

Doctor 022



Histology

Sheet no.6



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Dear colleagues , the texts that are written in black indicate to a doctor but in purple indicate to an extra information that I added it to more understanding.

Main topics:

- Collagen
- Ground substance
- The classification of connective tissues

Collagen

Collagen fibers are a big family and most abundant and widely distributed collagen, it's the most type of fibrous we usually see it in the connective tissue The most type of collagen that we can see it everywhere is type I

, it's non-extensible (can't stretch it) , it's usually stained with H&E , we have 28 types of collagen could be farther grouped into 3 families

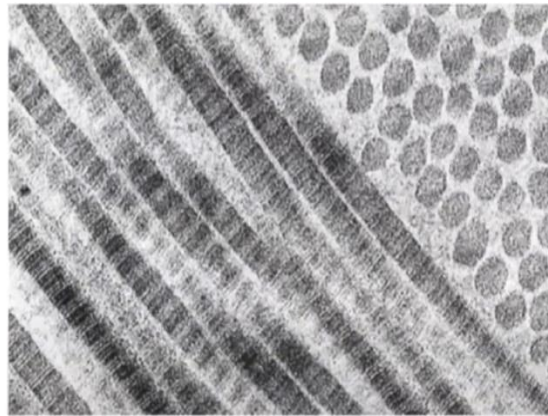
subfamilies which they are:

□ **Fibrillar collagen** (it has type I,II and III which we will see it until the last concept of connective tissue)

□ **Network or sheet forming** (it's a 3D structure and we usually see it in the basal lamina especially type IV(4))

□ **Linking/anchoring** (doctor mentioned it in the previous lecture but remember that collagens are short and small proteins (type VII). As their name shows they link or connect different other proteins together)

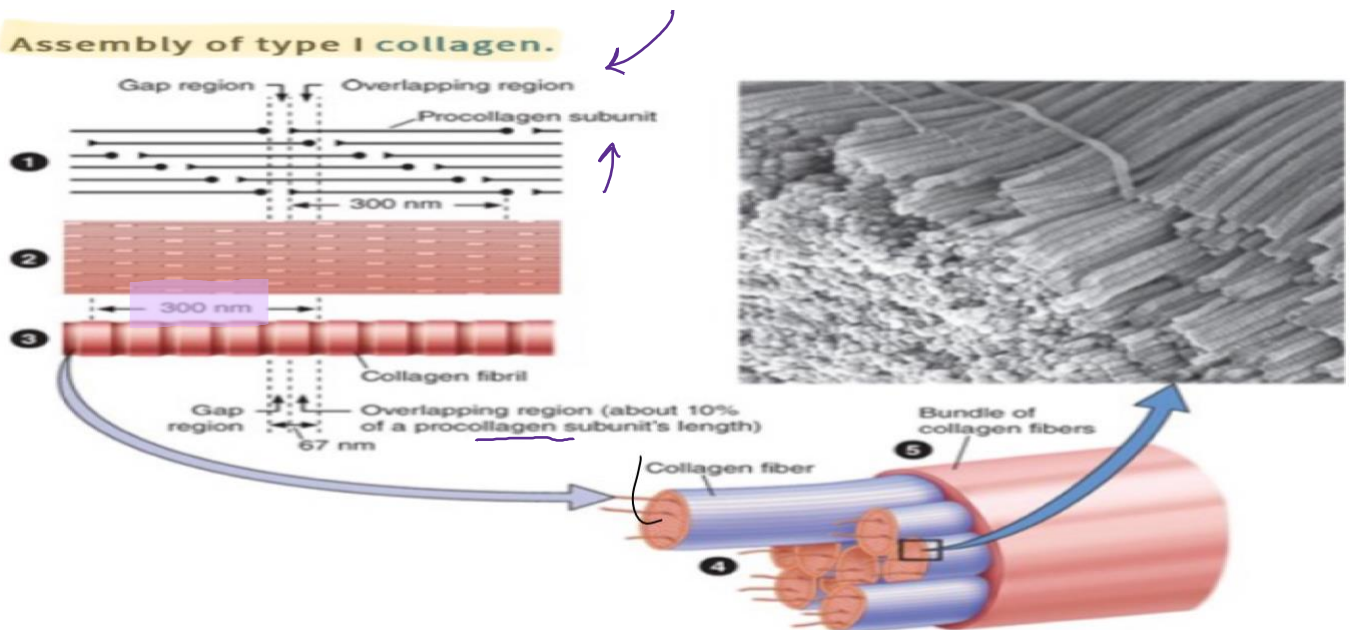
Collagen fibers in TEM



In cross section the cut ends of individual collagen molecules appear as dots

It shows the striation of the collagen fibers due to the presence of the gap between procollagens (the term striation more less usually designated for the skeletal muscle for different colors and consistent throughout the structure). Circle ones are cross section of collagen fibers. (Gapping lighter, no gapping darker).

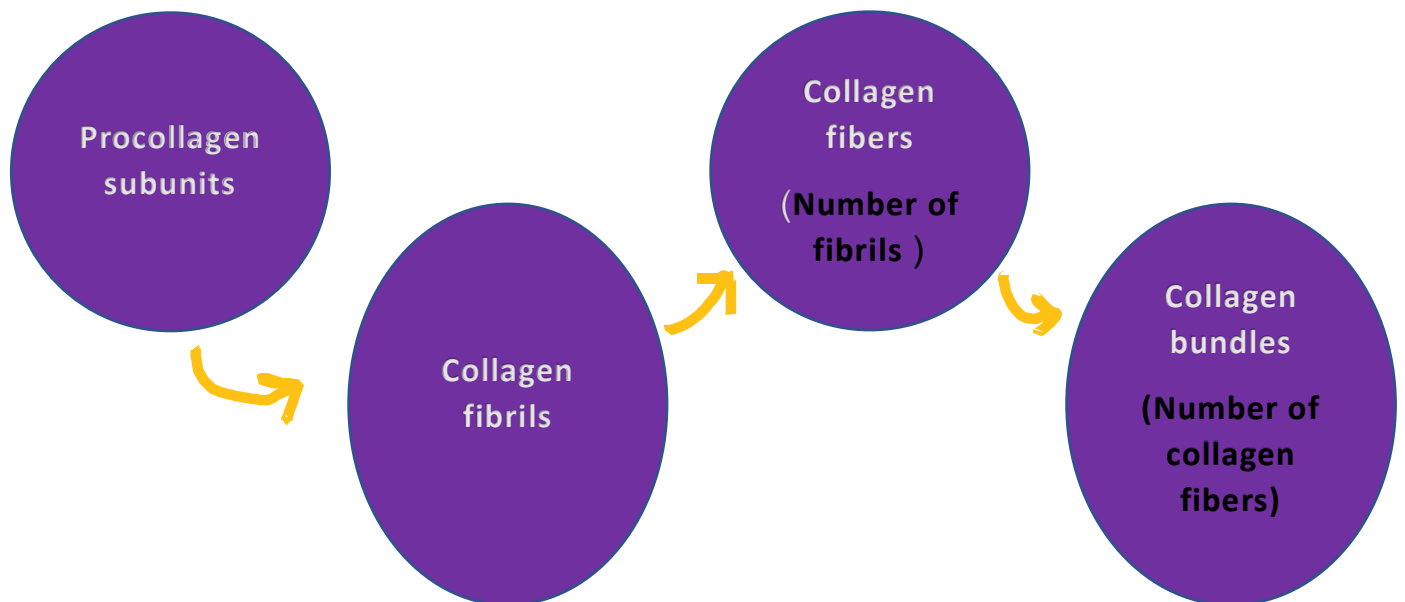
Collagen assembly of type I (The most type of collagen that we can see it everywhere is type I)



After synthesizing procollagens in (RER) which they are the building blocks or subunits performing collagen type 1 , these procollagens will be assembled in a specific fashion ,in a way that there will be a gap left before and after each procollagen (there's a gap between each subunit)and these gaps they don't overlap immediately with the next gap, The areas where there's more gaps overlapping will appear lighter in color particularly under the EM Procollagens subunits assembly to a certain number of them will give us the next larger structure which is collagen fibrils(first level of organization), These fibrils have an obvious striation so the intensity or density is quite clear in EM

A number of collagen fibrils(**smaller**)will later be incorporated into a larger structure which is collagen fibers(**bigger**) (number of collagen fibrils) to form structures such as tendons)

collagen is further assembled in bigger structures called collagen bundles(**biggest**)(number of collagen fibers). You will see collagen bundles quite clear in the dense connective tissue running in one direction wavy.



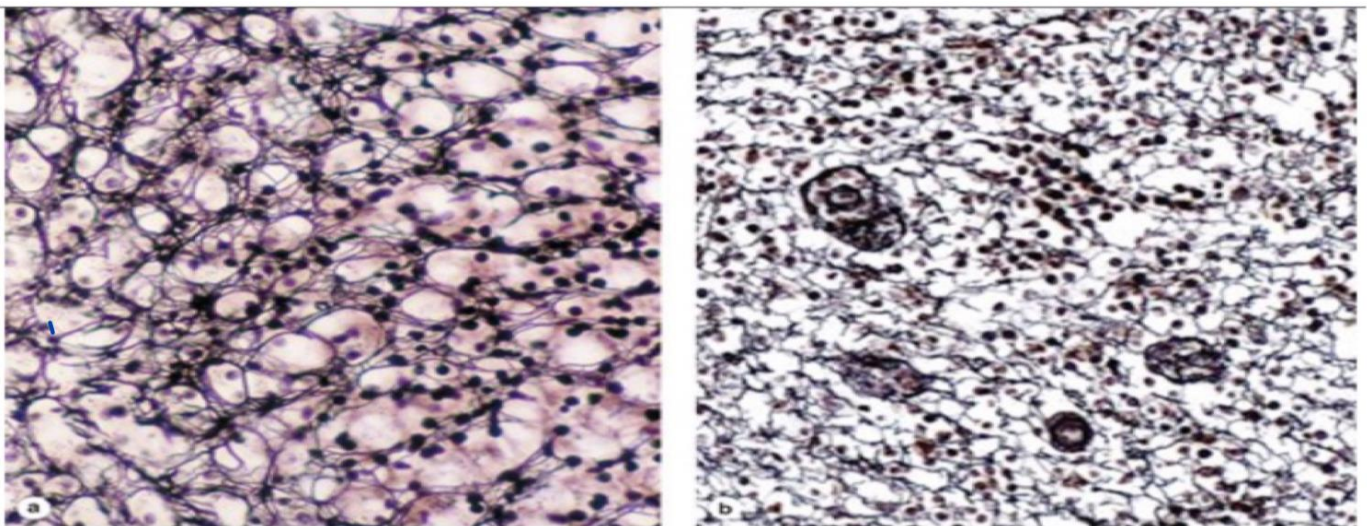
Reticular fibers

They are found in delicate connective tissue of many organs such as bone marrow ,liver(hematoxylin), lymph nodes and spleen which they are structures associated with blood cells formation and maturation , Reticular is mainly a collagen type III with some modifications

it's a stretchy extensible fibers (could be increased in length and recall back without any issues), Reticular fibers are synthesized by reticular cells whereas collagen and elastic are synthesized by fibroblasts . Reticular cells is a modified fibroblast only specialized in making reticular fibers .

It has many sugars attach to it , (Many of these types of collagen have been combined with carbohydrate) //Reticular fibers contain up to 10% carbohydrate and it's PAS positive)//*loves silver *

And the section of lymph node stained with silver(argyrophilia)



- ✓ rarely visible in H&E but are stained black after impregnation with silver salts. (argyrophilia)
- ✓ 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.

Elastic fibers

In the dermis,
you need collagen to resist tension
and
elastic fibers for recoiling.

Red:collagen.

Black:elastic

Elastic.

Blood vessels

Recoil case here



A-Hematoxylin and orcein(reddish color)

B-Aldehyde(collagen and elastic but elastic is much higher affinity than collagen)

C-H&E(section has seen in aorta)

- ✓ Thinner than the type I collagen fibers and form sparse networks interspersed with collagen bundles in many organs

✓ Have rubberlike properties that allow tissue containing to be stretched (and it's almost look like a ball so the applied force will flattening them , when the forces removed they return to the original shape) distended (lungs) لَمَّا نَتَنَفَّسْ ايش بصير بالرئة؟

Structure of the large ,in the middle of heart

في القلب تحديداً في المنتصف يوجد الاورتا (oarta) يلي هي (artery) بيطلع منه دم غني بالأكسجين وبوزعُه على بقية جسمنا وبنفس الوقت بيحيه دم فقير بالأكسجين عن طريق نوعان من الأوعية الدمويّة وهما : superior vein cava and inferior vein cava تمام بس ييجي الدم بده يطلع من القلب ييجي على oarta بضغط كثير وحجم كبير فسبب بتوسعه لأنه ال wall بيحتوي على elastic fiber بعدين لَمَّا ييجي بده يروح على next segment ويلي هي:

next blood vessel that is called muscular, the contraction and relaxation in this level are not controlled by elastic fibers but it is controlled by a smooth muscles

✓ Where can you find it ? In the wall of large blood vessels, 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 (you can't visualize it, so تخيل لو أنني أمسكت خيطاً صغيراً جداً وسألتك عمّا إذا كنت تراه ستجيبني ب لا ولكن لو أضفت العديد من الخيوط من نفس النوع وسألتك السؤال ذاته ستجيبني بنعم وهنا الفكرة التي أرادت طرحها الدكتورة بأنه :

If you have a single elastic fiber you won't see in H&E but if you add more elastic that tightly together you will visualize it in H&E

- ✓ Stained more darkly than collagen with other stains such as orcein and aldehyde fuchsin.

✓ *Ground substance*

✓ (حشوة .)

- ✓ • A semi- fluid gel (highly hydrated) and transparent material.

- ✓ • Function: medium for passage/exchange of molecules and metabolites

✓ **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**

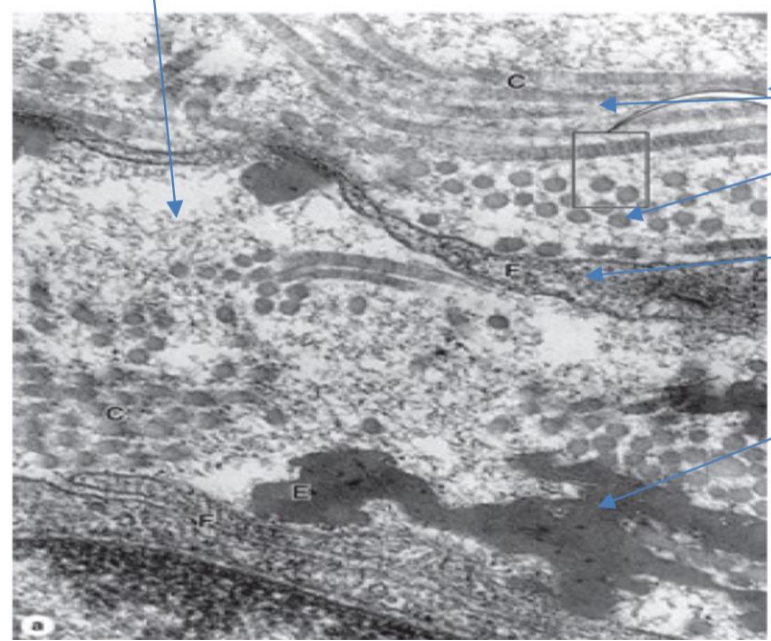
✓ Major component: proteins

✓ Minor component: sugar

Ground substance
(Mainly proteoglycans connected the the hyaluronon backbone)

Taken from the TEM

black, white and gray



Collagen

Fibroblasts

Elastic

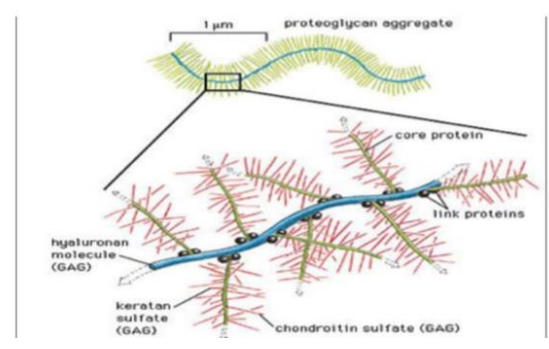
Glycosaminoglycans (GAGs)

a repeated disaccharide, these two subunits repeatedly connected give us GAGs

GAGS THAT FORM PROTEOGLYCAN

In the figure there's two components of ground substance (GAGs and proteoglycans)

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



hyaluronic acid (hyaluronan) : the longest GAG and the biggest in terms of molecular weight, also it's almost

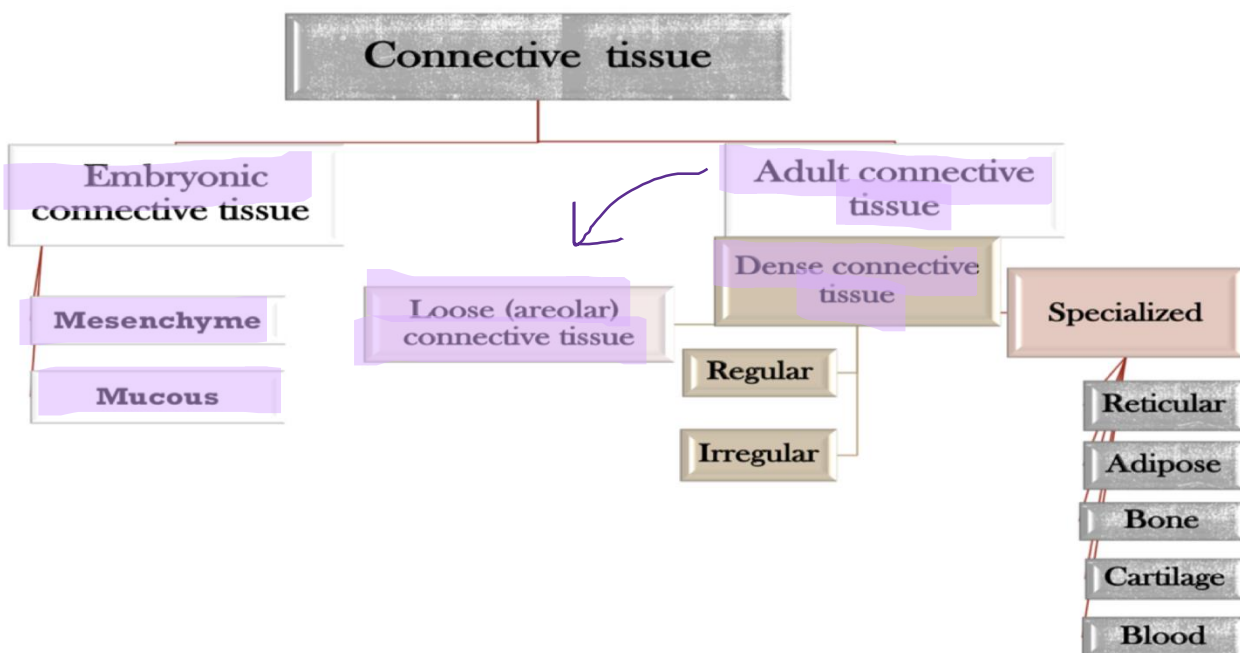
present everywhere, most of a ground substance in the connective tissue has hyaluronic acid

proteoglycans , a core protein attached to other members of GAG's family , the type depends on the location , because different tissue have different types of GAGs. The proteoglycans are connected to the long backbone hyaluronic acid by linking proteins

Only the red boxes are included

Glycosaminoglycan	Repeating Disaccharides		Distribution
	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
Chondroitin 6-sulfate	D-glucuronic acid	D-galactosamine	Cartilage, umbilical cord, skin, aorta (media)
Dermatan sulfate	L-iduronic acid or D-glucuronic acid	D-galactosamine	Skin, tendon, aorta (adventitia)
Heparan sulfate	D-glucuronic acid or L-iduronic acid	D-galactosamine	Aorta, lung, liver, basal laminae
Keratan sulfate	D-galactose	D-glucosamine	Cartilage, nucleus pulposus, annulus fibrosus

• The classification of connective tissue

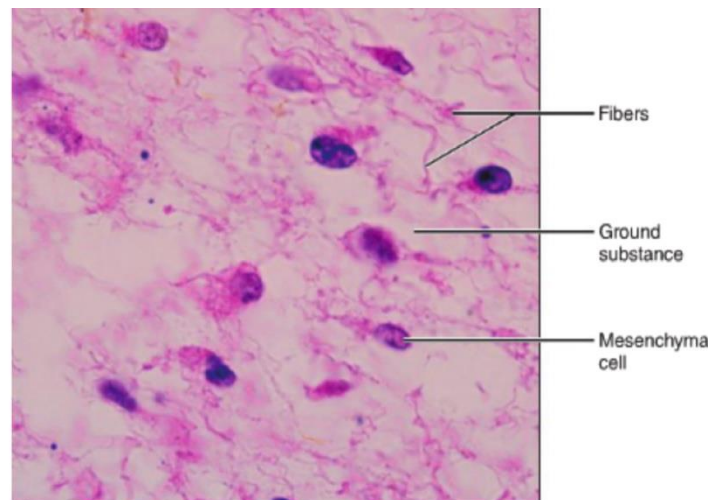
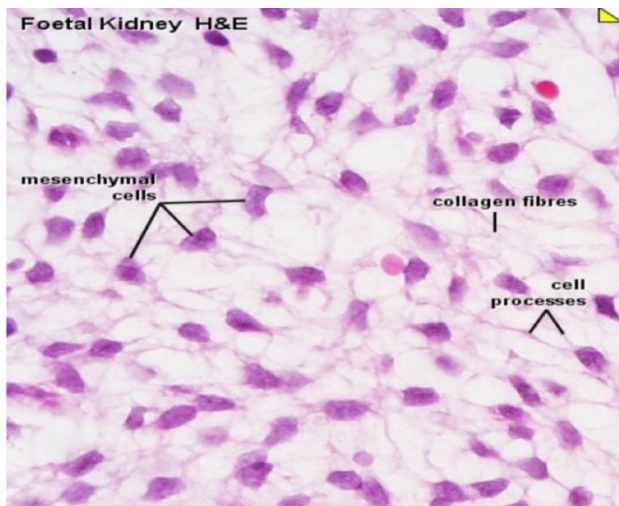


The types in the purple highlight that the doctor only mentioned it at the end of the lecture .

Embryonic connective tissue:

-Mesenchyme:

The embryo develop and these mesenchymal cells will be located in the future connective tissue (future bone or cartilage) , bone or cartilage at some step in the embryo will start developing and there will be mesenchymal stem cells , all start from mesenchymal cells and start to differentiate into specific types(mast cells,microphage , osteoclasts and adipose)of connective tissue in the adult.

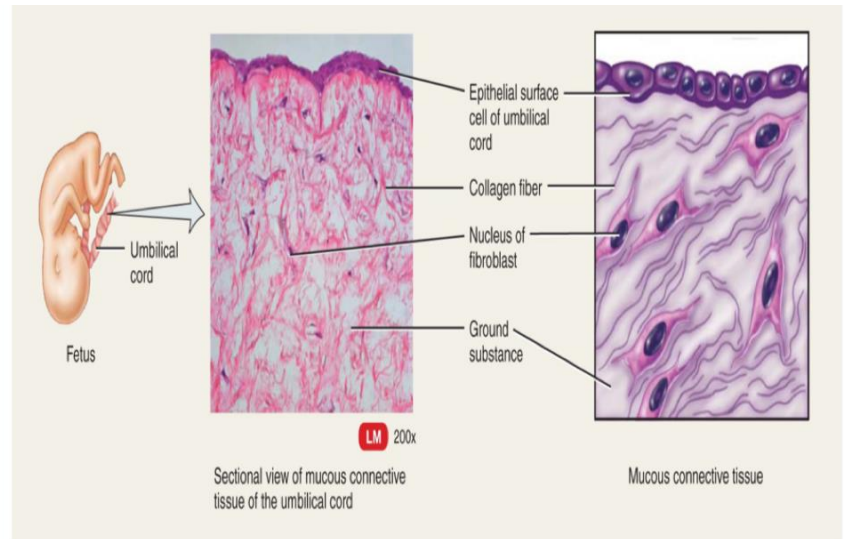
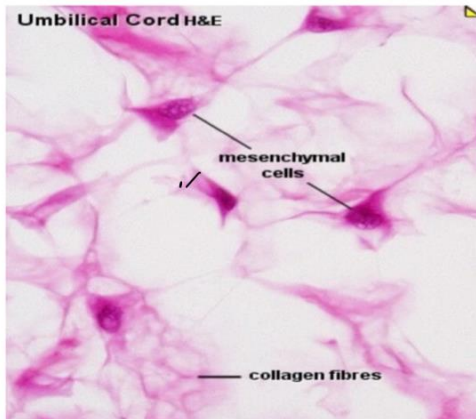


-Mucus:

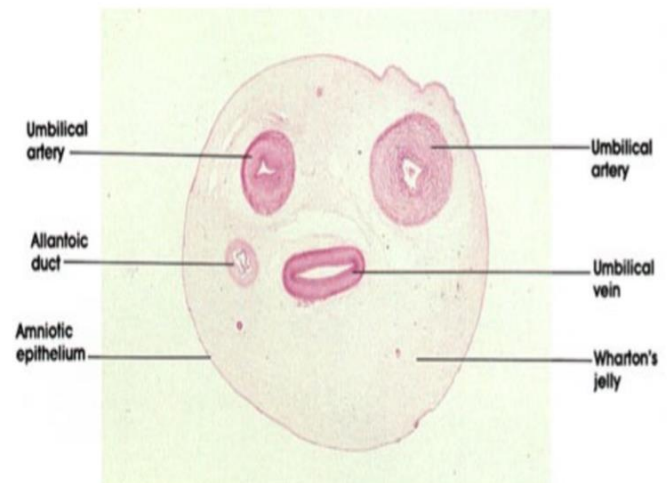
We consider it embryonic because it is formed in embryo umbilical cord (حبل سرّي) it attaches to the mother placenta (مَشِيْمَة) that's mean this cord is a link between the

fetus (جنين) and mother's (food and oxygen pass through it)

- It provide some sort of a support for the supported structures inside (arteries and veins and blood vessels)



This is a cross section in the umbilical cord



What's inside is lots of fibroblasts , ground substance , and mesenchymal stem cells (not as much as you would see in the mesenchymal connective tissue because they are there just to provide some protection to the blood vesses and after the delivery of the umbilical cord will be taken by certain companies, mesenchymal stem cells will extract them and store(in liquid nitrogen with Low temp below 120) them for any future complication this baby might encounter Stem cells therapy is very promising treatment modality and it's

مثلاً مريض عنده نسيج تلف بدل ما يجيله انسجة رح يستعمل يلي (growing very fast)
خزّنه)

✓ Adult connective tissue

Connective tissue Proper (everywhere without specific name like epithelial , tendons and ligaments unlike specialize they have name as reticular, bones and cartilage)

The connective tissue proper divided into **loose** or **dense**)

-the major difference between them the proportion of cells , fibers and ground substance that's mean that it depends on the contents of connective tissue

- **Loose (areolar) connective tissue**: it has more ground substance
- **Dense connective tissue**: regular or irregular , without ground substance but more fibers that tightly backed together. Doctor doesn't mention the connective tissue of adult in detail.

The end ☐

Q1) The collagen type that encoring the basal lamina with underlying reticular lamina?

- A) Collagen type
- B) Collagen type VI
- C) Collagen type VII
- D) Collagen type II E) B and C are correct

Answer is : C

Q2) The functions of collagen type IV:

- A) Resisting pressure

- B) Anchoring Fibrils
- C) Meshwork of the lamina densa
- D) Resisting tension
- E) B and C are correct

Answer is: C

Q3) Reticular fibers are:

- A) Thin structures
- B) Extensive network of collagen type III
- C) Formed in osteoblasts
- D) Found in lymph nodes
- E) All of the above are correct except c

Answer is: E

Q4) Ground substance is:

- A) Transparent 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

Q5) The structure that is responsible for the gel state of ECM is:

- A) GAGS
- B) Proteoglycan
- C) glycoproteins
- D) Fibers

E) A and B

Answer is: B

هذه الأمة تحتاج لطاقه كل فرد منا ، اليوم نحن ، لتكن
انت غداً ، بركة الوقت في إنجاز التفريغ رائعة ،

جربها ، لتكن انت التالي! عن أبي هريرة رضي الله تعالى عنه: أن رسول الله ﷺ

قال: إذا مات ابن آدم انقطع عنه عمله إلا من ثلاث: صدقة جارية، أو علم ينتفع به، أو ولد صالح يدعو له. رواه مسلم