

Connective Tissue-2

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Fibers of connective tissue

Fibers are polymers of protein monomers.

Polymerization happens in the ECM.

Translation of protein happens inside the cell.

- ▶ The fibrous components of connective tissue are elongated structures formed from proteins that **polymerize after** secretion from fibroblasts
- ▶ The three main types of fibers include **collagen**, **reticular**, and **elastic fibers**.
- ▶ **Collagen and reticular fibers** are both formed by proteins of the **collagen** family, and **elastic fibers** are composed mainly of the protein **elastin**.

Collagen (structural protein)

- ▶ The **collagens** constitute a family of proteins
- ▶ Collagen is the most abundant protein in the human body, representing 30% of its dry weight (Exclude water)
- ▶ Produced mostly by **fibroblasts**

Collagen subtypes

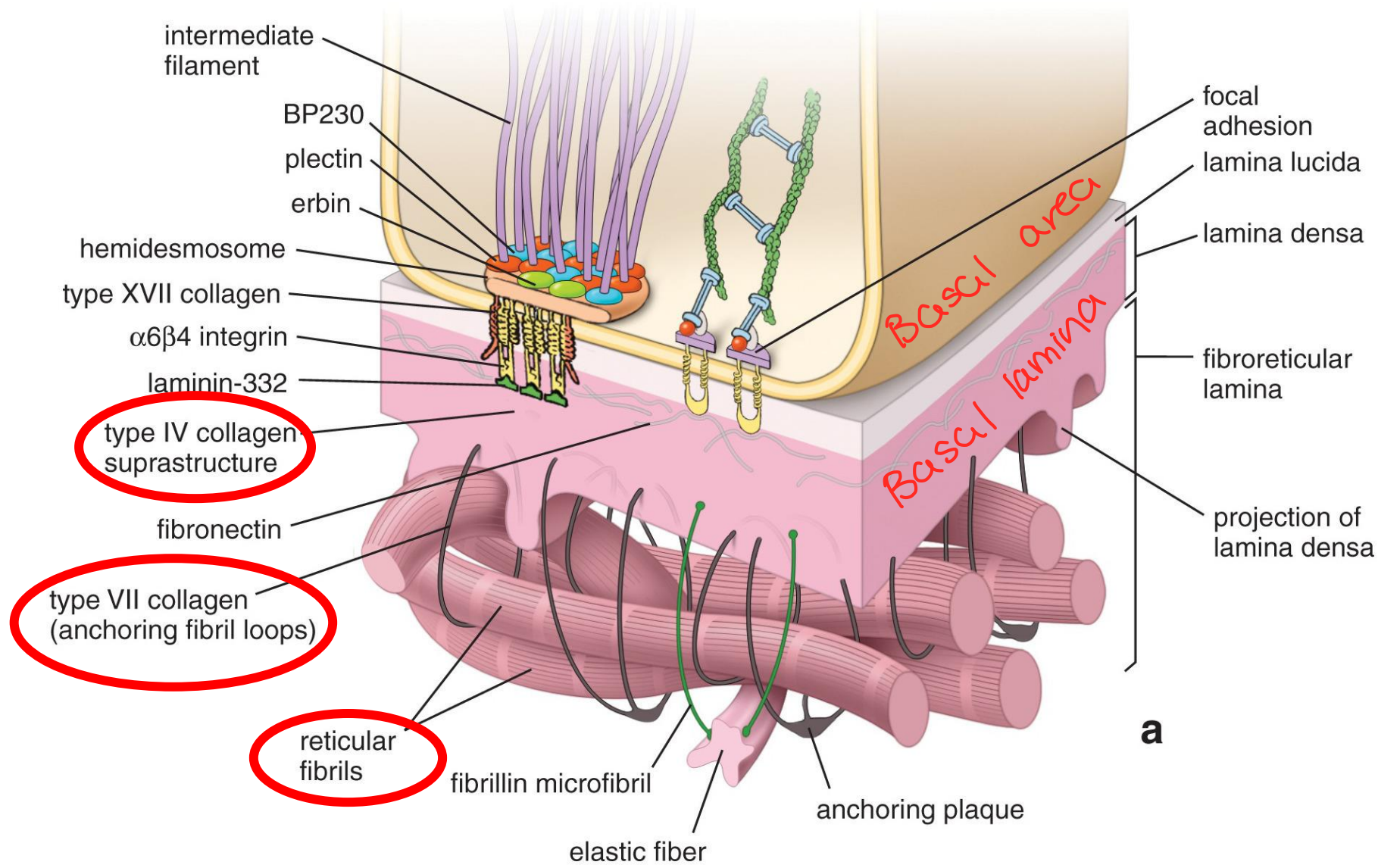
Only I forms fibers.

II and III remain fibrils.

I is specifically collagen fibres.

III is specifically reticular fibers or fibrils.

- ▶ Fibrillar collagens, such as **collagen types I, II, and III**, have polypeptide subunits that aggregate to form large fibrils clearly visible in the electron or light microscope
- ▶ Network or sheet-forming collagens, such as **type IV collagen** have subunits produced by epithelial cells and are major structural proteins all epithelial basal laminae.
- ▶ Linking/anchoring collagens are short collagens that link fibrillar collagens to one another (forming larger fibers) and to other components of the ECM. **Type VII collagen** binds type IV collagen and anchors the basal lamina to the underlying reticular lamina in basement membranes



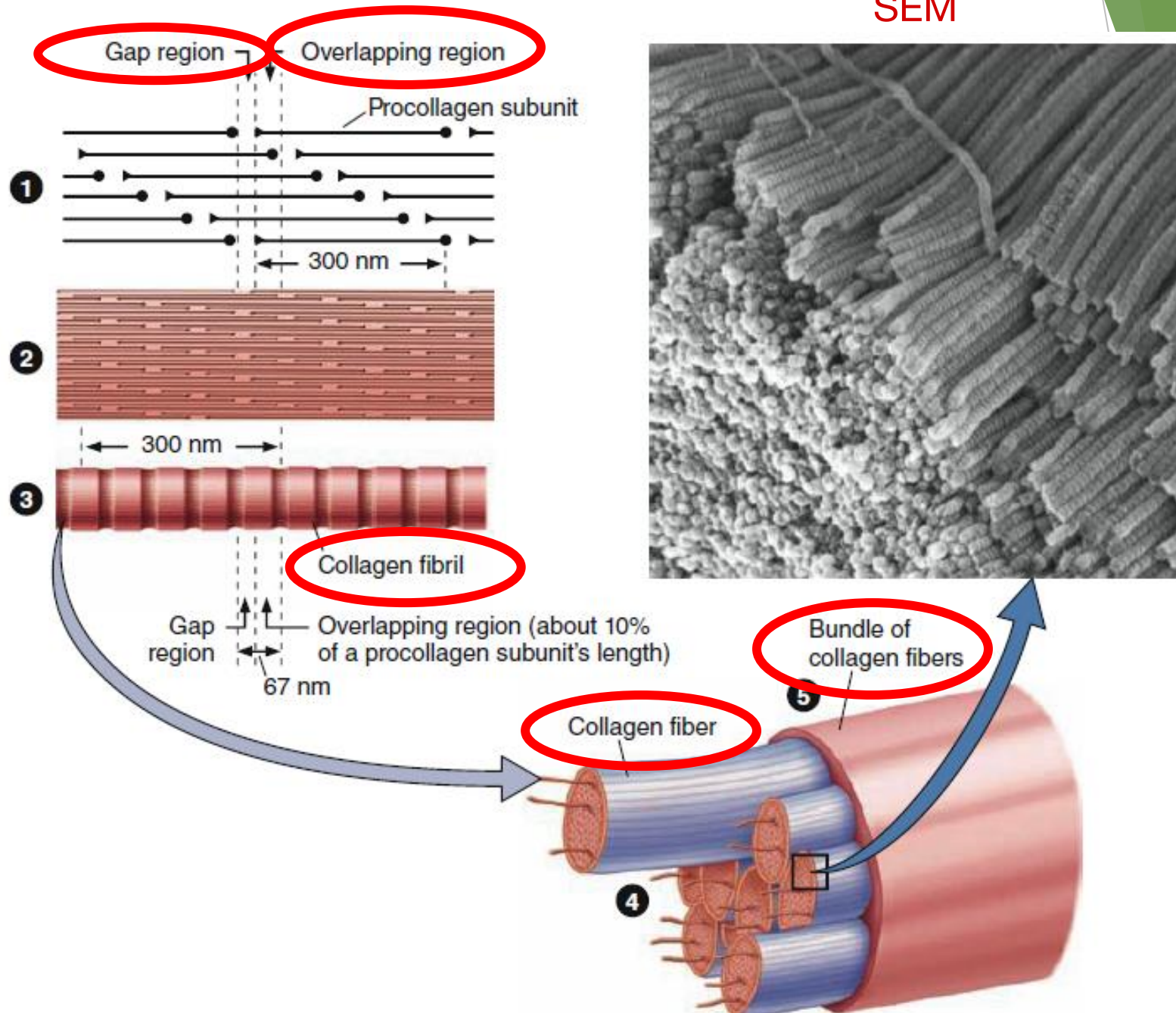
Type	Synthesizing cell	Function	Location
I	Fibroblast, osteoblast, odontoblast, cementoblast	Resist tension	Dermis, tendons, ligament, capsules, bone, dentin, cementum
II	chondroblasts	Resists pressure	Hyaline and elastic cartilage Exclusively
III	Fibroblasts, reticular cells, smooth muscle, hepatocytes	Form structural framework of organs	Reticuloendothelial system, lung, skin
IV	Epithelium, muscle, Schwann cells	Meshwork of the lamina densa	Basal lamina
VII	Epithelial cells of epidermis Connect epithelial and connective tissues.	Anchoring fibrils between the lamina densa and reticularis	Derma-epidermal junction

Collagen Fibers

- ▶ Type I collagen is the most abundant and widely distributed collagen
- ▶ Collagen type I subunits assemble to form extremely strong fibrils
- ▶ Fibrils bundle together further by other collagens into much larger structures called **collagen fibers**.
- ▶ Collagen fibers form structures such as tendons, organ capsules, and dermis

Overlapping region: less electrons are transmitted; therefore, appears darker.
Gap: more electrons are transmitted; therefore, appears lighter.

SEM

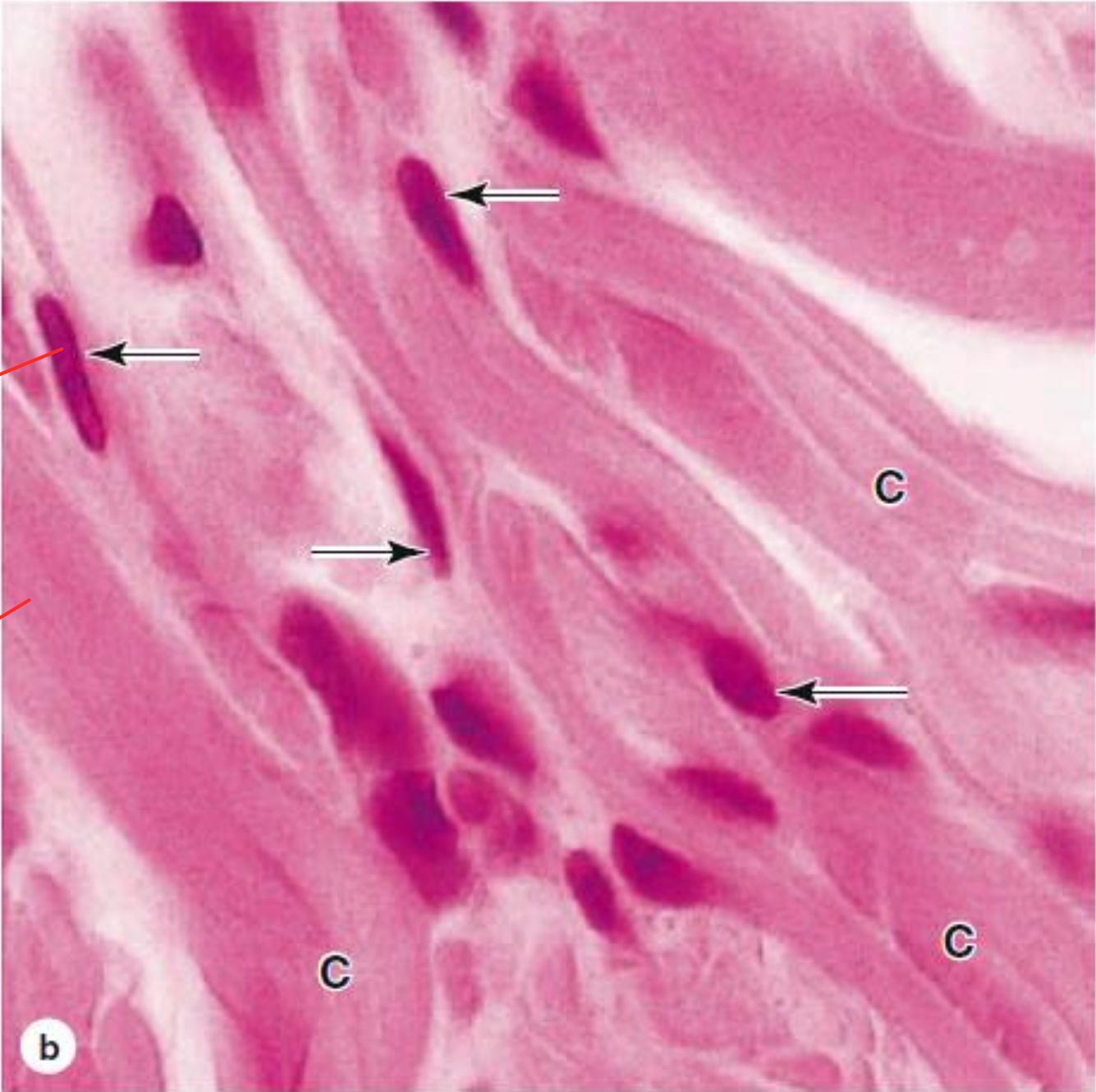


Collagen fibers in LM

- ▶ Collagen I fibers appear as large eosinophilic bundles
- ▶ They may fill the extracellular space.
- ▶ Subunits for these fibers were secreted by the fibroblasts associated with them.

Fibroblast

Collagen fibers

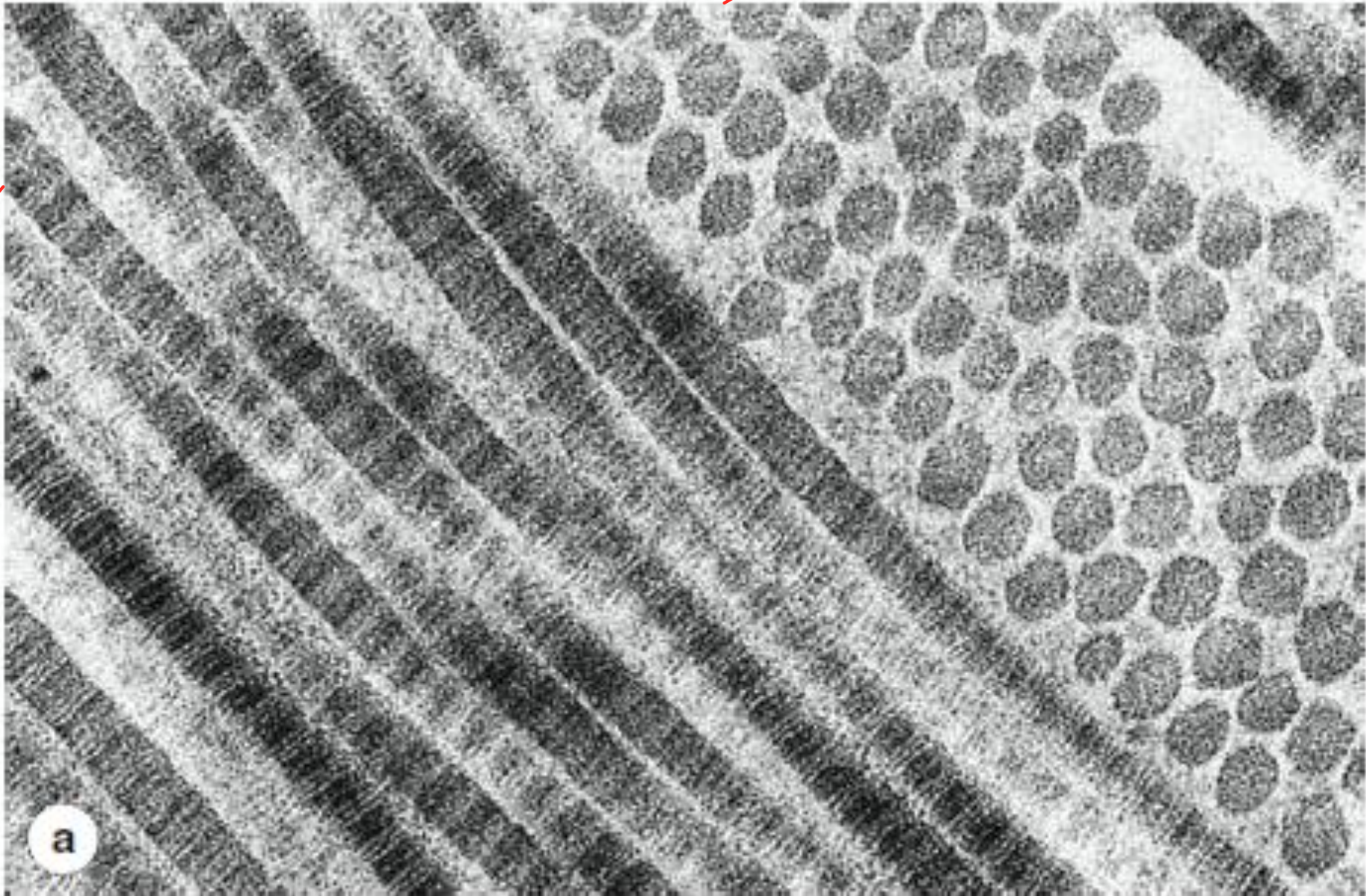


Collagen fibers in TEM

- ▶ In longitudinal sections fibrils display alternating dark and light bands (Due to polymerization patterns, overlapping and gap regions form)
- ▶ In cross section the cut ends of individual collagen molecules appear as dots.

Cross section

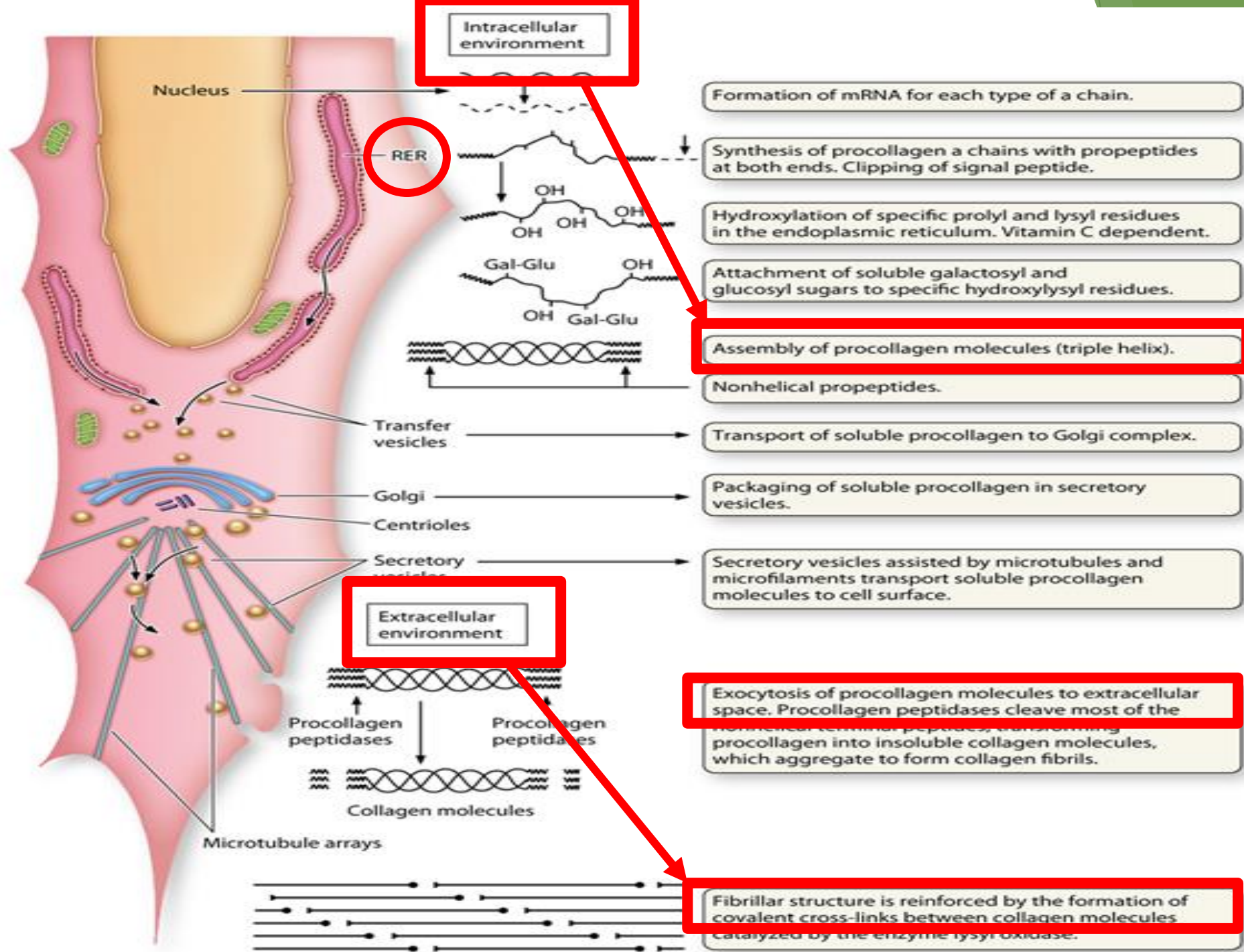
Longitudinal
section



Collagen Synthesis

- ▶ **Collagen synthesis** occurs in many cell types but is a specialty of fibroblasts.
- ▶ The initial **procollagen α chains** are polypeptides made in the RER.
- ▶ In the ER three α chains are selected, aligned, and stabilized by disulfide bonds at their carboxyl terminals, and folded as a **triple helix** **Quaternary structure**
- ▶ The triple helix undergoes exocytosis and is cleaved to a **procollagen molecule**
- ▶ Procollagen is the basic subunit from which the fibers are assembled.

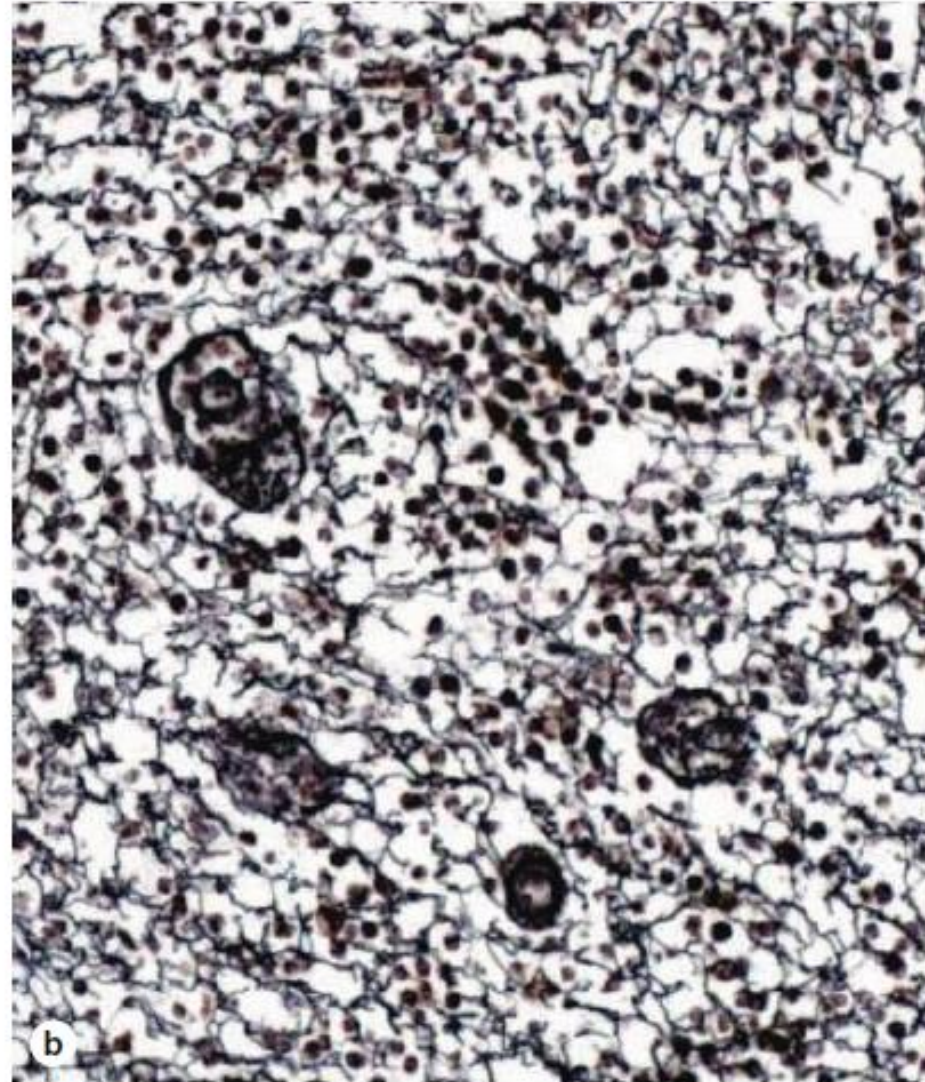
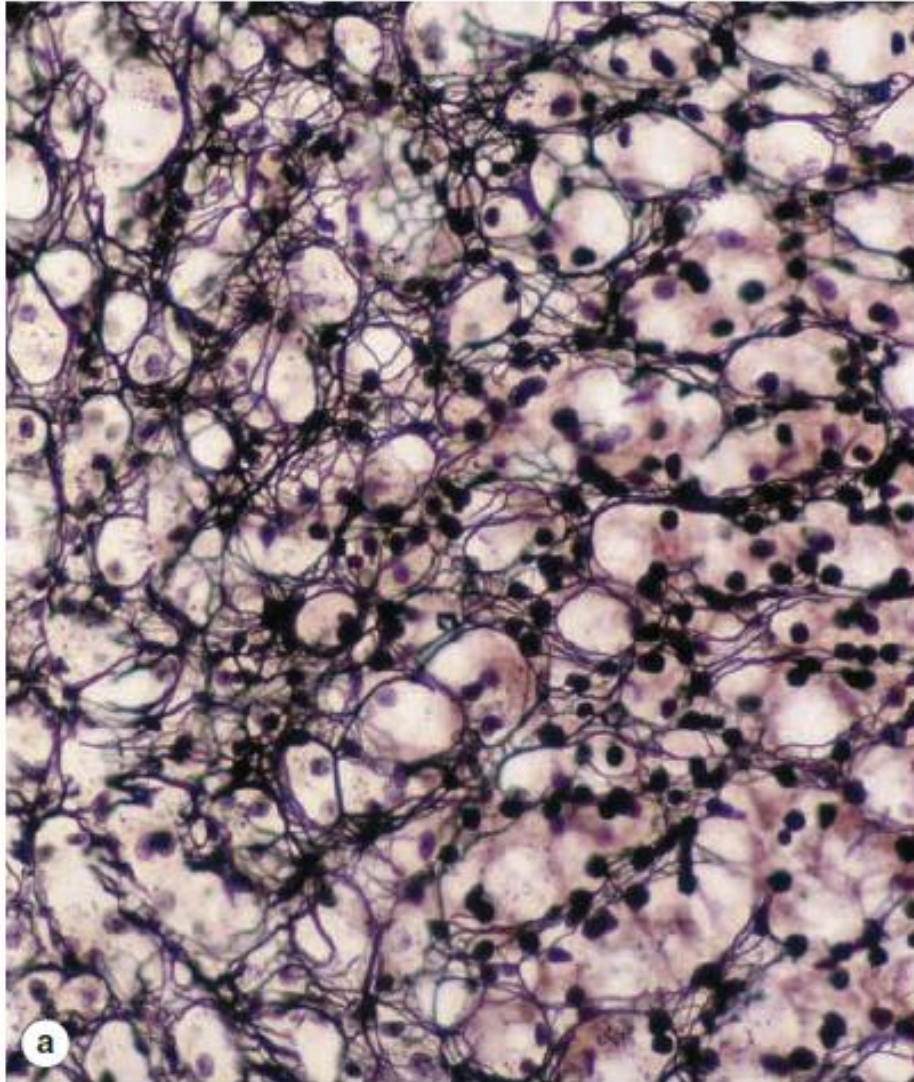
By cleavage of signal sequence in ECM which are used to direct the triple helix to RER, golgi, secretory vesicles and finally to the external environment.



Reticular Fibers

- ▶ **Reticular fibers** consist of collagen type III
- ▶ Collagen III forms an extensive network of thin fibers
- ▶ They are found in delicate connective tissue of many organs such as **liver, spleen, lymph nodes**
- ▶ Reticular fibers are not visible in hematoxylin and eosin (H&E) preparations
- ▶ They stain black after impregnation with silver salts, and are thus termed **argyrophilic** (Loves silver)
- ▶ Reticular fibers contain up to 10% carbohydrate and are therefore periodic acid-Schiff (PAS) positive

Reticular fibers-Silver stain



Elastic Fibers

- ▶ **Elastic fibers** are thinner than the type I collagen fibers
- ▶ They are found between collagen bundles
- ▶ Mainly found in organs subject to regular stretching or bending, such as the stroma of lungs **Inflation and deflation**
- ▶ They have rubber-like properties that allow tissue containing these fibers to be stretched and return to their original shape
Eg: Aorta
- ▶ In the wall of large blood vessels, especially arteries, elastin also occurs as fenestrated sheets called **elastic lamellae**.
- ▶ Elastic fibers and lamellae stain poorly with H&E
- ▶ They are stained more darkly than collagen with orcein and aldehyde fuchsin

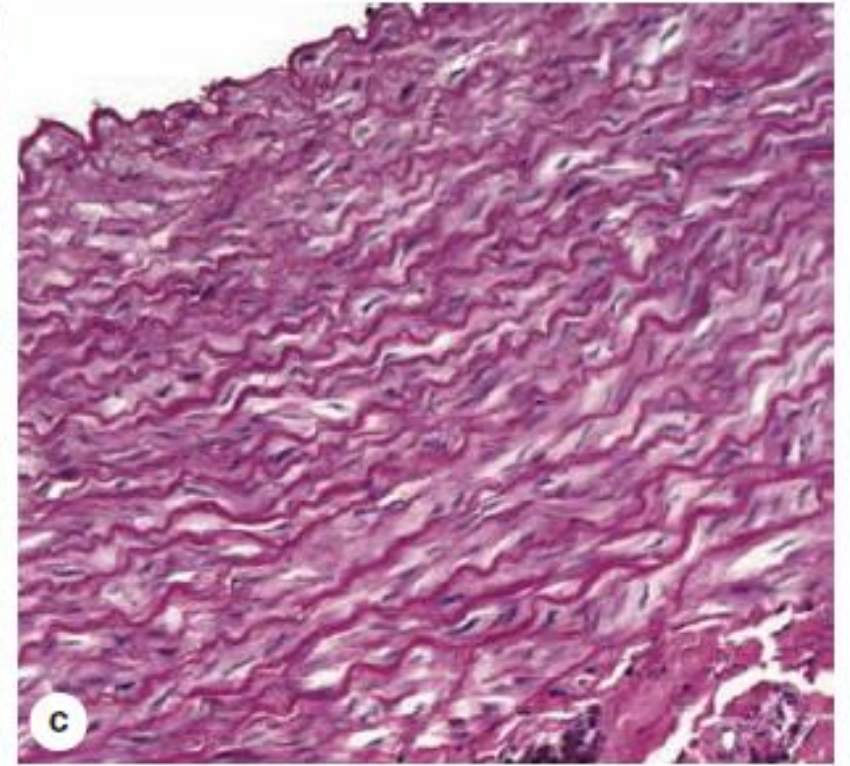
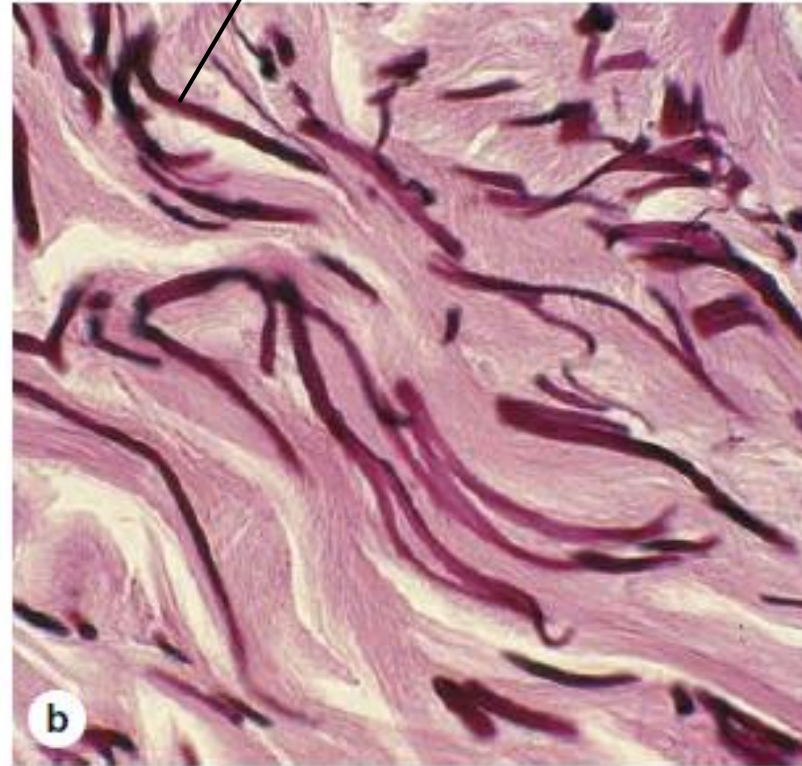
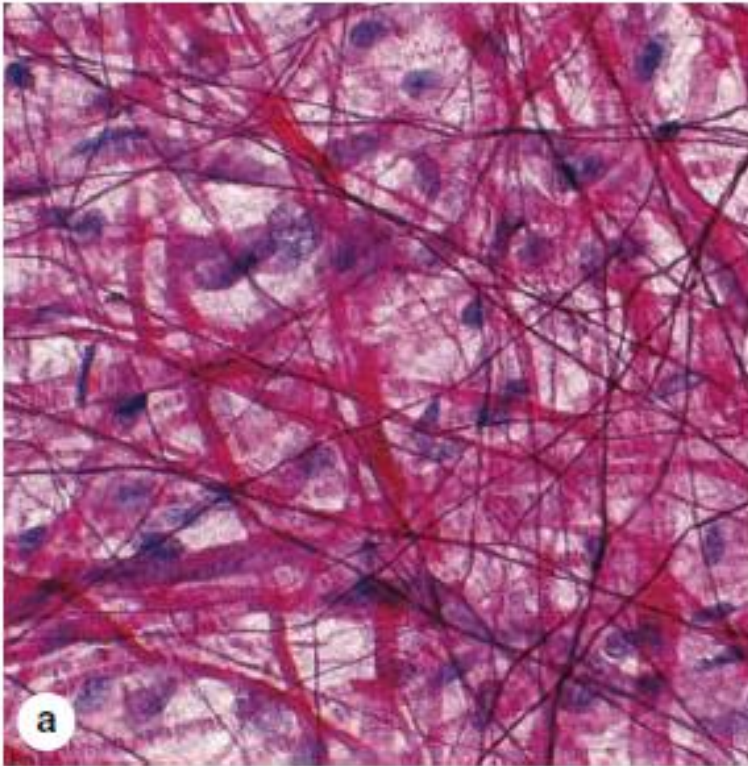
Elastic Fibers

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

Red: collagen
Black: elastic

Elastic

Blood vessels
Recoil case here



Pastpapers:

Q85) The collagen type that anchoring the basal lamina with underlying reticular lamina?

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

Answer is : C

Q86) The function/s 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

Q90) 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

BEST OF LUCK!