

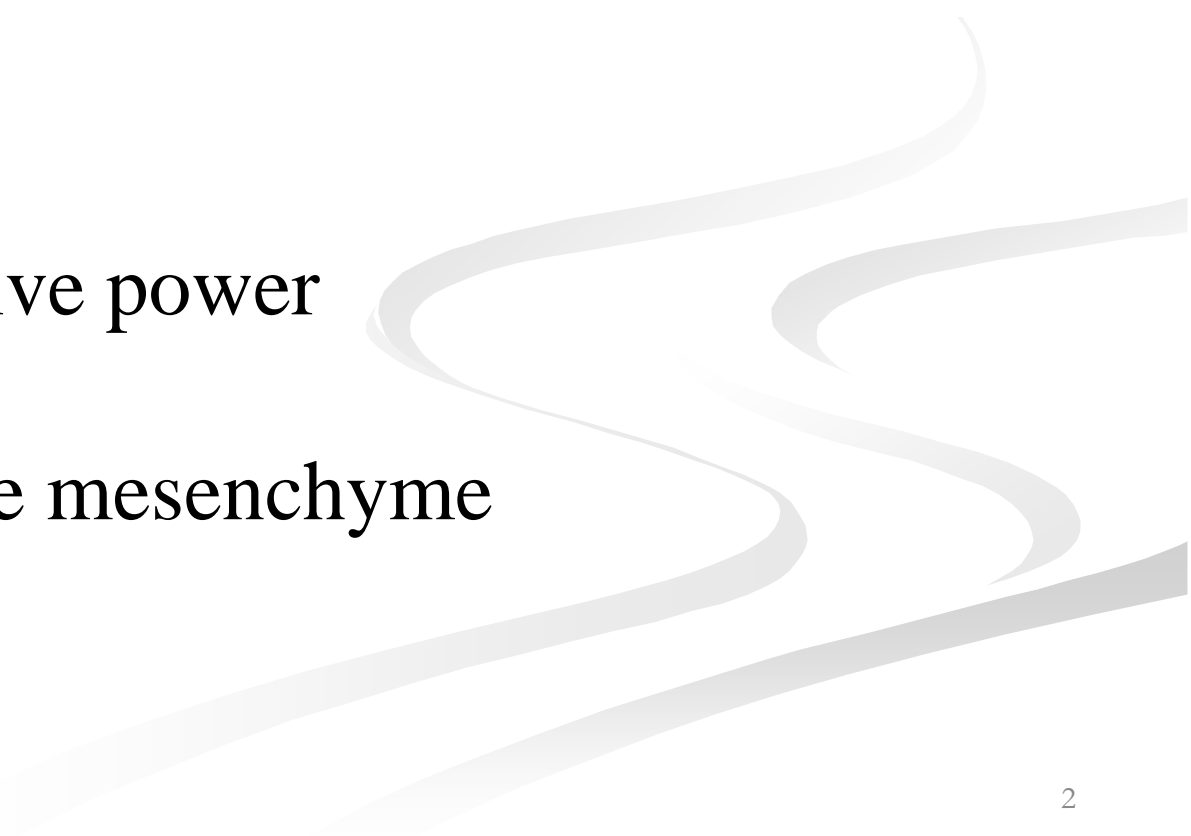


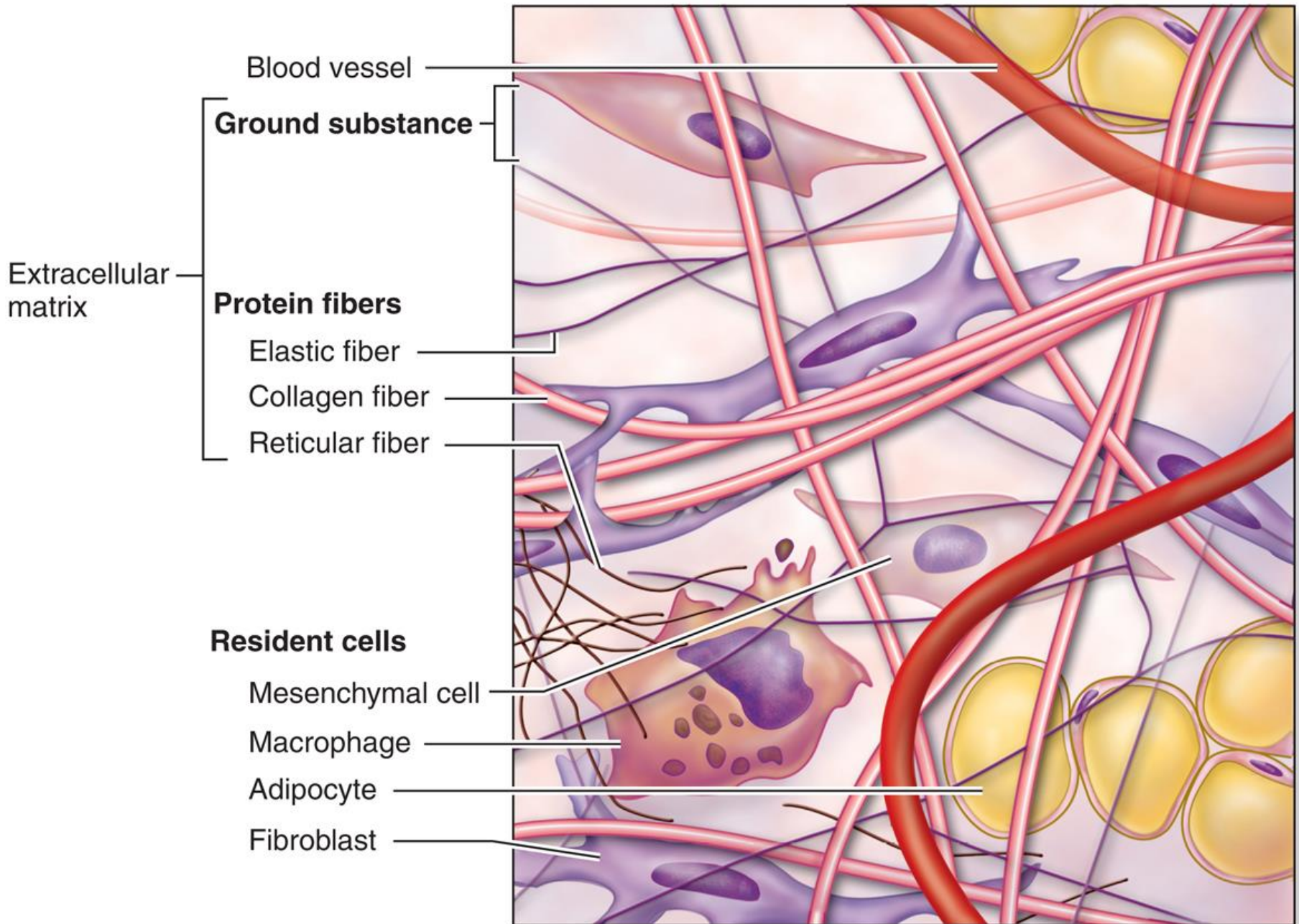
Connective Tissue

Part-2

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Features

- ✓ Composed of cells, fibers and extracellular matrix.
 - ✓ Highly vascular
 - ✓ Variable regenerative power
 - ✓ Originates from the mesenchyme
- 
- A decorative graphic consisting of several overlapping, wavy, light gray lines that flow from the right side of the slide towards the left, positioned behind the lower half of the text.



Functions of Connective Tissue

Support

Defense and protection

Storage

Transport

Extracellular Matrix

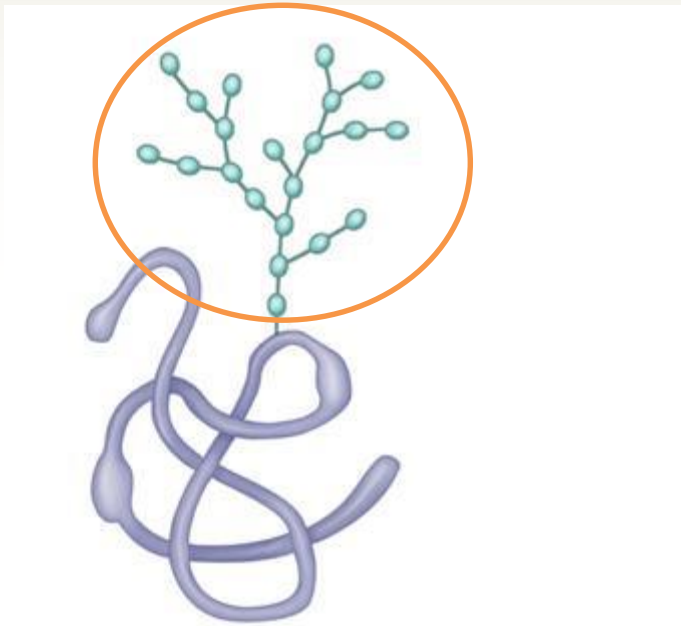
Extracellular Matrix = ground substance + fibers

- ✓ Resists compression and stretching forces.
- ✓ The water content allows rapid exchange of metabolites.

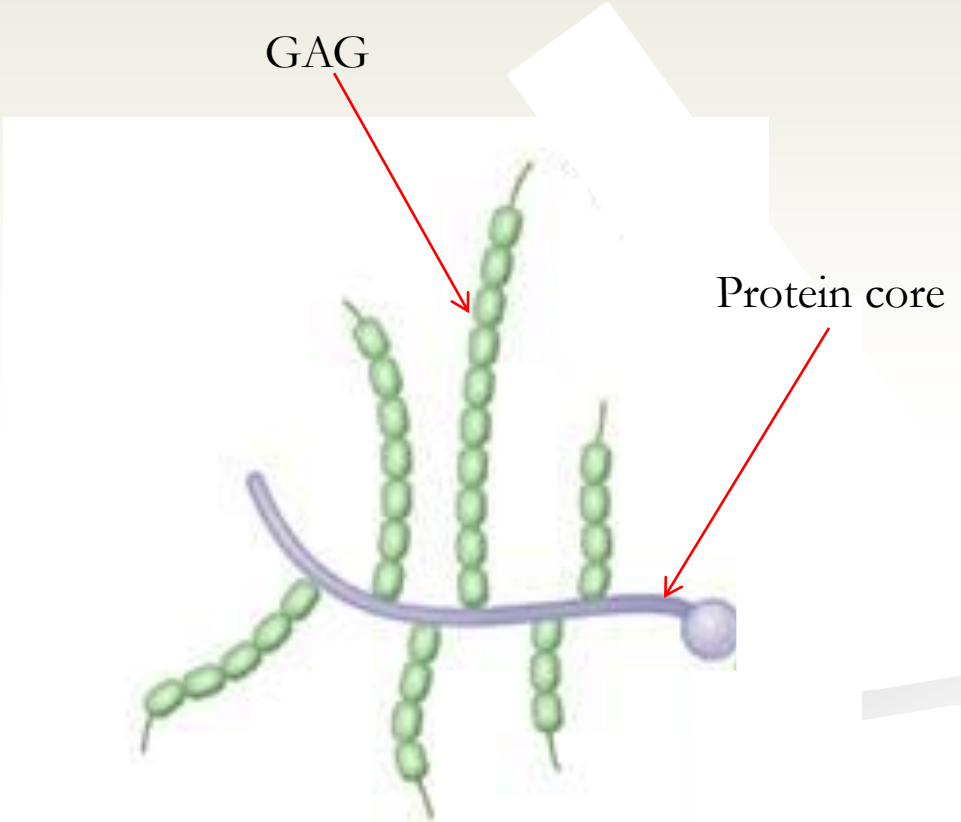
Ground Substance

Composed of:

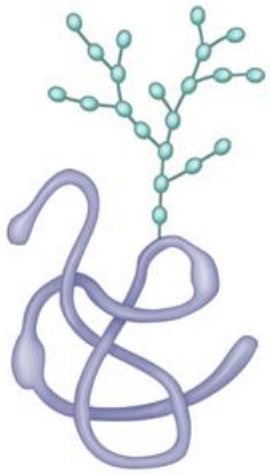
- Glycosaminoglycans:
 - Sulfated: keratan sulfate, chondroitin sulfate, dermatan sulfate and heparin.
 - Non-sulfated: hylauronic acid
- Proteoglycans: Responsible for the gel state of the extracellular matrix.
- Adhesive glycoproteins: laminin, chondronectin, osteonectin and fibronectin.



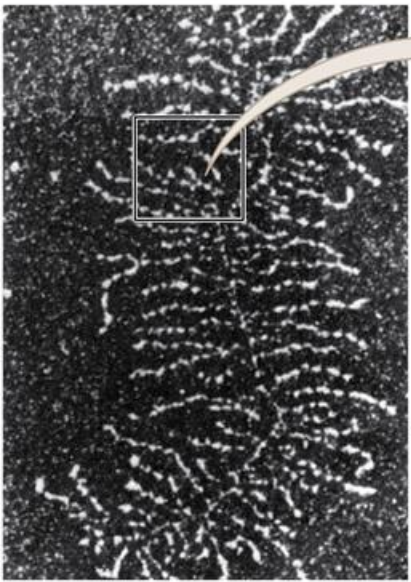
Glycoprotein



Proteoglycan



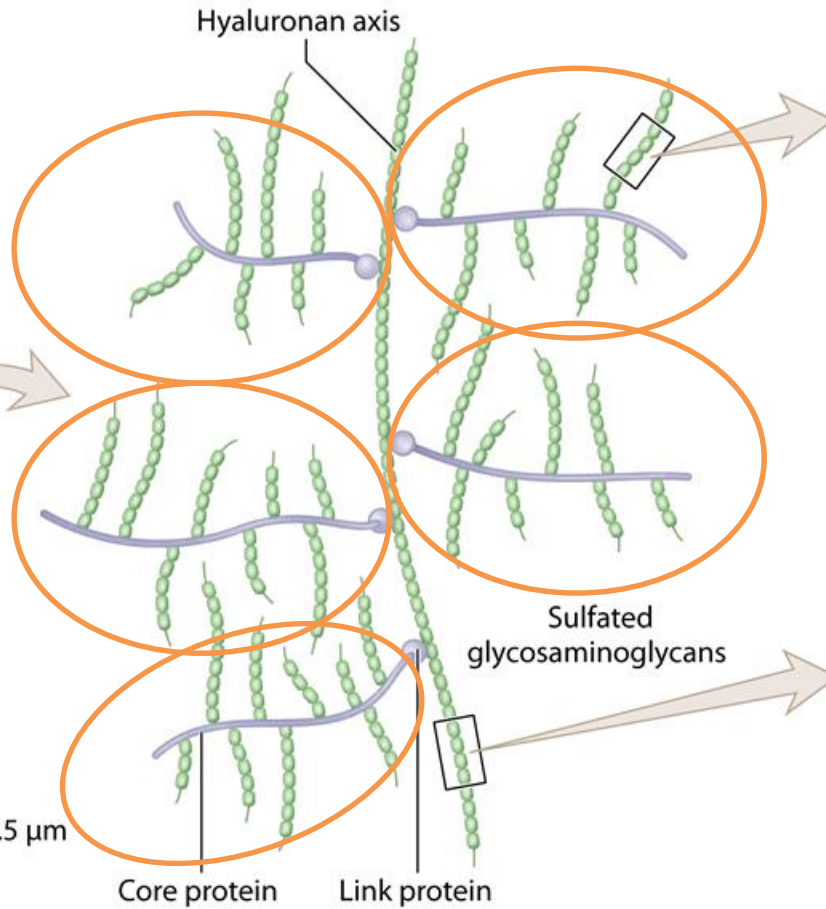
a A typical glycoprotein

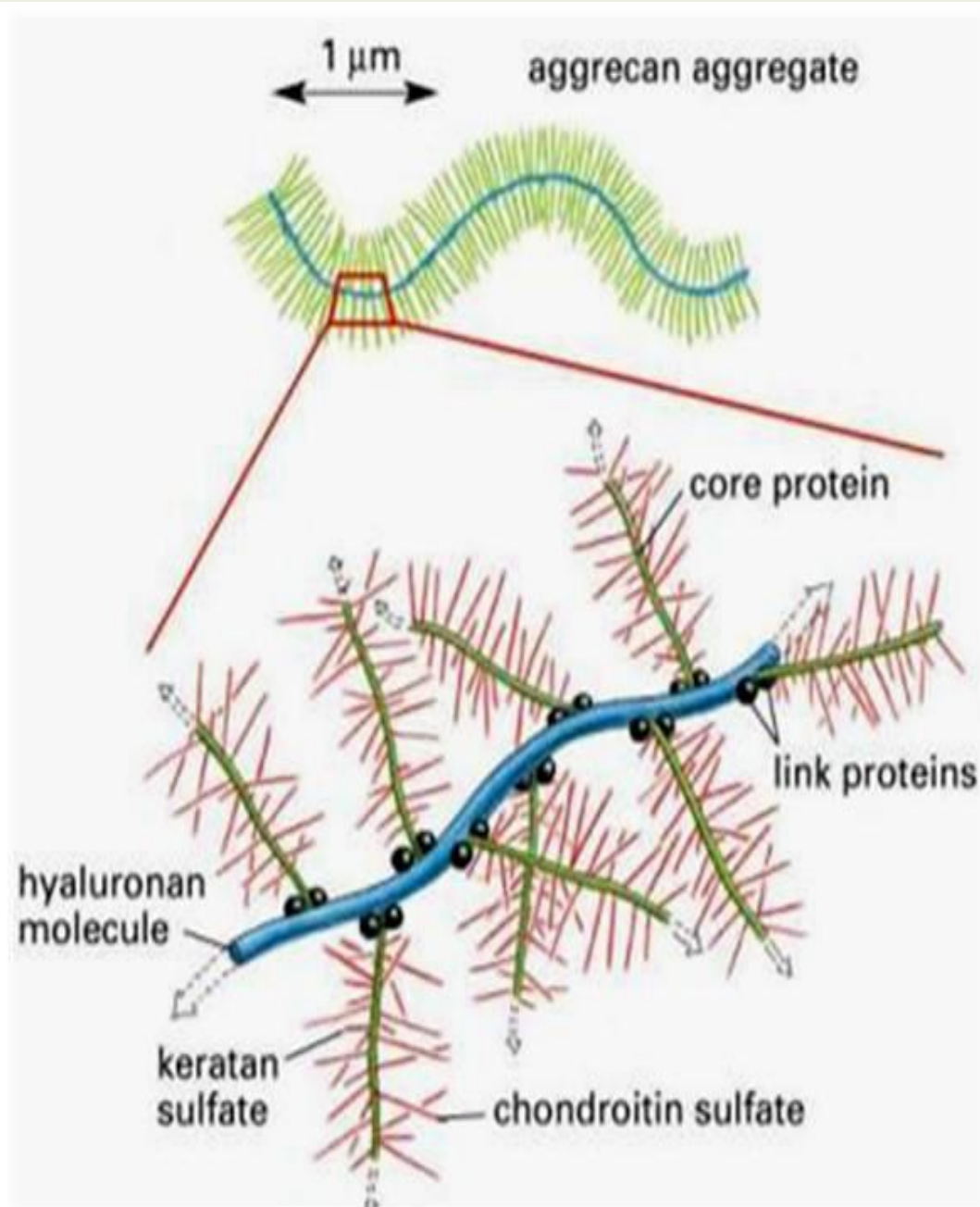
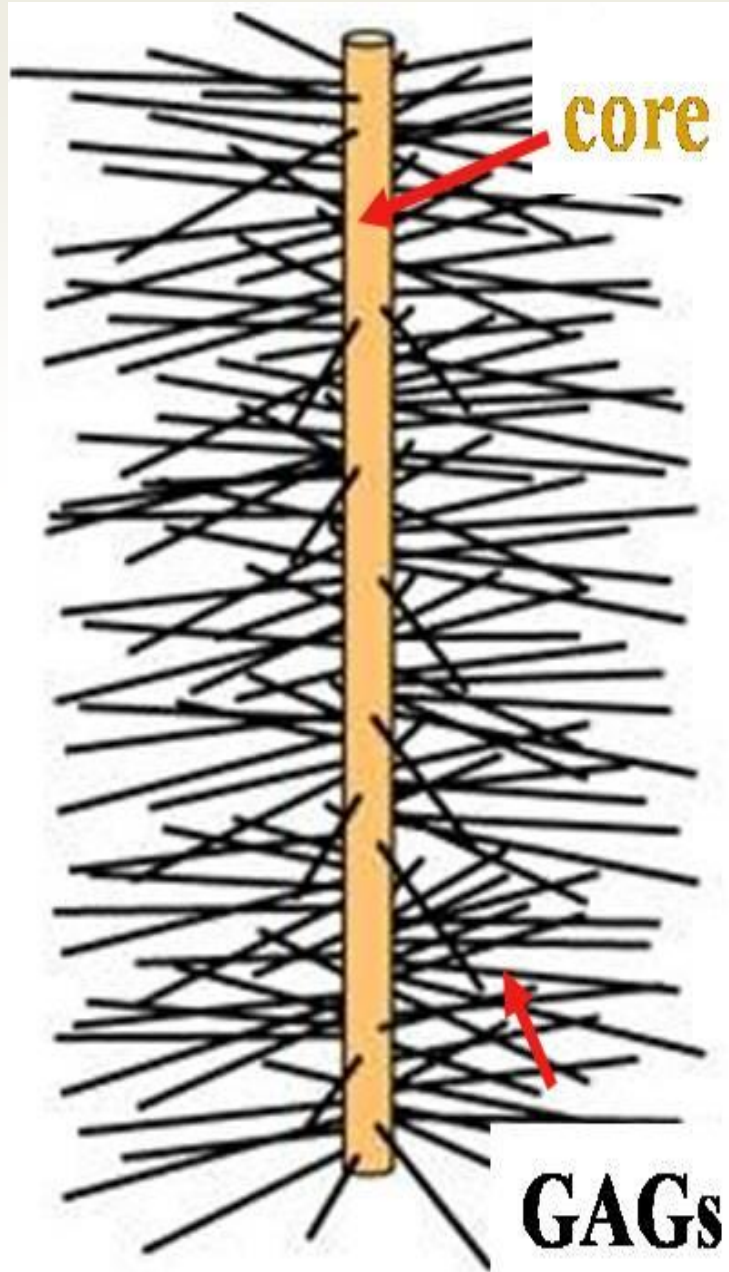


0.5 μm

b Proteoglycans linked to hyaluronan

hyaluronidase





Functions of Proteoglycans

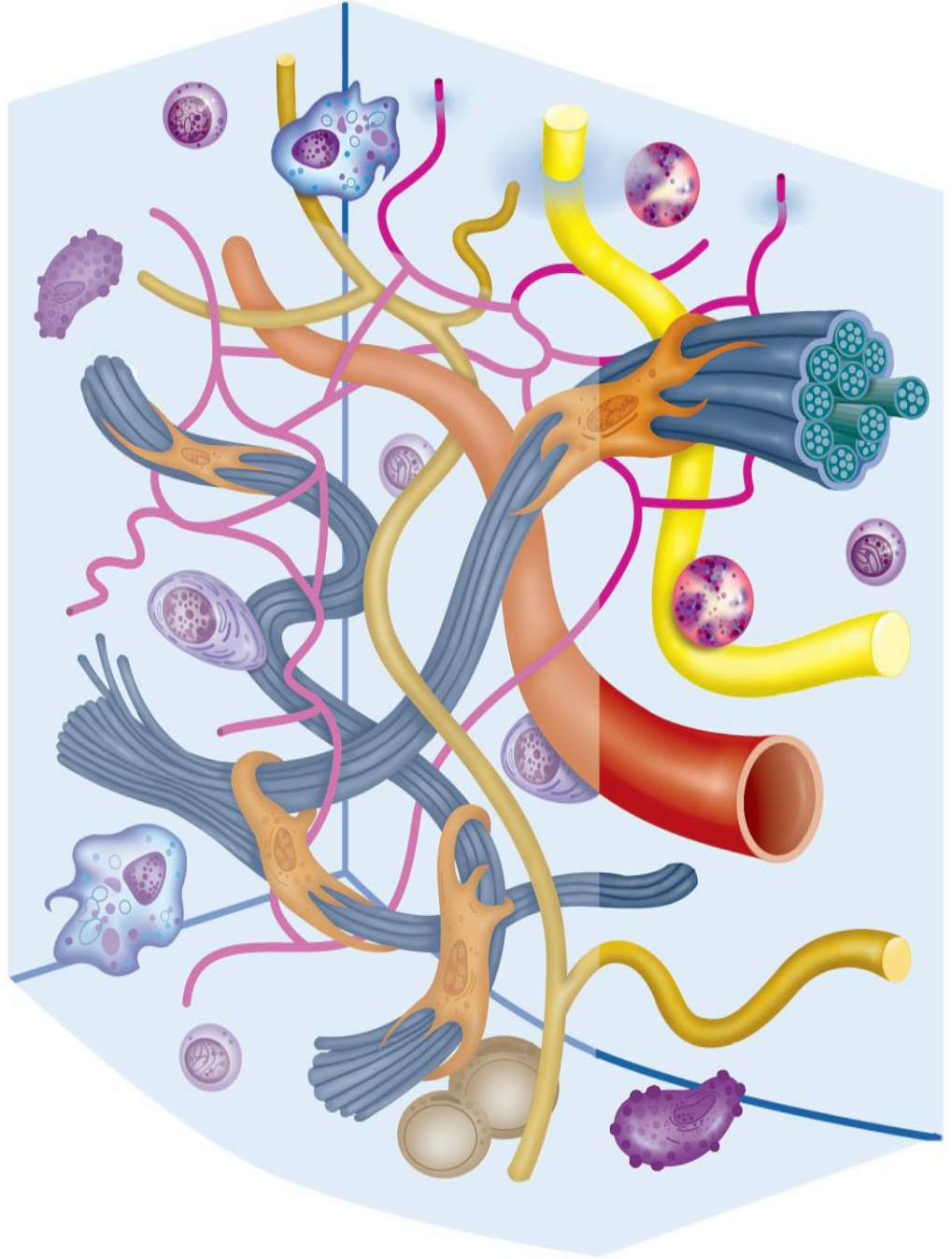
- Resistance of compression
- Retardation of movement of microorganisms
- Act as a filter

Types of GAGs

Read only

GAG	Distribution
Hyaluronic acid	Most connective tissue, cartilage, dermis, synovial fluid.
Keratan sulfate	Cartilage, cornea, intervertebral disc.
Heparan sulfate	Blood vessels, lung, basal lamina
Chondroitin 4-sulfate	Cartilage, bone, blood vessels
Chondroitin 6-sulfate	Cartilage, blood vessels, umbilical cord.
Dermatan sulfate	Skin, heart valves, blood vessels
Heparan sulfate (Heparin)	Mast cell granules, basophils, liver lung, skin.

Connective Tissue Fibers
Collagen
Elastic
Reticular



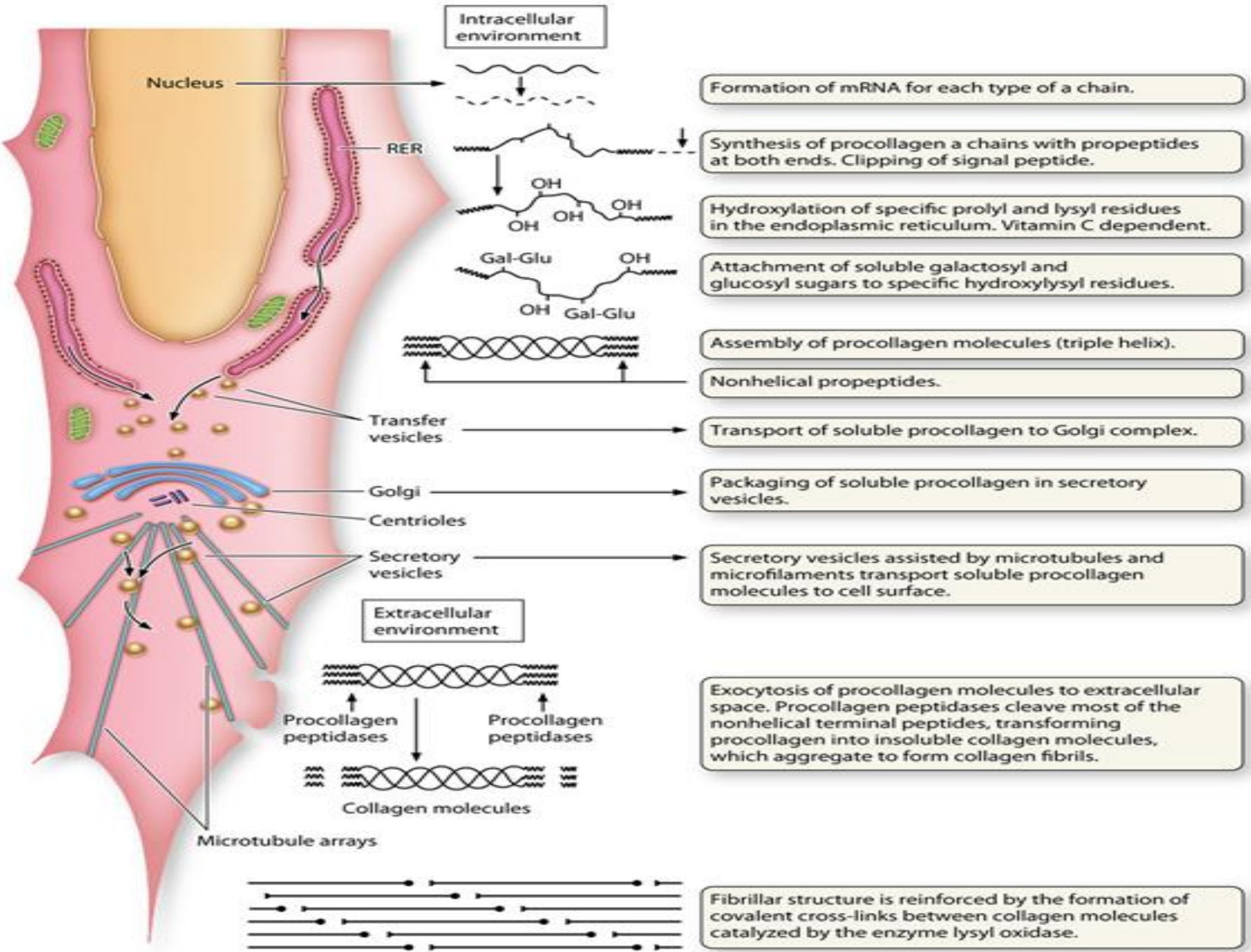
Collagen Fibers

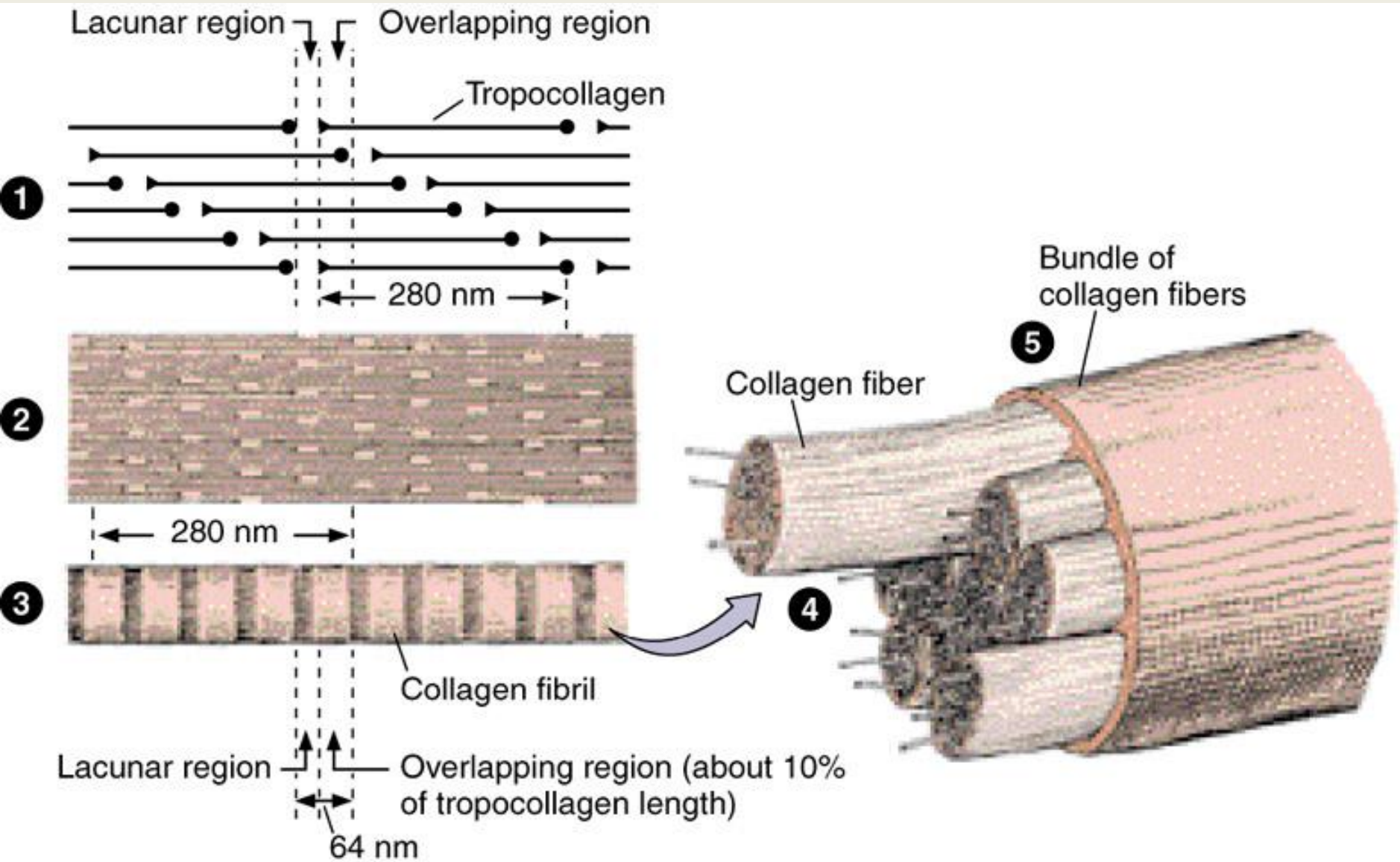
- Gives the extracellular matrix strength to resist tensile forces.
- Formed of protein collagen (30% of all proteins of the body).
- H & E: long, wavy pink bundles.
- Birefringent
- E.M: cross banding at 67 nm.
- Fibres are formed of aggregation of fibrils.
- Fibrils are formed of tropocollagen.
- Tropocollagen is formed of 3 helical polypeptide chains.

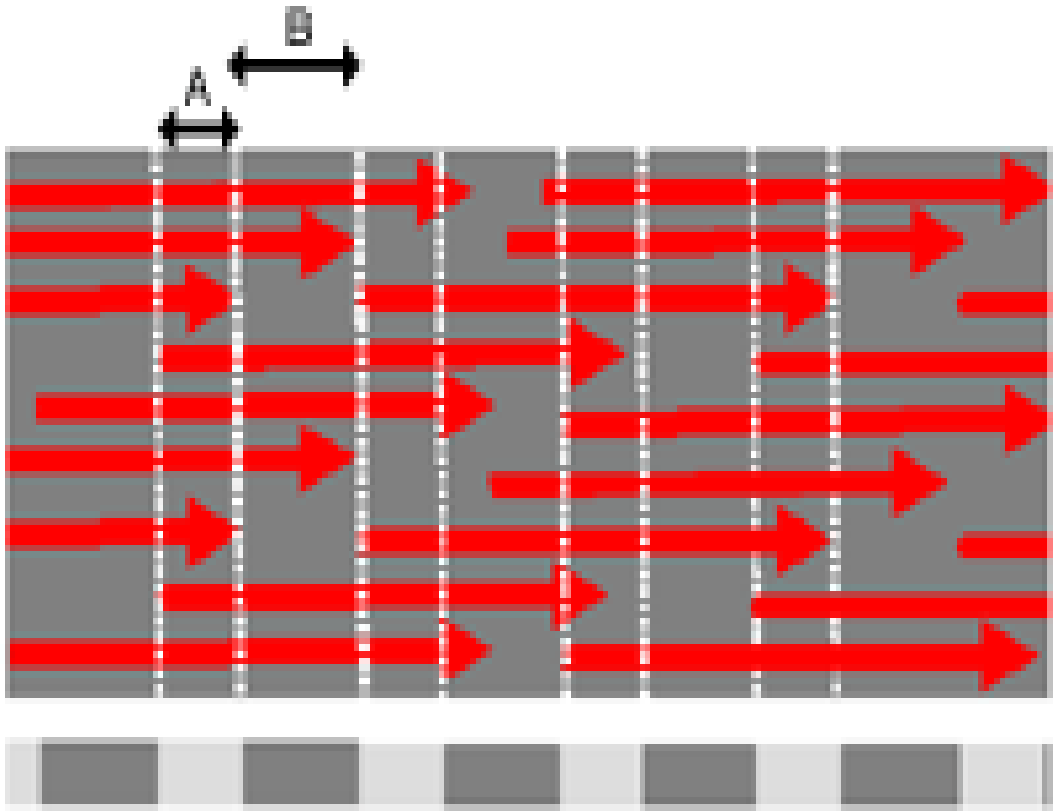
- α -chains possess 1000 amino acids.
- Every 3rd amino acid is glycine.
 - Other amino acids: proline, hydroxyproline, hydroxylysine.
- The sequence of aminoacids determines the type of collagen.
 - There are 28 types of collagen.

Major Types of Collagen

Type	Synthesizing cell	Function	Location
I	<u>Fibroblast, osteoblast, odontoblast, cementoblast</u>	Resist tension	<u>Dermis, tendons, ligament, capsules, bone, dentin, cementum</u>
II	chondroblasts	Resists pressure	Hyaline and elastic cartilage
III	Fibroblasts, reticular cells, smooth muscle, hepatocytes	Form structural framework of organs	Reticuloendothelial system, lung, skin
IV	Epithelium, muscle, Schwann cells	Meshwork of the lamina densa	Basal lamina
V	Fibroblasts, mesenchymal cells	Associated with type I.	As in type I and placenta
VII	Epidermal cells	Anchoring fibrils between the lamina densa and reticularis	Derma-epidermal junction







Collagen bundle



Fibers



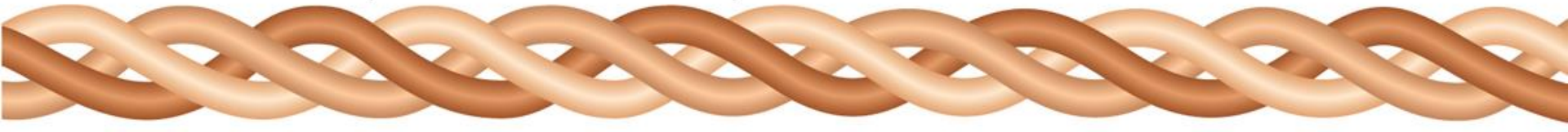
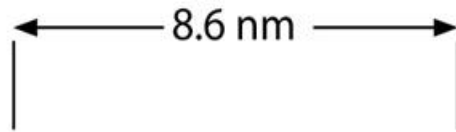
Fibrils

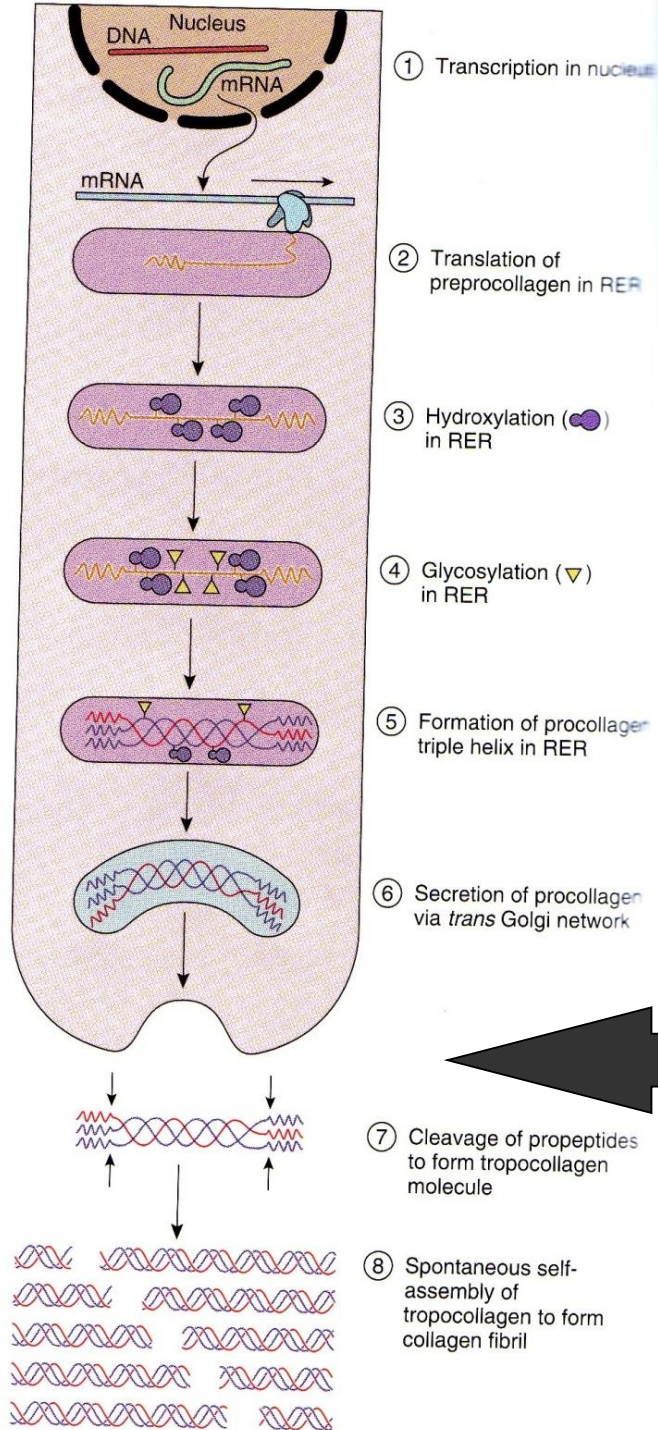


Tropocollagen



3 Helical polypeptide chains, α -chains.





Intracellular

- * Transcription (Nucleus).
- * Translation (rER).
- * Hydroxylation (rER).
- * Glycosylation (rER & Golgi).
- * Formation of the triple helix.
- * Secretion of procollagen (trans Golgi network and microtubules).

***** Vit. C is essential**

EXTRA CELLULAR

Cleavage and assembly

Clinical application

Vitamin C deficiency (Scurvy)

Keloid

Ehlers–Danlos syndrome



Vitamin C deficiency (Scurvy)





Keloids

Ehlers–Danlos syndrome – Type with Hypermobility



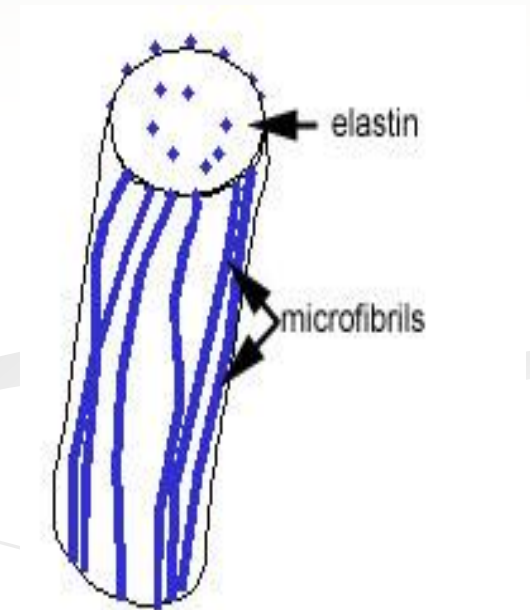
Elastic fibers

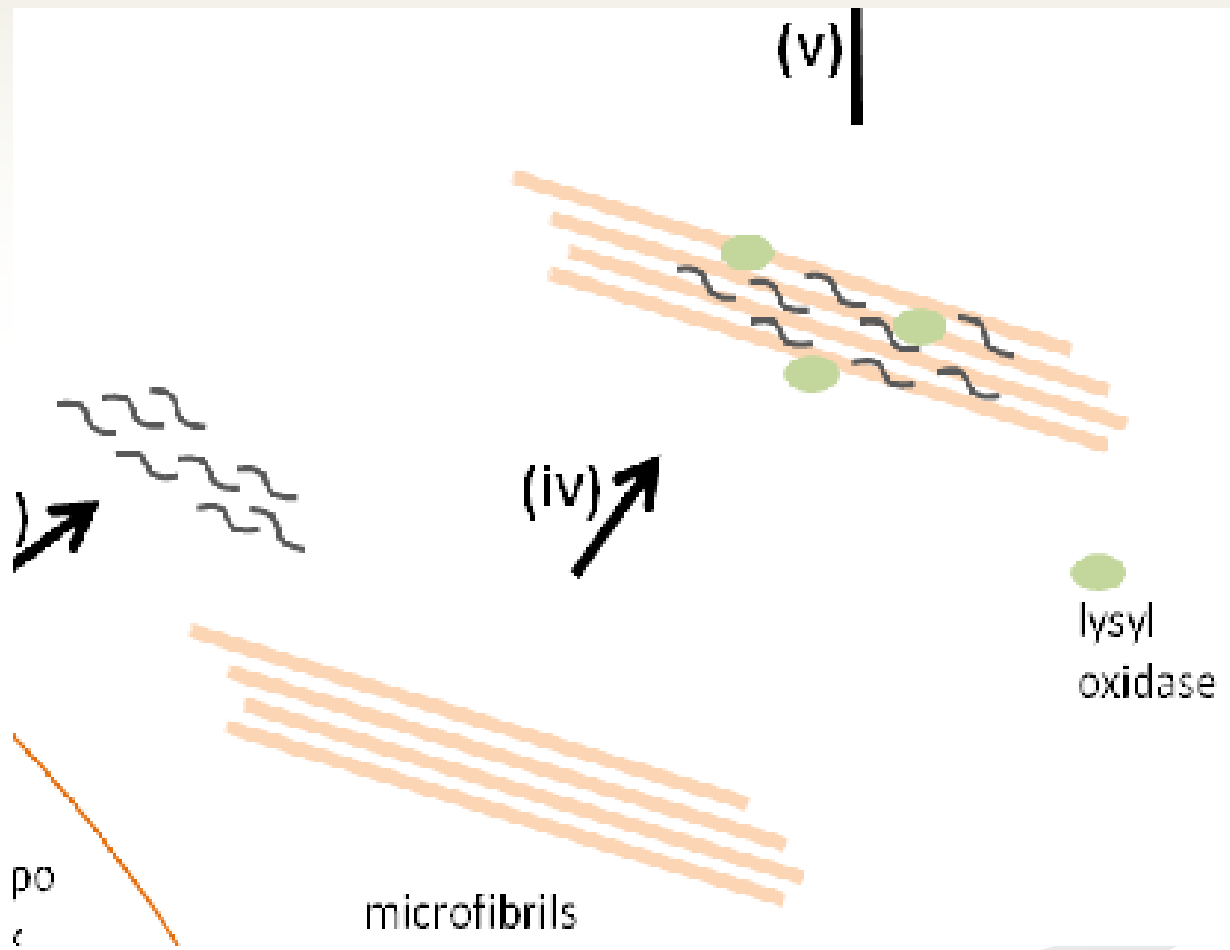
Elasticity is due to elastin.

Stability is due to fibrillin microfibrils
(resistant to boiling).

Appears yellow in fresh tissue (if large
amount is present)

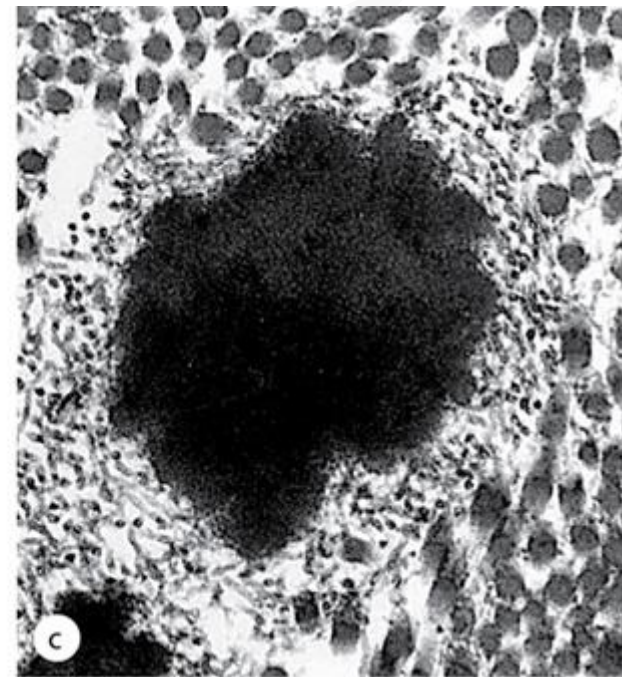
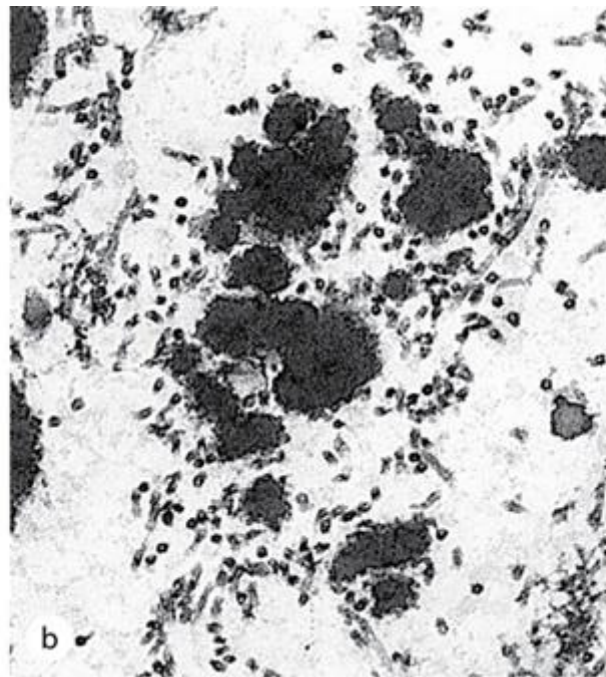
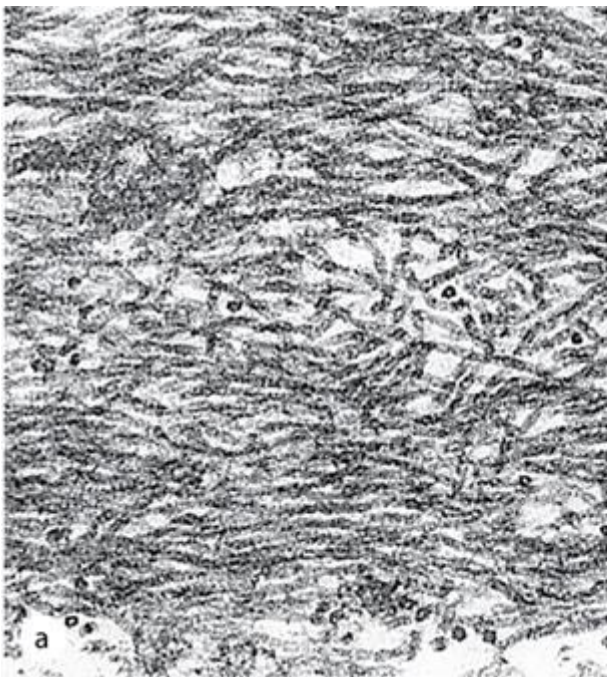
Digested by pancreatic enzyme elastase



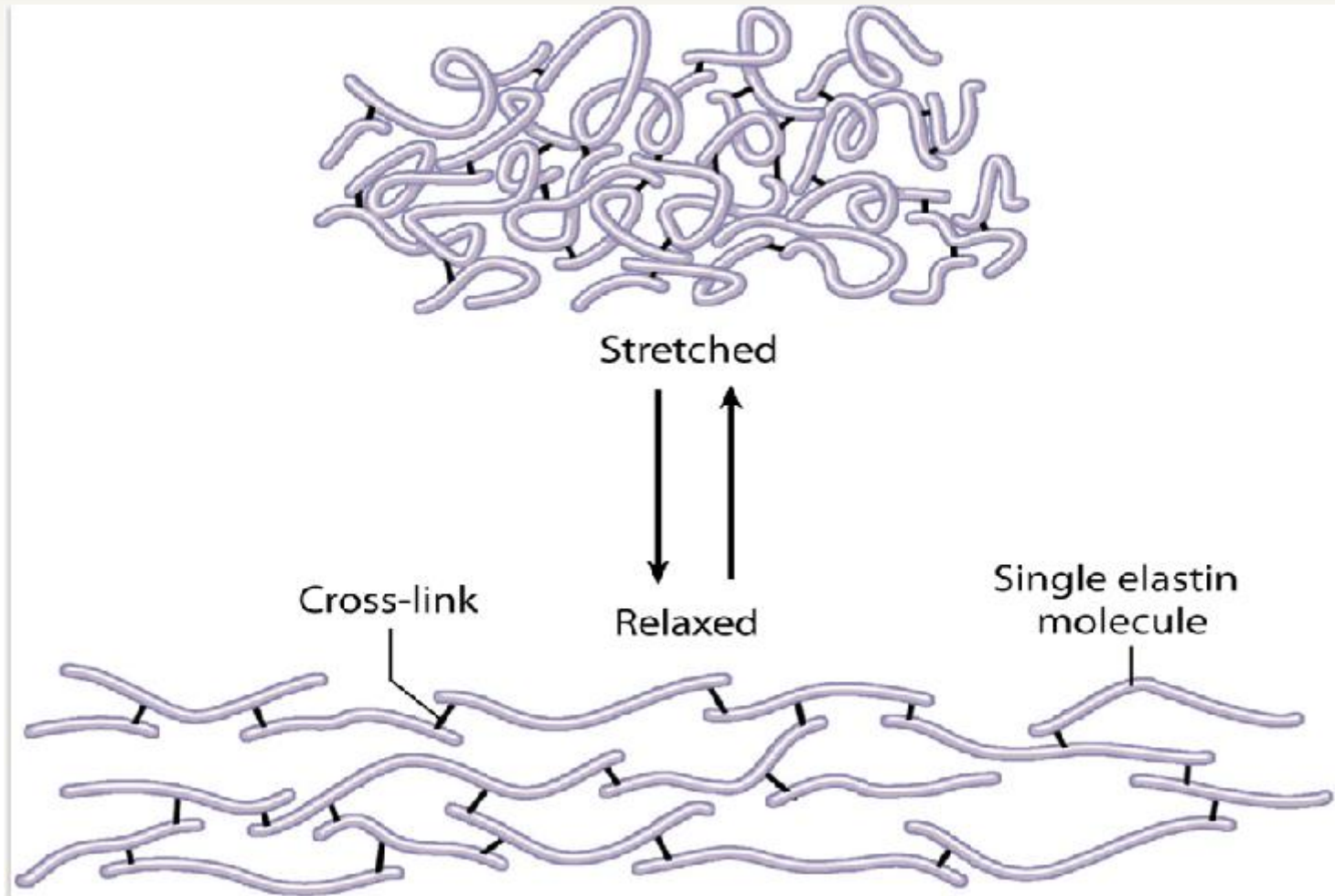


Elastic fibers consist of individual microfibrils (fibrillin) which are embedded in an amorphous matrix (90% of the fiber and composed of elastin)

Elastic material is found in certain ligaments (elastic ligaments), some cartilage (called elastic cartilage) and in large arteries (elastic arteries).

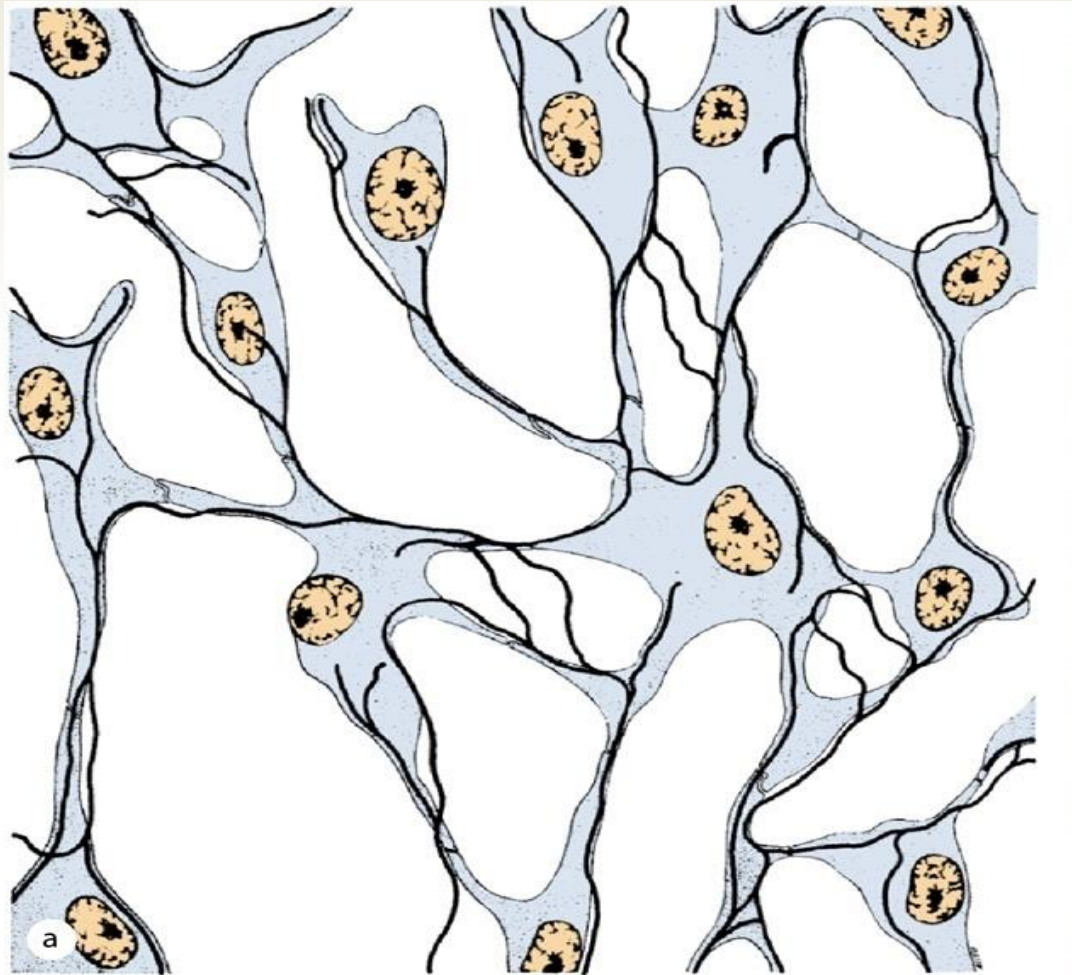


Elastin molecules are crosslinked by desmosine



Reticular fibers

- Consist mainly of type III collagen.
- Short, thin and branching.
- High sugar content
- Give PAS +ve reaction.
- Stain with Silver Nitrate (*Argyrophylic*).
- Found mainly in reticular lamina of basement membrane, RES organs (supporting stroma)



Reticuloendothelial System: liver, spleen, lymph nodes and bone marrow

Connective Tissue Fibers

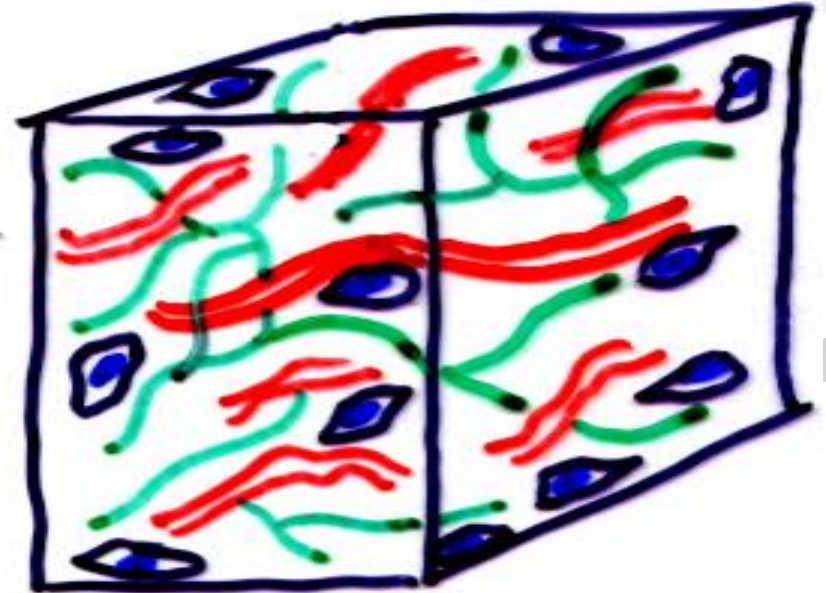
Fiber	Properties
Collagen	Undulating course of longitudinally striated bundles, stain pink-red in H&E. Nonextensible.
Elastic	Forms sheets or lamina, Unstained in H & E. Reversibly extensible. Stains brown-black in Orcein or Resorcin Fuchsin.
Reticular	Delicate network, Unstained in H & E. Reversibly extensible. PAS +ve, stains black in AgNO ₃ (Argyrophilic).

Classification of Connective Tissue

- **Connective tissue proper**: dense and loose
 - Loose (areolar)
 - Dense regular
 - Dense irregular
- **Special connective tissue**:
 - Reticular
 - Elastic
 - Adipose
 - Bone
 - Cartilage
 - Blood
- **Embryonic connective tissue**
 - Mesenchymal connective tissue
 - Mucous connective tissue

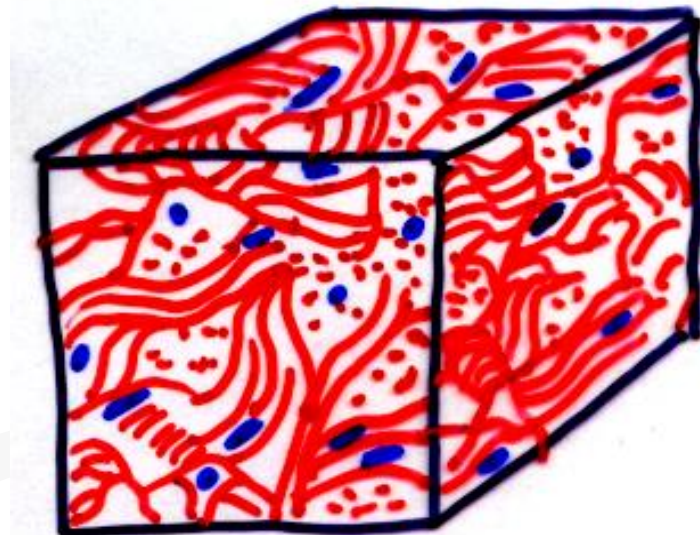
Loose connective tissue

- Called also areolar connective tissue
- Typically contains cells, fibers and ground substance in equal amounts
- Supports epithelium (ex. lamina propria)
- Surrounds small blood vessels
- Fills spaces between muscle and nerve cells
- Its flexible but not very resistant to stress



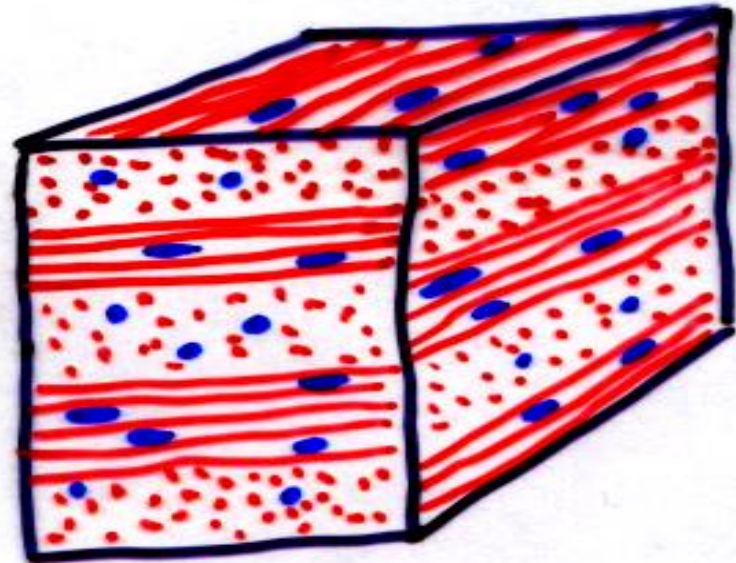
Dense irregular connective tissue

- Bundles of collagen fibers are randomly interwoven with no definite orientation
- Provides resistance to stress from all directions
- Dermis of skin (deeper layer), organ capsules, submucosa



Dense regular connective tissue

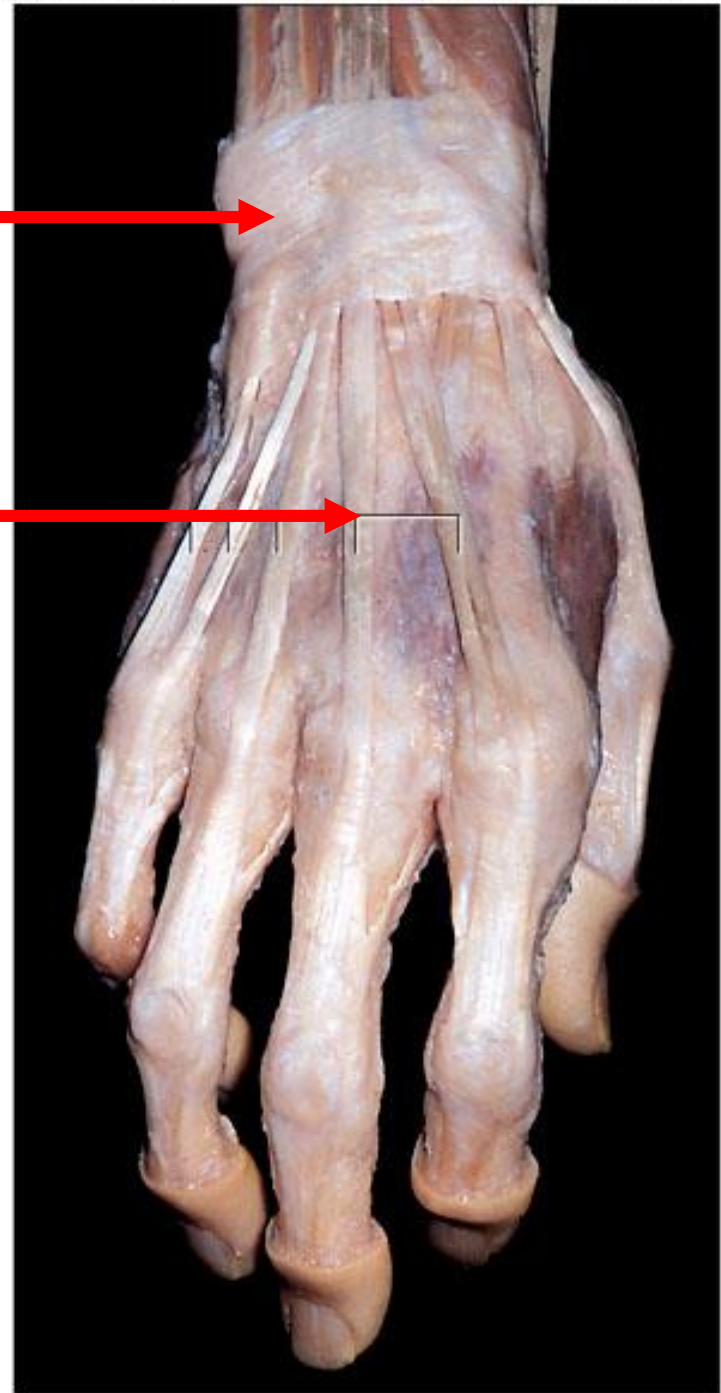
- Parallel Bundles of collagen fibers with few fibrocytes aligned with collagen and separated by very little ground substance
- Provides resistance to prolonged or repeated stresses exerted in the same direction
- Ligaments , tendons, aponeuroses
- Tendons are poorly vascularized and repair of damaged tendons is very slow

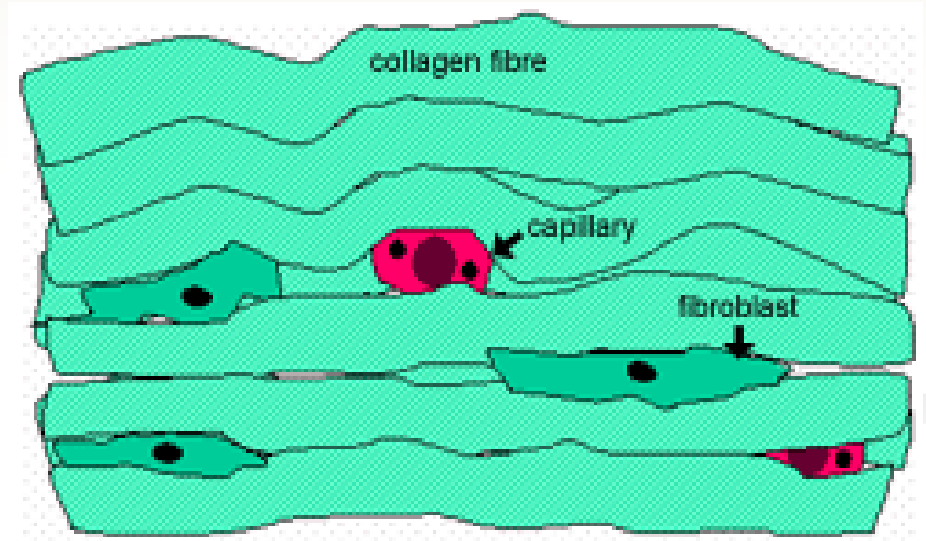
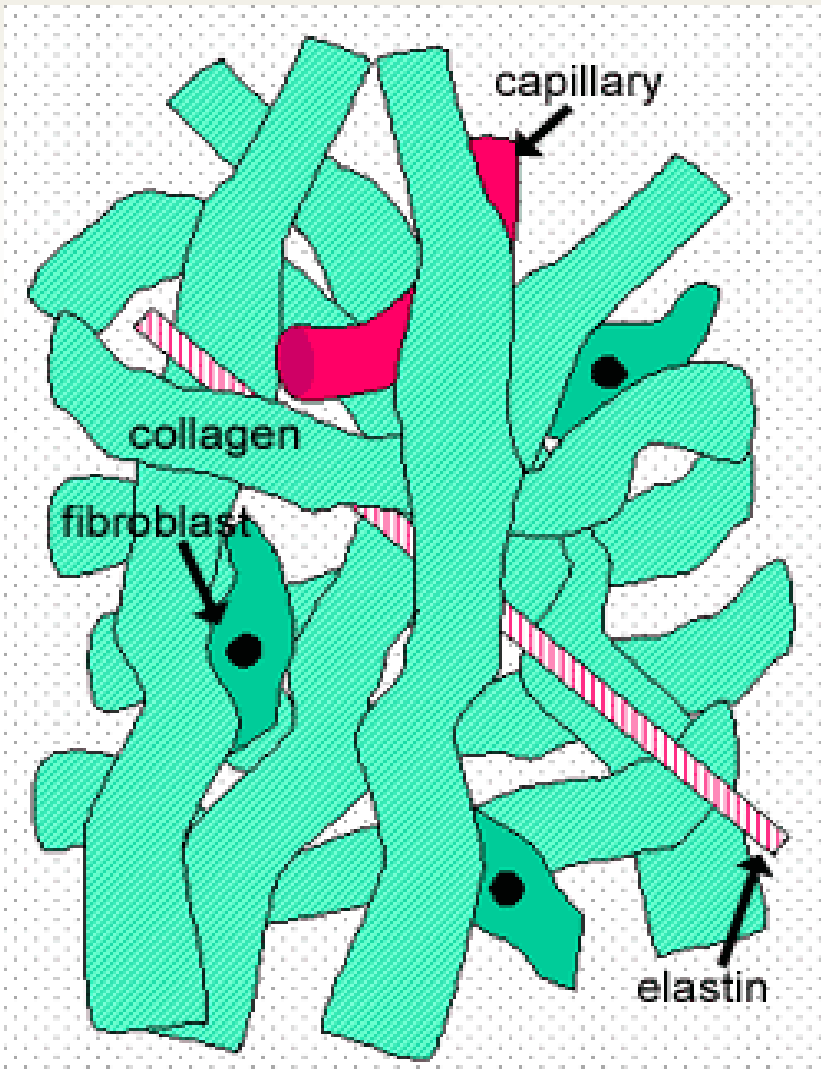


Collagen

**Tendon
(collagen)**

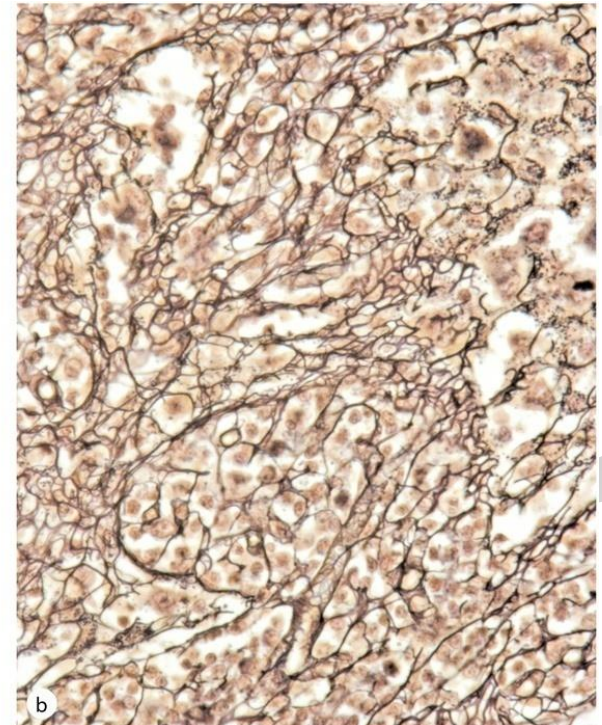
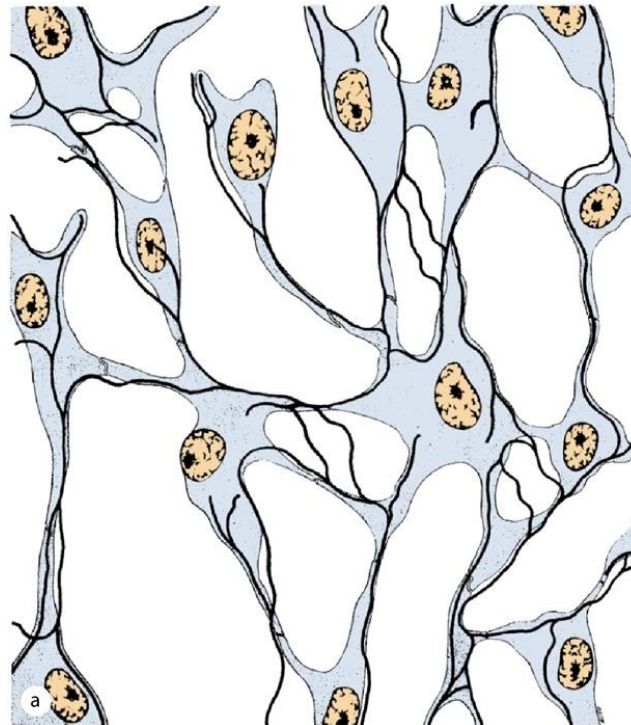
*Note the whitish appearance
of collagen fibers*





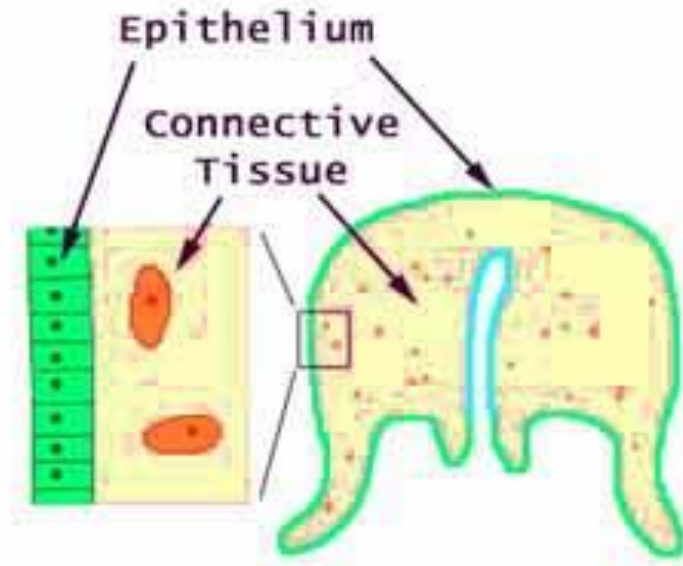
Reticular connective tissue

- Consists of reticular cells (modified fibroblasts) and the network of reticular fibers formed by them
- Forms the structural framework in which the cells of the organ are suspended
- In the liver, bone marrow, lymph nodes and the spleen



Mesenchymal connective tissue

- Mesenchyme forms the undifferentiated "filling" of the early embryo.
- It consists of mesenchymal cells, which interconnect by slender cell processes.
- Mesenchymal cells have stem cell properties, i.e. they are able give rise to other cell and tissues types.
- The wide extracellular space between the mesenchymal cells is occupied by ground substance, which can be stained with dyes that also stain mucin - hence the alternative name of this tissue type: muroid connective tissue



Mesenchymal connective tissue

Mucoid connective tissue also forms a compliant cushion around the vessels of the umbilical cord, where it is also called Wharton's jelly.

In adult humans, mesenchymal connective tissue is only found in the dental pulp.

