Collagen

PDB collagen-edu.pdb

Collagen is the most abundant protein in humans. It is a structural protein, providing strength to tendons and elasticity to the skin. Its function is intimately linked to the structure of the protein, which you will explore here.

For the purpose of this activity, a PDB file was created by modifying the existing structure of a short part of human collagen (original PDB: 1BKV). Download the modified PDB file (collagen-edu.pdb) available on the EzMol Teaching Portal. Load the PDB file into EzMol.

How many chains does collagen contain?
A molecule of collagen is made up of three chains.

Are there any α-helices or β-strands?
There are no α-helices or β-sheets.

Which amino acid residue is the most abundant in the sequence? How often does it come up?
The most abundant amino acid is glycine, which comes up at every third position.

What is the particularity of that residue? How is that relevant protein structure in general?
Glycine does not have a side chain and is therefore less restricted in the conformations it can adopt. It also allows it to form tighter structures (as there it is not encumbered by a side chain).

Each chain has a polyproline II-like structure. A polyproline II helix is a left-handed helix, which differs from an α-helix and is produced from the repetition of several proline residues.

The last proline in each chain is actually a hydroxyproline (proline with a hydroxyl group attached to its γ-carbon) but is shown here as proline for simplicity. In the complete protein, proline and hydroxyproline are found more often than any other residue in the two positions preceding glycine.

What is the particularity of proline and hydroxyproline? How may that explain the existence of helices that are not α-helical?
Proline and hydroxyproline have their side chain covalently attached to their backbone nitrogen. As a result, they are very restricted in the conformations they can adopt. Moreover, they cannot form hydrogen bonds that stabilise standard secondary structure elements, as their backbone nitrogen is not attached to a hydrogen atom.

Generate a figure showing the surface of each collagen chain in a different colour, as in Figure 4. The structure of the collagen molecule has been described as a ***triple helix***.

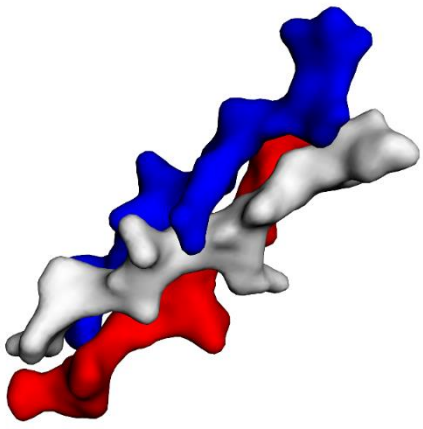

Figure 4 | Fragment of collagen with each chain in a different colour.

Explain the term triple helix in the context of collagen structure.
A molecule of collagen contains three helical chains (although they do not form α-helices), wound around each other to form another level of helicity.

Several collagen triple helices (each of which is made up of three polypeptide chains) are packed together side by side to form fibrils. There are many types of collagen, associated with different functions. In some types of collagen, several fibrils are then packed side by side again to form fibres with very large diameters. You can learn more about collagen structure and function on the RCSB *Molecule of the Month* website (http://pdb101.rcsb.org/motm/4).