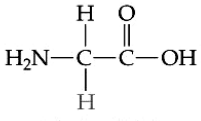
WHAT IS A PROTEIN?

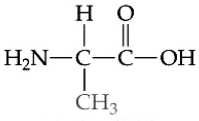
OBJECTIVES
The objective of this worksheet is to understand the structure and function of proteins

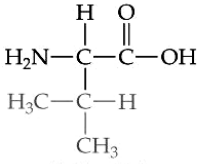
PART A: Understanding Proteins

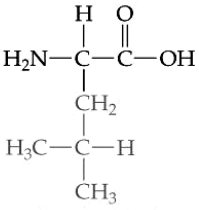
As you may already know proteins are an essential part of your diet. Proteins form many structures in cells and body tissues. They are the main components in things like hair, bone, muscle, and blood. Proteins also form enzymes which are molecules that assist in the many chemical reactions that take place within cells and the body. Probably the most commonly known enzymes are the stomach's digestive enzymes that help break down (hydrolyze) our food into smaller components. However, not all enzymes break things down in your body. There are many enzymes that utilize dehydration synthesis to create larger organic polymers. Note: an enzyme is a biological (living) catalyst. A catalyst is a substance that speeds up a reaction without becoming part of the reaction.

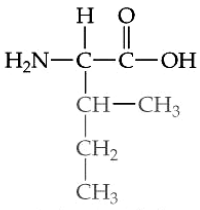
Proteins are polymers. They are made of strings of hundreds to thousands of amino acids (monomers). There are 20 different kinds of amino acids that can be strung in innumerable combinations to create different shapes and functions for the body. These are the structural formulas of each of the individual 20 amino acids.

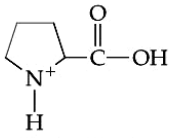

Glycine (Gly)

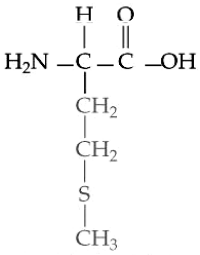

Alanine (Ala)

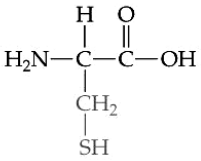

Valine (Val)

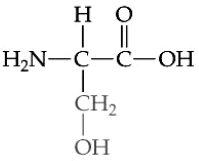

Leucine (Leu)

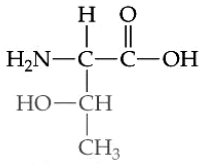

Isoleucine (Ile)

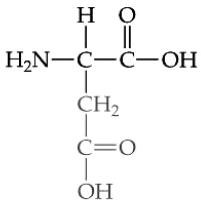

Proline (Pro)

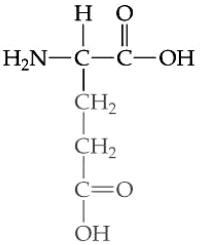

Methionine (Met)

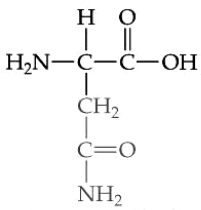

Cysteine (Cys)

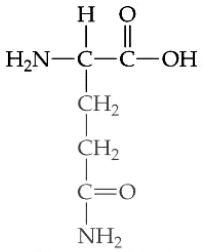

Serine (Ser)

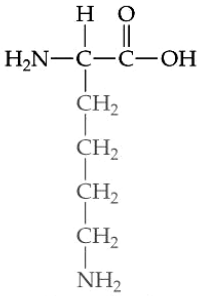

Threonine (Thr)

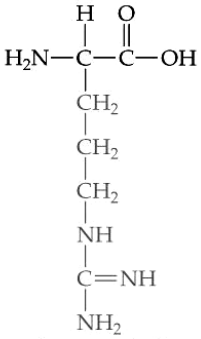

Aspartic acid (Asp)

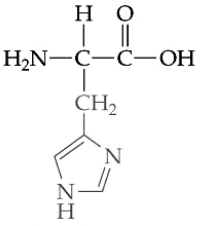

Glutamic acid (Glu)

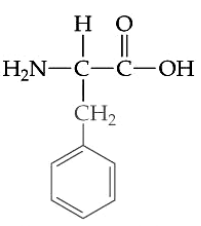

Asparagine (Asn)

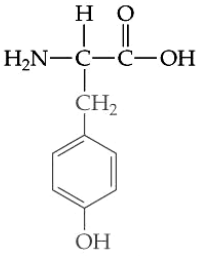

Glutamine (Glu)

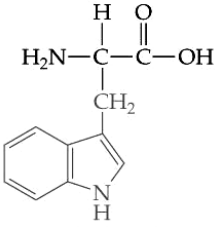

Lysine (Lys)


Arginine (Arg)


Histidine (His)

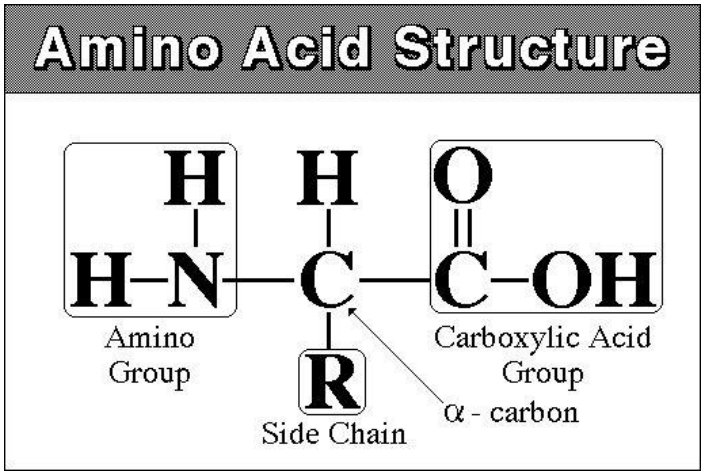

Phenylalanine (Phe)


Tyrosine (Tyr)

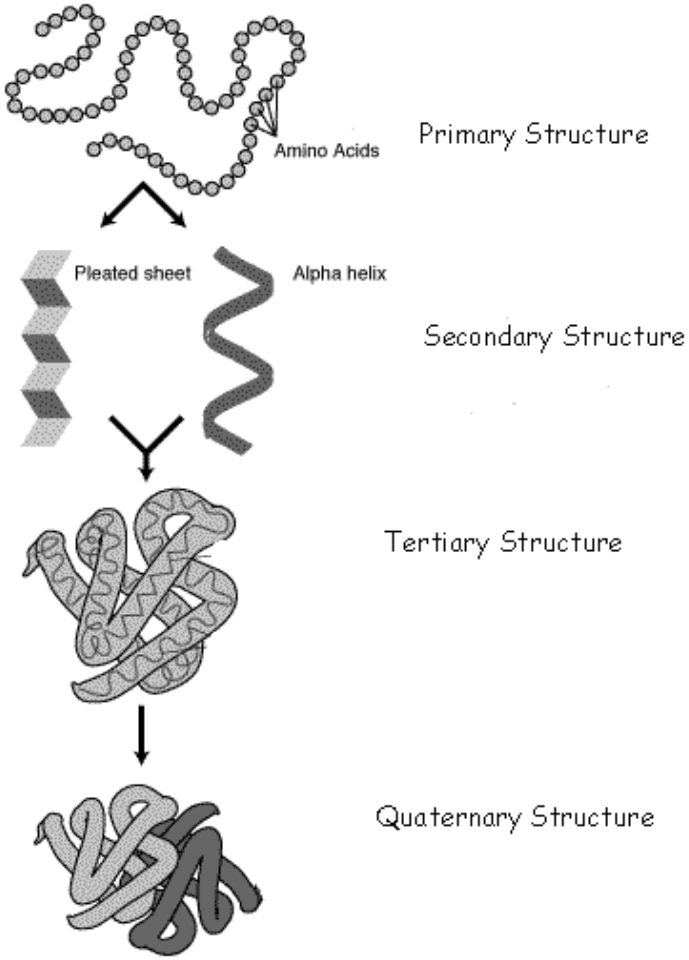

Tryptophan (Trp)

The basic structure of every amino acid is the same. Each amino acid contains an amino group ($-NH_2$) and a carboxyl group (-COOH). The only difference between one amino acid and the next is the "R" group.

"R" represents the "Radical" side chain that is different for each amino acid. The "R" group can either be one atom (H) or a group of atoms.



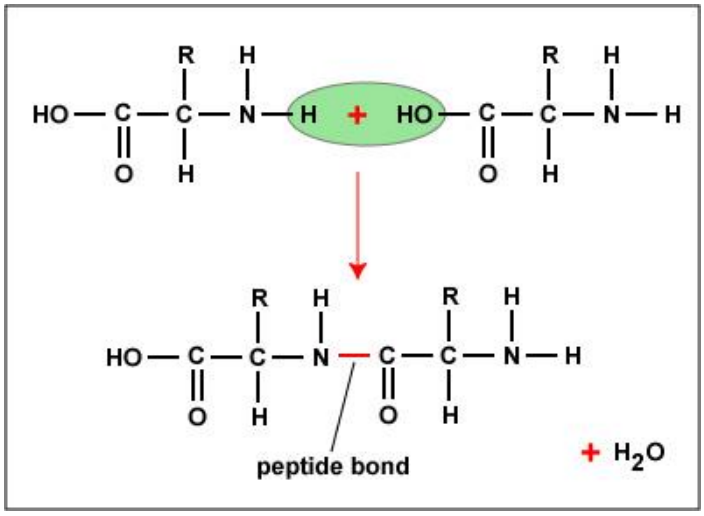
The amino acid sequence found in a protein is very important to its function. However, take a look at the diagram below. This diagram shows how the string of amino acids (primary structure) forms secondary shapes or structures, which then fold on themselves to form a tertiary structure. Some proteins combine tertiary structures as well to form a quaternary structure. The final shape of the protein is not random – this shape is specific and will determine the function of the protein. An important concept to realize here is that the amino acid sequence determines the shape of the protein and the shape of the protein determines its function.



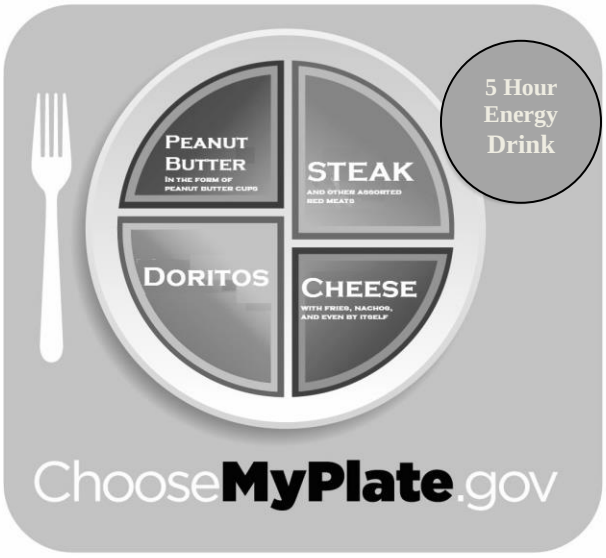
Forming proteins from amino acids

Amino acids are linked together by dehydration synthesis just as the monomers of carbohydrates and lipids are linked together. However, the bond that is formed between the two adjacent amino acids has a special name called a **Peptide Bond**.

Remember there are 20 different amino acids. Each amino acid is identical except for the R group.



Proteins are a vital part of both the structure and function of your body. The sequence of amino acids in a protein as well as the specific folding of each determines the final function of the protein. Proteins break down or are used up continuously in living organisms. Therefore new proteins have to be created constantly. There are two main ways in which your body receives the amino acids that it needs in order to construct new proteins. You need to consume amino acids as protein in your food or your body will create them. When you eat protein (from meat, dairy, etc.) your body digests the protein (by hydrolysis) to form individual amino acids. These amino acids are absorbed through the wall of your small intestine and enter your blood stream, where they are transported to each of your cells. There they will be organized into primary, secondary, tertiary, and even quaternary arrangements in order to perform specific tasks. Of the 20 amino acids found in your body, 8 of them are considered essential because they cannot be created from other compounds by the human body, and so must be taken in as food. The other 12 can be created from other compounds in the human body.



PART B: Applying your knowledge of proteins

As was mentioned above, proteins are the main structural and growth components of the cell in tissues such as skin, hair, muscle, and blood. Other proteins serve in a regulatory capacity as enzymes or hormones. Proteins always contain nitrogen in addition to carbon, hydrogen, and oxygen. Phosphorous and sulfur are also found in many proteins.

1. Use the chemical models to build each of the four amino acids listed below.

   When you have finished, have your teacher sign his/her name. _____

   a. Glycine
   b. Alanine
   c. Threonine
   d. Valine

key	
carbon	black
hydrogen	white
oxygen	blue
nitrogen	red
bond	white tube

2. The molecular formula of water is H_2O.
   This means that there are 2 atoms of hydrogen and 1 atom of oxygen in a molecule of water.

   a. The molecular formula for glycine is C __ H __ O __ N __.

   b. The molecular formula for alanine is C __ H __ O __ N __.

   c. The molecular formula for threonine is C __ H __ O __ N __.

   d. The molecular formula for valine is C __ H __ O __ N __.

2. Use the chemical models to build a dipeptide by joining two of your amino acids.

   When you have finished, have your teacher sign his/her name. _____

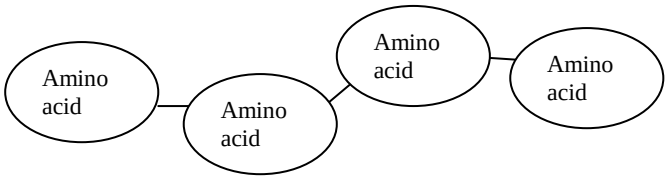
3. Create a polypeptide by joining your dipeptide molecule with another group's dipeptide molecule.

   When you have finished, have your teacher sign his/her name. _____

4. Would you describe what you just accomplished an example of dehydration synthesis or hydrolysis. Explain your answer:

5. What purpose is served by the loss of an "H" and "OH" from the two molecules as they join together during dehydration synthesis?

6. Suppose a piece of protein consisting of four amino acids undergoes hydrolysis. How many water molecules must be used in order to break apart this small protein? _____



7. Suppose a cell wishes to make a protein that has 100 amino acids. How many water molecules will be created in the making of this small protein? _____

8. All living cells contain protein. How might a muscle protein from a horse differ from a muscle protein of a human?