Ground substance

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Definition

- The **ground substance** of the ECM is a highly hydrated (with much bound water), viscous, transparent, complex mixture of three major kinds of macromolecules, filling the space between cells and fibers in connective tissue.

Composed of:

- Glycosaminoglycans (GAGs)

Glycose: contains sugar.

Aminoglycans: sugar that contains amine

- Proteoglycans: Responsible for the gel state of the extracellular matrix.

Major component: glycan …Minor component: proteo

Responsible for gel state of the ECM because of its ability to hold water.

- Adhesive glycoproteins

Major component:proteins

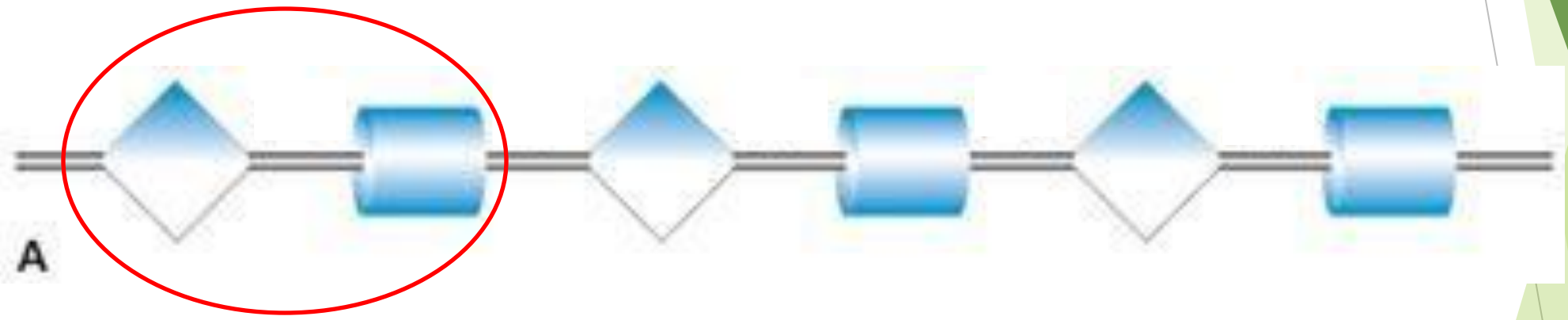
Minor component:sugar

Role: (anchor or adhere the cells to other compnents of the ECM)

GAGs

- Also called mucopolysaccharides (MPS), contain mucoid, they are highly hydrated
- Long polymers of repeating disaccharide units, usually a hexosamine and uronic acid.
- The hexosamine (سداسي) can be glucosamine or galactosamine, and the uronic acid can be glucuronate or iduronate.

  Eg: You can find glucosamine with iduronate or glucosamine with glucuronate; this creates multiple subtypes of the GAGs. This is what we see in tissues. They are usually sulfated.
- They have a high negative charge
- GAGs have an extended conformation
- They have space-filling, cushioning, and lubricant functions.



These two are a disaccharide

Major GAG in our body. (HA)
You will find it in areas that need resistance to compression because water acts as a shock absorbant(cushioning).

Chondro: found in cartilage

Present in intervertebral disc

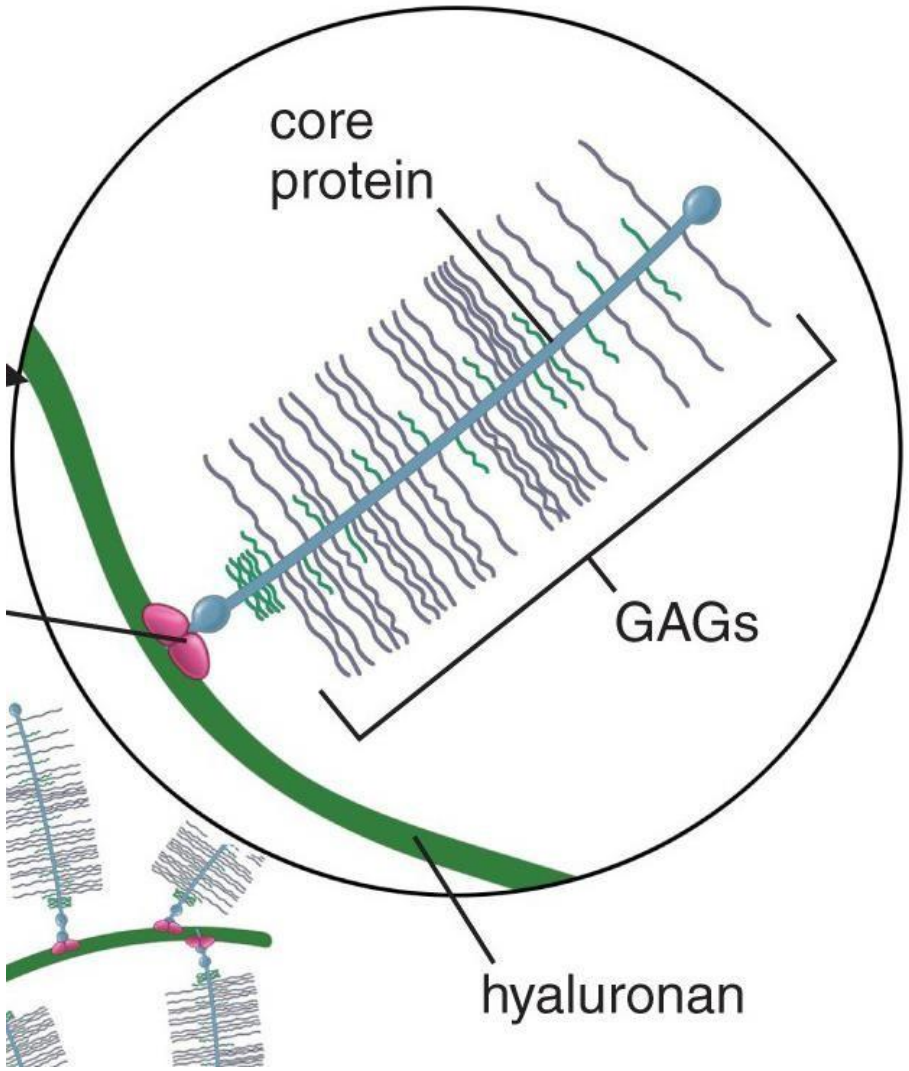
Glycosaminoglycan	Distribution
Hyaluronic acid	Umbilical cord, synovial fluid, vitreous humor, cartilage
Chondroitin 4-sulfate	Cartilage, bone, cornea, skin, notochord, aorta
Chondroitin 6-sulfate	Cartilage, umbilical cord, skin, aorta (media)
Dermatan sulfate	Skin, tendon, aorta (adventitia)
Heparan sulfate	Aorta, lung, liver, basal laminae
Keratan sulfate	Cartilage, nucleus pulposus, annulus fibrosus

(lubrication)

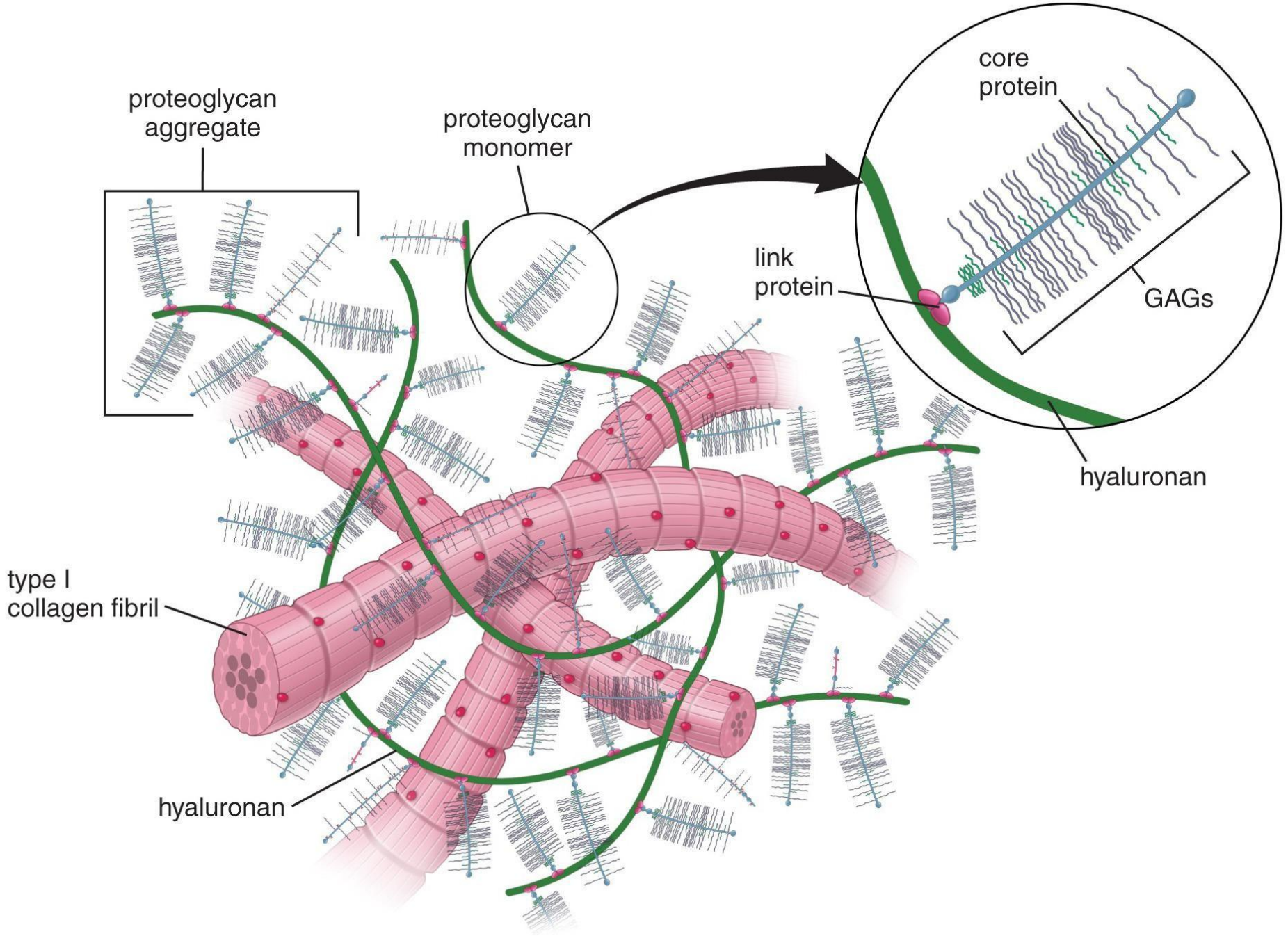
Proteoglycans

- **Proteoglycans** consist of a core protein to which are covalently attached various numbers and combinations of the sulfated GAGs.
- Like glycoproteins, they are synthesized on RER, mature in the Golgi apparatus, where the GAG side-chains are added, and secreted from cells by exocytosis.
- Unlike glycoproteins, proteoglycans have attached GAGs which often comprise a greater mass than the polypeptide core.

1-secretory protein made in RER.
2-modified in Golgi by attachment of GAGs by covalent bonding.
3-Exocytosis.



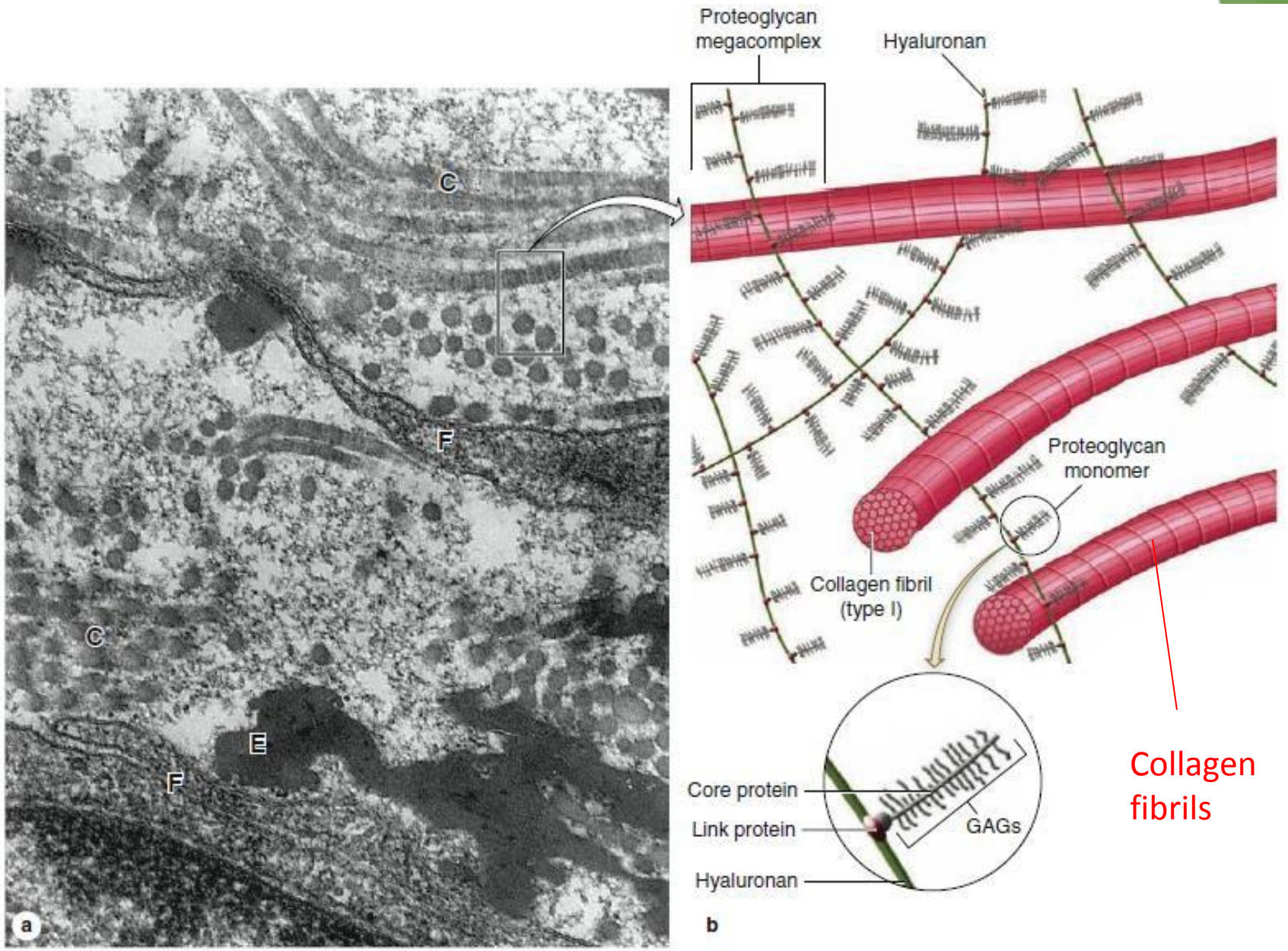
- After secretion proteoglycans become bound to the hyaluronan by link proteins and their GAG side-chains associate further with collagen fibers and other ECM components



Hyaluronan

- The largest and most ubiquitous GAG is **hyaluronan** (also called hyaluronate or hyaluronic acid) (present in fillers)
- Hyaluronan forms a viscous, pericellular (surrounding the cells) network which binds a considerable amount of water
- It has an important role in allowing molecular diffusion through connective tissue and in lubricating various organs and joints.

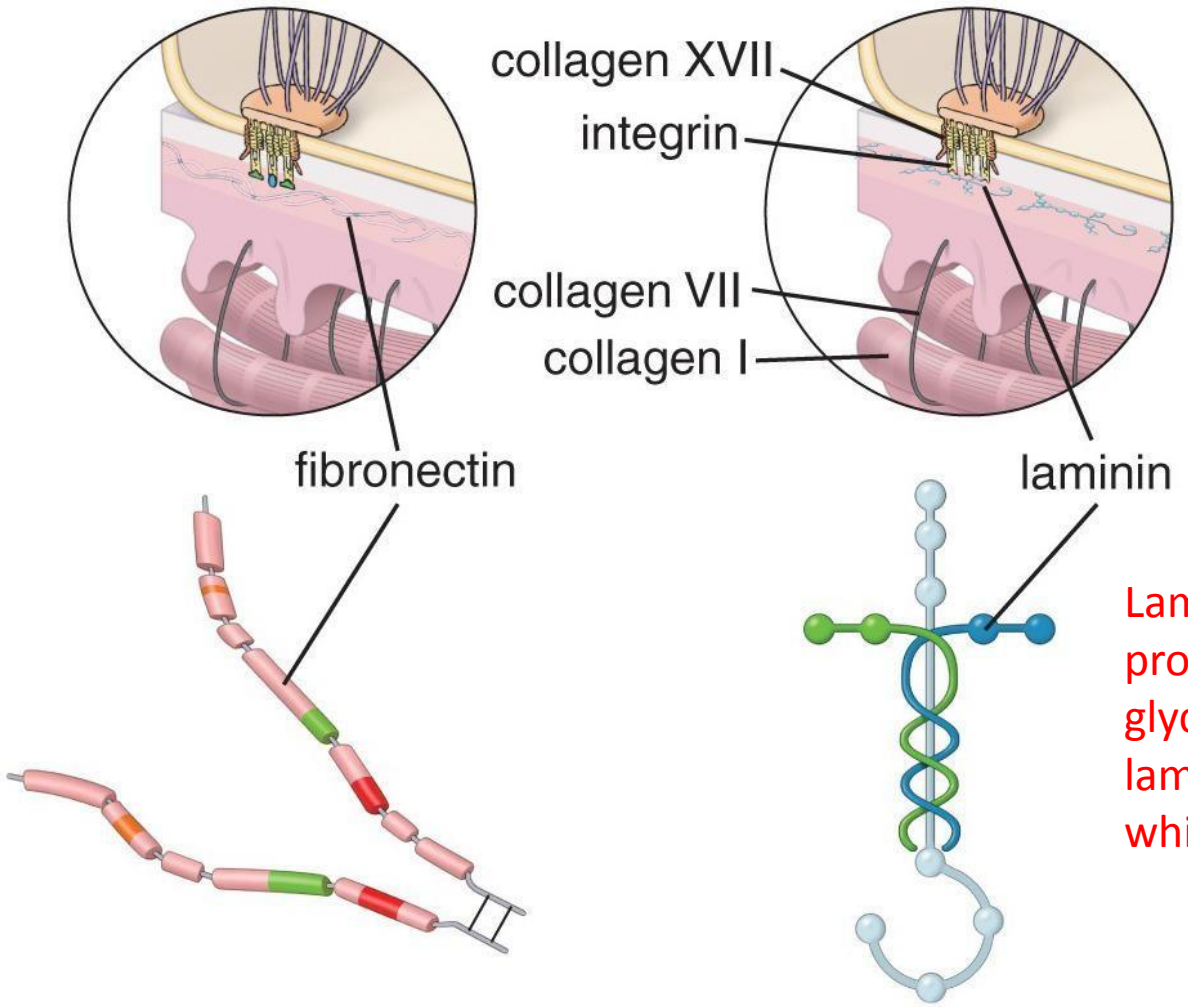
Amorphous)no specific shape) material filling the spaces between the fibrils and the cells: **ground substance**



Collagen fibrils

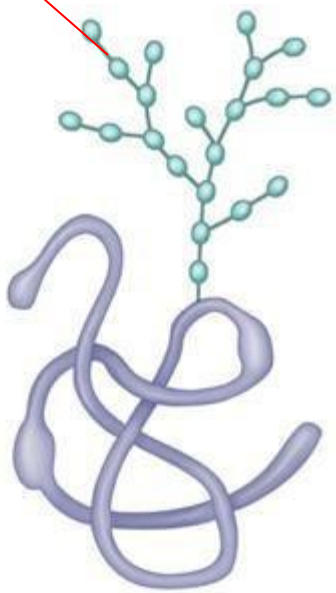
Adhesive Glycoproteins

- The adhesive glycoproteins are large molecules with branched oligosaccharide chains and allow adhesion of cells to their substrate
- They have multiple binding sites for cell surface integrins and for other matrix macromolecules..
- Examples: Laminin (connects between epithelium and basal lamina), chondronectin (cartilage), osteonectin (bone) and fibronectin (you can also find it in connective tissue).



Laminin is an anchoring or linking protein. It's a type of adhesive glycoproteins, is a part of the basal lamina and interacts with integrin which is a transmembrane protein.

Oligosaccharide
which is branched

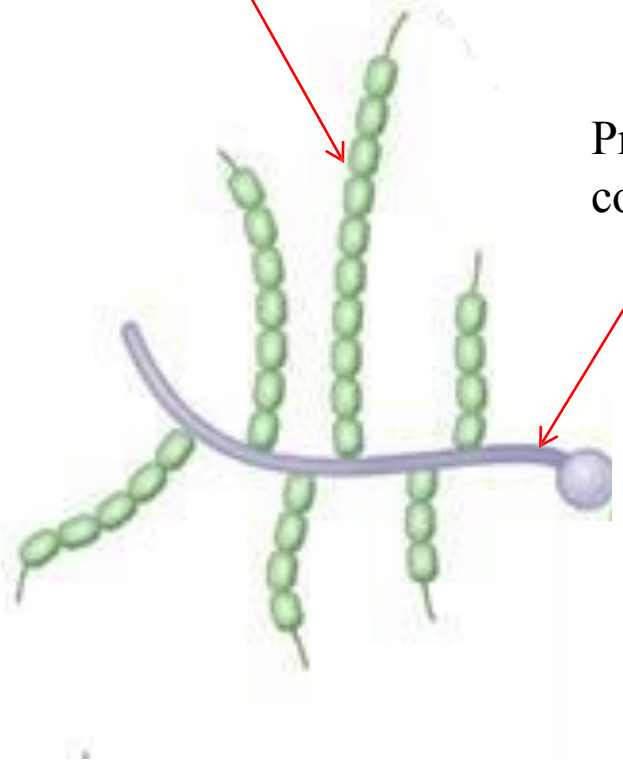


Glycoprotein

GAG (Unbranched)

Protein
core

(Polypeptide)



Proteoglycan

Classification of Connective Tissue

- **Connective tissue proper**:
  - Loose (areolar) less fibres, more ground substance, found in: umbilical cord, mesenchymal connective tissue, lamina propria, superficial dermis
  - Dense: lots of fibres
    - Dense irregular Eg: joint of the capsule, deep dermis (applied force from all directions,movement in all directions is allowed)
    - Dense regular Eg: tendon and ligament. (In order for fibres to resist tension, their direction should be in the direction of the force applied.)(one direction of movement)
- **Special connective tissue**:
  - Reticular (collagen type III)
  - Elastic
  - Adipose (main cells are adipocytes)
  - Bone (Extracelluar environment is calcified)
  - Cartilage (not hardened as much as bone is)
  - Blood (Extracelluar environment is liquid)
- **Embryonic connective tissue**
  - Mesenchymal (mucoid) connective tissue

Q71) Which of the following can be classified as a specialized connective

a. Mesenchyme

b. Mucous connective tissue

c. Dense connective tissue

d. Blood

e. Loose connective tissue

Answer: d

Q100) Sulfated GAGs are important constituents of what extracellular structures:

A. Hyaluronan

B. Elastic fibers

C. Type I collagen

D. Proteoglycans

E. Multiadhesive glycoproteins

Answer:D

Q73) Which of the following can be classified as embryonic connective tissue?

a. Cartilage

b. Mucous connective tissue

d. Adipose tissue

d. Bone

e. Blood

Answer: b

Q92) The structure that is responsible for the gel state of ECM is:

A)GAGs

B)Proteoglycan

C)glycoprotiens

D)Fibers

E)A and B

Answer is: B

Q91) Ground substance is:

A)Tranparent structure

B)Highly hydrated structure

C)Viscous Structure

D)Complex mixture of 3 kinds of macromolecules

E)All of the above are correct

Answer is: E

Q79) Which of the following is a component of the ground substance?

a. Hyaluronic acid

b. Proteoglycans

c. Glycosaminoglycans

d. Chondroitin sulfate

e. All of the above

Answer:e

Q77) Which of the following can be classified as connective tissue proper?

a. Adipose tissue

b. Dense irregular connective tissue

c. Bone

d. Blood

e. Cartilage

Answer:b

Q95) Laminin and Fibronectin are examples of:

A)GAGs

B)Glycoprotiens

C)Proteoglycan

D)A and B are correct

E)None of the above

Answer is:B