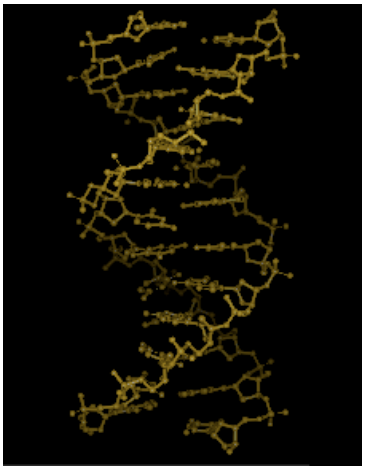
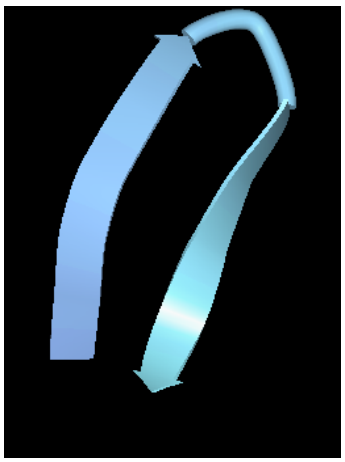
Visualize Secondary Structure

We know the primary structure of the protein is just sequence of amino acids bound together by a chemical bond called a peptide bond. There are some interesting consequences of this sequence of amino acids that can lead to very important folding patterns. These patterns are called the secondary structure of the protein.

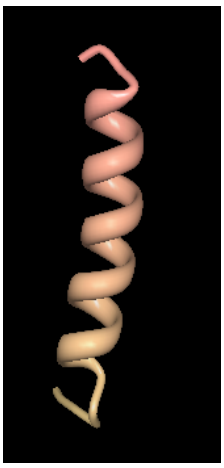


One shape you might be familiar with is the double helix of DNA. The twisted molecule forms regular and repeating patterns that are very similar to some secondary structures found in proteins.

The most common secondary structures are called alpha helices and beta sheets. These are bound together by a type of bond called a hydrogen bond that connect one amino acid to another not far away in the protein sequence.



Beta Sheet



Alpha Helix

In the beta sheet the bonding occurs between the left and right arrows while in the alpha helix the bonding is along the twists. These are weaker than the covalent interaction of the peptide bonds we saw in the primary structure. These bonds are not drawn but because of these shapes we are safe to assume they are there.

Let's take a quick look at the secondary structure found in the antifreeze protein.

Find a x-ray crystallography experiment of the antifreeze protein from the Protein Data Bank:

1. Open a web browser and type the URL for the Protein Data Bank: http://www.pdb.org
2. Enter "Antifreeze" in the top search text box and click the "Search" button

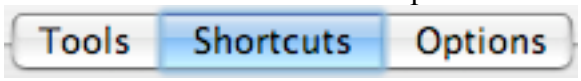
3. Click on the structure labeled: "1HG7"

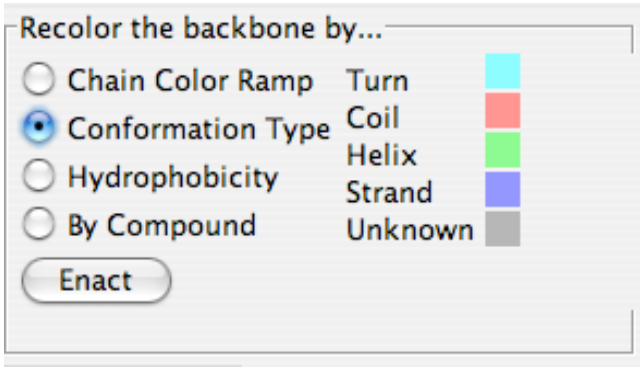
Load the antifreeze protein into Protein Workshop

1. Click on the link labeled "Protein Workshop" under the image of the molecule.
2. Click the "Trust" button and/or the "accept" button for each pop-up window

Highlight the secondary features of the protein:

Once this molecular viewer is open in the control panel click on the "Shortcuts" option:

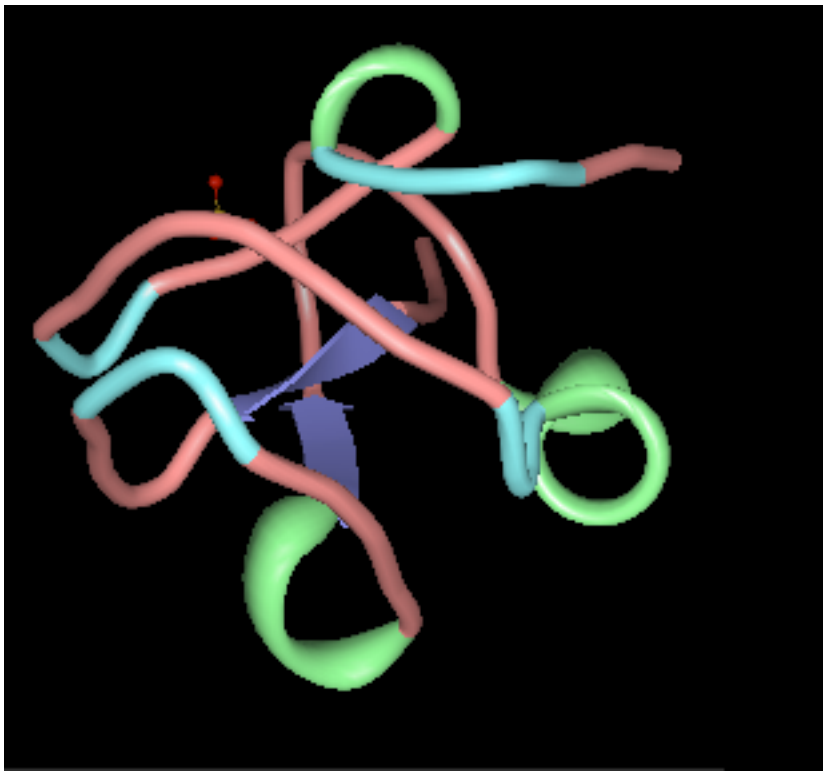




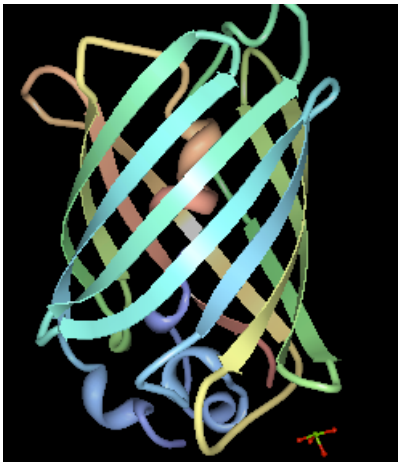
In the first panel of the shortcuts tab click on the button labeled, "Conformation Type". This will redraw the protein structure according to secondary structural features.

Click the "Enact" button.

You should have a protein that looks like this:



The green twists are the alpha helices and the blue arrows are the beta sheets. Though it is not clear in the antifreeze protein many proteins have specific roles for different types of secondary structure features. For example alpha helices are often found in trans-membrane proteins where the helices provide the ideal chemical properties to reach across the membrane of a cell. Beta sheets can be found in a unique structure called a beta barrel. This is the shape that defines the structure of the Green Fluorescent protein.



The unique properties of the beta barrel structure in green fluorescent protein allow it to protect a very important chemical component in the center of the barrrel called the chromophore. This chromophore absorbes UV light and re-emits it as fluorescent light providing the beautiful green light of fluorescent jellyfish.

Without the beta-sheet protection the protein could not function properly.