Chapter 2 **The Chemistry of Life** **Name _____**

Worksheet Chemistry of Proteins

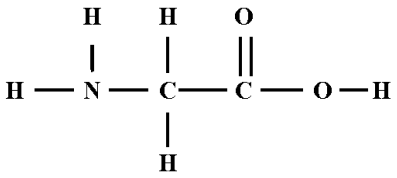
Introduction:

All living things are composed of many chemical compounds. Two such compounds are fats and proteins. Fats are a part of all cellular membranes. They may also be stored within a cell as energy. Proteins form part of almost all structures within a cell. Therefore, they are essential for cell growth and repair.

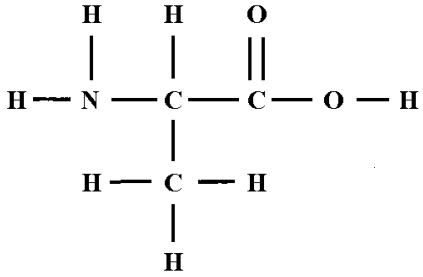
Carbohydrates consist of many monosaccharides joined together while fats consist of glycerol and three fatty acid molecules joined together. Proteins also consist of smaller molecules. These molecules are called amino acids. There are about twenty different amino acids that can join together in any possible way to form proteins. However, a protein, like insulin, may be made of two separate chains of amino acids; one chain will have 21amino acids and the other will have 30. Frederick Sanger found that the sequence for a protein is very specific, meaning that all human insulin will have the same arrangement and number of amino acid molecules in its make-up.

Procedure: Amino Acids

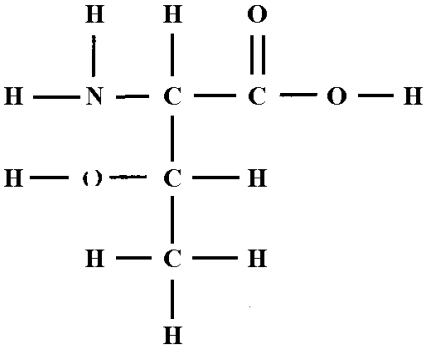
Examine the structural formulas and corresponding paper cut out models of four of the twenty different amino acids used to build proteins.



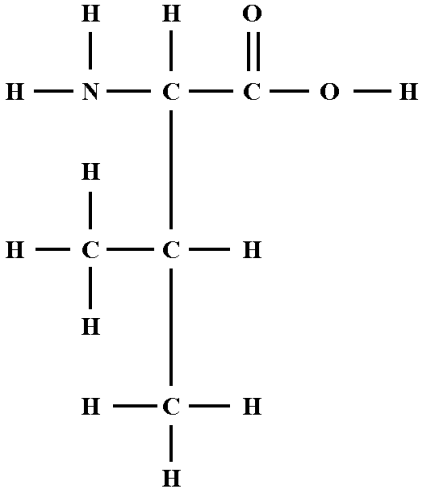
Glycine



Alanine



Threonine



Valine

1. The element nitrogen (N) is present in amino acids. Is nitrogen present in fats and carbohydrates?

2. What is the molecular formula of glycine? Add the correct subscripts. C H O N

3. What is the molecular formula of alanine? Add the correct subscripts. C H O N

4. Are the molecular formulas for all amino acids the same?

5. What functional group, or end arrangement of atoms, is present in amino acids that was also present in fatty acids?

6. Another functional group in all amino acids consists of a nitrogen atom and two hydrogen atoms. This group is called an amino group. Do all structural formulas for each amino acid have an amino group?

Combining Amino Acids to Form a Protein:

Protein is composed of many amino acids joined together chemically. A person's gene will determine the make-up of the protein. Genes specify the number and sequence of the amino acids that will form the specific protein. Proteins may be very large, consisting of 500 or more amino acids; or they may be very small, just a few amino acids. It is the types of proteins that each organism produces that makes it different from all other creatures. True, we say that we are different because of the genes that are parents gave to us at our conception, but remember the expression of genes determines the proteins that make up our body's physical appearance.

Directions: Cut out one of each of the four different amino acids models. Cut along, the solid lines only. Attempt to join the amino acids together to form a protein. By now you realize the cut outs will not stay together until you have created bonding sites. Join the molecules by removing as many OH groups and H groups as needed from the amino acids. All four amino acid molecules can be joined in this manner to form a protein. Join them in the **order** valine—threonine—alanine—glycine.

Remember to join the OH and H ends to form water. The type of chemical reaction that builds larger molecules from smaller molecules by losing a water molecule is called dehydration synthesis, or **condensation**. Attach the protein model and the three water molecules in the space below and title them. Call this first protein "blue eyes".

7. What chemical substance is formed when the OH and H are joined?

Chemists express the joining of these amino acids as follows:

$$\text{Valine} + \text{Threonine} + \text{Alanine} + \text{Glycine} \longrightarrow \text{Protein} + 3\ \text{Water}$$

8. How many molecules of water are formed when four amino acids join together?

Other combinations of amino acids result in the formation of a different protein. Construct a protein different from the one suggested above. Attach the models in the space below and title them. Let's call this protein "brown eyes". This new protein was caused by a change in the DNA. A change in the gene, or DNA, will produce a different arrangement of the amino acids and therefore a physically different protein results.

9. Dehydration means "loss of water". Syntheses means "putting together". Explain why the chemical process responsible for building a fat or protein molecule is called "dehydration syntheses, or condensation".

10. What two types of molecules are needed to form a fat molecule?

11. What type of molecule is needed for forming a protein?

12. How does a glycerol molecule differ from a carbohydrate molecule? Use structural formulas for comparison.

13. How does a fatty acid molecule differ from a carbohydrate molecule?

14. a) How do amino acid molecules differ from fatty acid molecules?

    b) How are they similar to each other?

15. How might a human muscle protein differ from a cow muscle protein?

16. What purpose is served by the loss of H and OH atoms from the two smaller molecules as they join together during a condensation reaction?

17. All fat molecules may undergo a process called hydrolysis (hydro means "water" and lysis means "to break apart"). This process occurs when a fat molecule is broken down into a glycerol molecule and three fatty acid molecules. Three molecules of water must also be used as the glycerol and fatty acid molecules form. To what are the water molecules (H and OH) reattached?

18. A protein consisting of ten amino acids undergoes hydrolysis, or digestion. How many water molecules must be broken down and reattached to the amino acid molecules during this process?

Complete the following table which summarizes glycerol, fatty acids, and amino acids. Use yes or no answers.

Summary of Glycerol, Fatty Acids, and Amino Acids			
Condition	**Glycerol**	**Fatty Acids**	**Amino Acids**
Carbon Present			
Hydrogen Present			
Oxygen Present			
Nitrogen Present			
A 2:1 Ratio of Hydrogen Atoms to Oxygen Atoms			
Has a Carboxyl (Acid) Functional Group			
Has an Amino (Base) Functional Group			
Molecules Join to Form Protein			
Molecules Join to Form Fat			
One Molecule Loses 3 OH Functional Groups			

Cut Out Models for the Protein Worksheet