

Protein Tertiary and Quaternary Structure

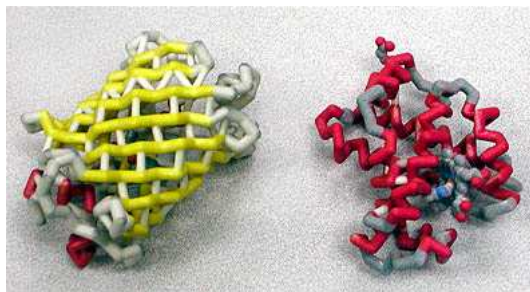
SMART Teams

Exploring the
Molecular World

Models

β -globin 1A3N.pdb

Green Fluorescent Protein (GFP) 1EMB.pdb



Activity

1. Define the function of β -globin and GFP proteins. *The β -globin protein is found in red blood cells and is responsible for transporting oxygen from the lungs to the cells, and CO_2 from the cells to the lungs. GFP is a protein in jellyfish that makes the jellyfish "glow" green when they are disturbed or threatened.*
2. Identify the secondary structures and determine how many of each secondary structure are present in β -globin and GFP proteins. *β -globin has 7 α -helices. GFP contains 11 β -strands and 3 short α -helices.*
3. Describe the difference between parallel and anti-parallel β -sheets. *A parallel β -sheet has at least two β -strands and the β -strands are oriented in the same direction, ie: strand 1-amino terminal end to carboxyl terminal end, strand 2-amino terminal end to carboxyl terminal end. In an anti-parallel β -sheet, the β -strands are oriented in the opposite direction: strand 1-amino terminal end to carboxyl terminal end, strand 2-carboxyl terminal end to amino terminal end.*
4. Describe the tertiary structure, or the overall shape, of the GFP and β -globin proteins. *GFP is shaped like a barrel, and the β -globin protein is globular.*
5. What would you predict about the chemical characteristics of the GFP or β -globin amino acids located:
 - a) on the surface of the proteins? *For both β -globin and GFP, the amino acids on the surface would be predicted to be polar.*
 - b) in the interior of the proteins? *The interior of both proteins would be predicted to be hydrophobic. However, since the β -globin protein exists as a tetramer, the surfaces of the protein that interact with the other components of the tetramer may be hydrophobic. This should be further explored in RasMol when working with the 1A3N.pdb file.*

The next two questions require opening the pdb files for the proteins in RasMol. The students need to be familiar with RasMol. Alternatively, these questions may be used to help students become familiar with exploring protein structures in RasMol.

6. Open the 1A3N.pdb file in RasMol and answer the following questions:
 - a. How many chains are present in the pdb file? *4 chains: A, B, C, D.*
 - b. The β -globin model is based on Chain B in this pdb file. Are the four chains (A, B, C, and D) identical? *No.*
 - c. A mutation in amino acid 7 of globin, changes a glutamic acid to a valine. This mutation is associated with sickle cell anemia. How does replacing the glutamic acid with valine affect the protein structure? *A charged amino acid is replaced with a non-polar amino acid on the surface of the protein. This hydrophobic patch will seek to avoid water.*
 - d. Quaternary structure is the association of multiple polypeptide chains to form an active protein complex. Does β -globin have quaternary structure? *Yes.*
 - e. Open the 1EMB.pdb file in RasMol and answer the following questions:
 - i. How many chains are present in the 1EMB pdb file? *One.*
 - ii. Does GFP have quaternary structure? *There is only one chain. GFP does not have quaternary structure.*