Histology

Modified n. n.11

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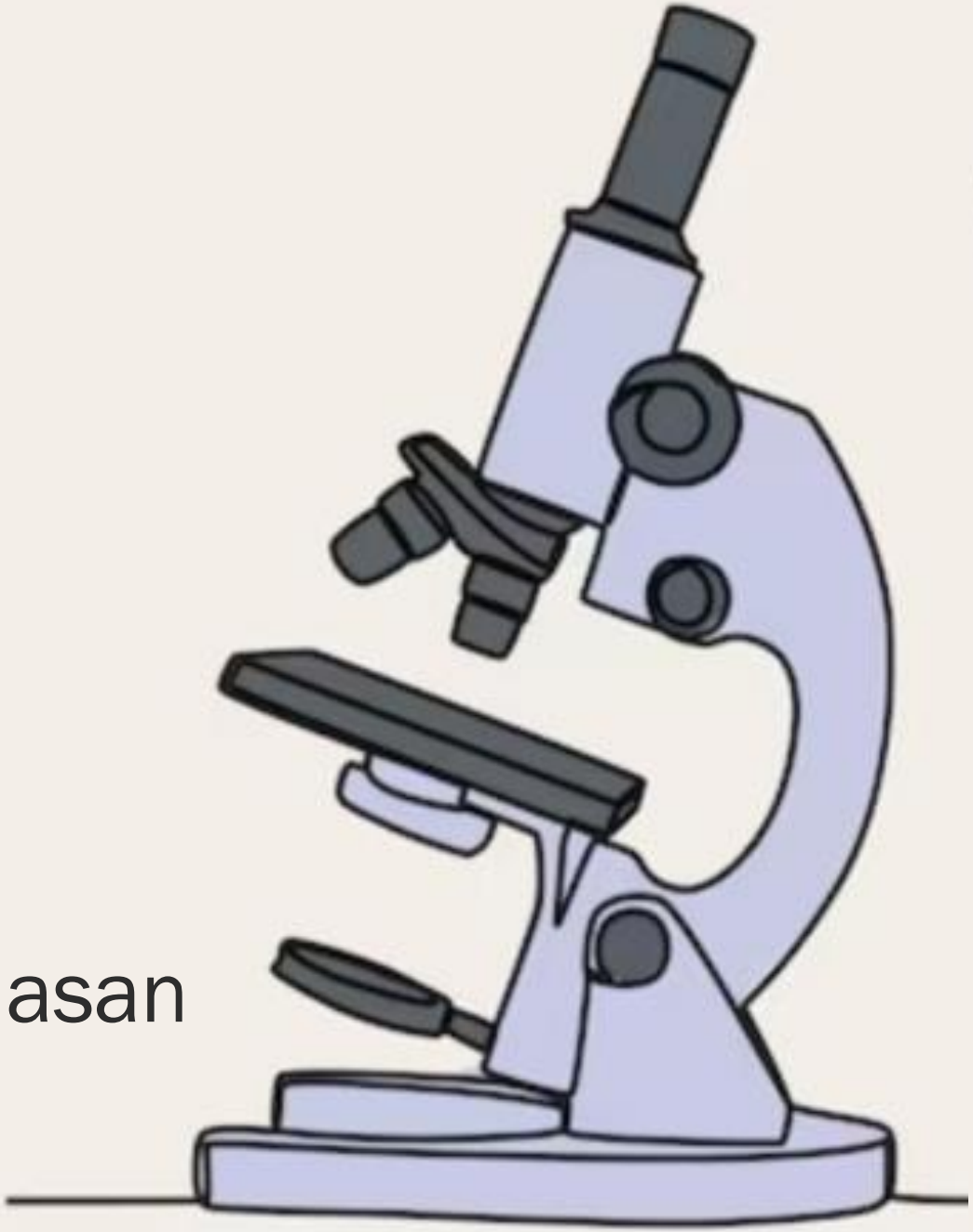


Connective tissue Fibers/Collagen

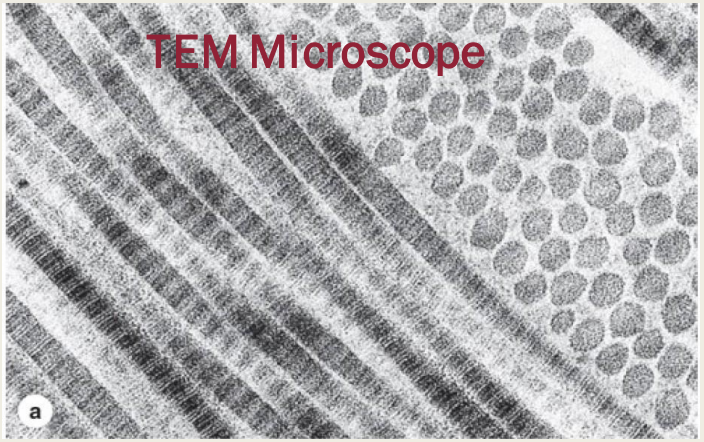
- Form various extracellular fibers, sheets, and networks.
- Extremely strong and resistant to normal shearing and tearing forces. Which make it a great candidate for structure like ligaments which hold bones together
- Collagen is a key element of all connective tissues, as well as epithelial basement membranes and the external laminae of muscle and nerve cells.
- Most abundant protein in the human body, representing 30% of its dry weight.
- A family of 28 collagens exists in vertebrates.
- offers different functions and features and each is special on its own

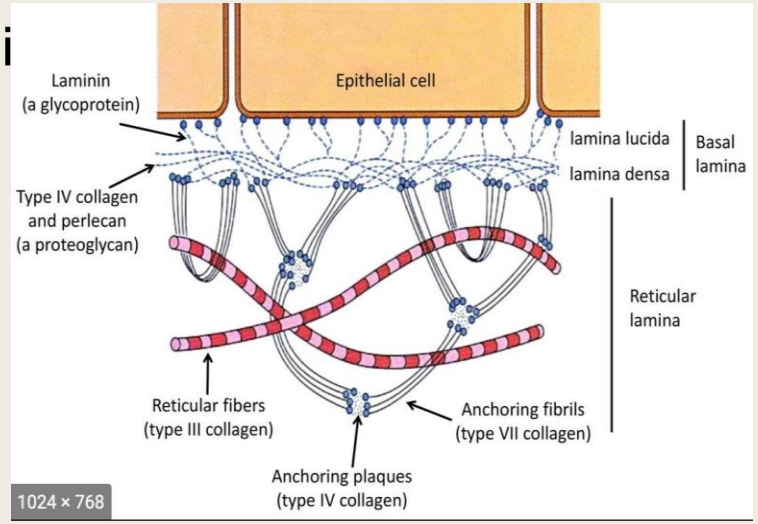
Collagen types

28 types are classified into 3 types

- **Fibrillar collagens**, notably collagen types I, II, and III. Form structures such as tendons, organ capsules, and dermis . extremely strong in structural tendons and capsules where protection and resistance is offered
- **Network or sheet-forming collagens** such as type IV collagen have subunits produced by epithelial cells and are major structural of external laminae and all epithelial basal laminae. In the basal lamina support epithelium
- **Linking/anchoring** collagens are short. Smaller can link different protei type 7 and 9

Shows cross section and longitudinally image of fibers
Dark and light regions
Striations in collagen fibers



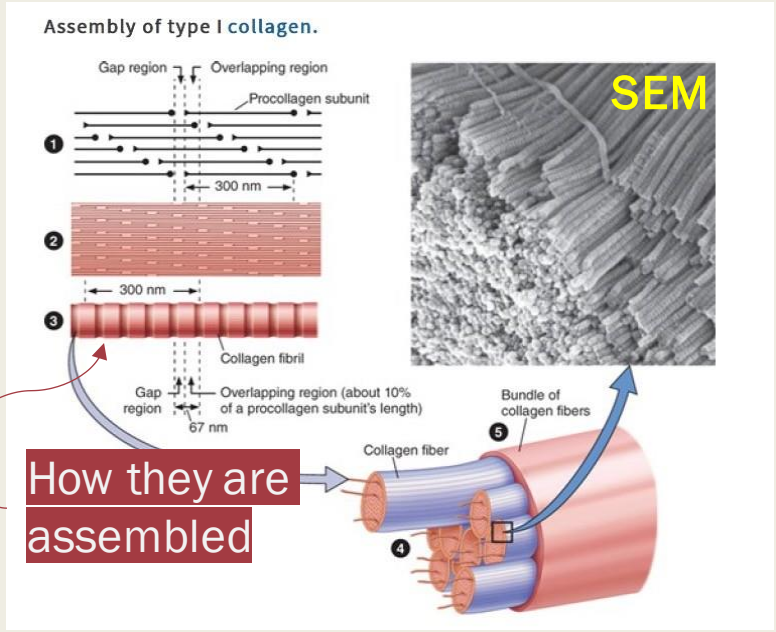


Collagen Assembly

1.Rodlike triple-helix collagen molecules, each 300-nm long, self-assemble in a highly organized, lengthwise arrangement of overlapping regions. procollagen are tiny subunits and self assemble to longer structures called collagen fibrils and there is a smaller gap between them

2.The regular, overlapping arrangement of subunits continues as large collagen fibrils are assembled. lighter region is due to overlapping and can only be seen through an electron microscope

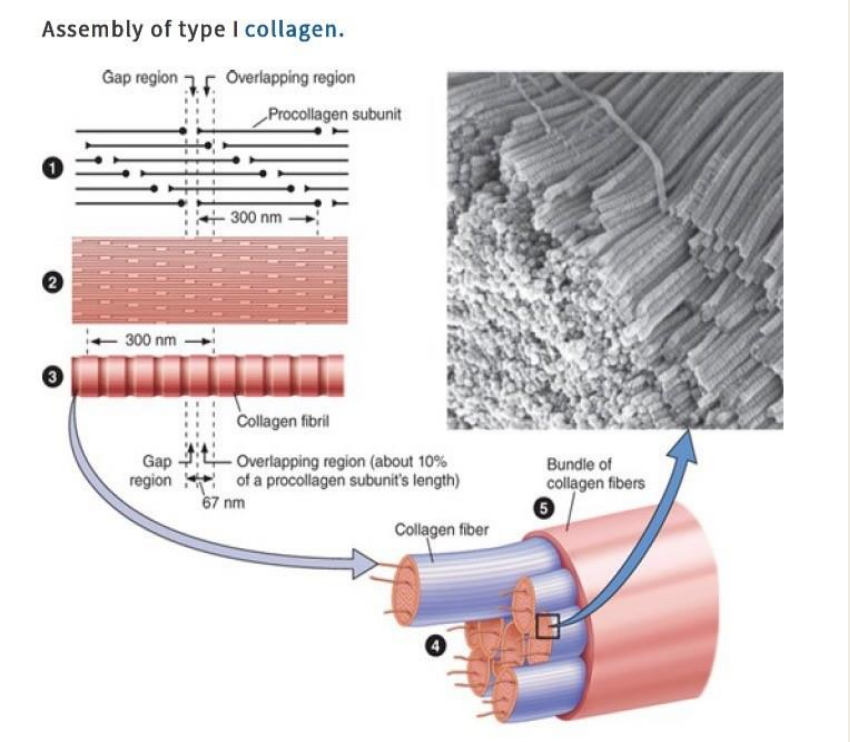
3.Further assembly to larger structure fibers→ further assembled to mega structure called collagen bundles from fibers (can be seen in tendons and dermis)



Collagen type I from tiny units → bundles present in tendons capsules and dermis that support the epidermis

Collagen Assembly

1. Units fibrils fibers bundles
2. Can't be visualized through light microscope
3. This structure causes fibrils to have characteristic cross striations with alternating dark and light bands when observed in the EM.
4. Fibrils assemble further and are linked together in larger collagen fibers visible by light microscopy.
5. Type I fibers often form into still larger aggregates bundled and linked together by other collagens.



Connective tissue Fibers/Reticular Collagen type 3

- Found in delicate(organs)→(endocrine glands ,bone marrow and liver) connective tissue of many organs, notably in the immune system. best location to study it→ liver--3D structure that can protect and house the liver cells→ which are called Hepatocytes
- Consist mainly of collagen type Ⅲ, which forms an extensive network.
- Seldom visible in hematoxylin and eosin (H&E) but are stained black after impregnation with **silver** salts.
- Periodic Acid–Schiff (PAS) positive-----due to the high content of sugar chains.
- Reticular fibers contain up to 10% carbohydrate as opposed to 1% in most other collagen fibers.
- Surround adipocytes, smooth muscle and nerve fibers, and small blood vessels.
- Serve as the supportive stroma for the parenchymal secretory cells, liver and endocrine glands.
- Stroma of hemopoietic tissue (bone marrow), the spleen, and lymph nodes
- 1&2 can be stained with H&E and trichrome easily
- 3→Can't be visualized with H&E → must use silver salts →darkish fine lines under LM .PAS can be used because these fibers are rich with sugars→10% of their structure unlike other collagen types

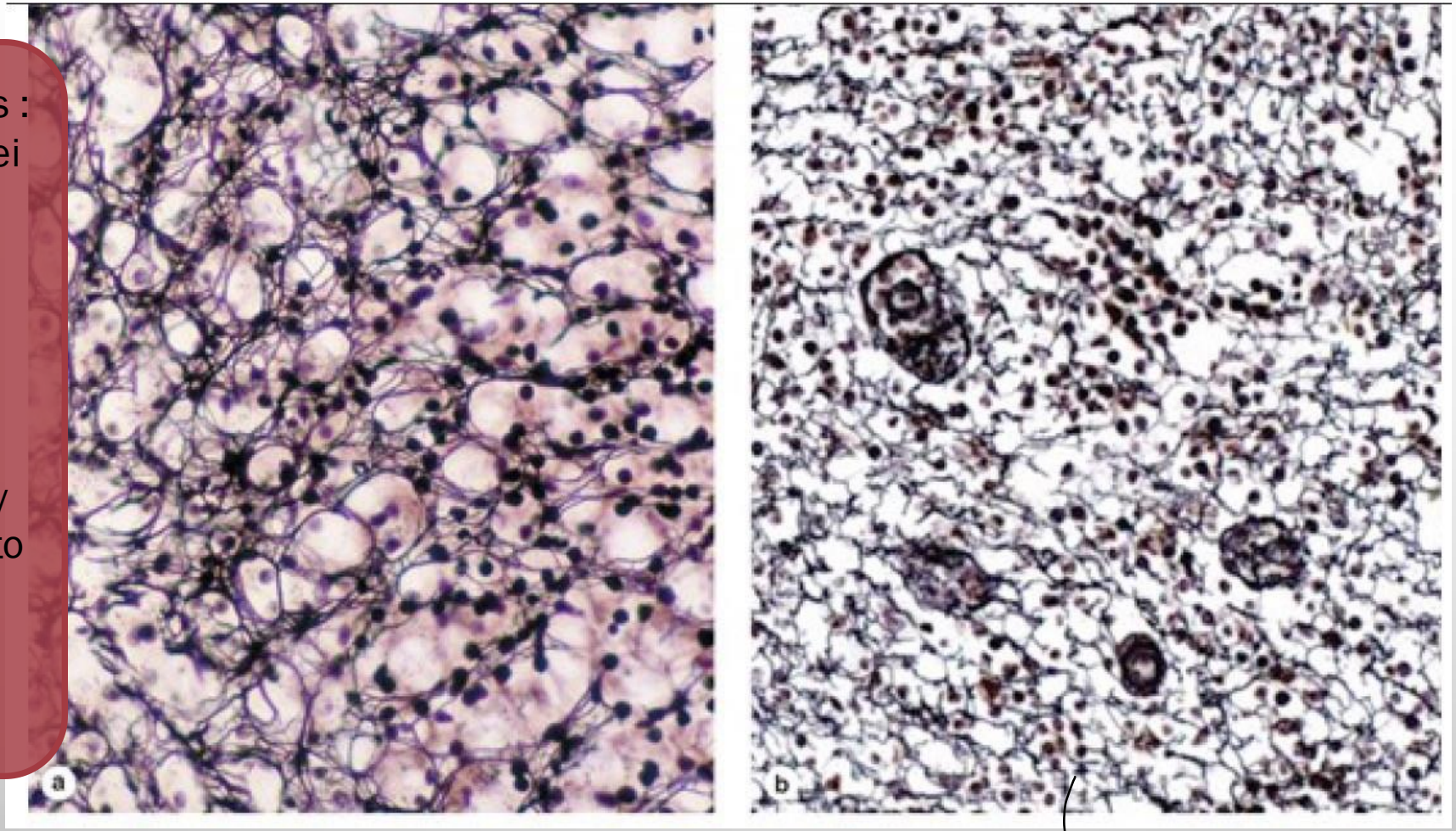
Reticular Fibers

Lymph nodes rich with reticular fibers – silver stain

Silver salt stains :
-Dark dots nuclei

-Fine blackish irregular structures → reticular fibers

-They create tiny compartments to support the interior delicate cells

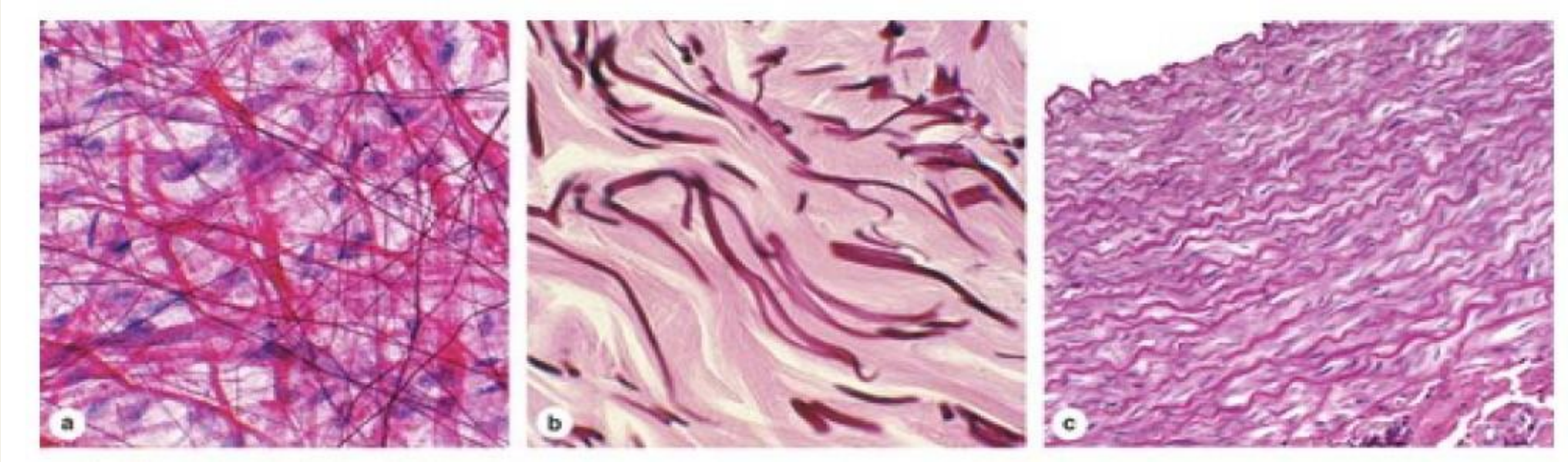


More magnified

Connective tissue Fibers/Elastic

- Thinner than the type I collagen fibers and form sparse networks interspersed with collagen bundles in many organs (subject to regular stretching or bending).
- Have rubberlike properties that allow tissue containing to be stretched or distended (lungs).
- In the wall of large blood vessels→ rely on them enable them to stretch to accommodate incoming blood from heart, especially arteries, elastin also occurs as fenestrated sheets called elastic lamellae.
- Elastic fibers and lamellae are not strongly acidophilic and stain poorly with H&E.
- Stained more darkly than collagen with other stains such as orcein and aldehyde fuchsin. will give a maroon red color
- Dermis → second layer →skin undergoes a lot of stretching and pulling forces → present of elastic fibers is important and it's rich with collagen and elastic fibers
- Stain poorly with H&E unless there is a good amount of them.
- Unique → we can stretch them to a specific limit and they recall back to normal length and shape →recoil
- Seen in structures where stretching is needed such as lungs that increase their volume with inhaling

Connective tissue Fibers/Elastic



A- Hematoxylin and orcein).

B-Aldehyde fuchsin).

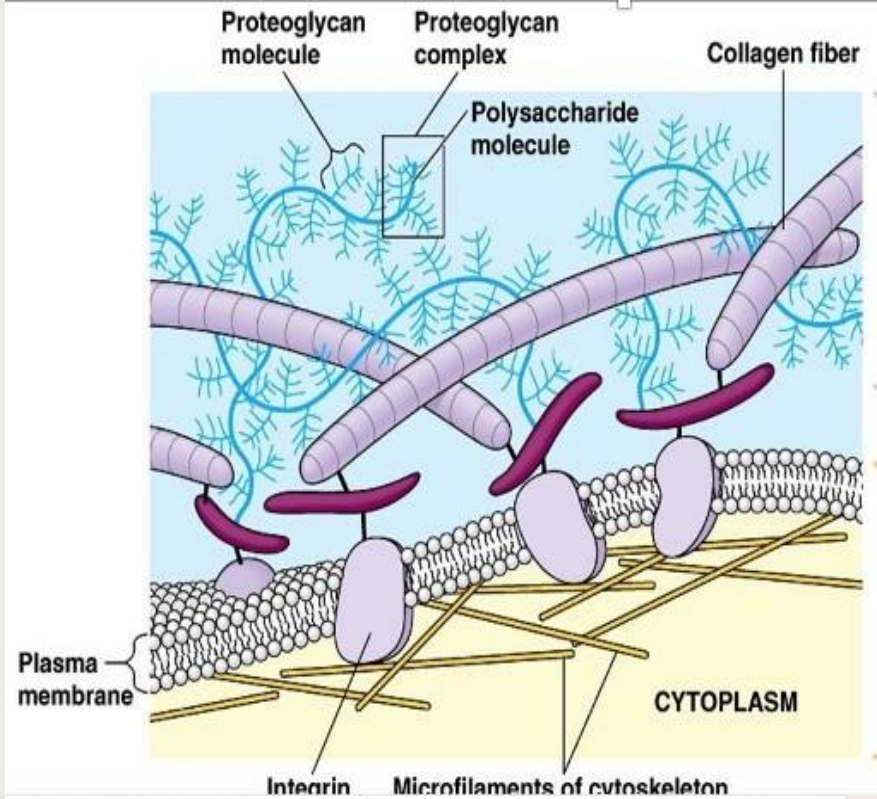
Can identify elastic fibers

C- H&E

Part of the wall
Wavy dark pinkish structures → elastic lamina
Luckly good amount stacked together they show more color in contrast of collagen and smooth muscles

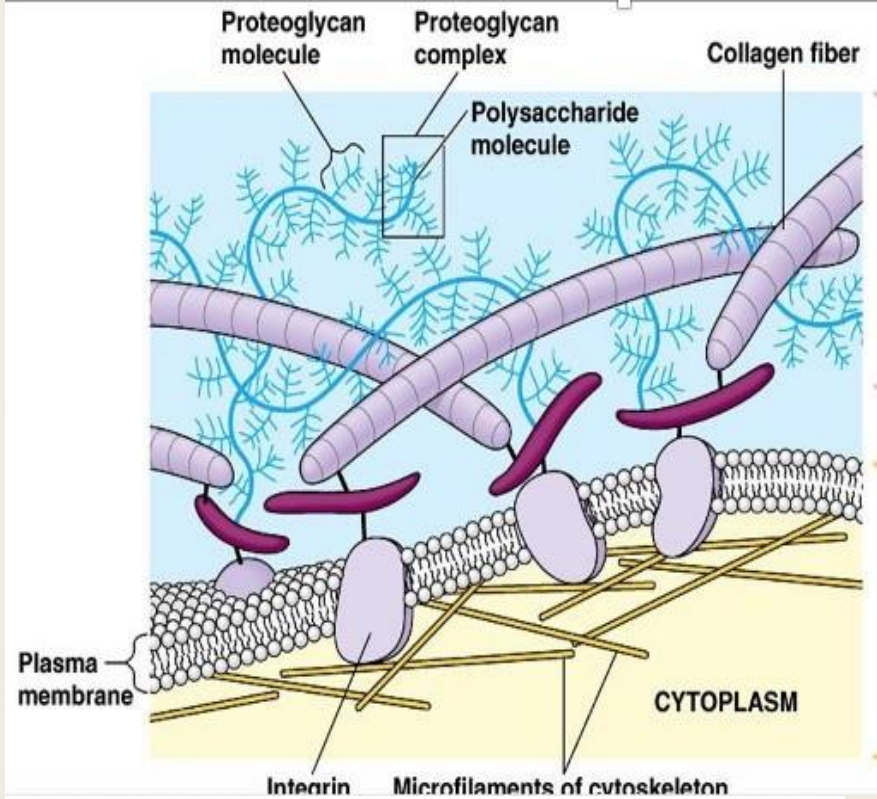
Ground Substance

- A semi- fluid gel (highly hydrated) and transparent material
- The ground substance of the ECM is a highly hydrated (with much bound water), transparent, complex mixture of three major kinds of macromolecules: glycosaminoglycans (GAGs), proteoglycans, and multiadhesive glycoproteins.
- Filling the space between cells and fibers in connective tissue.
- Allows diffusion of small molecules.
- Because it is viscous---lubricant and a barrier to the penetration of invaders.



Ground Substance

Filling between fibers and cells →a specific composition depending on type of connective tissue
Semi fluid→ high hydration → rich with sulfate in some locations and negative charge carried on their molecules
lubrication in specific location such as umbilical cord → provide protection to blood vessels and allow diffusion → vascularization → facilitate diffusion of nutrients
Viscous → movement of microorganisms → Halts their ability to do more destruction



GAGs

- GAGs (mucopolysaccharides) are long polymers of repeating disaccharide units, usually a hexosamine and uronic acid.
- The largest and most ubiquitous is hyaluronan (hyaluronate or hyaluronic acid).
- Hyaluronan forms a viscous, pericellular network that binds a considerable amount of water (diffusion through connective tissue and in lubricating various organs and joints). umbilical cord have a good amount of this acid → where nature of the anterior comes from

GAG → glucose and aminoglycans
Depending on the type of sugar there will be different types of GAGs

GAGs

- All other GAGs are much smaller, sulfated, bound to proteins (as parts of proteoglycans).
- Major GAGs found in proteoglycans are dermatan sulfate, chondroitin sulfates, keratan sulfate, and heparan sulfate (different disaccharide units)
- Their high negative charge forces GAGs to an extended conformation and causes them to sequester cations as well as water.
- These features provide GAGs with space-filling, cushioning, and lubricant functions.
- Cartilage matrix is basophilic → stained with hematoxylin

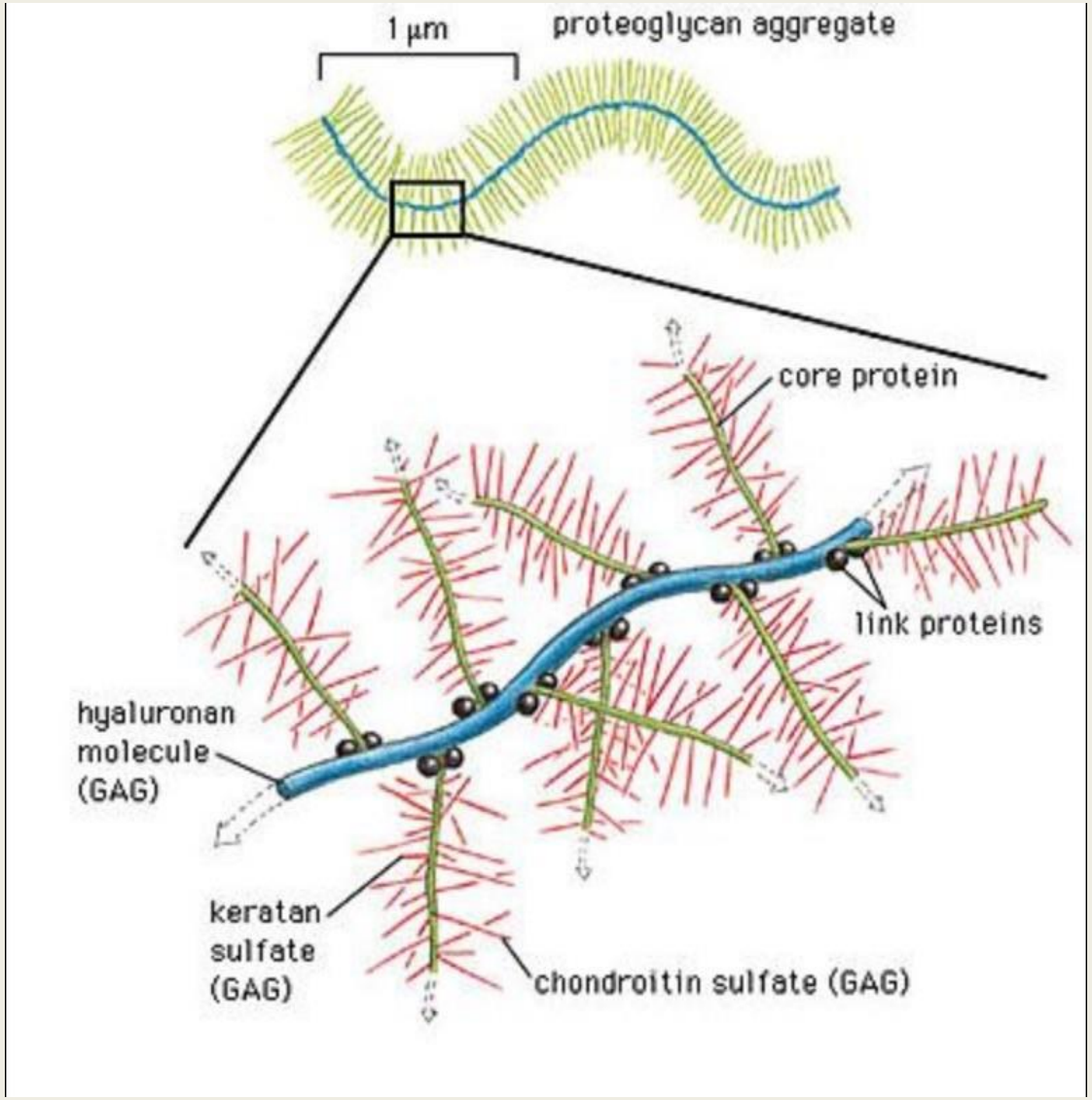
GAGs

Glycosaminoglycan	Repeating Disaccharides		Distribution	Electrostatic Interaction with Collagen
	Hexuronic Acid	Hexosamine		
Hyaluronic acid	D-glucuronic acid	D-glucosamine	Umbilical cord, synovial fluid, vitreous humor, cartilage	
Chondroitin 4-sulfate	D-glucuronic acid	D-galactosamine	Cartilage, bone, cornea, skin, notochord, aorta	High levels of interaction, mainly with collagen type II
Chondroitin 6-sulfate	D-glucuronic acid	D-galactosamine	Cartilage, umbilical cord, skin, aorta (media)	High levels of interaction, mainly with collagen type II
Dermatan sulfate	L-iduronic acid or D-glucuronic acid	D-galactosamine	Skin, tendon, aorta (adventitia)	Low levels of interaction, mainly with collagen type I
Heparan sulfate	D-glucuronic acid or L-iduronic acid	D-galactosamine	Aorta, lung, liver, basal laminae	Intermediate levels of interaction, mainly with collagen types III and IV
Keratan sulfate	D-galactose	D-glucosamine	Cartilage, nucleus pulposus, annulus fibrosus	None

GAGs that form proteoglycans

- Hyaluronic acid
- Chondroitin 4-sulfate
- Chondroitin 6-sulfate
- Dermantan sulfate
- Heparan sulfate
- Heparin
- Keratan sulfate

Diagram→ is a proteoglycan aggregate
After expanding it :
Hyaluronic →backbone for smaller structures
And these smaller structures have a core protein
Which binds to many GAGs
Type of GAGs→ depend on the type of tissue
Cartilage→ Chondroitin sulfate
Core protein in linked to link protein



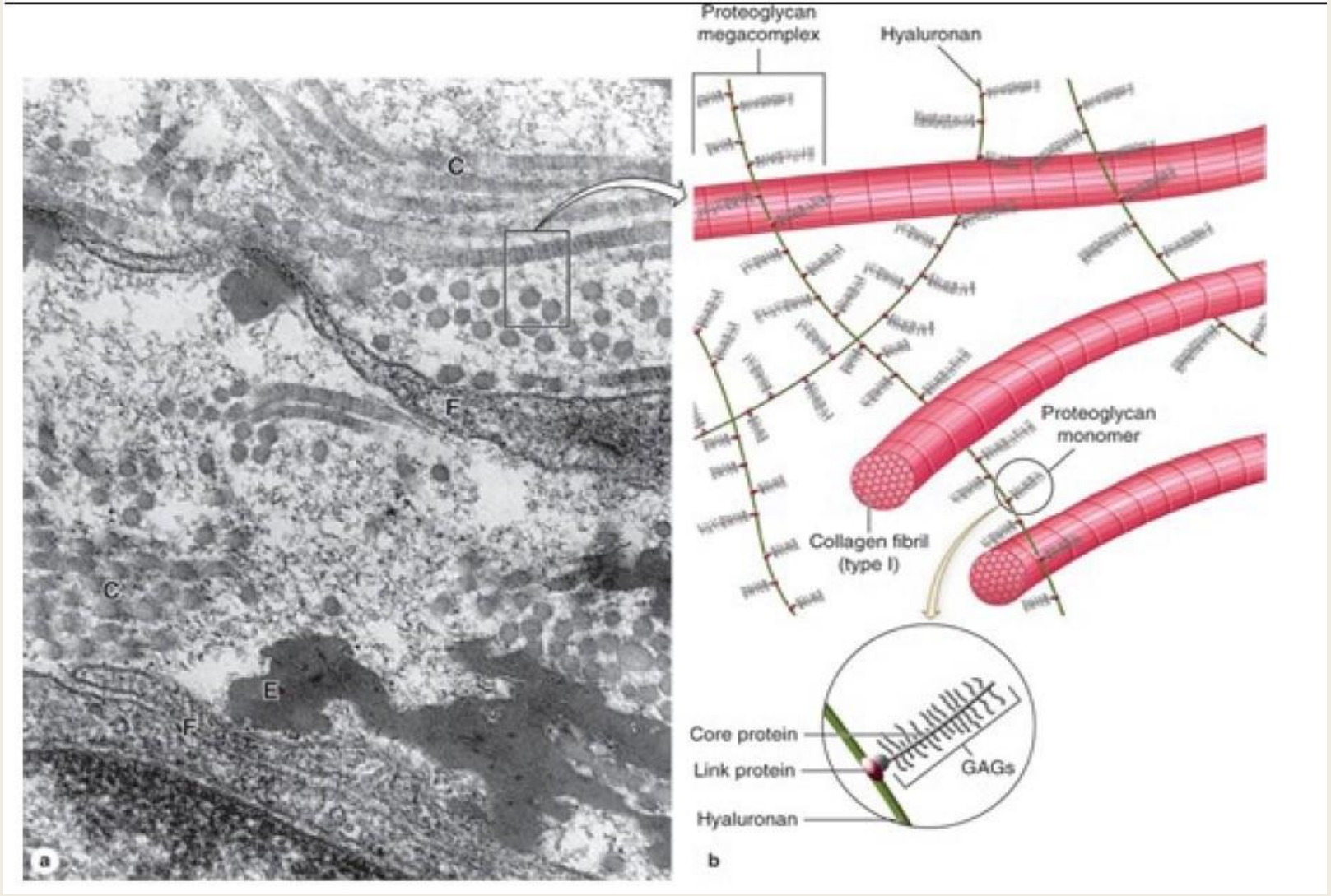
TEM

Rounded perfect structures are cross sectional collagen fibers Also longitudinal collagen fibers

More irregular structure → elastic fibers

More in the relaxed form would appear different flexed

Tiny greyish →ground substance



1. What are the major components of the ground substance in the extracellular matrix(ECM)?

A) water,glycoproteins, And lipids
B) collagen,elastin, and fibronectin
C) Glycoproteins,proteoglycans and GAGs
D) Hemoglobin , myoglobin and albumin

2. Which GAG is found in the vitreous humor of the eye?

A. Chondroitin 4-sulfate
B. Hyaluronic acid
C. Dermatan sulfate
D. Heparan sulfate

3. Which type of fibers have the property that allows tissues to stretch (stretching) and then return to their original shape (recoiling)?

A. Elastic fibers
B. Collagen fibers
C. Reticular fibers
D. Muscle fibers

4. How do elastic fibers and lamellae stain with H&E?

A. They are strongly acidophilic
B. They stain poorly
C. They are basophilic
D. They are basophilic

1.C
2.B
3.A
4.b

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