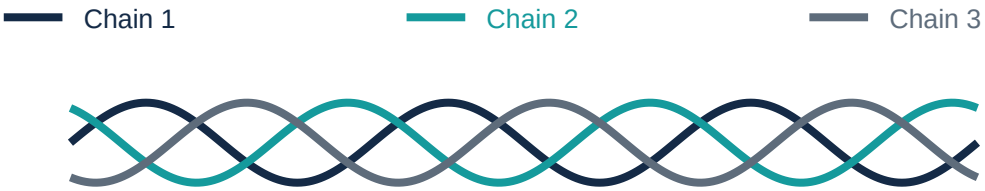
Three chains, one molecule

Collagen is a fibrous protein with a long, narrow, rope-like shape. This lesson follows fibril-forming collagen from its polypeptide chains to larger fibres.

THE COLLAGEN TRIPLE HELIX



Three polypeptide chains wind around one another.

Together they form ONE collagen molecule.

Schematic segment: colours distinguish chains, not different molecule types. The real molecule is much longer and thinner than this drawing.

1. EACH CHAIN IS A POLYPEPTIDE

Amino acids are linked by covalent peptide bonds along each chain. The three chains remain separate polypeptides even though they associate closely in the triple helix.

2. THE TRIPLE HELIX IS NOT AN ALPHA HELIX

Do not describe collagen as three ordinary alpha helices. Its individual chains have a different helical conformation and wind together into a triple helix. Multiple chains contribute to the molecule's quaternary structure.

Keep the scale clear: three chains make one collagen molecule, not one whole collagen fibre.

Supporting reading: RCSB PDB-101: Collagen.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 7, p. 18.

Pack molecules into larger fibres

A collagen molecule and a collagen fibre are not the same object. Many molecules assemble in an ordered arrangement outside cells to build larger structures.

STAGGERED MOLECULES IN PART OF A FIBRIL



Each short rod represents ONE triple-helical molecule.

Molecules lie parallel, with ends offset rather than all aligned.

1. MANY MOLECULES FORM A FIBRIL

Collagen molecules pack side by side in a staggered array. Their repeated overlap and gap pattern produces the characteristic banding seen in collagen fibrils with an electron microscope.

2. MANY FIBRILS FORM A FIBRE

Fibrils group into larger collagen fibres. Covalent cross-links between neighbouring collagen molecules help hold the assembly together. A fibre therefore contains many more than three polypeptide chains.

Assembly hierarchy: polypeptide chains → triple-helical molecules → fibrils → fibres. The diagram is not drawn to scale.

Supporting reading: Molecular Biology of the Cell: extracellular matrix.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 7, p. 18.

Keep the levels of bonding clear

Different bonds act at different levels of collagen organisation. Always say whether you mean amino acids in a chain, chains in a molecule, or neighbouring molecules.

LEVEL	KEY BOND OR INTERACTION
Within one chain	Peptide bonds join amino acids into a continuous polypeptide.
Between the three chains	Interchain hydrogen bonds help stabilise the triple helix.
Between molecules	Covalent cross-links strengthen the packed fibril; these are not the peptide bonds along a chain.

SUPPORTING DETAIL: WHY GLYCINE FITS

In the triple-helical region, glycine occurs at every third position. Its side chain is only a hydrogen atom, allowing close packing at the centre. Proline and hydroxyproline are also common; their arrangement supports the characteristic structure.

A COMPLETE STRUCTURAL DESCRIPTION

Collagen is a fibrous protein. Three polypeptide chains wind together into a triple helix. Many collagen molecules align in staggered, parallel arrays to form fibrils, which group into fibres. Cross-links hold neighbouring molecules together.

This lesson describes the structure. Lesson 2.3.8 connects that structure to tensile strength and the roles of collagen in tissues.

Supporting reading: Molecular Biology of the Cell: extracellular matrix.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 7, p. 18.