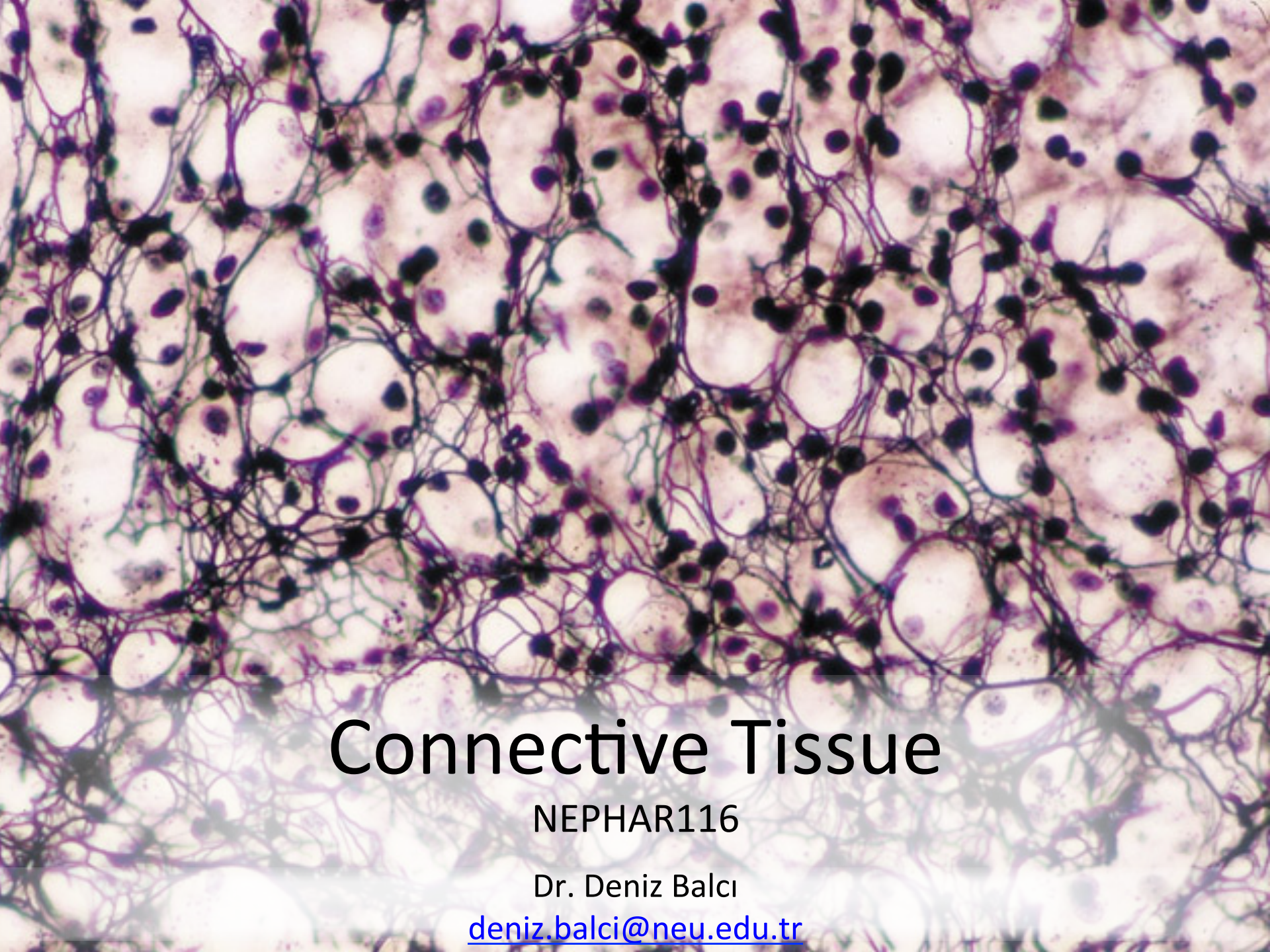

Connective Tissue

NEPHAR116

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Connective Tissue

- Originate from embryonic tissue called **mesenchyme**

- **Most diverse and abundant** type of tissue

Function:

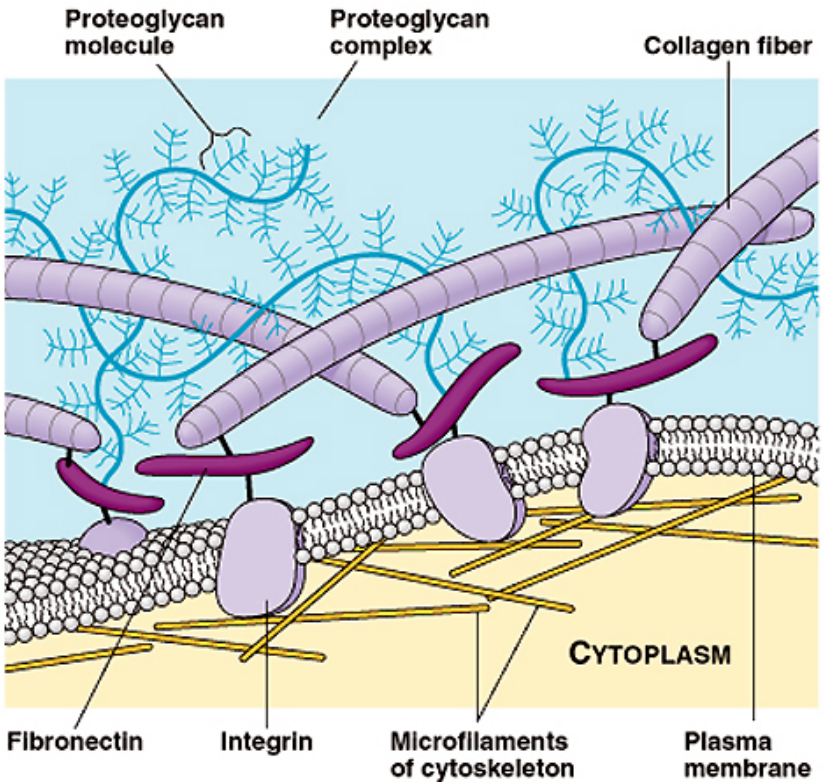
- **Enclose organs** as a capsule and separate organs into layers. Areolar
- **Connect** tissues to one another. Tendons and ligaments.
- **Regeneration.** Fibroblast.
- **Support and movement**. Bones.
- **Storage.** Adipose.
- **Insulation.** Adipose.
- **Transport.** Blood.
- **Protection.** Bone, cells of the immune system.

Connective Tissue Lecture Outline

- Extracellular matrix of connective tissue
- Cells of connective tissue
- Classification and examples of connective tissue

Composition of Connective Tissue

- Extracellular matrix (ECM) is the major component of connective tissue. → The area between cells
- Cells are a minor component of connective tissue.
- The other basic tissues (epithelium, muscle, nerve) are fundamentally different in that they are composed mainly of cells.



Composition of Extracellular Matrix (ECM)

Protein fibers

- Collagen fibers
- Elastic fibers

Ground substance

- Glycosaminoglycans
- Proteoglycans
- Glycoproteins

Tissue fluid (interstitial fluid)

A thin watery fluid that brings nutrients, electrolytes, hormones, and oxygen from blood and dumps waste products into lymph.

Two Main Protein Fibers in ECM

Collagen protein (Collagen gives structure)

- Flexible, non-extensible
- Over 20 types!
- Made of polypeptide chains
- **Reticular fibers (crossed collagen) gives order**

Elastic fibers (Elastin gives elasticity)

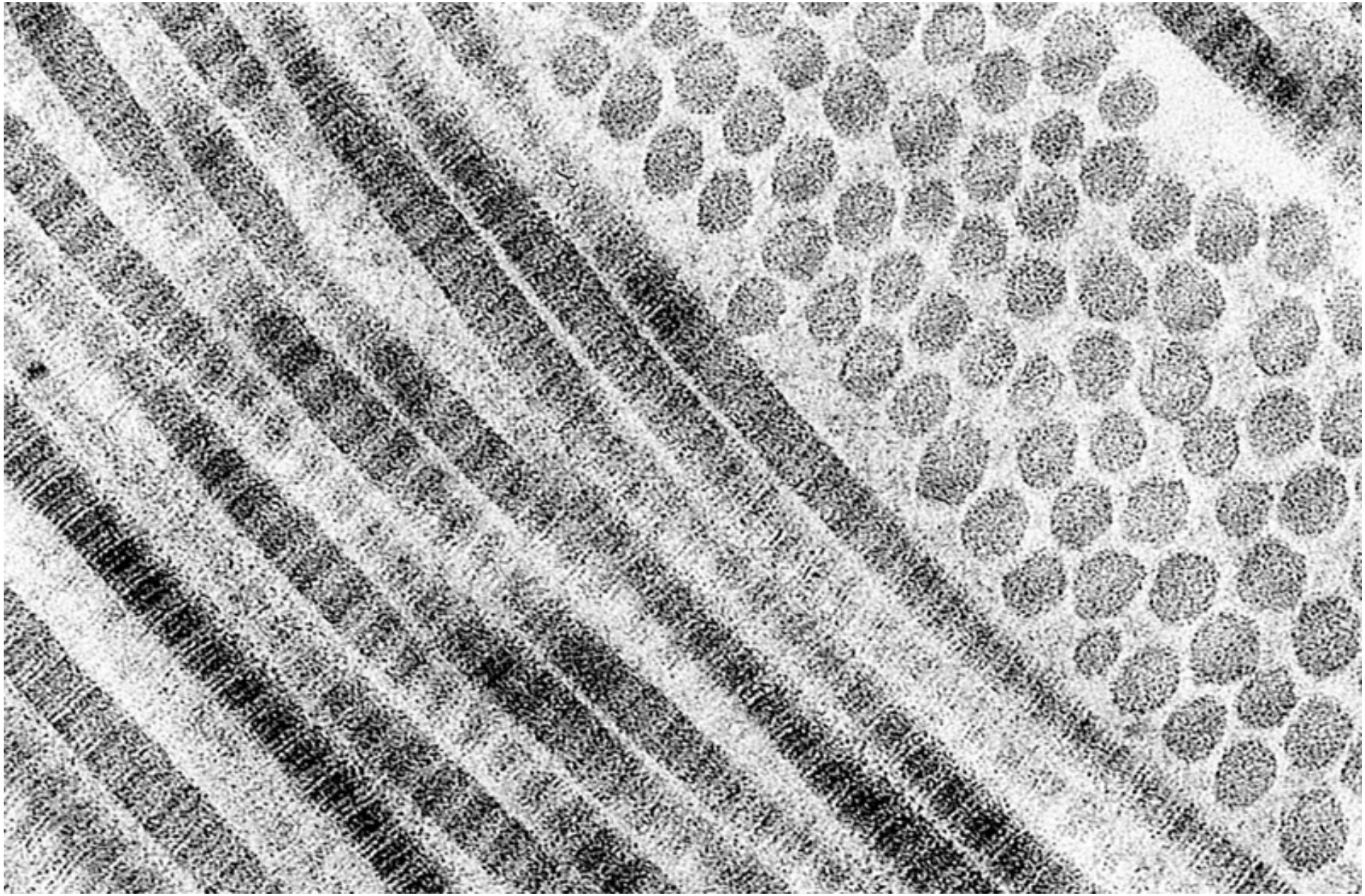
- Thinner than collagen, and stretchier
- Made of elastin and fibrillin

Some (!) Types of Collagen

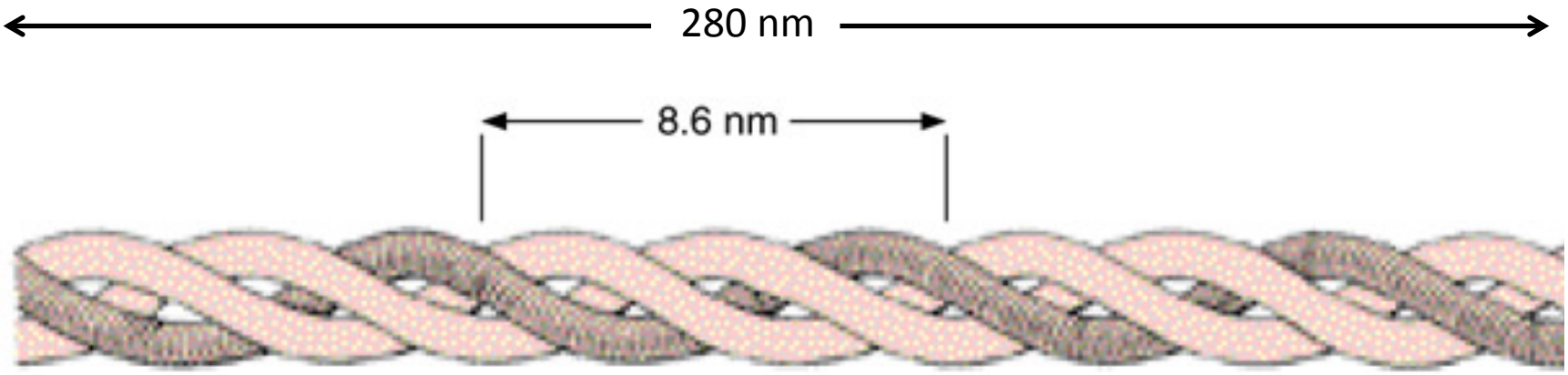
Type	Structure	Light microscope	Common locations	Main function
I	**280-nm banded fibrils**	**Thick! Can form fibers and bundles**	**Skin, tendon, bone, dentin, cementum**	**Resistance to tension**
II	280-nm banded fibrils	Loose fibrils	Cartilage	Resistance to pressure
III	**280-nm banded fibrils**	**Also called reticulin. Need silver stain to see.**	**Skin, muscle, blood vessels, hematopoietic organs**	**Maintains structure in expansible organs**
IV	**Cross-linked network**	**Not visible**	**All basal lamina**	**Support, filtration**
VII	Anchoring fibrils	Not visible	Epithelium and basement membrane	Anchors epithelium to connective tissue

Collagen Types I, II, III = "Fibrillar"

Type	Locations	Cell of synthesis	Microscopic	Main function
I	Dermis, tendon, bone, dentin, fibrocartilage, organ capsules, sclera	Fibroblast, osteoblast, odontoblast, chondroblast of fibrocartilage	Thick. Forms bundles. Eosinophilic in H&E stains.	Resistance to tension
II	Cartilage (both hyaline and elastic)	Chondroblast	Thin! Abundant ground substance.	Resistance to pressure
III	Smooth muscle, endoneurium, spleen, liver, lymph nodes, kidney, arteries	Smooth muscle, fibroblast, Schwann cell, hepatocyte	Thin, uniform diameter, forms networks. Need silver stain to see.	Flexible network in expansible organs

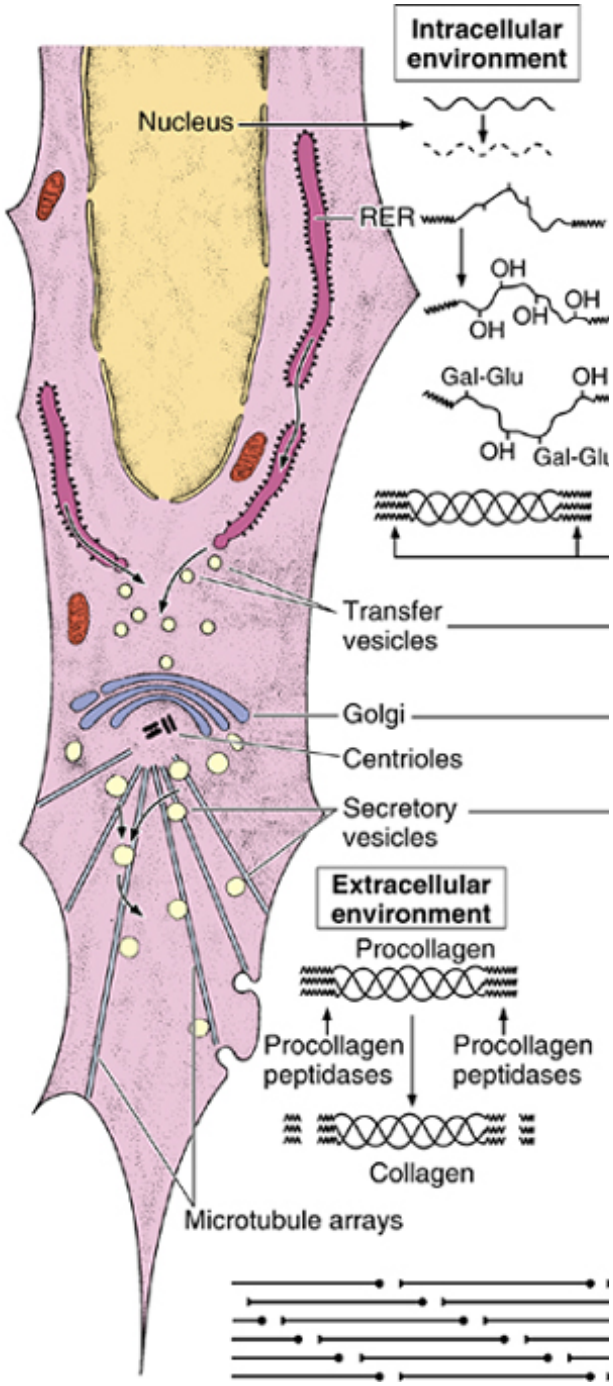


Collagen fibers, longitudinal and in cross-section, by EM



Type I collagen is the **most abundant** form of collagen and is made of tropocollagen molecules

How do fibroblasts make collagen?



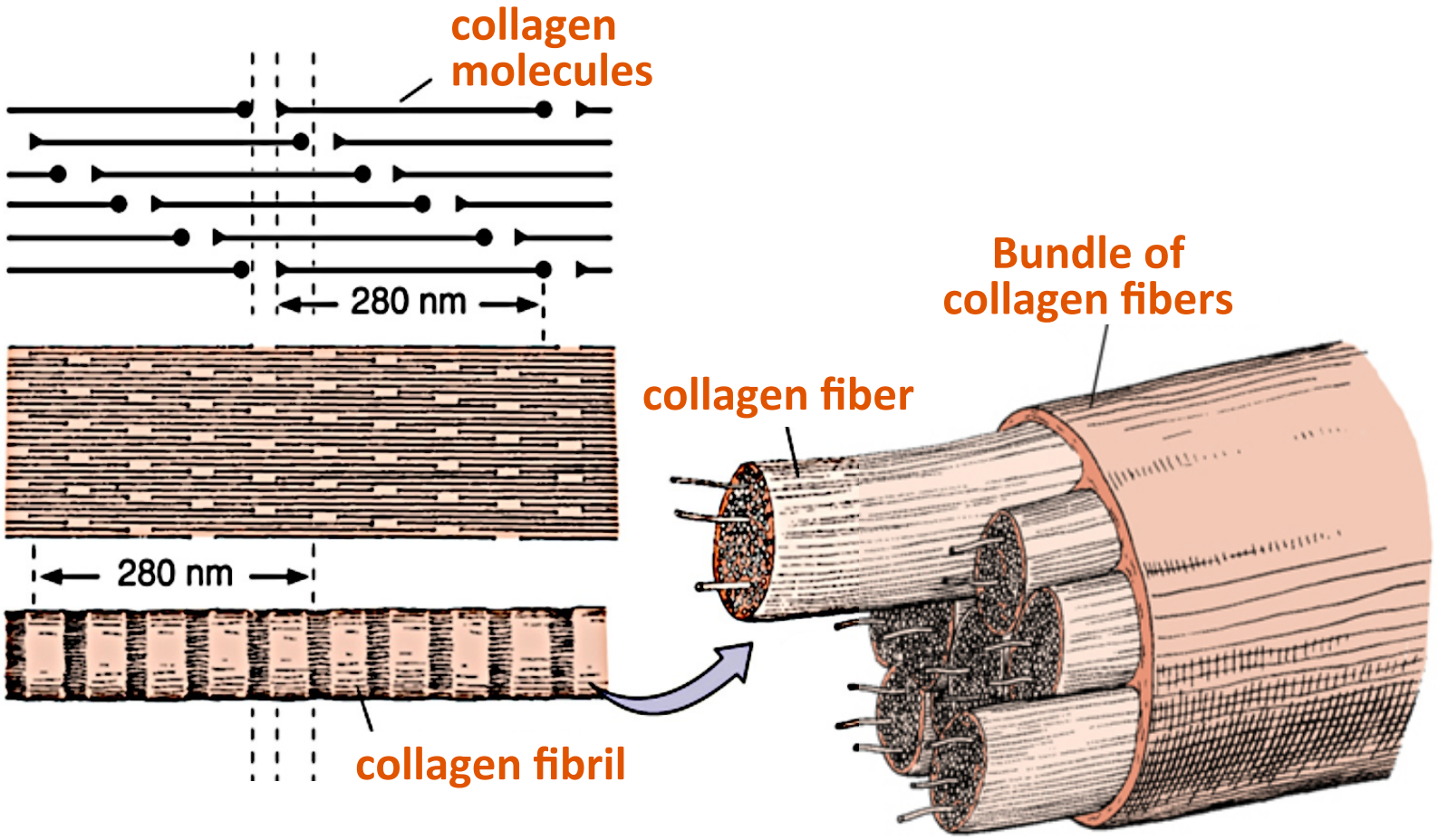
RER makes procollagen molecules. You will learn about this *ad nauseum* in biochemistry.

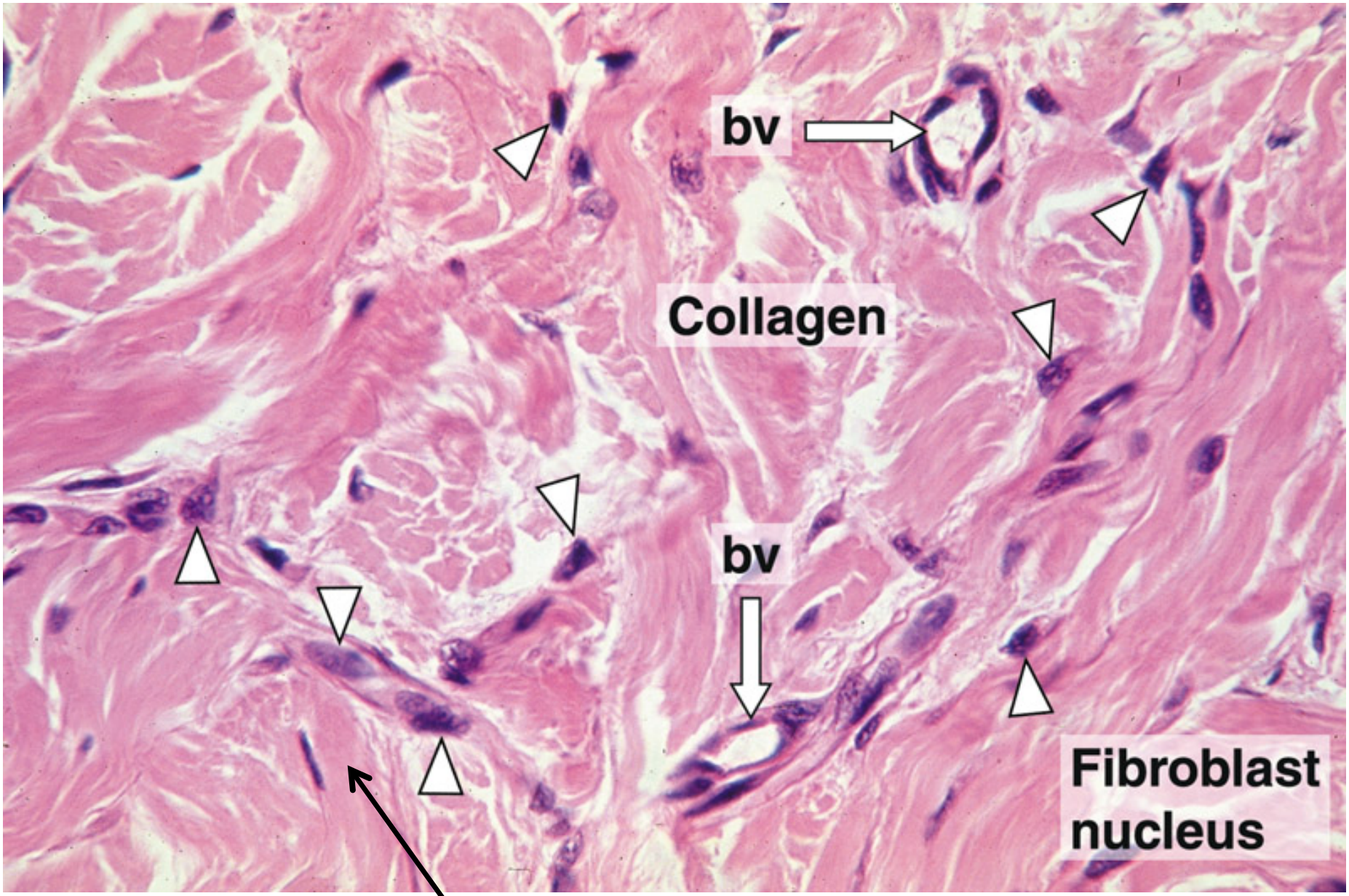
Golgi packages procollagen, secretory vesicles transport it to extracellular space.

Procollagen (soluble) is cleaved into tropocollagen (insoluble) which aggregates to form collagen fibrils.

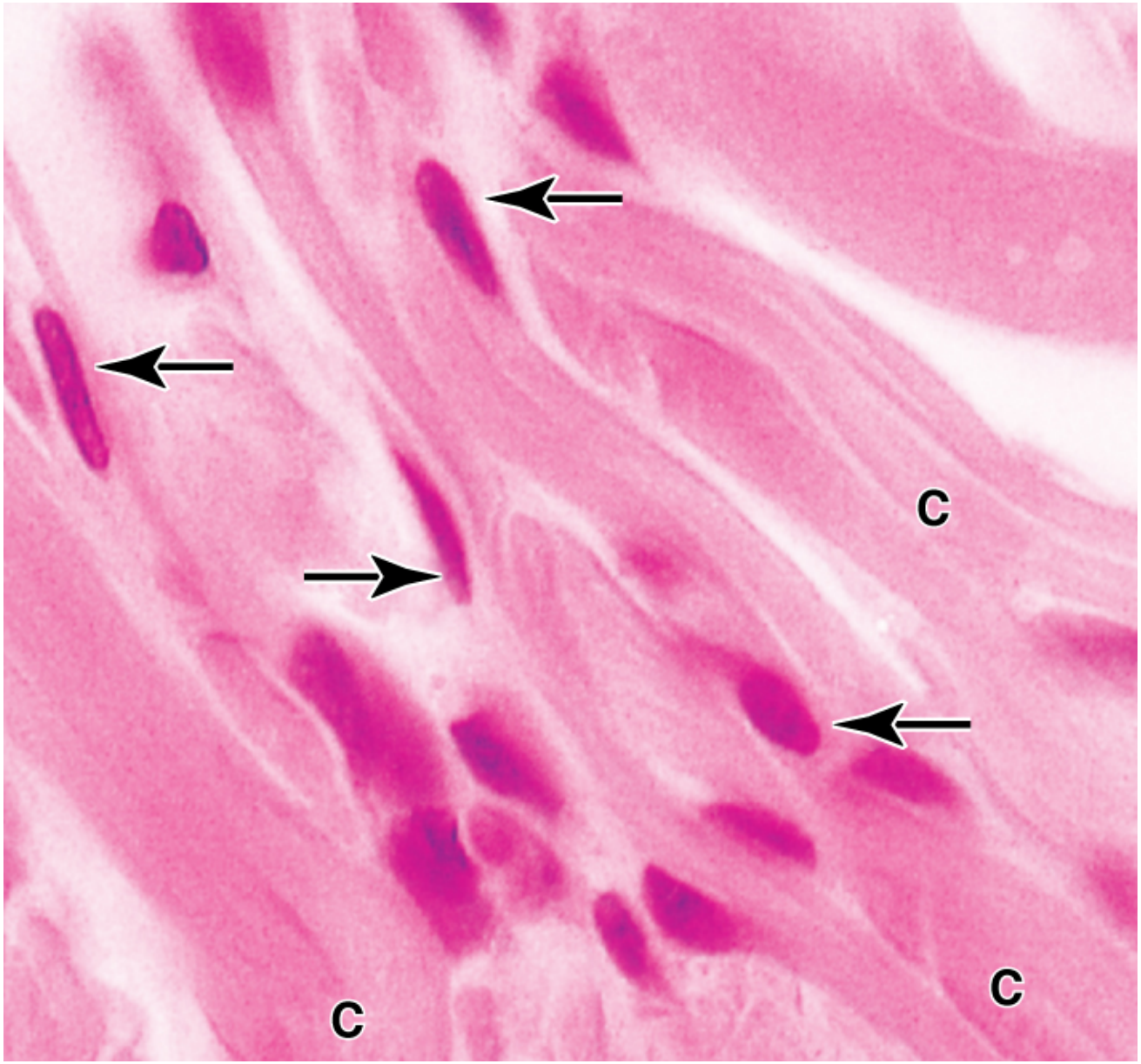
For even more strength, tropocollagen is cross-linked.

Collagen is assembled into bundles

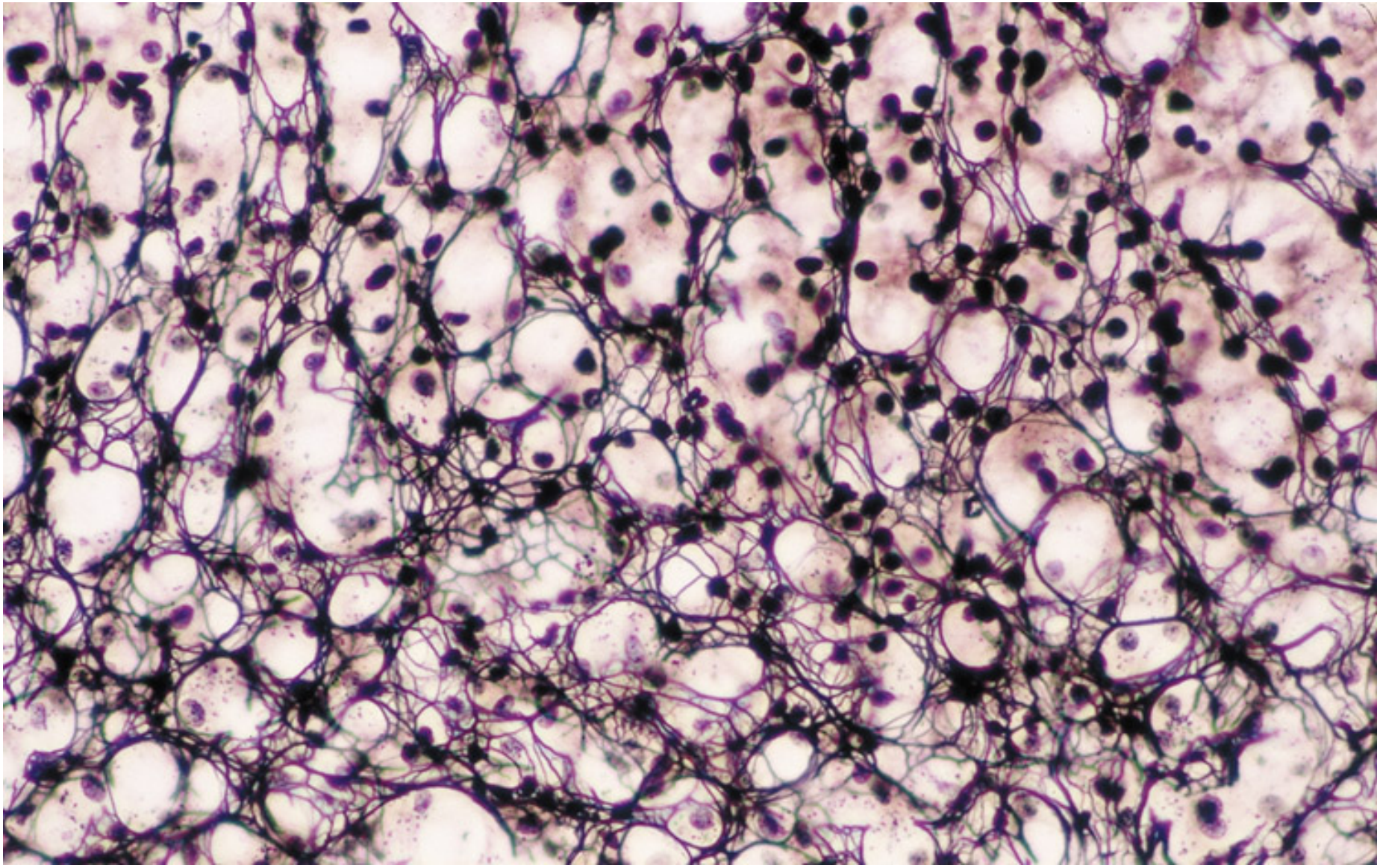




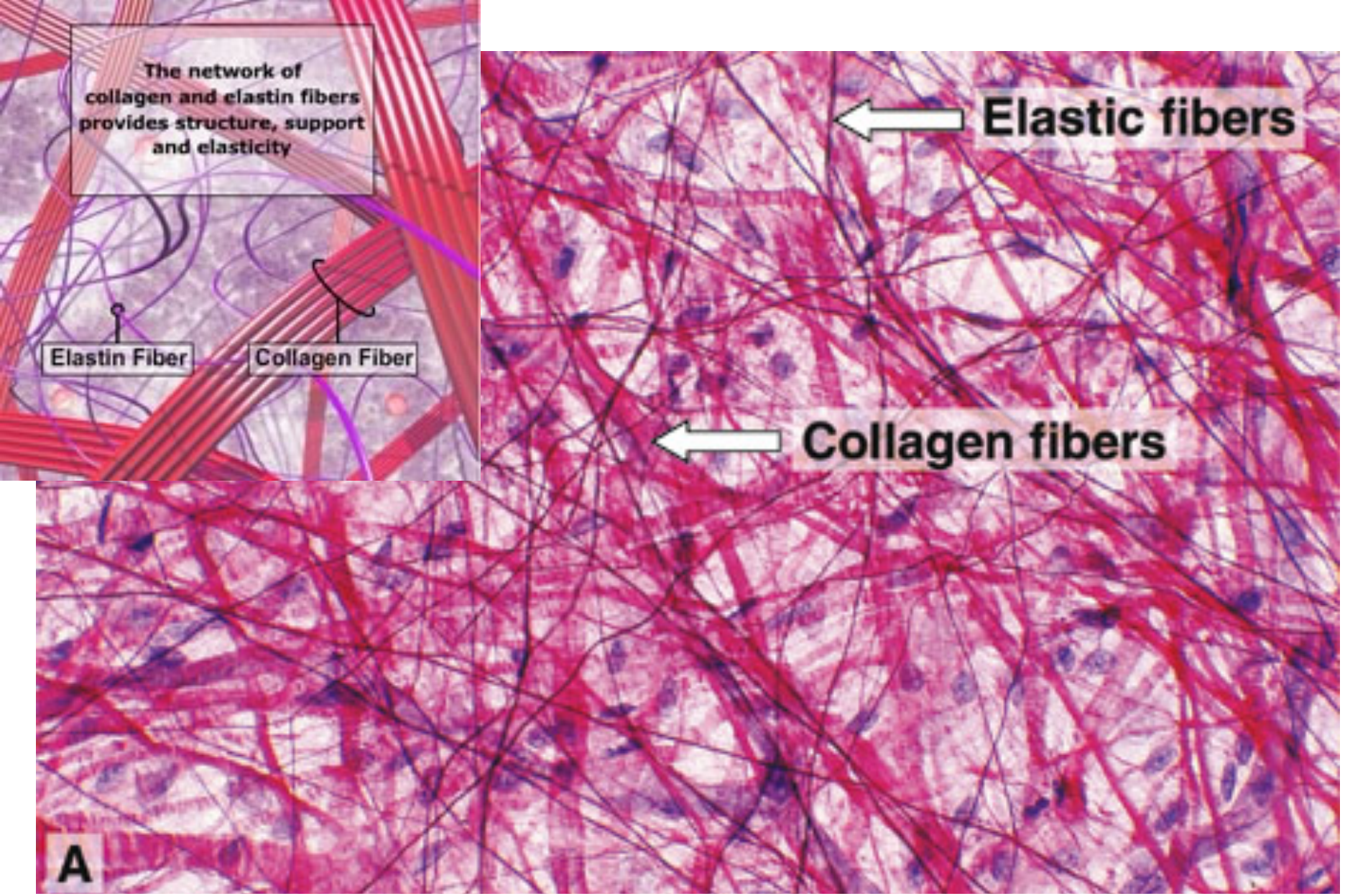
Fibers and bundles of type I collagen



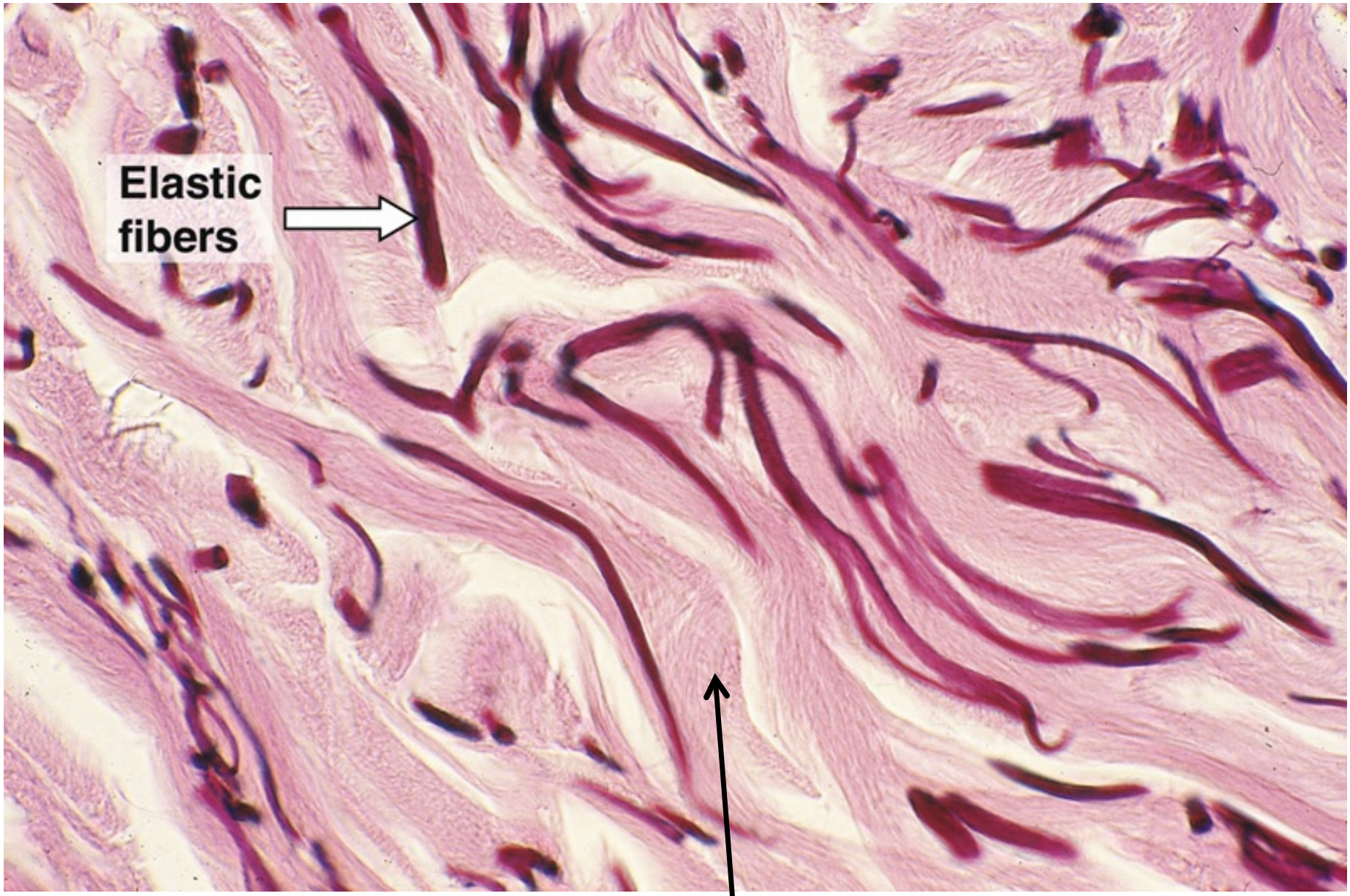
Fibers and bundles of type I collagen. Fibroblasts at arrows.



Reticular fibers (type III collagen) forming a network. These fibers are argyrophilic (stainable with silver stains).

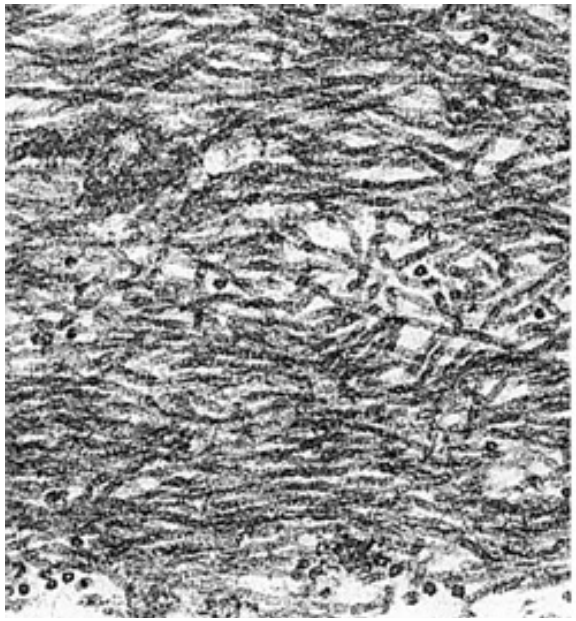


Thinner elastic fibers and **thicker** collagen fibers give a tissue both strength and elasticity.

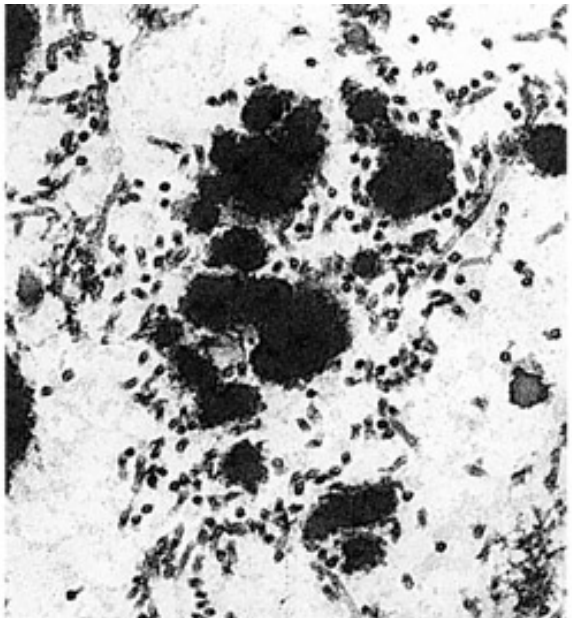


Elastic fibers & collagen fibers in skin

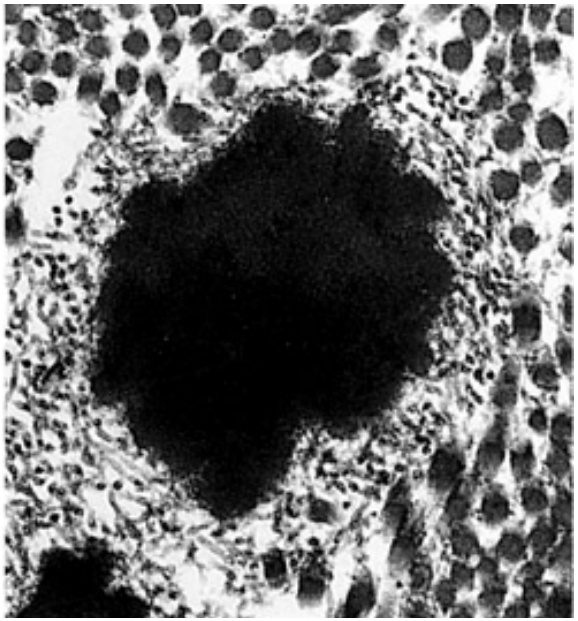
Elastic fibers develop in stages



Stage 1: Fibroblasts and smooth muscle cells secrete fibrillin microfibrils.

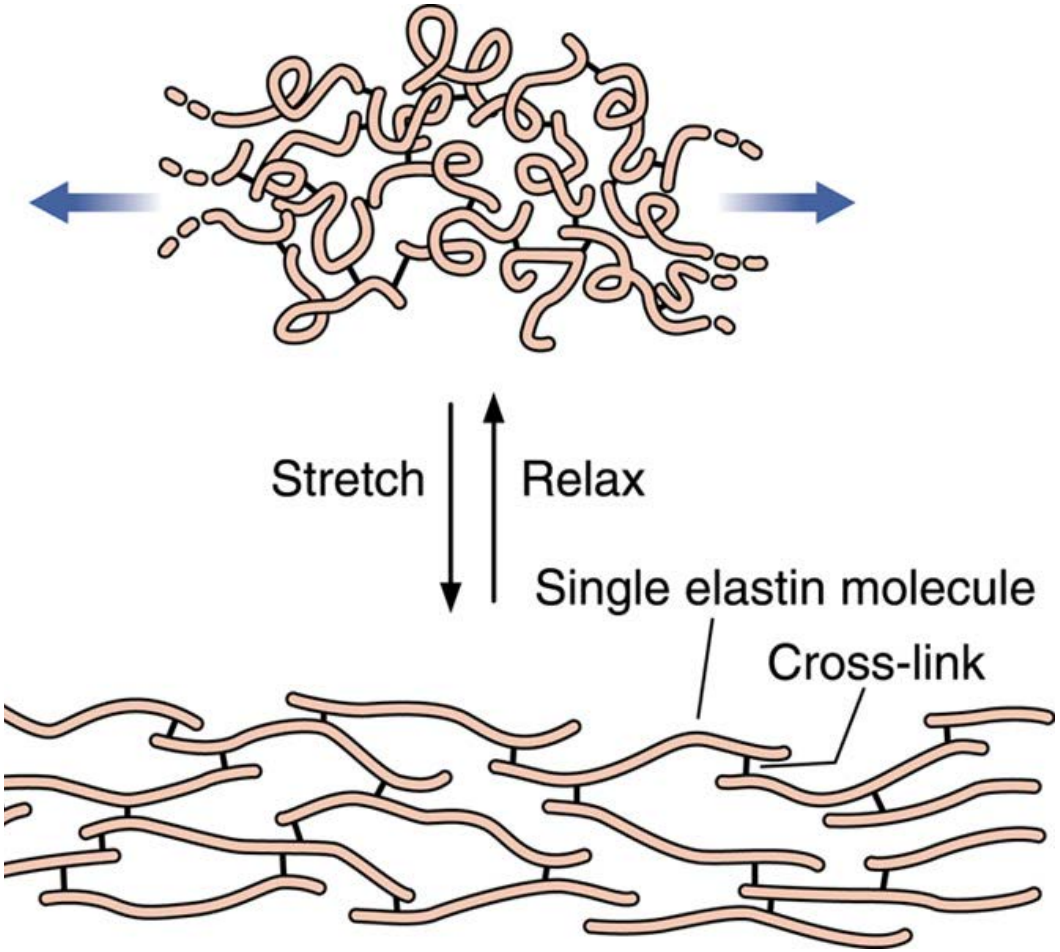


Stage 2: Elastin protein is deposited around fibrillin microfibrils.



Stage 3: Elastic fiber with elastin clumped in center and microfibrils on periphery.

Marfan Syndrome: defect in elastic fiber synthesis; reduced elasticity in skin and lungs, skeletal defects (bones are longer and thinner than usual), cardiovascular complications (aneurism, valve prolapse)



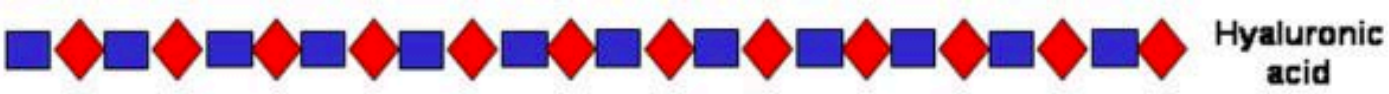
Elastic fibers form a cross-linked network which can expand and contract. This is great for organs that bend and stretch (like large arteries and skin).

Ground substance

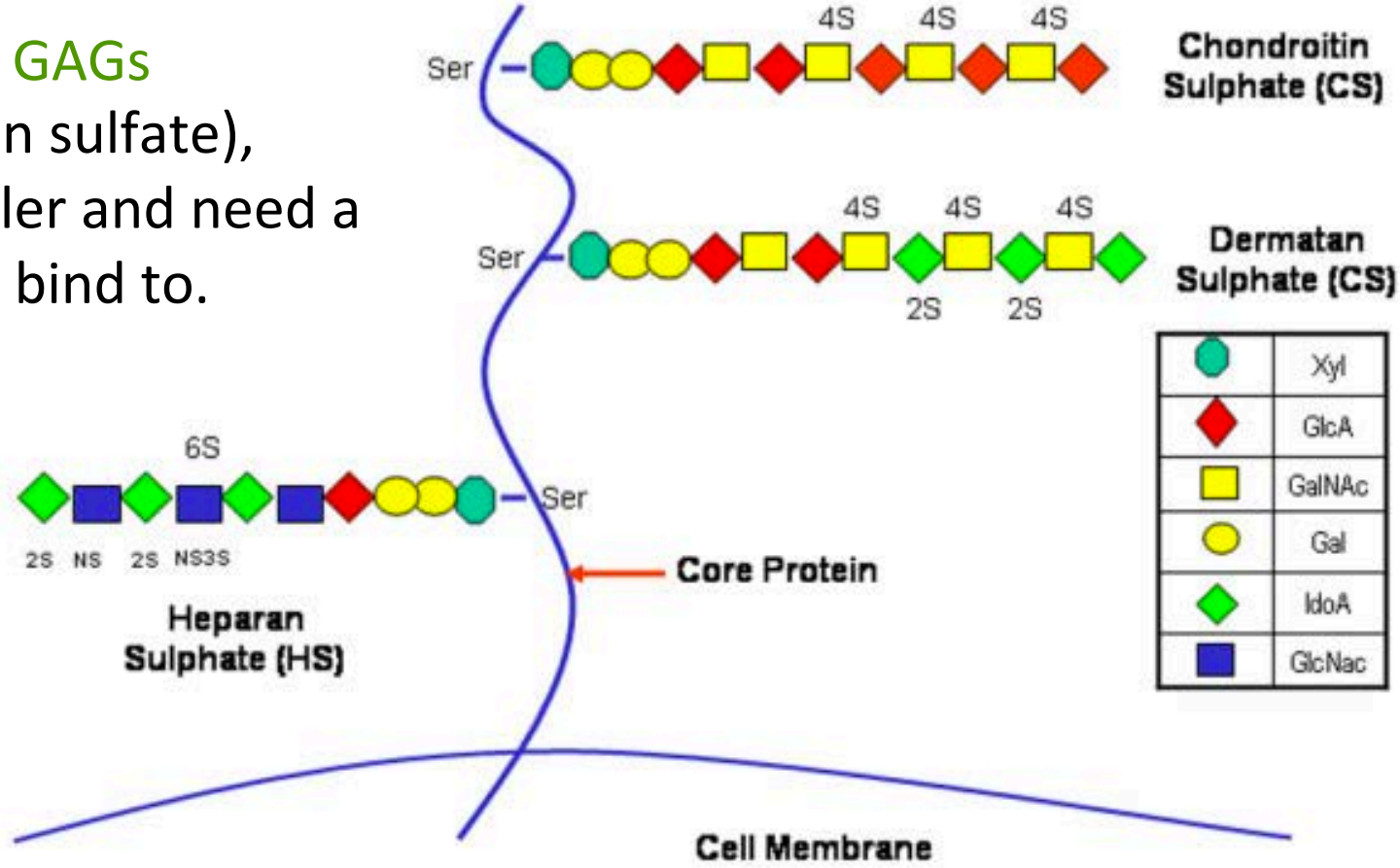
- A viscous gel that fills spaces between cells and fibers in connective tissue.
- Functions: binds water, fills space, acts as a barrier to infection, binds fibers and anchors cells to ECM.
- Not well seen in histologic sections.
- Main constituents: glycosaminoglycans, proteoglycans, glycoproteins

Glycosaminoglycans (GAGs) are unbranched polysaccharide chains. There are two kinds:

1. Hyaluronic acid: simple, really long, and doesn't have a core protein.



2. All the other GAGs (like chondroitin sulfate), which are smaller and need a core protein to bind to.



Proteoglycans consist of a **protein core** with **bound glycosaminoglycans** (polysaccharides). They contain more carbohydrate than protein.

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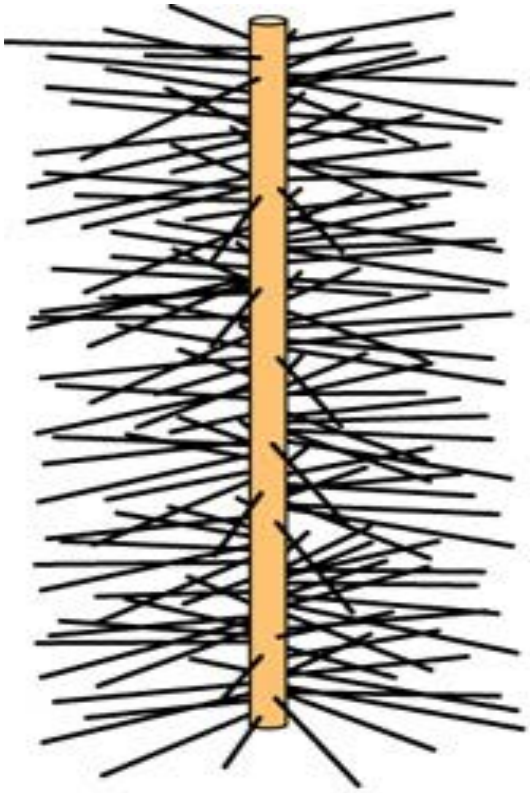
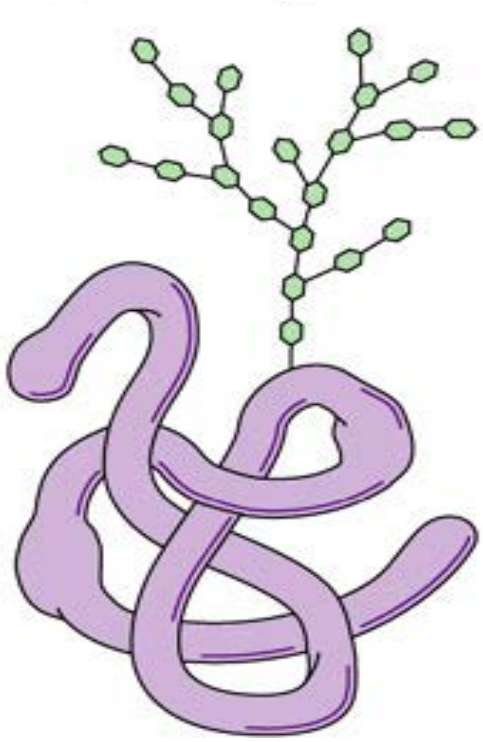
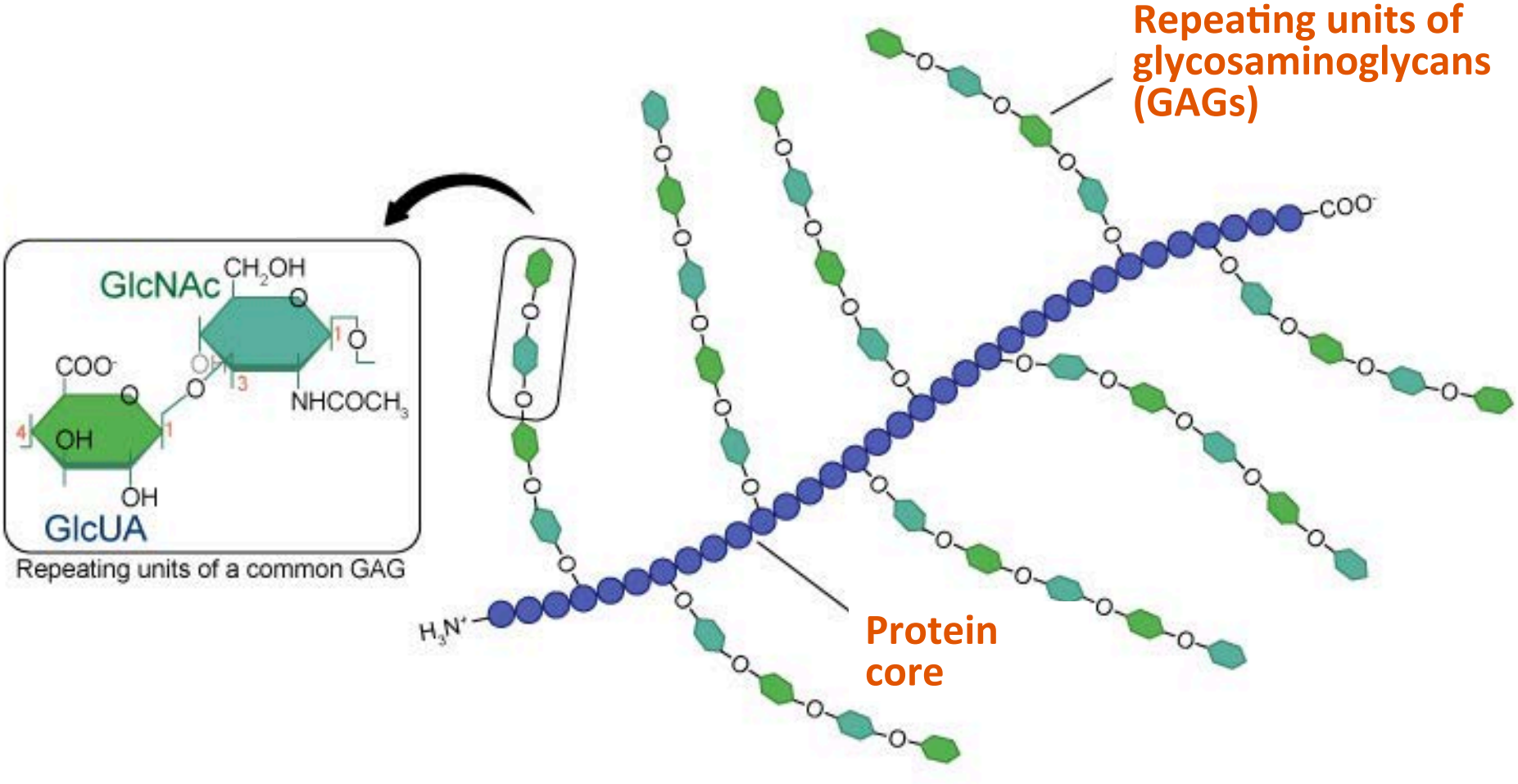




Glycoproteins are globular proteins with bound carbohydrates. They contain more protein than carbohydrate.



Proteoglycan.

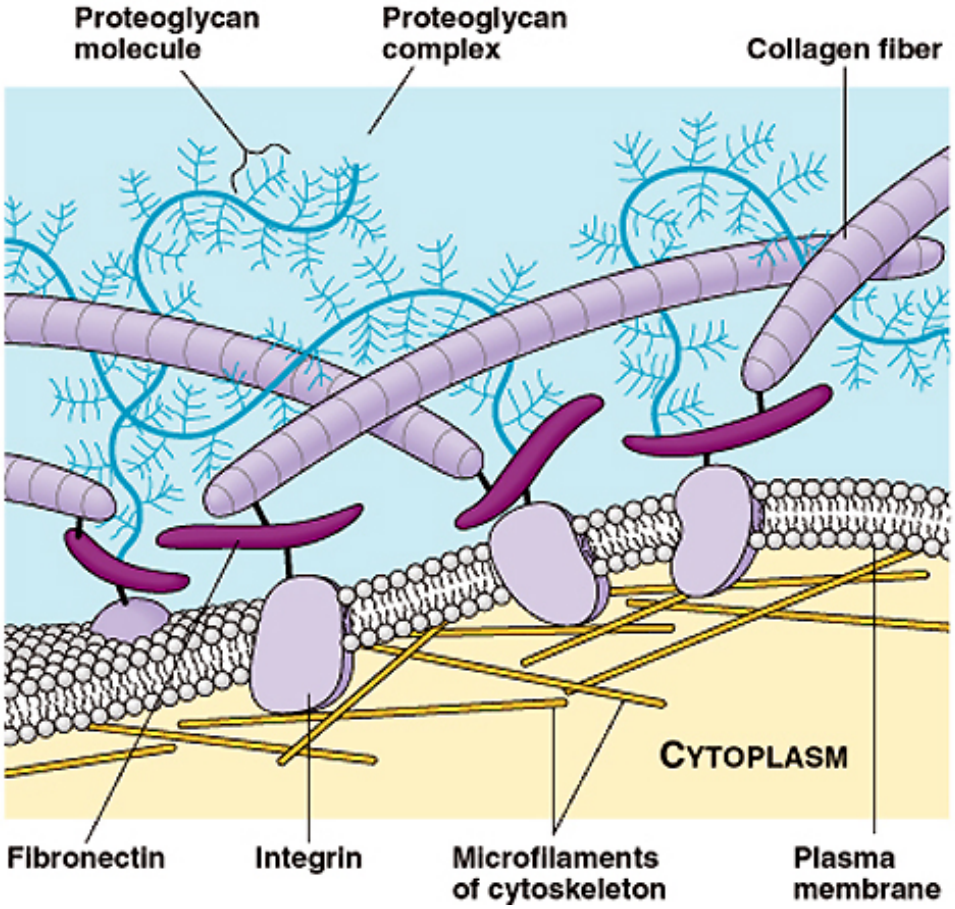
Examples of glycoproteins

Fibronectin

- Present throughout connective tissue
- Mediates normal cell adhesion and migration

Laminin

- Present in basal lamina
- Helps epithelial cells stick to basal lamina
- Also important in cell differentiation and migration



Cells are attached to the ECM by

On one side, fibronectin is attached to proteins in the plasma membrane, On the other side, the fibronectin is attached to the glycoproteins of the ECM

Tissue (interstitial) fluid

- Watery fluid similar to blood plasma
- Continuously moves from capillaries into connective tissue due to hydrostatic pressure of blood.
- Carries nutrients to connective tissue and picks up metabolic waste products.
- Re-enters circulation by moving into venules and lymphatic vessels.

What if there's too much tissue fluid in CT?

Sometimes, excess tissue fluid accumulates in connective tissue. This is **called edema.**
Some causes include:

Injury and inflammation
This can cause increased permeability of capillaries, and leakage of fluid into connective tissue.

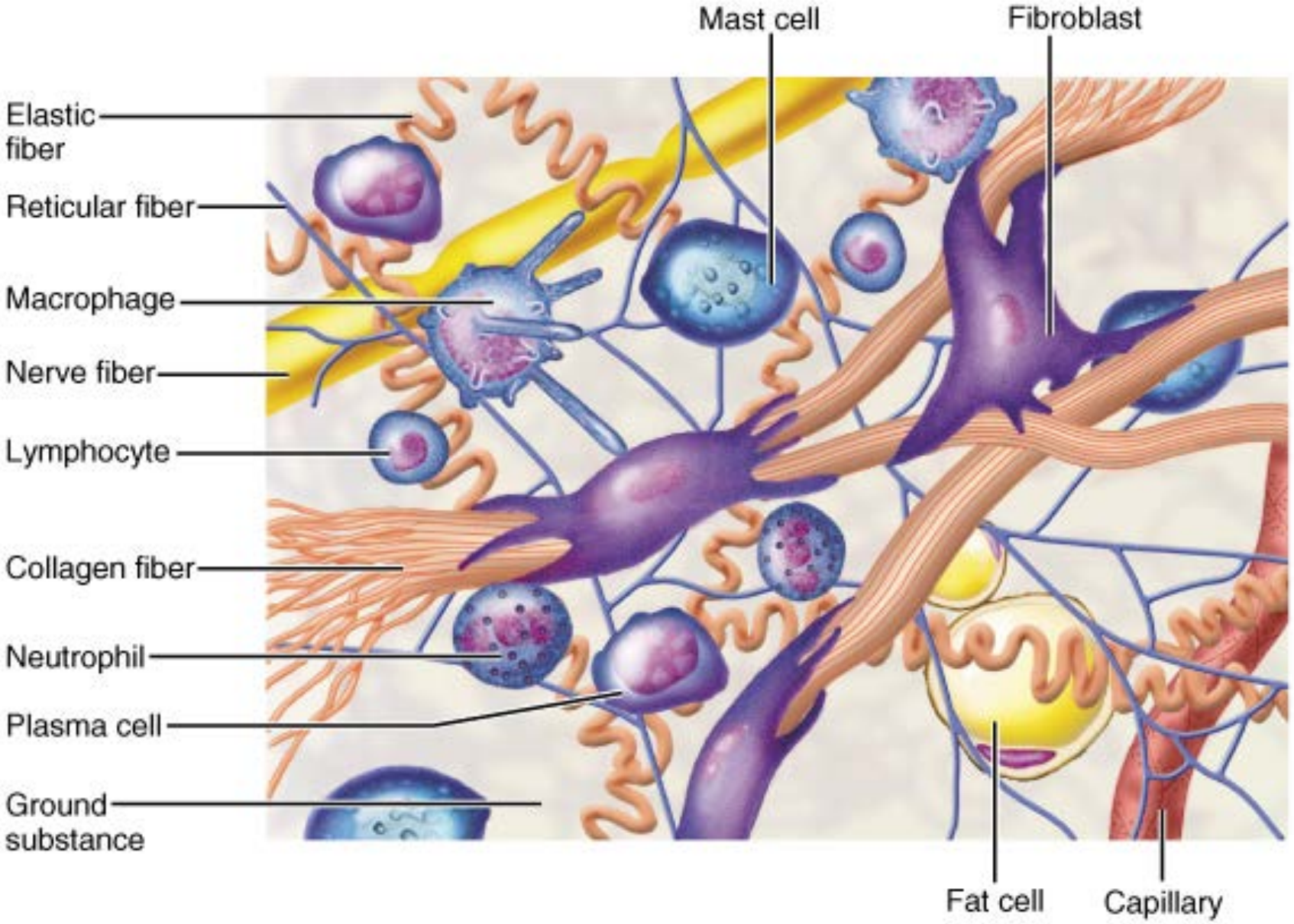
Too few plasma proteins in blood
This decreases the osmotic pressure within vessels, and fluid leaks out of vessels into connective tissue.

Some Functions of Connective Tissue Cells

- Structural: production of fibers and ground substance
- Immune responses: phagocytosis, cytokine secretion and antigen presentation, allergic reactions, antibody formation
- Energy storage: adipose cells store neutral fats and produce heat

Functions of specific connective tissue cells

Cell	Function
Fibroblast, chrondroblast, osteoblast, odontoblast	Production of fibers & ground substance
Neutrophil	Phagocytosis of bacteria & debris
Macrophage	Phagocytosis of foreign material and bacteria, antigen presentation
Lymphocyte	Participation in immune response
Plasma cell (B Lymp.)	Production of antibodies
Eosinophil, mast cell, basophil	Allergic reactions, regulation of inflammatory reactions



Connective Tissue: Embryonic Origin

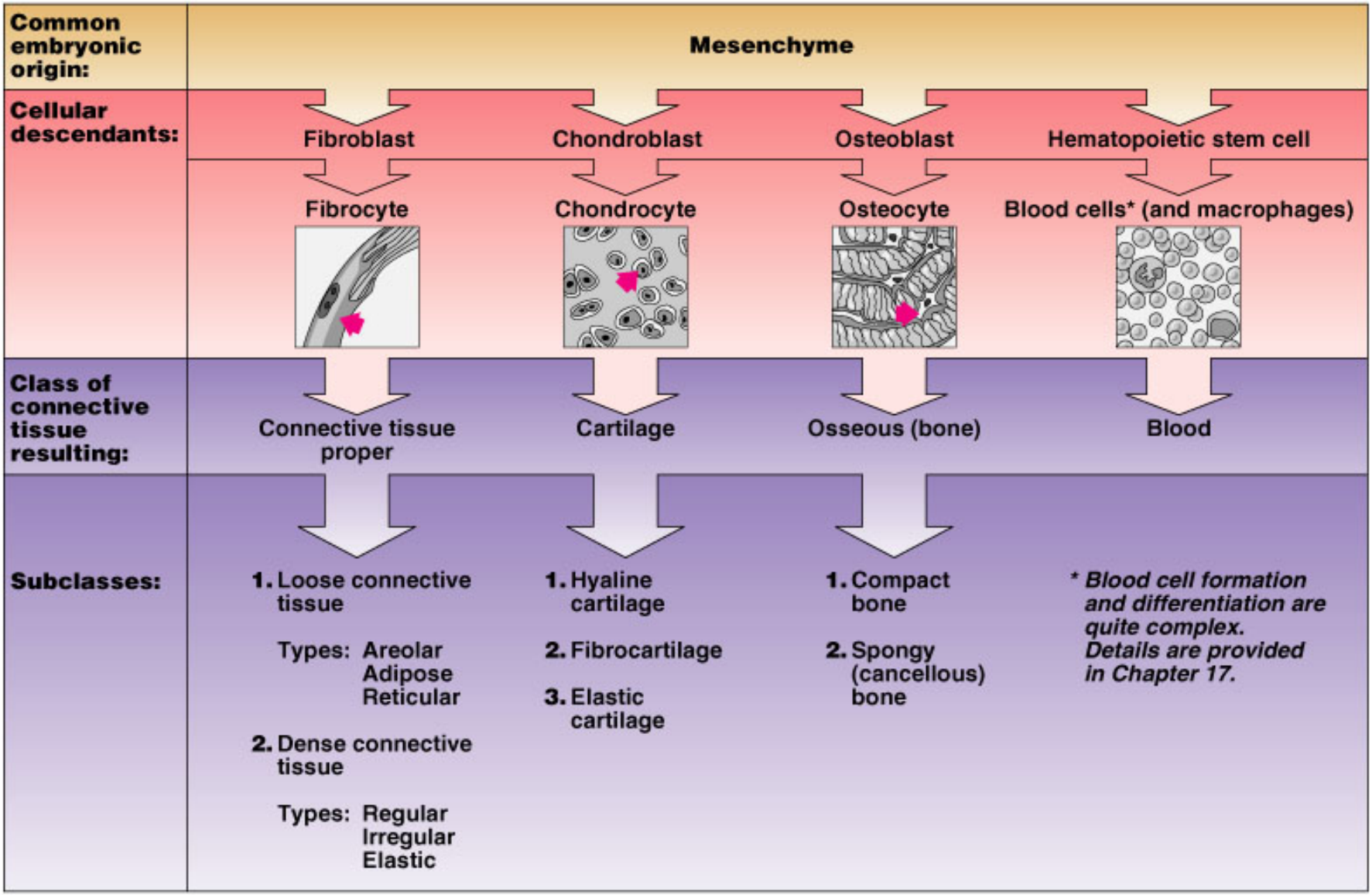


Figure 4.5

Classification of Connective Tissue