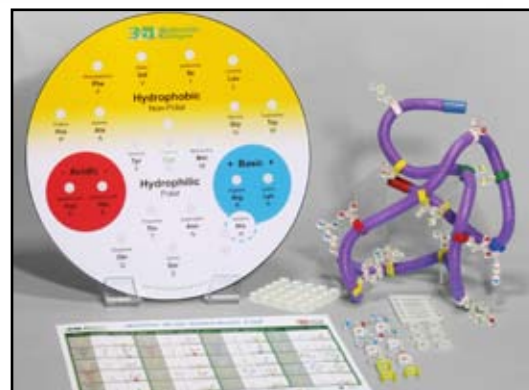


Introduction

Proteins are large, linear polymers of amino acids that spontaneously fold into complex 3D shapes. Although protein structure appears to be very complex, the chemical properties that determine protein structure are relatively simple.

The Amino Acid Starter Kit® allows your students to explore how the unique chemical properties of the 20 amino acids determine the final shape of a protein. Three student handouts lead your students through the hands-on activities.



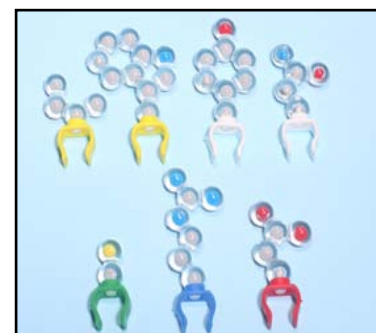
Student Handout 1

A dual coloring scheme allows students to:

- group the different sidechains into one of five categories: hydrophobic (nonpolar), hydrophilic (polar), negatively charged, positively charged, and cysteines, which sometimes form disulfide bonds.
- examine the atoms that make up each sidechain to learn how different functional groups determine the chemical properties of amino acids.

Your students will attach sidechains to a 4-foot mini-toober and fold it into a 15-amino acid protein, following the chemical properties of the sidechains. As they fold their proteins your students will discover that it is easy to find a 3D shape in which all of the hydrophobic sidechains are on the inside of their globular structure. As they continue to fold their protein—applying each additional property—it becomes increasingly difficult to find shapes that simultaneously satisfy all of the properties.

Following this engaging, hands-on protein folding activity, your students will have a basic understanding of how the physical and chemical properties of amino acids affect protein structure. They also will be ready to begin a more thorough exploration of molecular structure using the computer visualization tools that are on the website: www.3dmoleculardesigns.com/resources.php.



Student Handout 2

In the first set of activities in this kit, *Student Handout 1*, your students explored the primary and tertiary structure of proteins, including the role of the amino acid sidechains in determining the overall shape of a protein. The second set of activities in the kit explores the secondary structure of proteins.

Simple models allow students to:

- Identify alpha helices and beta sheets are the two primary elements of secondary structure.
- Model hydrogen bonds in alpha helices and beta sheets as protein structure stabilizers.
- Discover alpha helices and the beta sheets represent different ways to optimize the hydrogen bonding that can occur between the amino nitrogen of one amino acid and the carboxyl oxygen of another.
- Realize a single hydrogen bond is weak but multiple hydrogen bonds in the alpha helices and beta sheets contribute significantly to the stability of molecular structures.
- Recognize alpha helices and beta sheets are features of the backbone atoms.



Using the mini-toobers – and their fingers as bending jigs – your students will form a beta sheet and stabilize it with hydrogen bond connectors. Then they will form an alpha helix and stabilize it with hydrogen bond connectors. Then with a couple of folds, you students will make a Zinc Finger and learn about its function.

The computer visualization tools on the website (www.3dmoleculardesigns.com/resources.php) will allow your students to begin a more thorough exploration of the secondary structure.

Student Handout 3

Although most enzymes consist of 200 or more amino acids, the active site of an enzyme is made up of only 2 to 3 amino acids that are precisely positioned in 3D space. In this activity, your students will be asked to think about how all the other amino acids in the enzyme create a compact, stable scaffolding upon which the several active site amino acids can be positioned. This activity will also demonstrate the role of protein secondary structure in achieving this stable scaffold. In addition your students may be surprised to discover that the three active site amino acids in this example are very far apart from each other in the linear sequence of amino acids that make up the protein.

