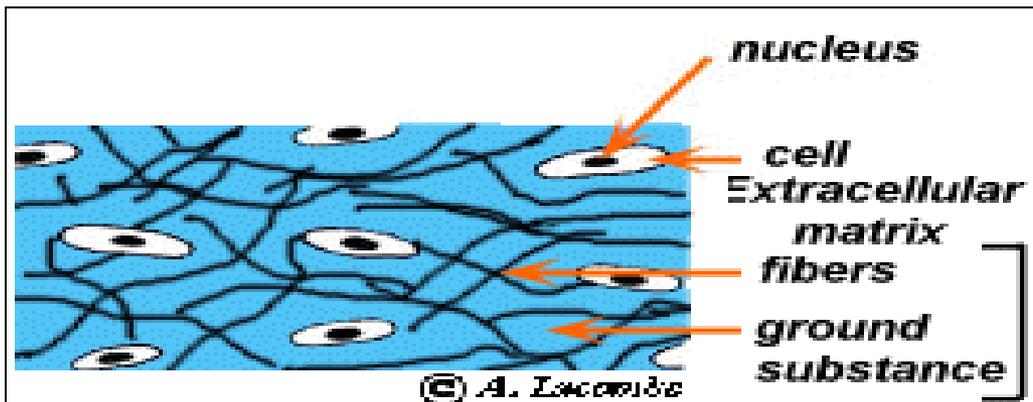
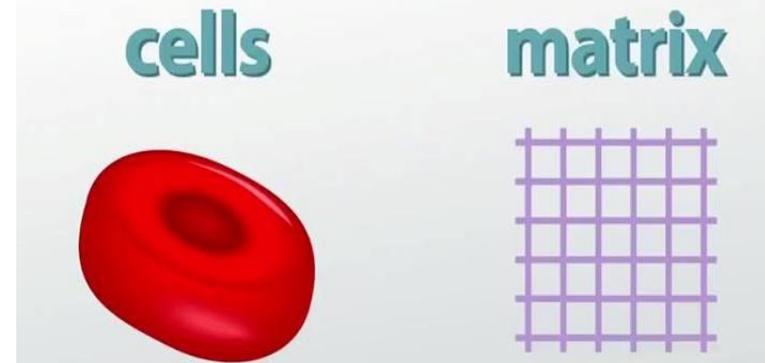
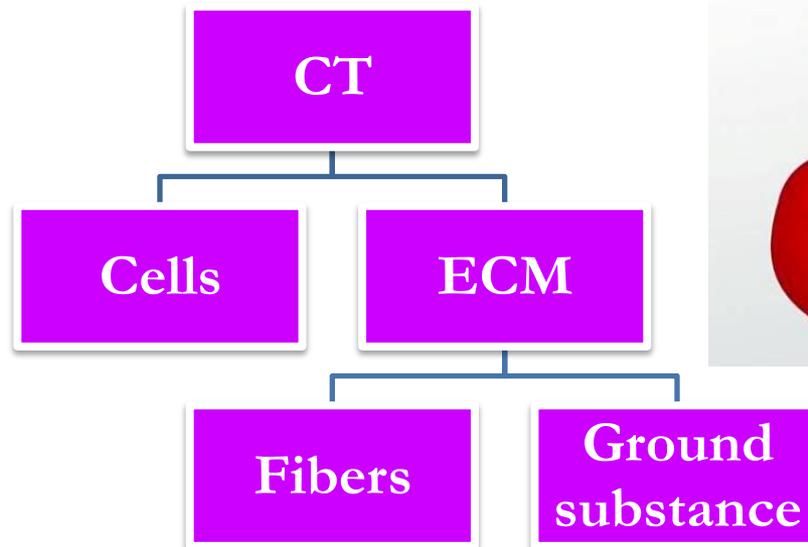
Connective tissue: that **connect** and **bind cells** and **organs** together.

-Cells connect to the macromolecules of the matrix by specialized junctions.

ECM is a complex of nonliving **macromolecules** that synthesizes by **tissues cells** and exported by them into the extracellular space.

Structure of Connective tissue.

- Connective tissue cells (less-widely separated)
- Extracellular Matrix (More- the major constituent).



Extracellular matrix (ECM)



Ground substance
(hydrated gel-like substance)



Resist compression



Fibers
(*embedded in the ground substance*)



Resist tension



Ground substance

Character:

- Abundant (**Major constituent of C.T.**)
- Amorphous
- Colorless
- Transparent
- Homogenous substance
- Jelly Like
- Hydrated



Site:

- Present *inbetween* the connective tissue cells.
- Connective tissue fibers are in it.

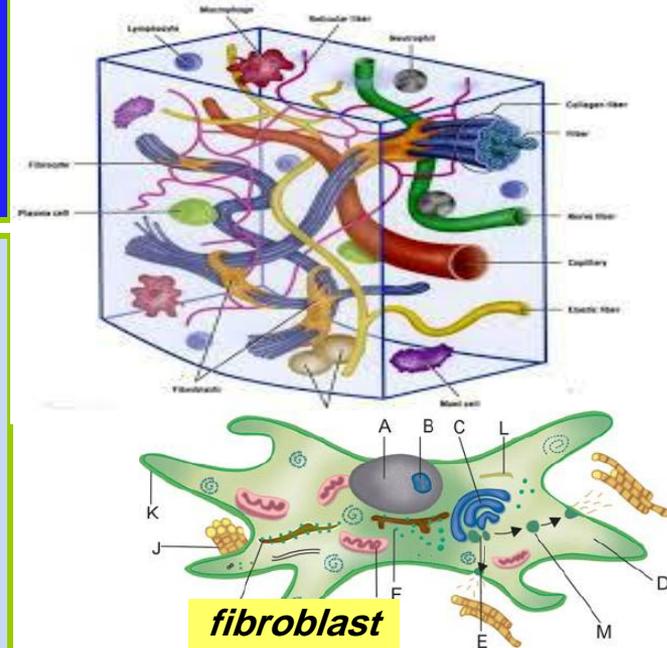
Composition:

Water + Macromolecules:

1. **Glycosaminoglycans**
2. **Proteoglycan**
3. **Glycoproteins**

secreted by:

Fibroblasts.



**Ground
substance**

```
graph TD; A[Ground substance] --- B[Glycosaminoglycans]; A --- C[Proteoglycans]; A --- D[Glycoproteins];
```

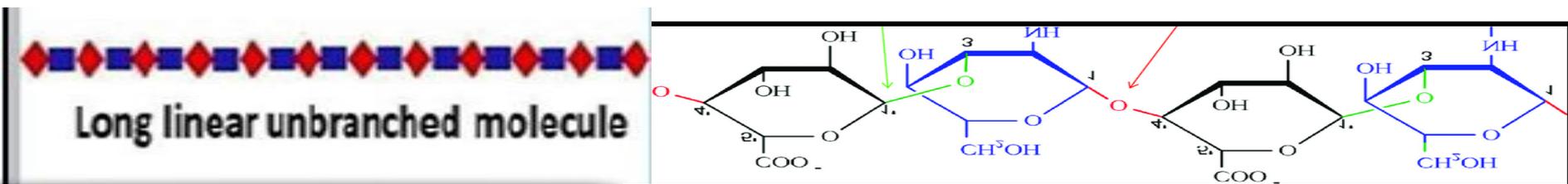
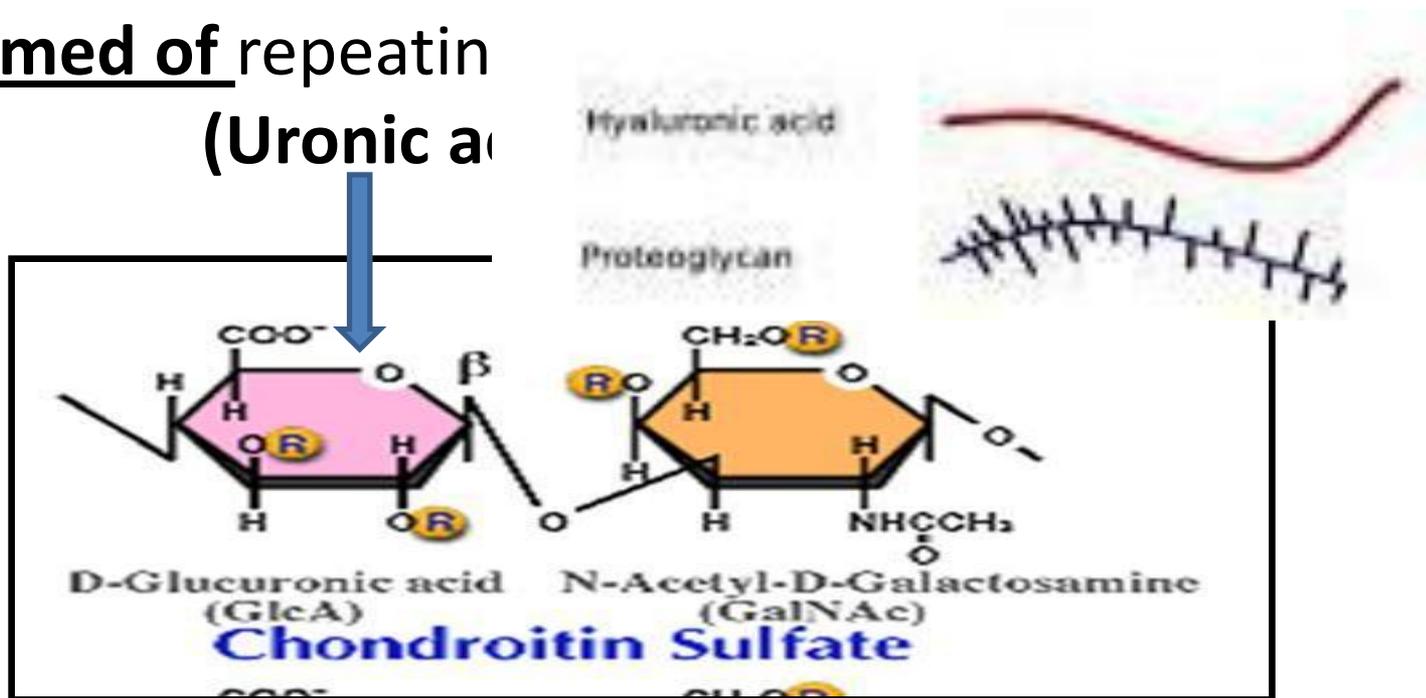
Glycosaminoglycans

Proteoglycans

Glycoproteins

1- Glycosaminoglycans (GAGS)

- Long linear unbranched molecules of polysaccharides.
- Negatively charged – usually *sulfated*
- Formed of repeating (Uronic acid



Types of GAGS

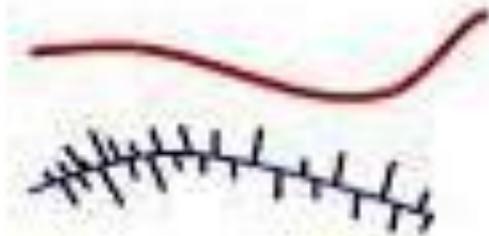
Non sulfated

Hyaluronic acid

Huge macromolecule that
dose not form a bound with
protein molecules

Hyaluronic acid

Proteoglycan

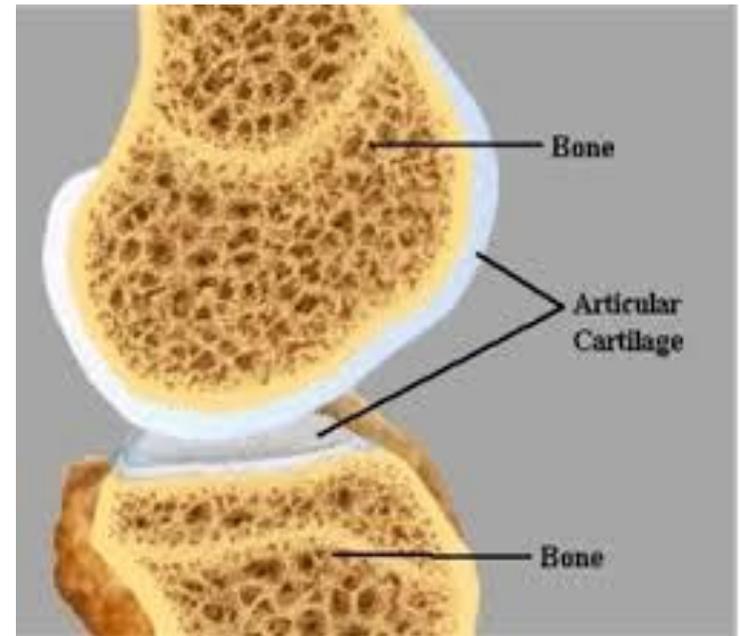


Sulfated

-Chondroitin sulfate
-Dermatan sulphate

Usually link to
proteins molecules to
form **proteoglycans**

Glycosaminoglycans are negatively charged → attract Na^+ → attract H_2O → hydrated matrix → resist compression

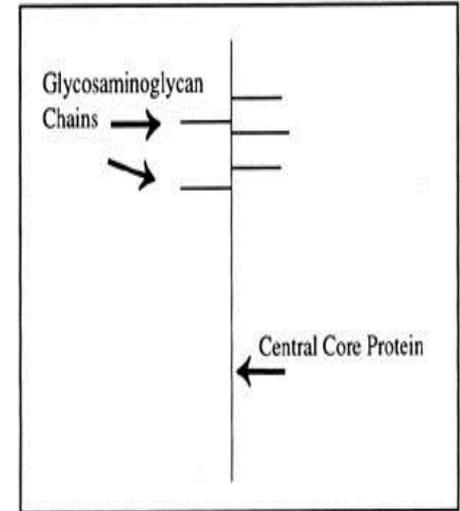


Glycosaminoglycans are negatively charged → repel each other → slippery texture (jelly like)



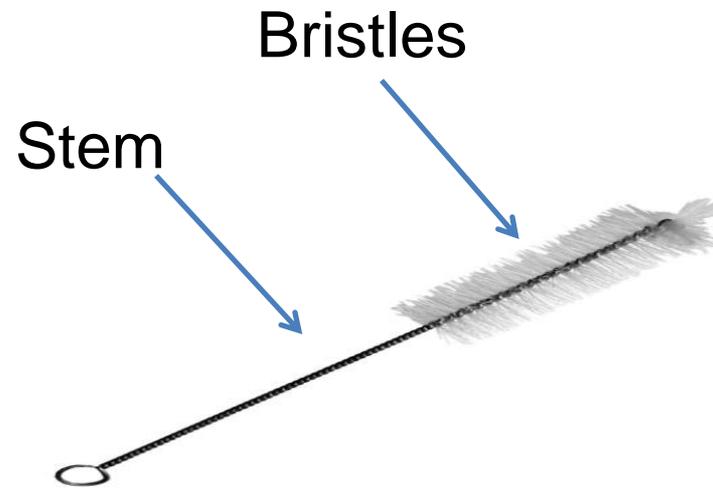
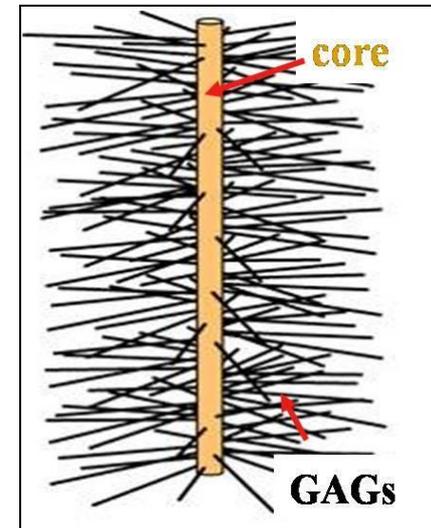
2- Proteoglycans

Sulphated GAGs + Protein core →
proteoglycan



Proteoglycan molecule is similar to test tube brush.

-The wire **stem** represents the **protein core** and the **bristles** represent the **GAGS**

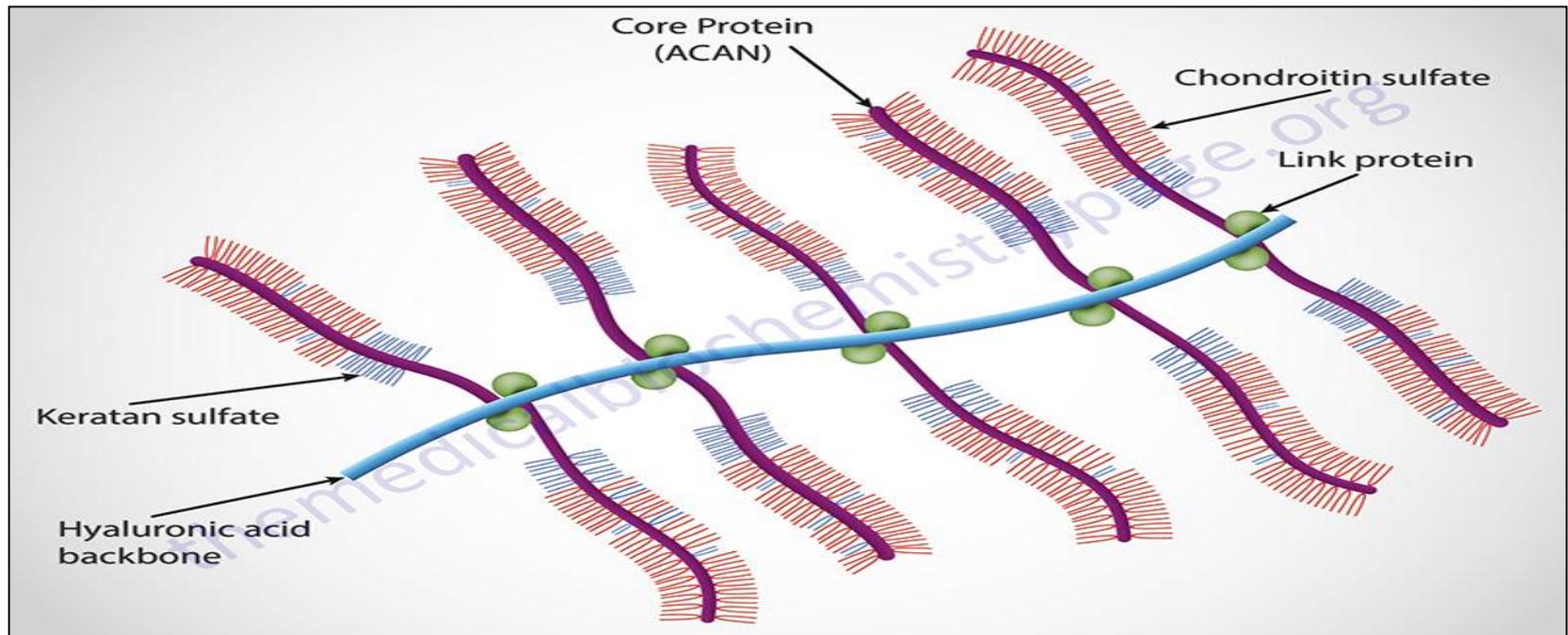


Proteoglycan- hyaluronate complex

When several proteoglycans are bound to hyaluronic acid →

proteoglycan- hyaluronate Complex

(responsible for gel state of ECM)



3- Glycoproteins

Structure: Macromolecules are formed mainly of protein conjugated with branched oligosaccharides (few sugars)

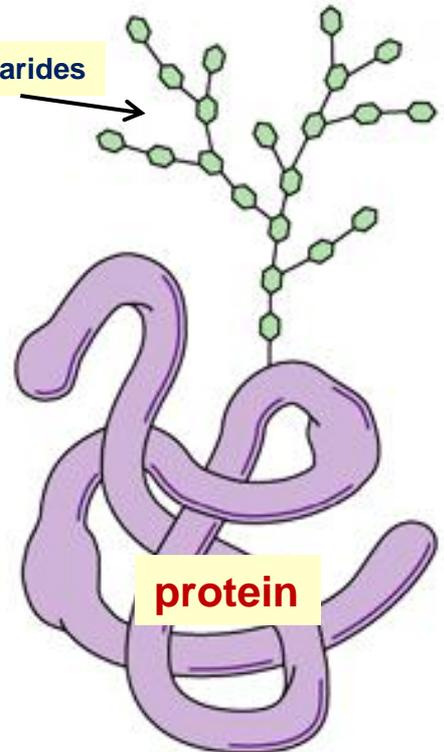
Examples:

1-Fibronectin: present in **CT**.

2- Chondronectin: present in **cartilage**.

3-Laminin: present in **basal laminae**.

oligosaccharides



In contrast to Proteoglycans,

glycoproteins are characterized by:

- The **protein part** predominates.
- The carbohydrates are **branched**.

Proteoglycan (Sulphated GAGs)

Glycoproteins

Carbohydrates moiety predominates

Proteins moiety predominates

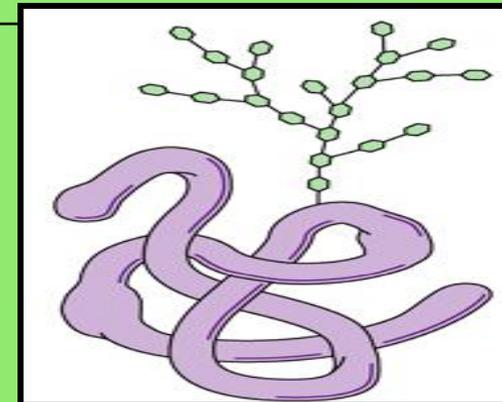
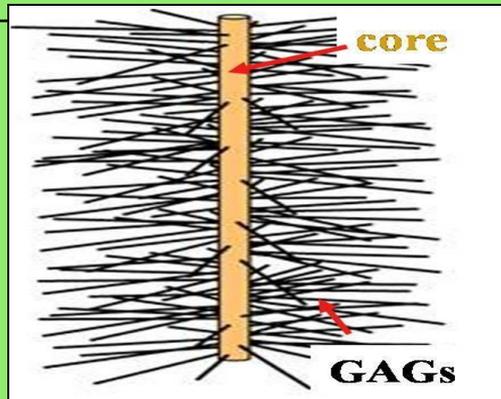
Linear polysaccharides

Branched oligosaccharides

Repeated disaccharides

oligosaccharides

Sulphated



Functions of ground substance

GAGs

Glycoproteins

Supportive

As in cartilage (viscous nature)

Protective

Acts as a barrier against bacterial invasion

Lubricant

As in joint

Transport

Tissue fluid- nutrients to epithelial cells

Bind growth factors

Inhibit or activate them

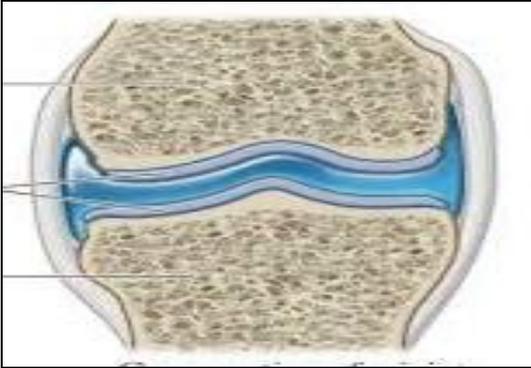
Multi-adhesive

Play role in

-Adhesion of cells to surrounding.

-interaction between neighboring cells.

Functions of ECM



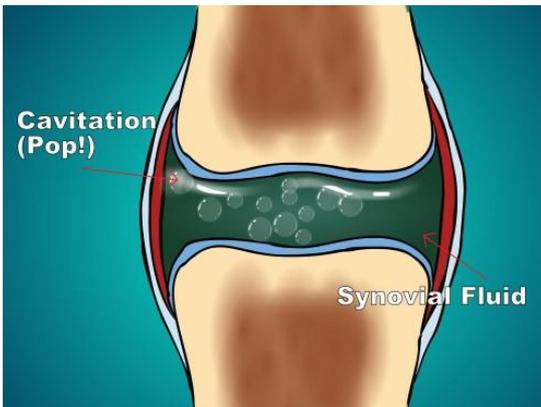
Supportive



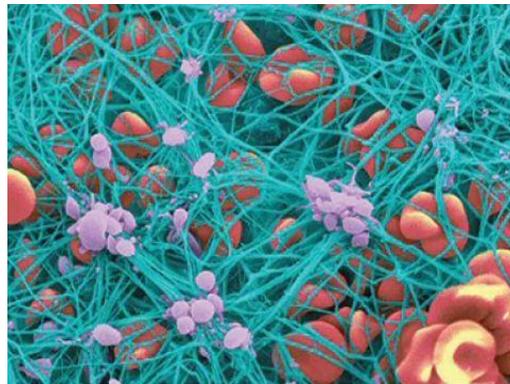
Protective



Bind growth factors



Lubricant

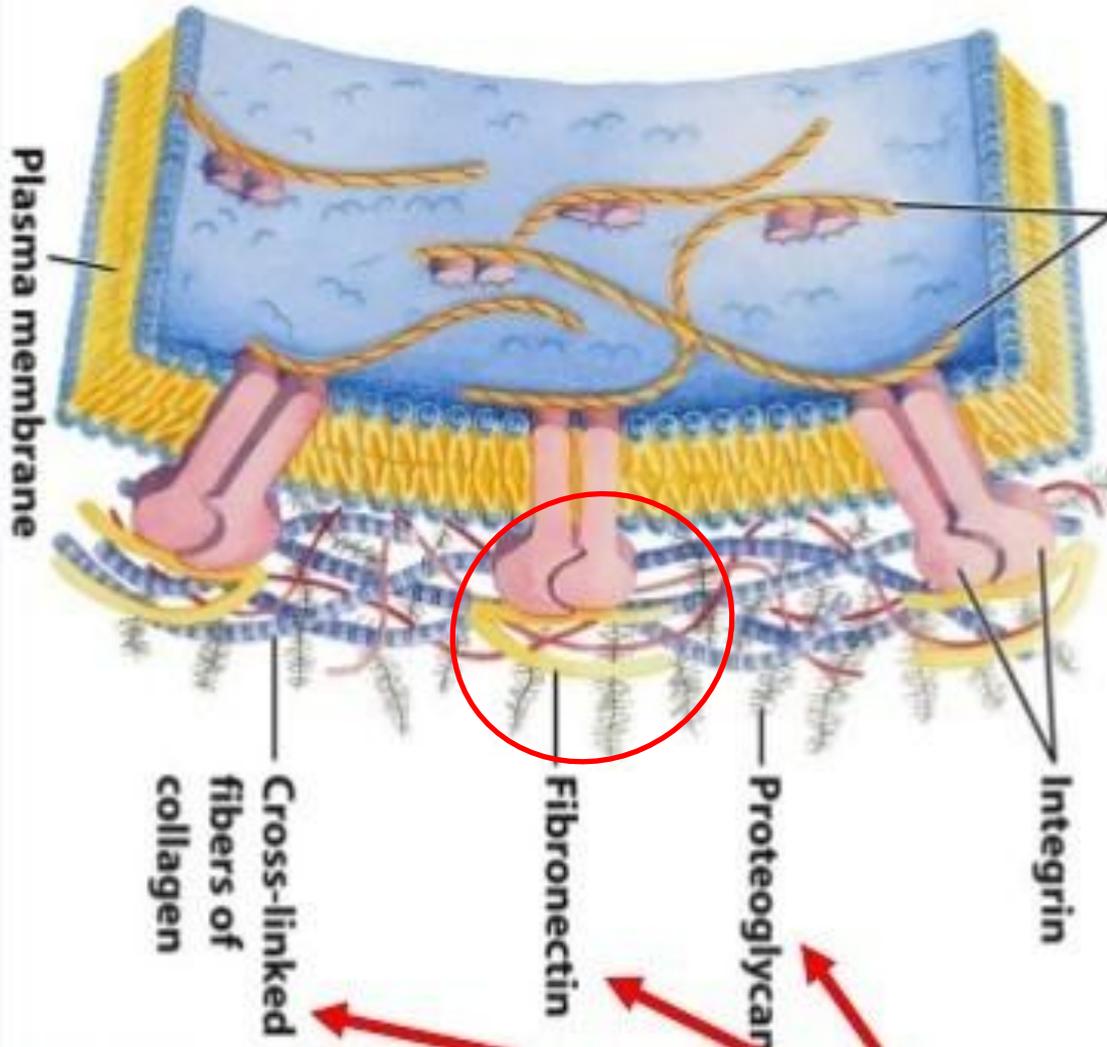


Transport



**Multiadhesive
Glycoproteins**

Multia-dhesive glycoproteins (fibronectin)



glycoproteins

Have *binding sites* for:

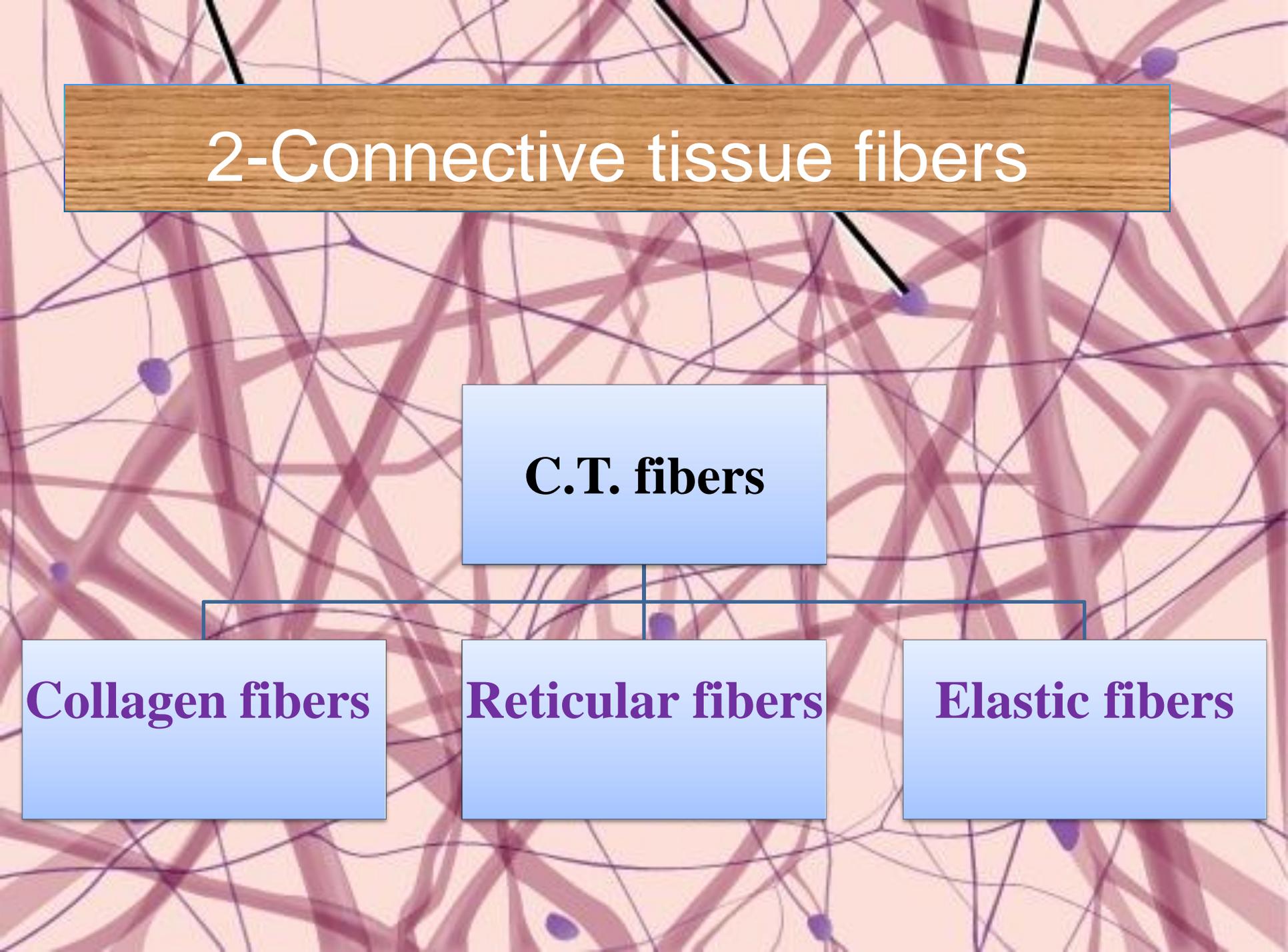
-C.T. Fibers

-GAGS

-Cells transmembrane proteins

so connect the component of GS together.

2-Connective tissue fibers



```
graph TD; A[2-Connective tissue fibers] --> B[C.T. fibers]; B --> C[Collagen fibers]; B --> D[Reticular fibers]; B --> E[Elastic fibers]
```

C.T. fibers

Collagen fibers

Reticular fibers

Elastic fibers

Connective tissue fibers

Character

Structure

Formation

Stain

Sites

Collagen fibers

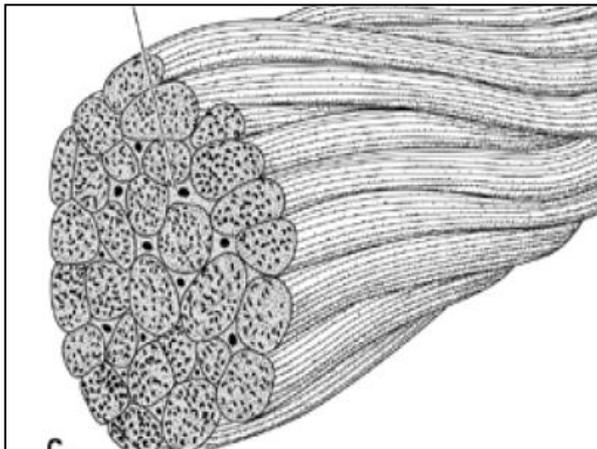
➤ Most numerous fibers of connective tissue

➤ Characters:

-Non-branching **fibers**, Form **wavy** branching **bundles**.

-**Inelastic**, but highly resistant to stretch.

-Individual fiber is colorless, but when fibers present in great amount, they give the tissue a **white color** e .(Tendon)



wavy collagen bundles



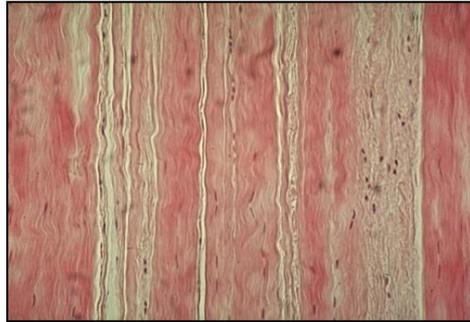
Tendon

➤ Structural protein : collagen.

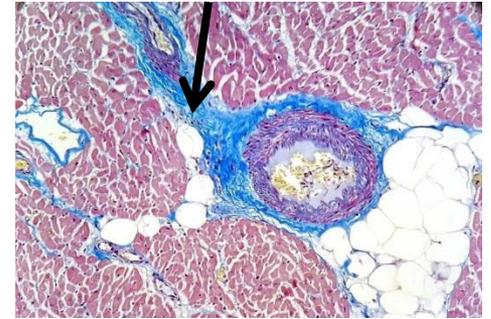
-Most abundant protein in human body representing 30% of its dry weight

➤ Cell secreting fiber: Fibroblast - others

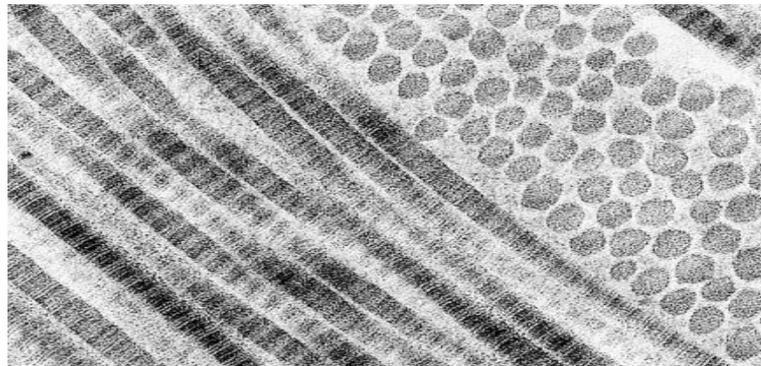
➤ Stain (LM): Eosin: .Red



Mallory: Blue



➤ EM of collagen fibrils: show characteristic banding pattern (cross striations)



Structure of collagen fibers:

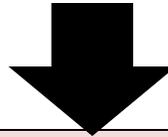
The building units is tropocollagen molecules

Tropocollagen molecules

Each molecule is formed of **three** polypeptide chains (α -chains)

The 3 chains wrapped around each other to form **helix**

Multiple **tropocollagen molecules** assembly to form



Collagen fibrils

Multiple **collagen fibrils** assembly to form

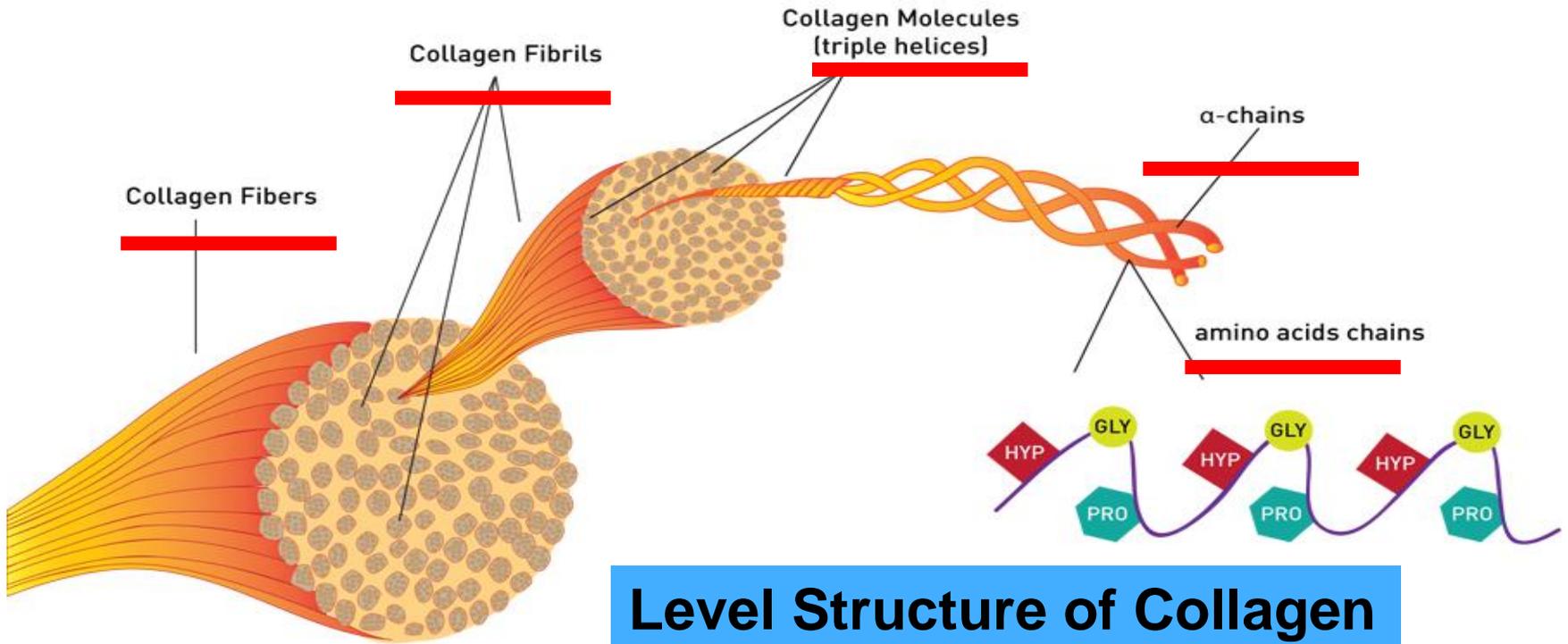


Collagen fibers

Groups of **collagen fibers** assembly to form

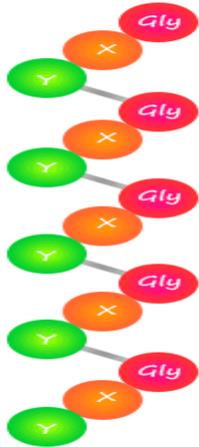


Collagen bundles



Level Structure of Collagen

AMINO ACID TRIPLE HELIX FIBER



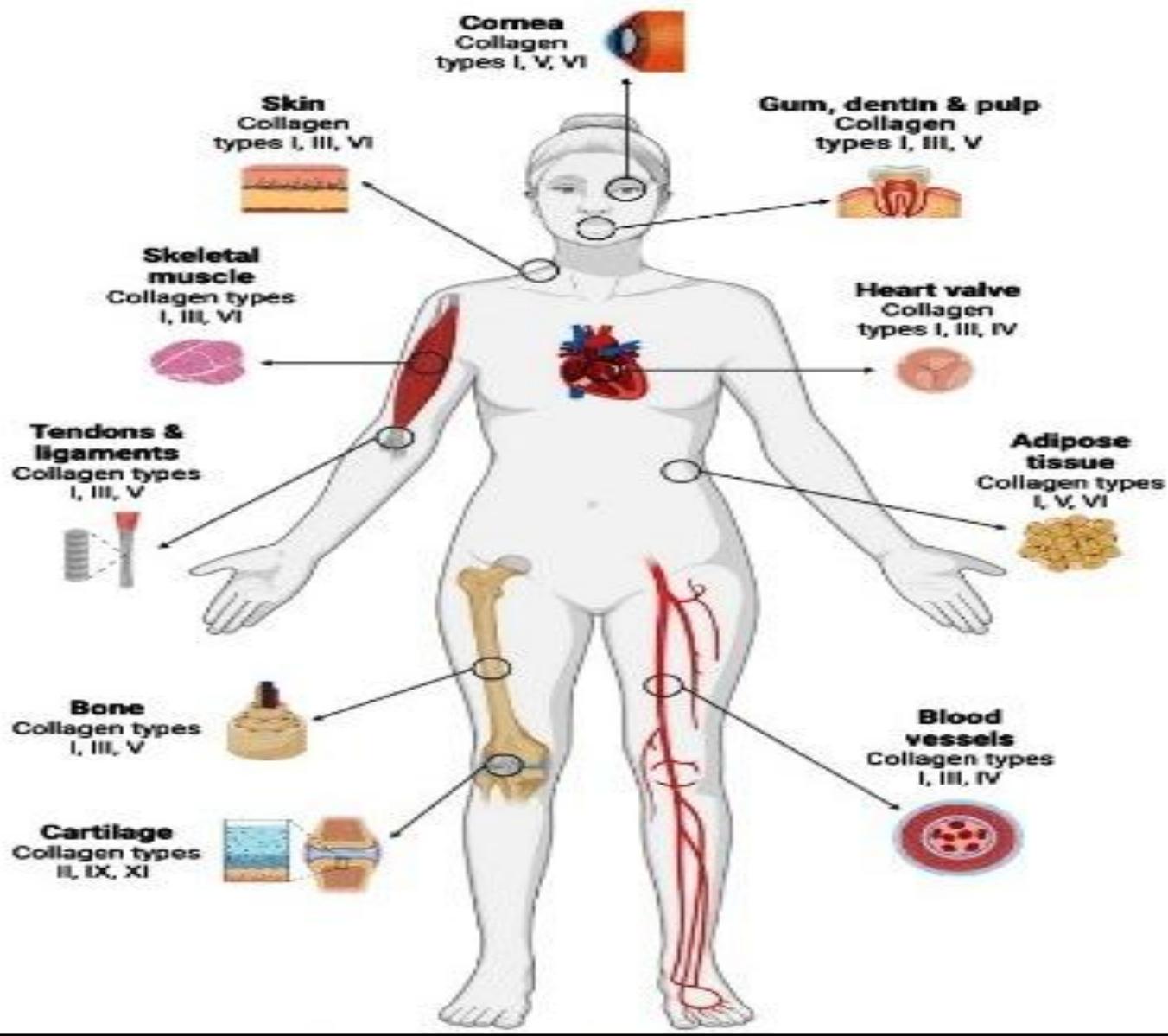
X & Y represent amino acids other than glycine



transverse striations

Structure of Collagen

Collagen type	Tissue distribution	Cells synthesize it	Function
I	<ul style="list-style-type: none"> *CT proper *Bone *Dentin 	<ul style="list-style-type: none"> *Fibroblast *Osteoblast *Odontoblast 	Resists tension
II	*Hyaline, Elastic cartilage	*Chondroblast	Resists pressure
III	<u>Lymph nodes</u> <u>Bone marrow</u> Liver	<ul style="list-style-type: none"> * Reticular cells. * *Hepatocytes. 	Supportive
IV	*Basal lamina	<ul style="list-style-type: none"> *Epithelial cells. *Endothelial cells. 	Acts as a filter



Sites & types of collagen fibers

Elastic fibers

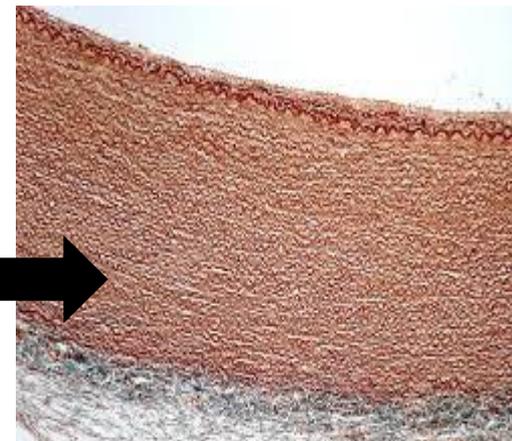
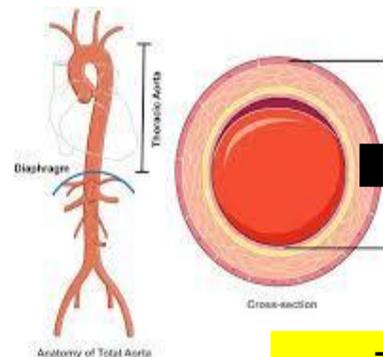
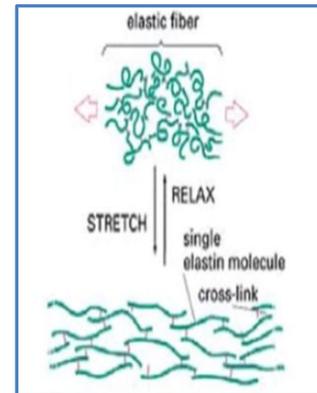
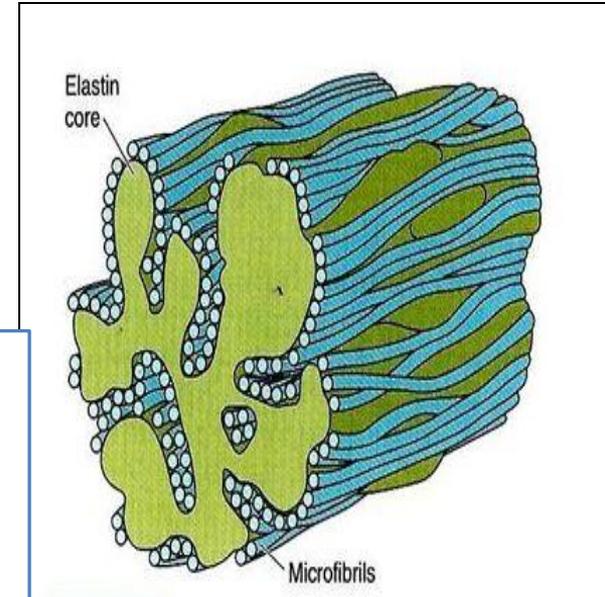
- **Structure:** thin fibers, **Branched.**
- **Form:** Usually present **singly-** **Rubbery.**
 - When present in large amounts, they give the tissue a **yellow color**

- **Formation: 2 proteins**

- Central core of **Elastin** protein.
- Surround by **Fibrillinis proteins** (microfibrils)

- **Stain:** **Brown** with **orcein**

- **Sites:** The wall of aorta



The wall of aorta with orcein

Reticular fibers

➤ Structure & Form:

-Formed of fibrils that **branch and reunite** to form network (**reticulum**)

-*does not* run in bundles.

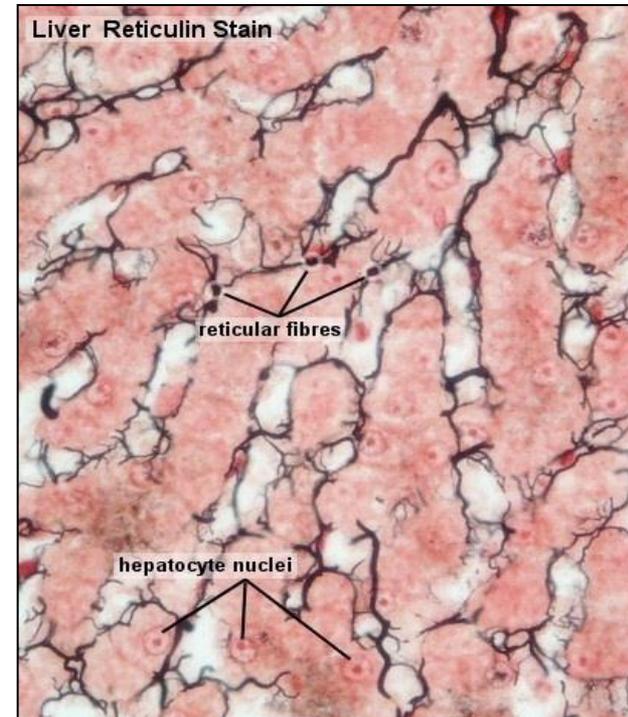
➤ Formation:

-Composed mainly of **collagen Type III**

-High content of CHO.

➤ Stain: black with **sliver**

➤ Sites: Liver - lymph nodes - bone marrow



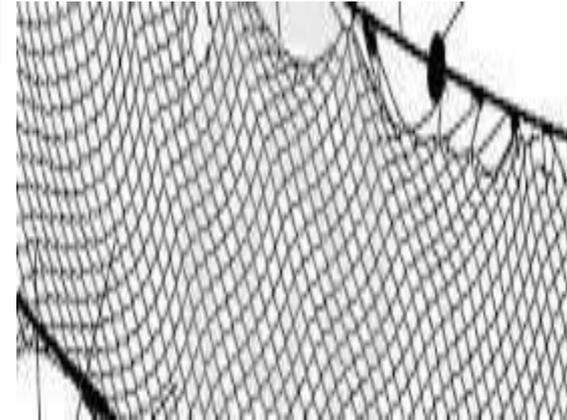
Type of fiber	Collagen fibers	Elastic fibers	Reticular fibers
structure	Fibers	Branched rubbery thin fibers	Fibrils
Form	Bundles	Single	Network
Protein	Collagen	-Elastin -Fibrillinis	Collagen Type III
Stain	-Red with eosin -Blue with Mallory stain	Brown with Orcein	Black with silver



Collagen fibers



Elastic fibers



Reticular fibers

MCQ

Which of the following is TRUE as regards glycoprotein molecules of the connective tissue matrix?

- Contain linear polysaccharides.
- Formed of repeated disaccharide unites.
- Resemble to test tube brush.
- The carbohydrates moiety predominates.
- The protein moiety predominates.

What is the main function of glycoproteins part of the ground substance?

- Multi-adhesive function
- Supportive function
- Protective function
- Digestive function

Which type of collagen fibers is able to resist tension?

- Collagen type I.
- Collagen type II.
- Collagen type III.
- Collagen type IV.
- Collagen type V.

MCQ

Which one of the following types of junction, The tight junction is considered?

Communicating junction.

Impermeable junction.

Gap junction.

Adhering junction.

Which one of the following is a feature of desmosome?

It encircles the cells.

It is band shaped adhesion.

It is a gap junction.

It is a disk-shaped junction.

Formed from claudin and occludin proteins.

All of the following are correct as regards zonulae occludens EXCEPT:

Allow passages of ions between cells.

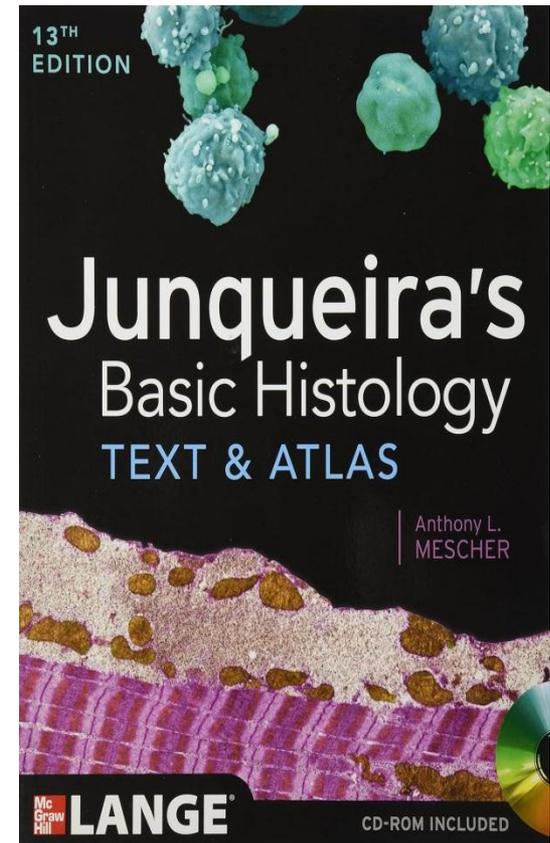
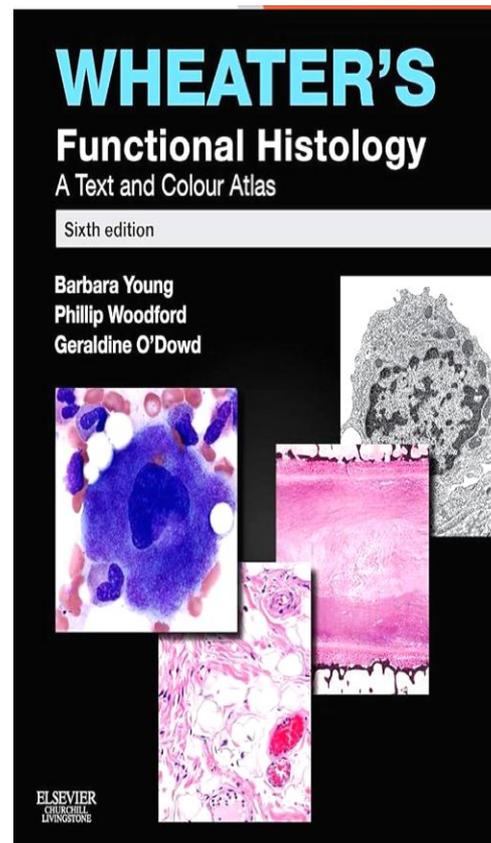
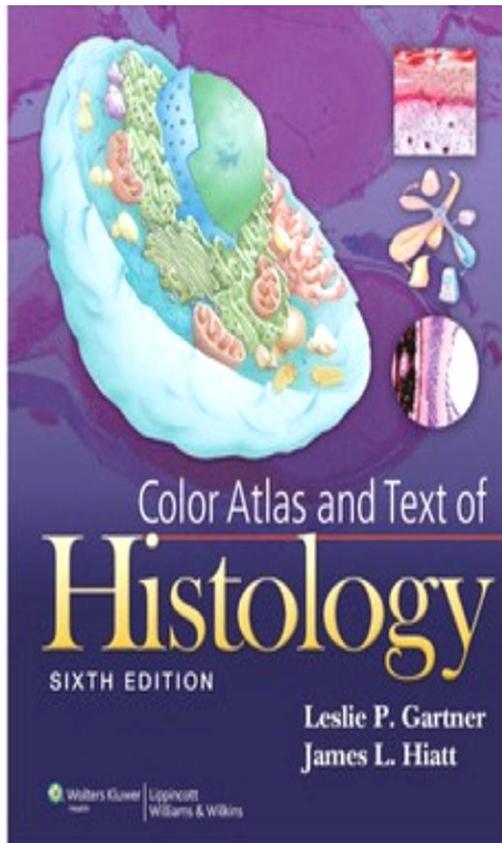
Form a ring around cells.

Present in the absorptive intestinal cells.

Located apically at the lateral surfaces of two adjacent cells.

Formed of five layers at the area of fusion.

References



Thank you

