بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

HISTOLOGY

وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

MID | Lecture 10

Classification of Connective Tissue

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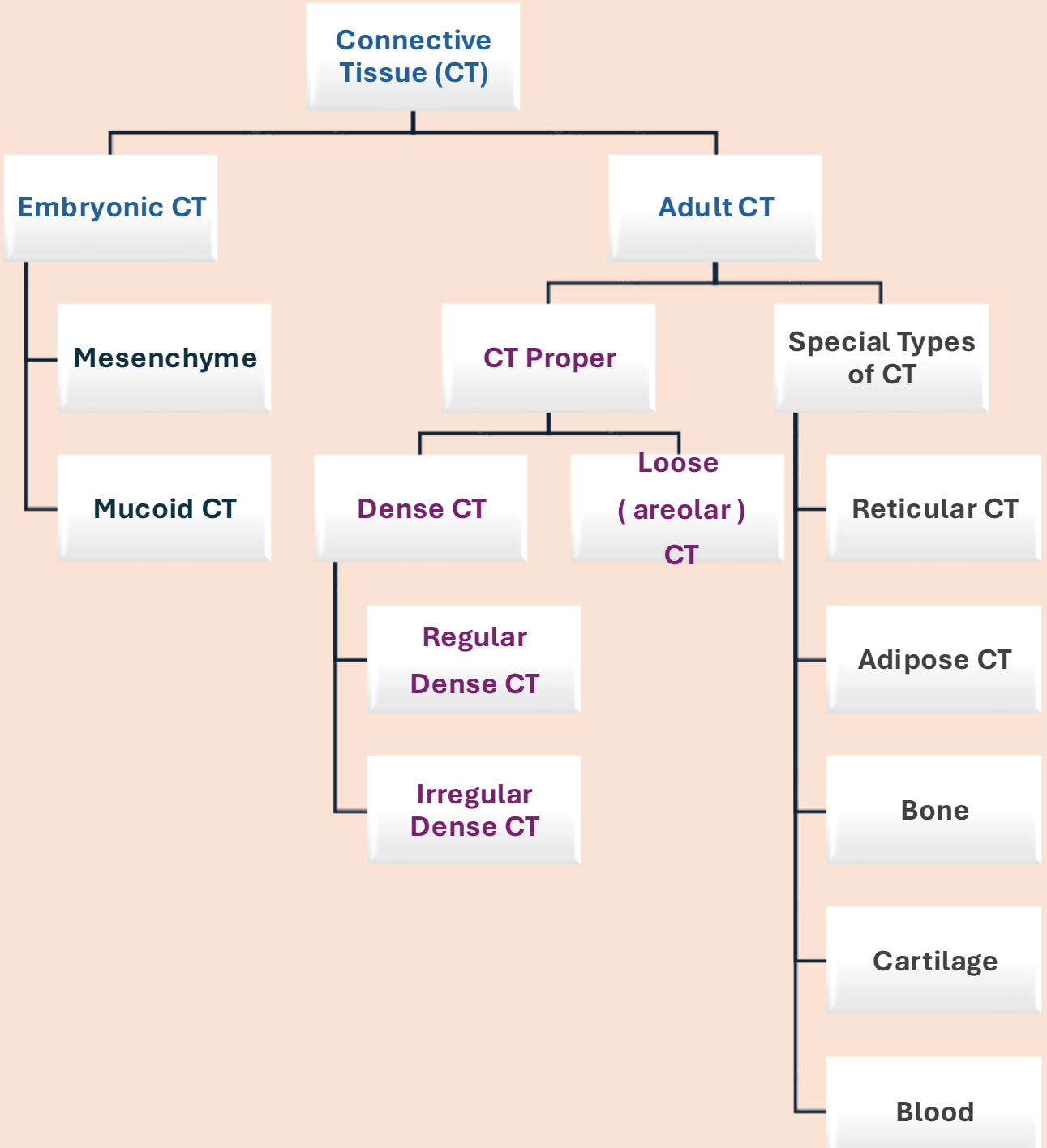
Lamar Khorma

Color coding used in the modified:

- *Black: the original slides*
- *Maroon: the doctor's explanation/words*
- *Gray: additional information and explanation*
- *Red: important information*

Classification Of Connective Tissue



- Connective tissue consists of : cells, fibers, and ground substance, which determine its type
- In adults, connective tissue is divided into :

1. Connective tissue proper (loose and dense)
2. Specialized types (cartilage, bone, blood) Characteristics of Different Connective Tissues: -

- Loose connective tissue:
  - Has less fibers and more ground substance and cells
  - Provides cushioning and support
  - Facilitates nutrient diffusion
- Dense connective tissue:
  - Primarily composed of fibers
  - Can be classified as regular (tendons and ligaments) and irregular
  - Fibers can be aligned in different orientations
  - The strongest type of connective tissue that we have

Specific Types and Their Properties: -

Dense Irregular Connective Tissue:

- Found in the dermis
- Collagen fibers oriented in multiple directions for multidirectional strength

Ligaments:

- Have parallel collagen fibers
- Provide unidirectional tensile strength

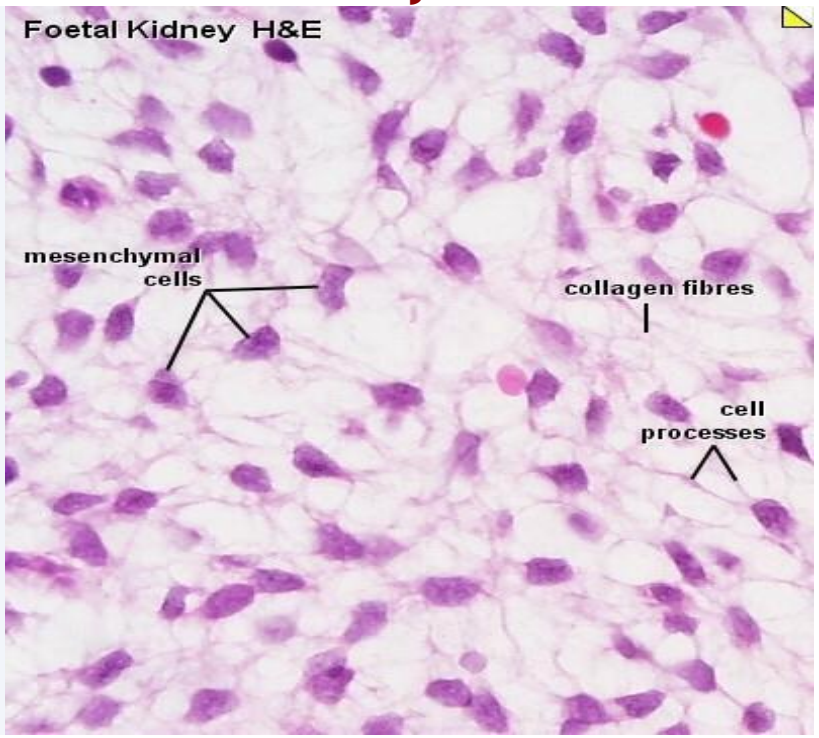
Reticular Connective Tissue:

- Contains reticular fibers (collagen type III)
- Supports delicate structures
- Found in lymphoid organs

Classification-Embryonic C T

Embryonic Connective Tissues	General Organization	Major Functions	Examples
Mesenchyme	Sparse, undifferentiated cells, uniformly distributed in matrix with sparse collagen fibers	Contains stem/progenitor cells for all adult connective tissue cells	Mesodermal layer of early embryo **Can then differentiate into different types of connective tissues**
Mucoid (mucous) connective tissue	Random fibroblasts and collagen fibers in viscous matrix	Supports and cushions large blood vessels	Matrix of the fetal umbilical cord

Evenly-distributed-undifferentiated mesenchyme cells

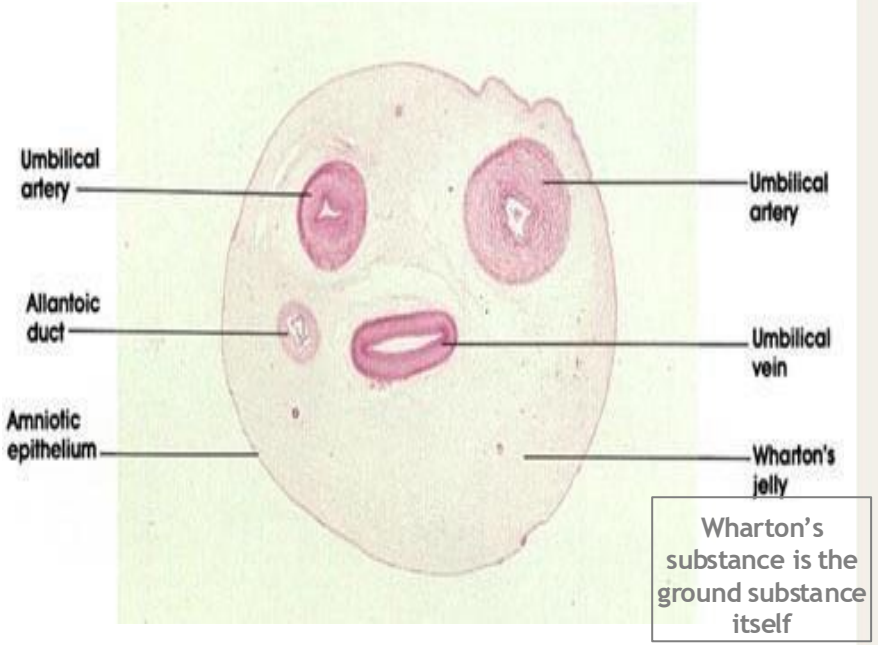


Mesenchyme

Embryonic Development:

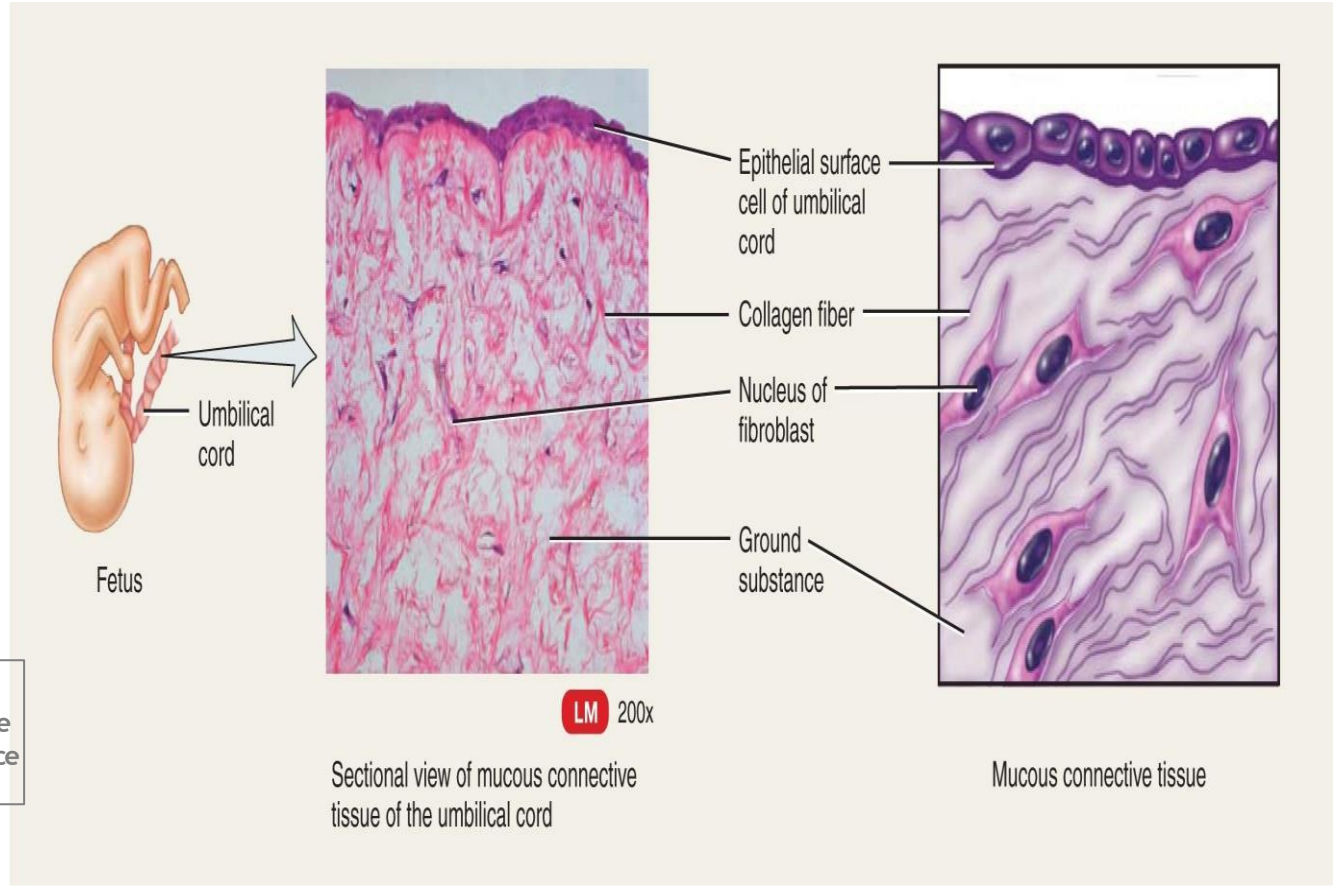
- **Embryonic connective tissues include mesenchyme and mucous tissue**
- **Undifferentiated cells differentiate into various adult connective tissues like fibroblasts and osteoblasts**
- **Mucous connective tissue is present in the umbilical cord The umbilical cord connects the embryo to the placenta, facilitating nutrient and waste exchange**

Mucous Connective Tissue



Across section of the umbilical cord (from where the embryo get its nutrients and oxygen from its mother)

Embryonic Connective Tissues			
Mucoid (mucous) connective tissue	Random fibroblasts and collagen fibers in viscous matrix	Supports and cushions large blood vessels	Matrix of the fetal umbilical cord



The ground substance is a great source for undifferentiated mesenchymal stem cells (they are different from the mesenchymal cells because they are already differentiated)**, after birth, you can arrange with specific companies to extract the mesenchymal stem cells from the umbilical cord and store them until the baby needs for a treatment that could benefit from the undifferentiated mesenchymal stem cells**

Classification-Adult C T

	General Organization	Major Functions	Examples
Connective Tissue Proper Depends on the amount of fibers			
Loose (areolar) connective tissue	Much ground substance; many cells and little collagen, randomly distributed	Supports microvasculature, nerves, and immune defense cells	Lamina propria beneath epithelial lining of digestive tract
Dense irregular connective tissue	Little ground substance; few cells (mostly fibroblasts); much collagen in randomly arranged fibers	Protects and supports organs; resists tearing	Dermis of skin, organ capsules, submucosa layer of digestive tract
Dense regular connective tissue	Almost completely filled with parallel bundles of collagen; few fibroblasts, aligned with collagen	Provide strong connections within musculoskeletal system; strong resistance to force	Ligaments, tendons, aponeuroses, corneal stroma

Less fibers and a good amount of ground substances and cells

Most of the tissue are fibers with little ground substances

Loose means cushioning

Dense means protection

Dermis is the second layer in the skin under the epidermis, it resists tensile forces in different directions and that is offered by the different directions of collagen fibers

Ligaments bind or hold 2 bones together because they contain a huge amount of collagen fibers (stronger than steel) running parallel to each others and resisting the pulling and tensile strength in unidirectional scheme

Classification-Specialized CT

	General Organization	Major Functions	Examples
Reticular connective tissue (see Chapter 14)	Delicate network of reticulin/collagen III with attached fibroblasts (reticular cells)	Supports blood-forming cells, many secretory cells, and lymphocytes in most lymphoid organs	Bone marrow, liver, pancreas, adrenal glands, all lymphoid organs except the thymus (delicate organs)

Reticular fibers are simply collagen type 3, so they create small spaces support delicate cells and small vessels or nerves .
Because we so much of them , Reticular is separated from connective tissue proper and put it in special type .

Loose (Areolar) Connective Tissue

Connective tissue under the epithelium is loose and the ground substances gives its looseness , features and functions so it allow the passage and the diffusion of the nutrients from the connective tissue with blood vessels toward the epithelium

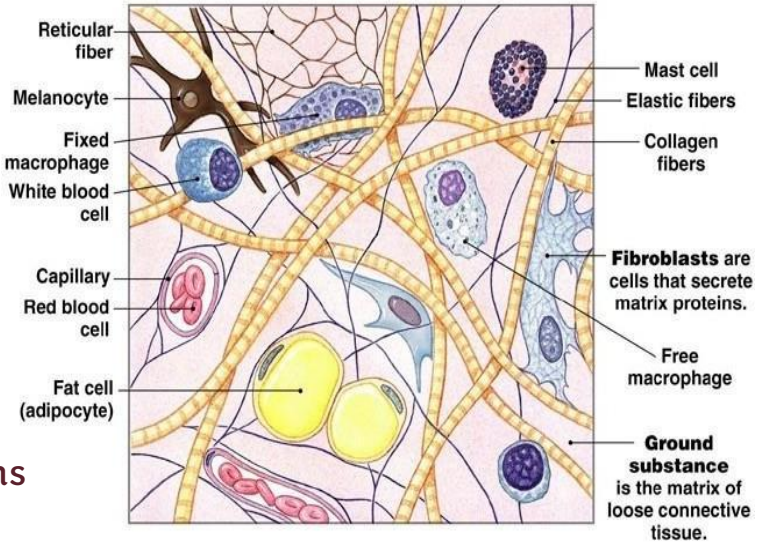
- Consists of all 3 types of fibers, several types of cells, and semi-fluid ground substance.
- Found in subcutaneous layer and mucous membranes, and around blood vessels, nerves and organs
- Function = strength, support and elasticity

Cellular and Molecular Composition:

- The matrix surrounding cells contains:
  - Collagen fibers
- Ground substance
  - Hyaluronic acid

Special Observations:

- Elastic fibers in the aorta allow for stretching and recoil
- Visualization of elastic fibers requires special stains like orcein
- Stem cells from the umbilical cord can potentially treat diseases



Loose connective tissue

Fig. 3-29

Dense Connective Tissue

- Contains more numerous and thicker fibers and far fewer cells than loose CT.

a. Dense regular connective tissue Tendons and ligaments

Tendons are connective tissue at the end of the muscles , where muscles attached to bone

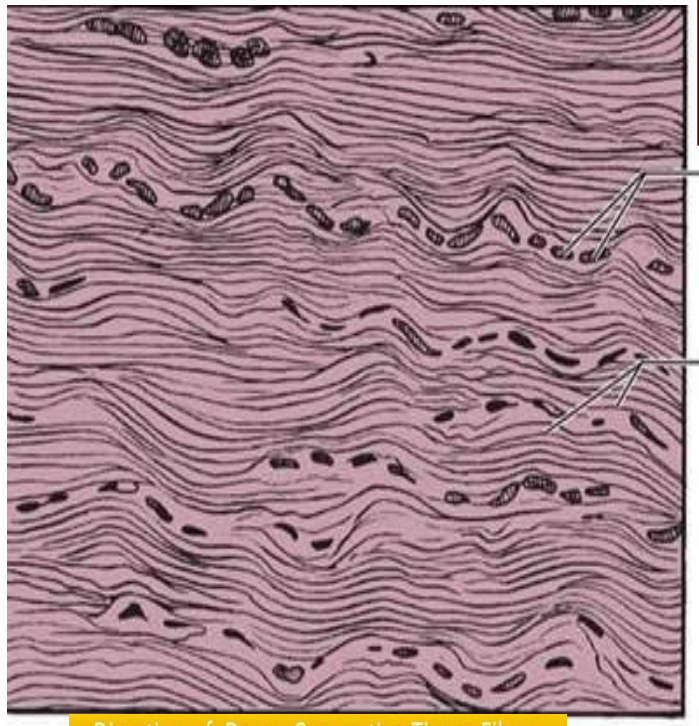
Ligaments are connective tissue structures that connect 2 bone together

b. Dense irregular connective tissue Dermis of skin

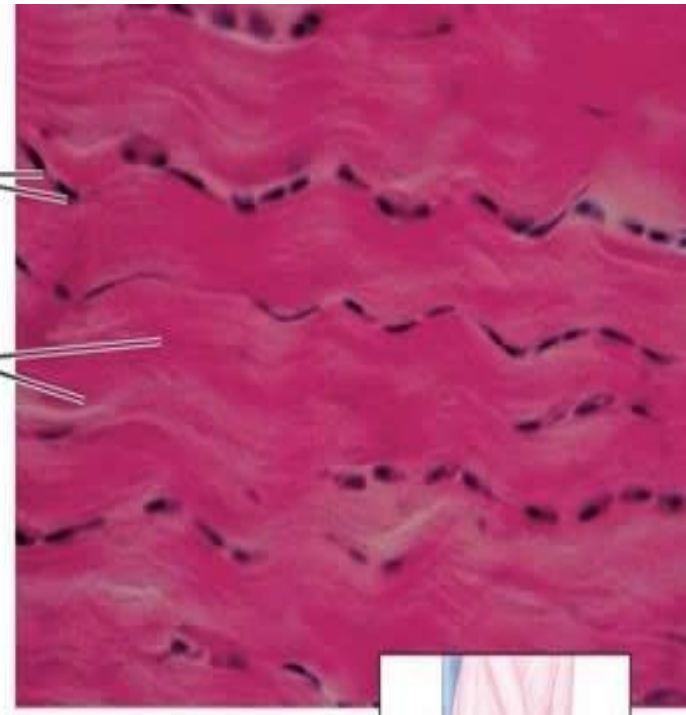
Dense Regular Connective Tissue

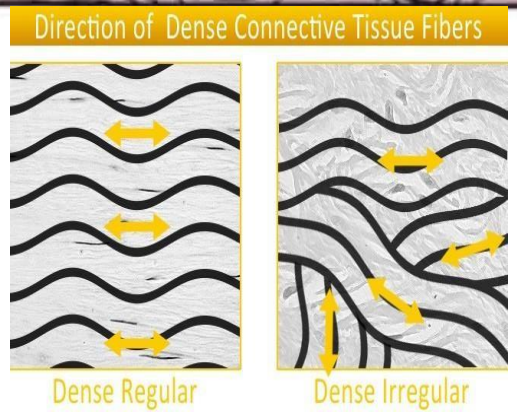
Show the alignment of the fibers , so more or less (most of them) are around one axis and you can see the richness of the collagen fibers (**regularity and alignment)**

- Consists of bundles of collagen fibers and fibroblasts.
- Forms tendons, ligaments.
- Function = provide strong attachment between various structures.



Usually are squeezed in between and be in rows



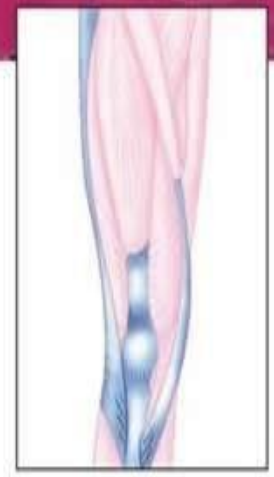


Dense Connective Tissue

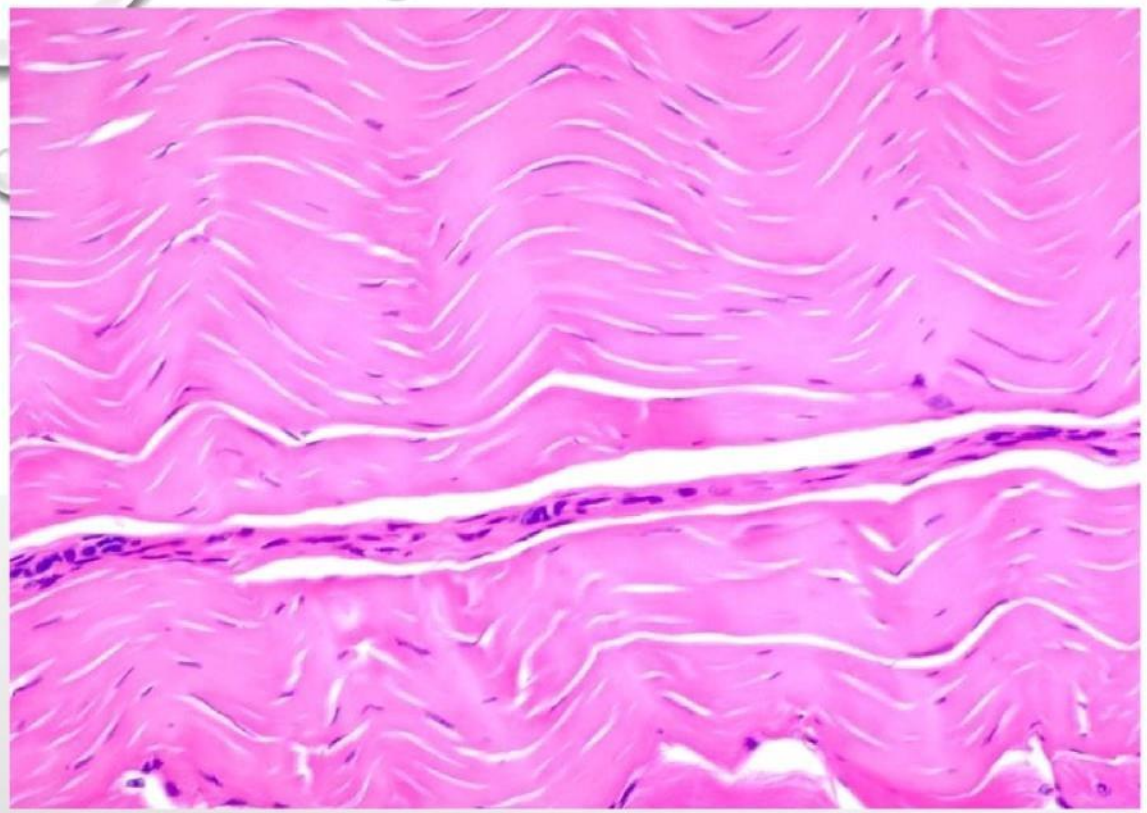
Location: Tendons; ligaments

Function: Binds organs together

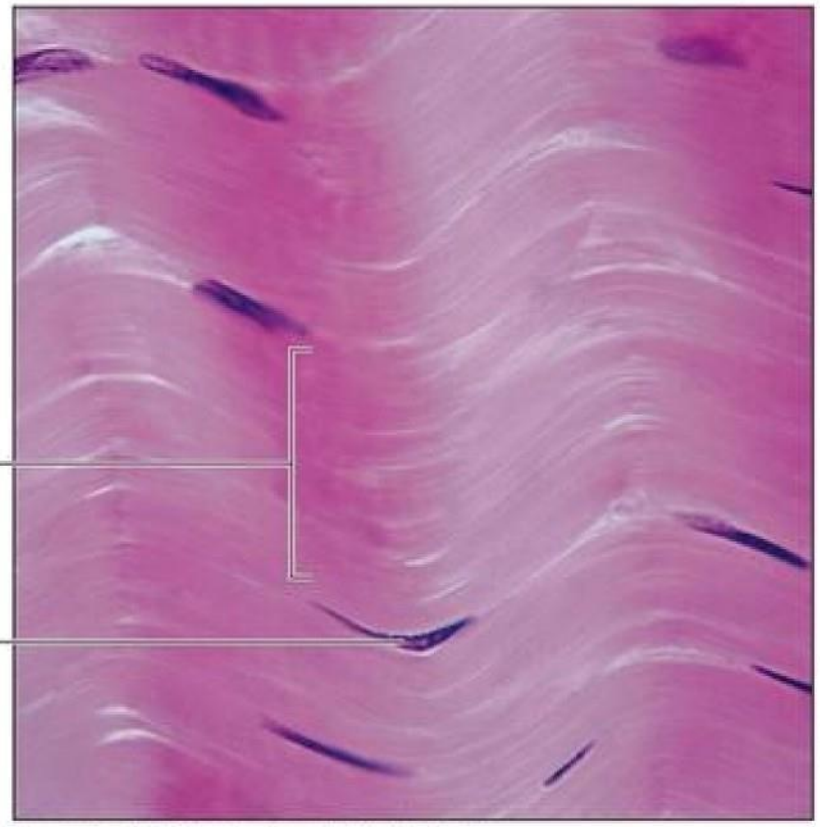
H and E stained section from the tendon



Read only :
Left Image (Larger):
- Purple and pink color palette
- Wavy tissue structure with white and light colored undulating lines
- Shows tissue architecture with overlapping color gradations
- Appears like layered, wavy patterns typical of microscopic tissue



Images for regular dense connective tissue are acquired by light microscope and are stained with H and E



slides
Right Image (Smaller):
- Darker purple tone
- Similar wavy pattern to the left image
- Labeled "Fibroblast nucleus"
- Displays more detailed cellular tissue structure

Dense Irregular CT

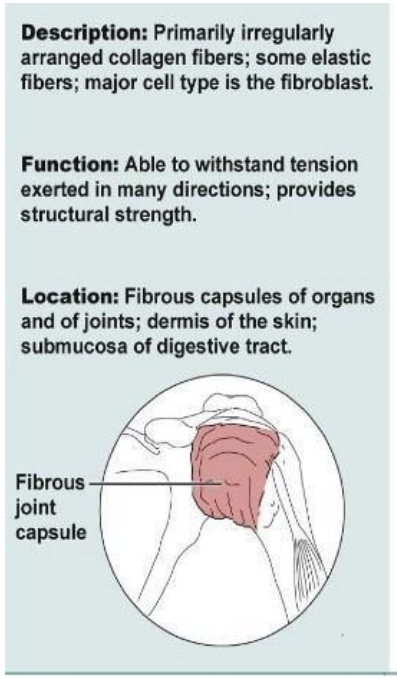
It seems to run in every direction of the tissue (**not aligned and no order**)

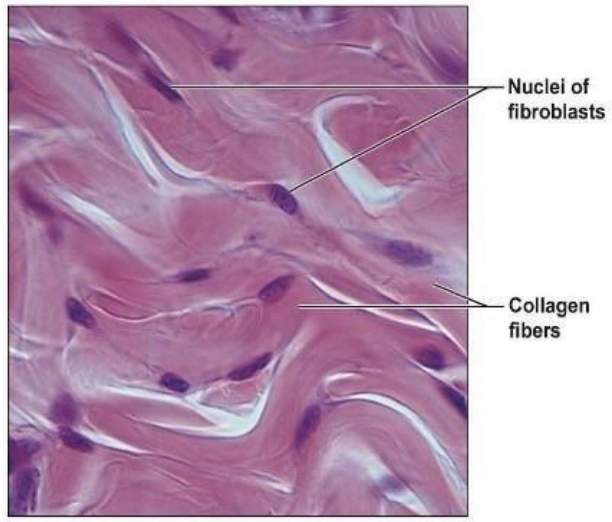
- Consists Of **Randomly-** arranged Collagen Fibers And A Few Fibroblasts.
- Found In Dermis Of Skin, capsules of joints and organs

Capsules are sheets of dense irregular connective tissue surrounded the 2 bones that they participate in the formation of joints to isolate them

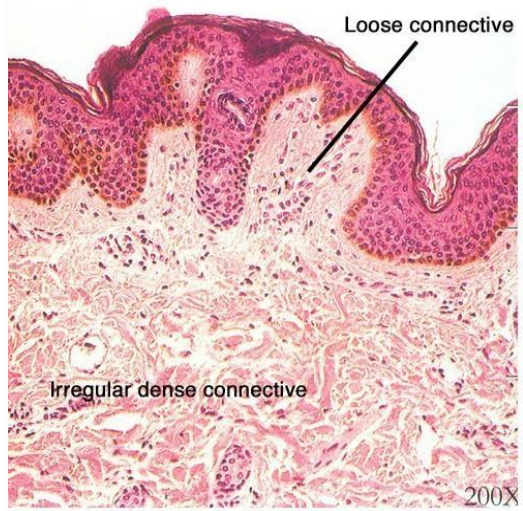
- Function = Provide Strength and protection

Microscope Images Show: - Purple and pink colored tissue - Intertwined, wavy fiber patterns - Different layers and textures

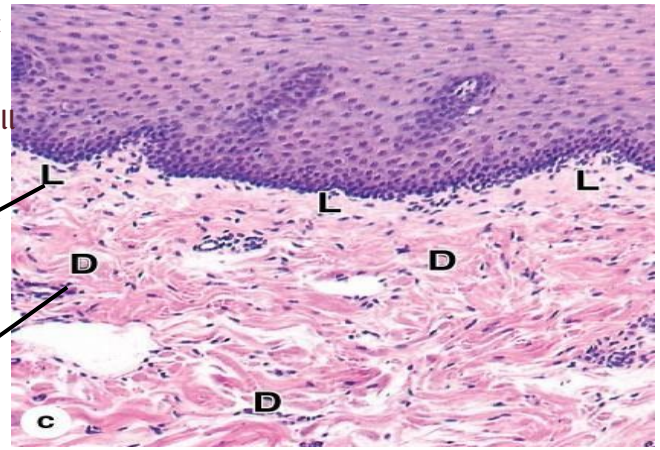




Photomicrograph: Dense irregular connective tissue from the dermis of the skin (600×).



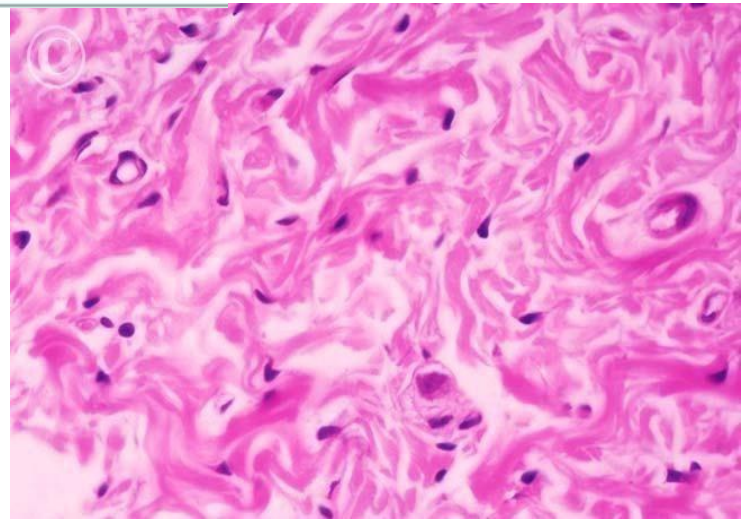
The most superficial part (stratum corneum) doesn't appear in the image.
The pinkish structures are collagen fibers running in all directions



Loose connective tissue beneath to the epithelium

2 layers

Deeper dense connective tissue



Section through epidermis

- What Makes It Unique:
  - Fibers are scattered in different directions
  - Looks complex under a microscope
  - Helps maintain structural integrity of body parts
  - Supports and protects different organs and tissues

- Think of it like a strong, randomly woven fabric that:
  - Can withstand pressure from multiple directions
  - Acts as a protective shield
  - Helps tissues maintain their shape and resist stretching

Elastic Connective Tissue

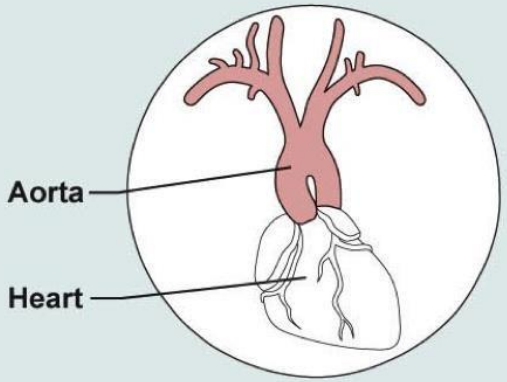
They tend to run parallel to each others

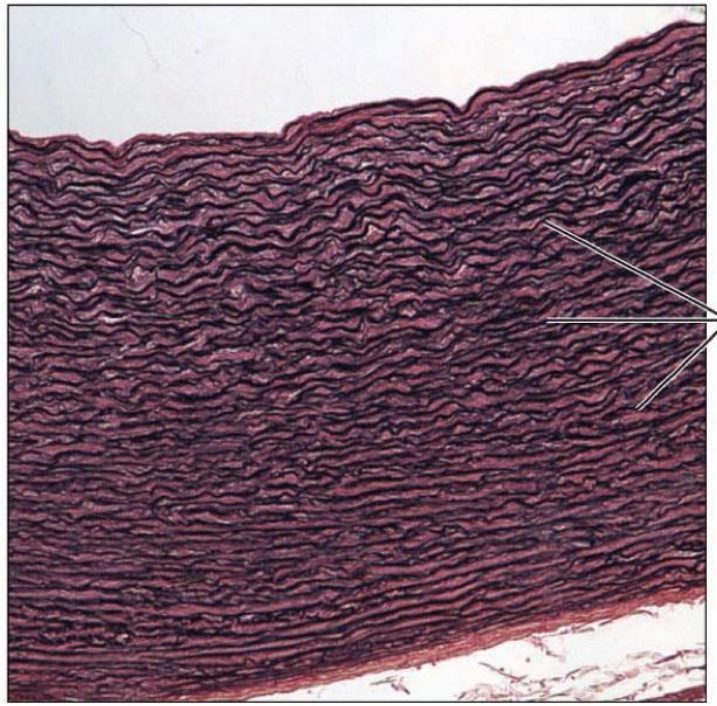
(g) Connective tissue proper: dense connective tissue, elastic

Description: Dense regular connective tissue containing a high proportion of elastic fibers.

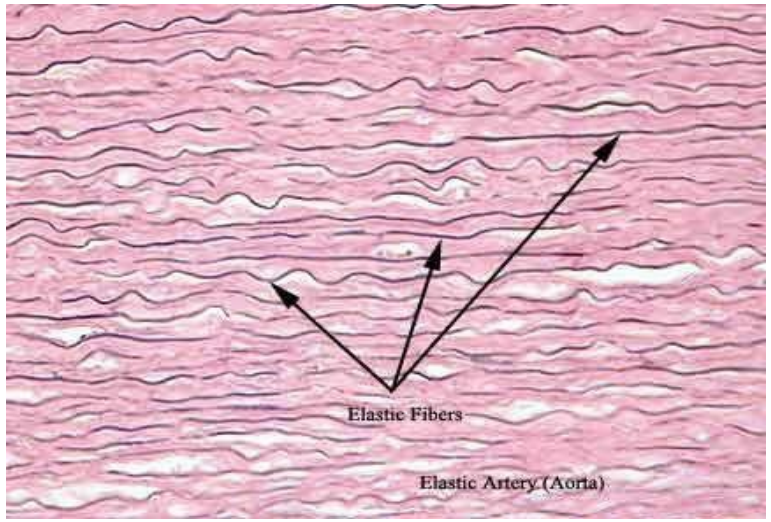
Function: Allows recoil of tissue following stretching; maintains pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.

Location: Walls of large arteries; within certain ligaments associated with the vertebral column; within the walls of the bronchial tubes.





Photomicrograph: Elastic connective tissue in the wall of the aorta (85×).



Elastic fibers can't see very well by H and E staining and we have to use special staining such as orcein to visualize them and distinguish them

This image is taken from aorta(the largest blood vessel that emerges from left ventricle of the heart and carriers oxygenated blood toward the rest of the body), which is one good location for elastic fibers and has a lots of elastic laminae in its wall , due to its elasticity ,stretching and recoil back they allow slight stretching of the aorta.

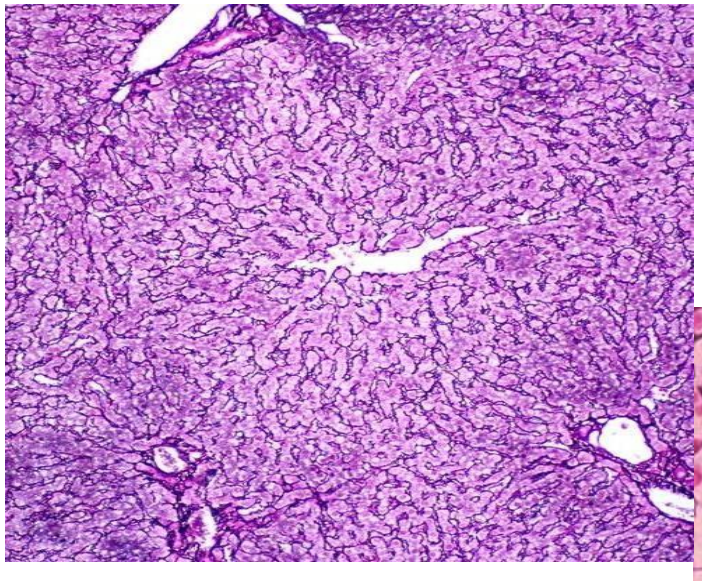
Specialized-RETICULAR CT

- Consists of fine interlacing reticular fibers and reticular cells.
- Found in liver, spleen and lymph nodes.
- Function = forms the framework (stroma) of organs and binds together smooth muscle tissue cells.

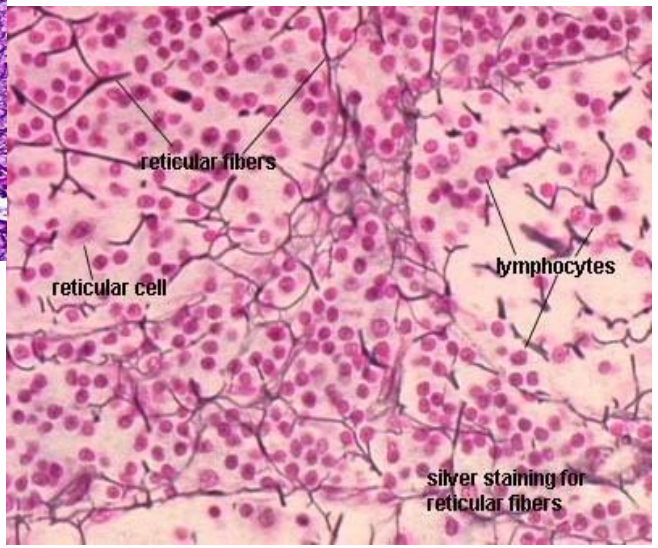
It presents in lymphoid tissue and delicate organs such as liver ,lymph nodes and bone marrow

Cells that synthesize and release reticular fibers are called reticular cells

These are fibroblast but they have specialized in reticular fibers synthesis



Dark areas = reticular fibers to surround , support and protect the hepatocytes which are the primary functional epithelial cells of the liver. Also, in the lymphoid organ we see delicate reticular fibers creating those tiny rooms to support the inner lymphoid cells



We can also identify those reticular cells because they are bigger and larger than those lymphocytes inside (which is small with small nucleus)

These Sections through a liver and a lymphoid organ

Medical Application
Collagen

Scurvy	Lack of vitamin C, a required cofactor for prolyl hydroxylase	Ulceration of gums, hemorrhages
Osteogenesis imperfecta	Change of 1 nucleotide in genes for collagen type I	Spontaneous fractures, cardiac insufficiency

Now , test yourself by this quiz:

https://forms.gle/L9NbTCBRNDQJ7CPQ7

For any feedback, scan the code or click on i

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			

Additional Resources:

Reference Used:
(numbered in order as cited in the text)

1. ***Dr. Ghada Abu Al-Ghanem's lecture***

رسالة من الفريق العلمي:

عن أبي هريرة عن النبي صلى الله عليه وسلم قال إنَّ اللهَ إذا أحَبَّ عَبدًا دَعا جِبريلَ فقال :إنِّي أُحِبُّ فُلانًا فأحِبَّه، قال :فيُحِبُّه جِبريلُ، ثُمَّ يُنادي في السَّماءِ، فيَقولُ :إنَّ اللهَ يُحِبُّ فُلانًا فأحِبُّوه، فيُحِبُّه أهلُ السَّماءِ، قال :ثُمَّ يوضَعُ له القَبولُ في الأرضِ، وإذا أبغَضَ عَبدًا دَعا جِبريلَ فيَقولُ : إنِّي أُبغِضُ فُلانًا فأبغِضْه، قال :فيُبغِضُه جِبريلُ، ثُمَّ يُنادي في أهلِ السَّماءِ :إنَّ اللهَ يُبغِضُ فُلانًا فأبغِضوه، قال : فيُبغِضونَه، ثُمَّ توضَعُ له البَغضاءُ في الأرضِ.

اللهم اجعلنا من عبادكَ الذين تُحبهم ، وترضى عنهم .