

# Collagen

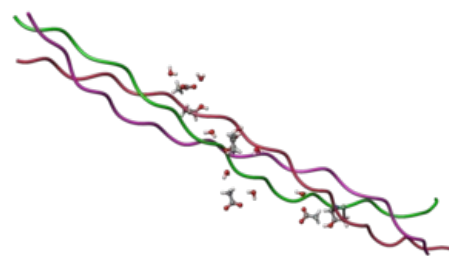
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Collagen is an extracellular scleroprotein, water-insoluble and forms the basic building block of connective tissues. It makes up 25-30% of all proteins in the body of mammals, in the form of collagen fibers it is a component of the intercellular mass. Currently, at least 28 different types of collagen are known. Collagen fibers often form bundles that measure 0.5–15  $\mu\text{m}$  in diameter. It is responsible for elasticity, firmness, proper moisturizing of the skin and continuous immersion of its cells. As a result of aging, a collagen deficiency occurs, which is, for example, the cause of the formation of wrinkles.



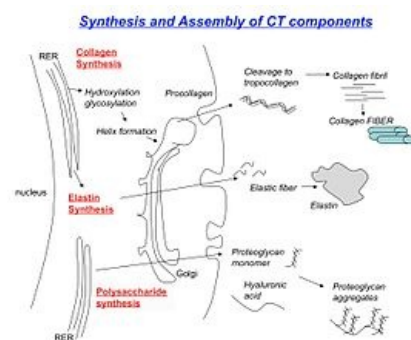
The structure of collagen

## Synthesis of collagen

Collagen synthesis occurs on polyribosomes, which are localized near the rough endoplasmic reticulum (RER) membrane. The resulting polypeptide chains of procollagen are segregated in its cisternae, where initial glycosylation and hydroxylation occur. Hydroxylation takes place on the amino acid residues of proline and lysine, resulting in hydroxyproline and hydroxylysine. At the end of each procollagen chain, there are registration peptides, which prevent premature intracellular polymerization of the resulting molecules. At the same time, they help the formation of a triple helix from each of the three chains of procollagen - this is how procollagen is created. From the RER, procollagen is transported to the Golgi complex, where it is condensed and enveloped by the membrane of secretory vesicles. Subsequently, it is released into the extracellular space through the process of exocytosis.

The enzyme procollagen peptidase cleaves the registration peptides from procollagen in the extracellular space and thus tropocollagen is formed. A tropocollagen molecule is 280 nm long, measuring about 1.5 nm in diameter.

Neighboring cells organize tropocollagen in a stepwise manner and form collagen fibrils, which further form fibers from the fibrils. The fibers are stabilized by the enzyme lysyl oxidase using mutual bonds of lysine and hydroxylysine residues in neighboring tropocollagen molecules.



Collagen synthesis

## Types of collagen

The structure of individual types of collagens differs by the amino acid sequences in the polypeptide chains. These differences are mainly reflected in the degree of polymerization and aggregation of molecules. Here are the most important types:

**Type I** collagen is the most abundant collagen in the body. Fibrils (with a diameter of 75 nm) form thick fibers (with a diameter of 1–20  $\mu\text{m}$ ) and bundles of fibers that can already be seen by eye. Branching occurs only when fibers cross from one bundle to another. This type of collagen is found in tendons, ligaments, bone, joints, organ sheaths and thin connective tissue.

**Type II** collagen is mainly in the cell mass of hyaline and elastic cartilage. They form thin, non-aggregating fibrils with a diameter of 20 nm.

**Type III** collagen is similar to **type I** but contains more proteoglycans and glycoproteins. Therefore, the PAS method is used for its dyeing or it is dyed with silver salts. Type III collagen fibrils (diameter 45 nm) aggregate into thin fibers (0.2–2  $\mu\text{m}$ ) and form a reticular network. The fibers are more loosely and less regularly arranged than collagen I fibers. Reticular fibers provide support for soft, pliable tissues – e.g. smooth muscle cells, nerve fibers, adipocytes. Reticular fibers are also found in hemopoietic tissues and in the reticular lamina of basal laminae of epithelia.

**Type IV** collagen does not form organized structures of fibrils or fibers. It is located in the area of the basal laminae.

**Type V** collagen is related to type IV and is found in the outer laminae of muscle cells, adipocytes and glial cells.

**Type VI** collagen is also related to type IV. It is localized in interstitial tissue.

**Type VII** collagen forms anchoring fibrils that strengthen the connection between the dermis and the epidermis . It is similar to type II.

**Type X** collagen is found in the matrix that surrounds the hypertrophic chondrocytes in the cartilage of the growth plate in the places where bone will form.

Collagen **types IX** and **XI** are found in cartilage together with type II.

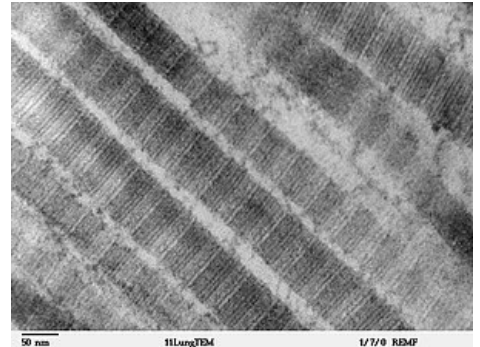
## Histological appearance

### Light microscopy

Collagen is seen as bundles of fibrils or individual fibrils and in sections stained with hematoxylin + eosin it is stained pink (strongly eosinophilic). When stained with Masson's trichrome , collagen fibers are stained green. Reticular fibers (collagen type III) are stained dark with PAS or with silver salts. Collagen molecules that do not form fibers or fibrils can only be distinguished from the basic mass by immunohistochemical methods .

### Electron microscopy

All collagen fibrils and fibers are striated along their entire length with a period of 64 nm. Transverse striations are caused by the staggered arrangement of tropocollagen molecules. This creates areas where tropocollagen molecules overlap and areas where two molecules come into contact = lacunar areas . In the lacunar areas, there are more free chemical radicals that bind the lead used for contrast. Therefore, lacunar areas appear as dark bands on electrograms.



Collagen microscopy

## Links

### related articles

- Epithelial tissue
- Marfan's syndrom

### External links

- Kolagen (česká wikipedie)
- Collagen (anglická wikipedie)

### References

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- PAULSEN, Douglas. *Histologie a buněčná biologie : opakování a příprava ke zkouškám*. 1. edition. Jinočany : H & H, 2004. ISBN 80-7319-024-9.

## Reference