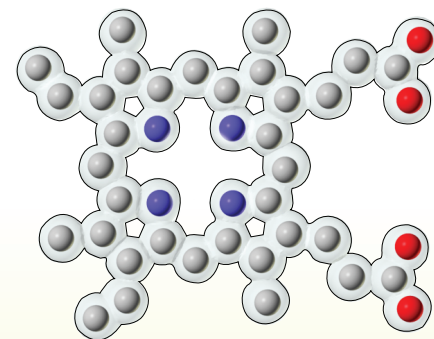




Student Overview

β-Globin and Oxygen Transport

Why does my body need oxygen?

Each cell in your body needs oxygen for energy and growth. Without it your cells would die. When you take a deep breath, oxygen-rich air sweeps into your lungs where it diffuses into your blood. Through a specialized process, proteins in your blood deliver oxygen to your cells.

How do my cells use oxygen for energy and growth?

Your cells also need glucose for energy. When you eat carbohydrates — pasta, breads, cereals, fruits and vegetables — your digestive system converts most carbohydrates to glucose. Glucose is absorbed into your blood when it moves from your stomach to your small intestine.

Mitochondria are complex structures in your cells that function as powerhouses to convert oxygen and glucose into energy. As oxygen is delivered to your cells, oxygen moves to the mitochondria where it is used to make ATP (adenosine triphosphate), which is the source of energy for many of your cells' metabolic processes. The β-Globin Folding Kit® focuses on the protein that transports oxygen to your cells.

How does oxygen get absorbed into my blood?

Take another deep breath. Oxygen-rich air is sweeping into your lungs, entering passages with many branches that lead to delicate air sacs, called alveoli. Many tiny vessels, called capillaries, supply your alveoli with blood. The alveoli and capillaries come into contact with each other over a very large surface area. In this ideal environment, oxygen diffuses into your blood where it binds to hemoglobin proteins in your red blood cells. In each red blood cell you have 300 million hemoglobin proteins ready to bind oxygen. β-globin is one part of hemoglobin.

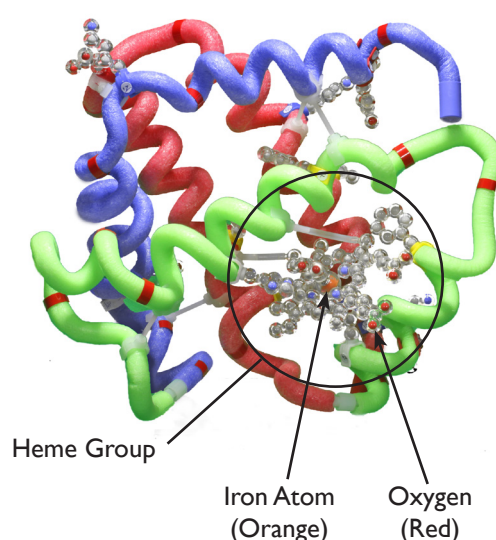
What are proteins?

Think of proteins as molecular machines. Proteins are large complex molecules that do most of the work in your body. They are essential for your body to function properly.

How can proteins act as molecular machines?

The structure of a protein determines the function it will be able to perform. Think about machines in your home. You couldn't use a toaster to clean your floor and you couldn't use a vacuum cleaner to toast bread.

Folded β-Globin Model



β-Globin Folding Kit®

β-Globin Overview Continued

The proteins in your body need to be a specific structure to perform the right job (function). The function of hemoglobin is to carry oxygen to your body's cells. After you have folded the β-globin model, you will see how its structure makes it possible for hemoglobin to transport oxygen to your cells.

What determines the structure of proteins?

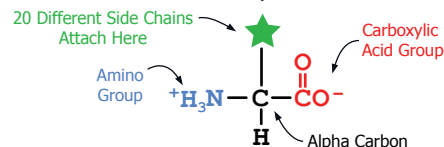
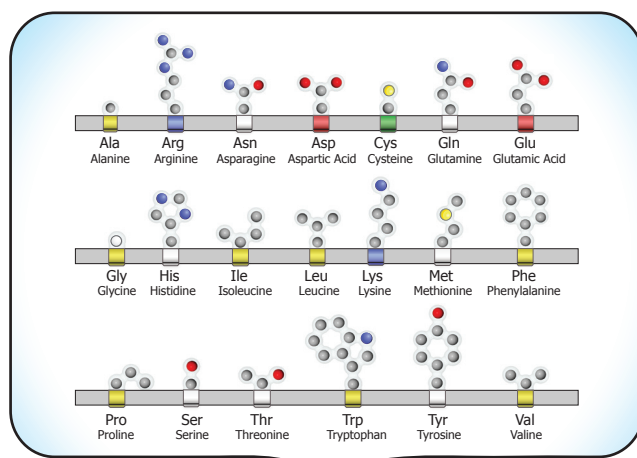
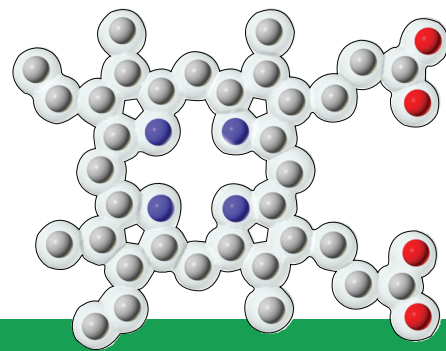
Amino acids are small molecules. Think of them as building blocks. Cells use specific sequences of amino acids (building blocks) to make proteins. There are 20 amino acids (building blocks). Each consists of two parts — a backbone and a side chain. The backbone is the same in all 20 amino acids, yet the side chain is different in each. Each side chain consists of a unique combination of atoms which determines its shape and chemical properties.

The top section of this illustration shows the combination of atoms and 3-D shape that make each side chain unique. (The key below the illustration shows the color coding of the atoms.) The bottom of the illustration shows that the backbone structure is the same in all amino acids. When different amino acids join together (like building blocks) to make a protein, the unique properties of each amino acid determine how the protein folds into its final 3-D shape. You will learn more about the properties of the side chains as you start to fold the β-globin protein model.

The side chains selected for the β-Globin Folding Kit® illustrate how specific amino acid side chains cause β-globin to form its stable compact structure and transport oxygen to your body's cells.

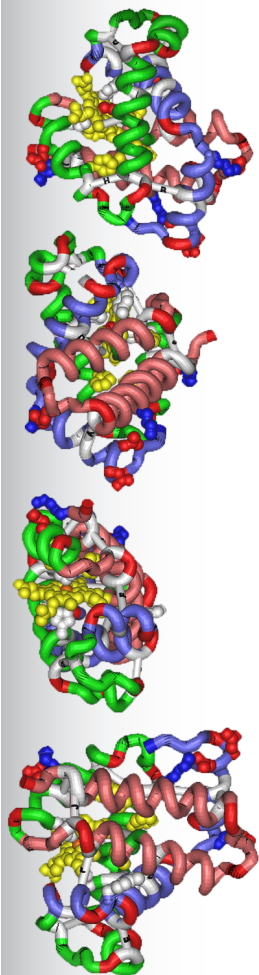
What if a protein can't perform its function?

There may be serious consequences if a protein can't do its job. Without oxygen the cells in your body will die. Even a seemingly small change in the composition of a protein can impact how it performs its function. After you have folded the β-globin model, you will discuss sickle cell anemia and how a single mutation in the human β-globin gene can change how well hemoglobin works.

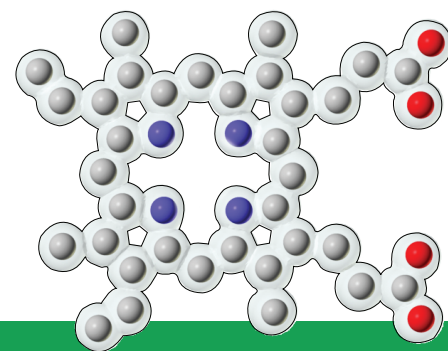


Atoms Color Key

- Carbon (C)
- Nitrogen (N)
- Oxygen (O)
- Sulfur (S)
- Hydrogen (H)



β-Globin Folding Kit®



β-Globin Overview Continued

What is the structure of hemoglobin?

Hemoglobin is a protein that consists of four subunits. Two of the subunits are identical to each other and are called alpha (α) subunits or α-globin. The other two subunits are also identical to each other and are called beta (β) subunits or β-globin. The α- and β-globins are similar to each other, but not identical. Each subunit has a heme group with an iron (Fe) atom in the center. (See photo: the two β-globin subunits are red and the two α-globin subunits are white.) An oxygen molecule (O₂) binds to the iron atom in the heme group so it can be delivered through your blood to your cells.

Do all proteins have four subunits?

No. Some proteins consist of only one subunit. Proteins that have more than one subunit exhibit quaternary structure. Since hemoglobin is a globular protein with two α-subunits and two β-subunits, it exhibits all four levels of protein structure. The four levels of protein structure are described and illustrated below:

- Primary – the sequence of amino acids in the protein chain
- Secondary – initial folding into right-handed alpha helices or beta pleated sheets
- Tertiary – final folding of the protein in three-dimensional space
- Quaternary structure – assembly of two or more subunits to make a functional protein

