Name _____ Date _____

Chemistry of Fats and Proteins

8

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 food. Proteins form part of almost all structures within a cell. Therefore, they are essential for cell growth and repair.

In this investigation, it is expected that you:

(a) distinguish between paper molecule models and actual chemical formulas of molecules
(b) determine differences between glycerol and fatty acids by using structural formulas
(c) properly construct fat molecules using paper models
(d) determine differences between amino acids by using structural formulas
(e) properly construct protein molecules using paper models

Remember that paper models do not represent the actual three-dimensional shape of the molecules. Models simply serve as a means of helping you learn how smaller molecules can be organized into larger, more complex molecules.

Materials

scissors

Procedure

Part A. Fats

On a molecular basis, all fats are somewhat similar. Just as carbohydrates are composed of monosaccharide molecules, all fats are composed of smaller molecules. The smaller molecules in fats are glycerol and fatty acids.

Glycerol

1. What elements are present in glycerol? (See page 39.)_____

_____

_____

2. Are there any elements in glycerol that are not in carbohydrates? _____

3. What is the molecular formula for glycerol? (Add the correct subscripts.) C H O

4. What is the ratio of hydrogen atoms to oxygen atoms? _____ How does this ratio compare with the ratio in carbohydrates?

_____

Fatty Acids

The second molecule which contributes to forming fat is a long molecule called a fatty acid. Many different fatty acids exist, but all are similar in several ways.

- Examine the structural formulas and the models of the three fatty acids on page 39.

5. What elements are present in all fatty acids?

_____

6. What is the molecular formula of butyric acid? (Add the correct subscripts.) C H O

7. What is the molecular formula of caproic acid? (Add the correct subscripts.) C H O

8. Does a 2 to 1 ratio of hydrogen atoms to oxygen atoms exist in fatty acids? _____

9. Is the ratio of hydrogen atoms to oxygen atoms the same in each fatty acid? (Give specific examples in your answer.)_____

_____

10. Note the end of butyric acid containing the oxygen atoms. This special end arrangement of carbon, hydrogen, and oxygen is called a carboxyl group $\left(\begin{matrix}O\\ \|\\ -C-O-H\end{matrix}\right)$. Is the carboxyl group present in all fatty acids shown? _____

Combining Glycerol and Fatty Acids to Form Fats

A fat molecule consists of one glycerol molecule and three fatty acid molecules joined together.

• Cut out the glycerol and fatty acid paper model molecules from page 39. You may want to paste the page on lightweight cardboard before cutting out the models. *Cut along the solid lines only.* Attempt to construct a fat molecule.

11. Will the fat molecule stay together? _____

• Remove three -OH ends from the glycerol molecule and three -H ends from the fatty acids. Now it is possible to join the molecules to form a fat.

• Join the -H and -OH ends.

12. What chemical substance is formed when the -H and -OH ends are joined? _____

Production of a fat molecule is a chemical reaction. A chemical shorthand way of expressing the formation of a fat is as follows:

Glycerol + fatty acid molecules ⟶ Fat + water molecules

13. How many water molecules are formed when one fat molecule is produced? _____

Many fats exist in living things. The wide variety of fats are formed by different combinations of fatty acid molecules.

14. What molecule remains the same in all fats?

_____

Part B. Proteins

Carbohydrates consist of many monosaccharides joined together while fats consist of glycerol and fatty acid molecules joined together. Proteins also consist of smaller molecules. These molecules are called amino acids.

Amino Acids

• Examine the structural formulas and corresponding paper models of the four representative amino acids on page 41.

15. The element nitrogen (N) is present in amino acids. Is nitrogen present in fats and carbohydrates? (Use structural formulas as a guide.)_____

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

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

18. Are the molecular formulas for all amino acids the same? _____

19. What end arrangement of atoms is present in amino acids that was *also* present in fatty acids?

_____

20. Another end arrangement in all amino acids consists of a nitrogen atom and two hydrogen atoms. This group is called an amino group $\left(\begin{matrix}H\\ |\\ H-N-\end{matrix}\right)$. Do all structural formulas for each amino acid have an amino group?_____

Combining Amino Acids to Form Protein

Protein is composed of many amino acids joined together chemically.

• Cut out the four amino acids from page 41. *Cut along the solid lines only.* Attempt to join the amino acids. Will the protein molecule stay together? _____

Name _____ Date _____

• 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.

• Rejoin the -OH and -H ends.

21. What chemical substance is formed when the -OH's and -H's are joined? _____

Chemists express the joining of these amino acids as follows:

Valine + Threonine + Alanine + Glycine ⟶ Protein + Water

22. 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.

Analysis

1. Dehydration means "water loss." Synthesis means "to put together." Explain why the chemical process responsible for building a fat or protein molecule is called dehydration synthesis. _____

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

3. What type of molecule is needed to form protein molecules? _____

4. How does a glycerol molecule differ from a carbohydrate molecule? (Use structural formulas for comparison.) _____

5. How does a fatty acid molecule differ from a carbohydrate molecule? _____

6. How do amino acid molecules differ from fatty acid molecules? _____

   How are they similar? _____

7. How might a human muscle protein molecule differ from a cow muscle protein molecule? _____

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

_____

9. All fat molecules may undergo a process called hydrolysis (*hydro* means water; *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 water molecules must also be used as the glycerol and fatty acid molecules form. To what are the water molecules (H and OH) reattached? _____

_____

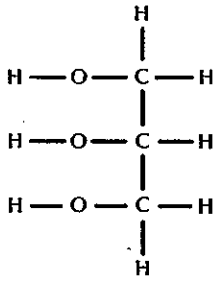
10. A protein consisting of six amino acids undergoes hydrolysis. How many water molecules must be broken down and reattached to amino acid molecules during this process? _____

11. Complete Table 8–1 which summarizes glycerol, fatty acids, and amino acids. Use yes or no answers.

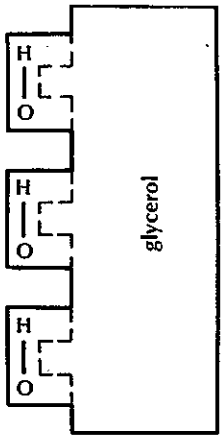
Table 8–1. Summary of Glycerol, Fatty Acids, and Amino Acids

	Glycerol	Fatty acid	Amino acid
Carbon present			
Hydrogen present			
Oxygen present			
Nitrogen present			
2:1 ratio between hydrogen and oxygen			
Has a carboxyl group			
Has an amino group			
Molecules join to form protein			
Molecules join to form fats			
One molecule loses 3 OH ends			

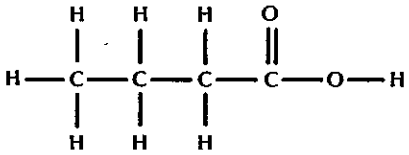
structural formula of glycerol



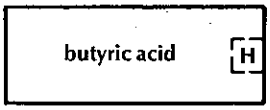
model of glycerol



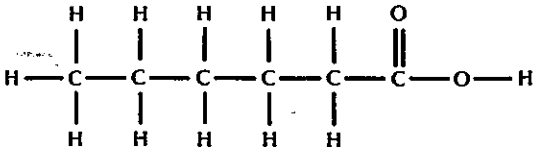
structural formula of butyric acid



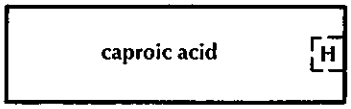
model of butyric acid



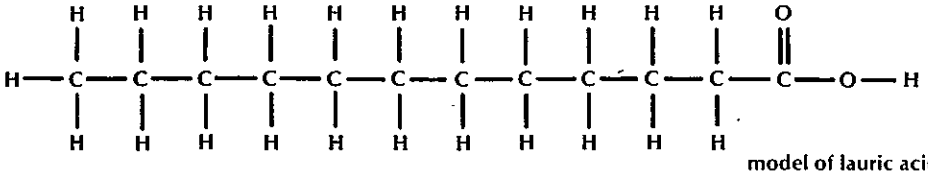
structural formula of caproic acid



model of caproic acid

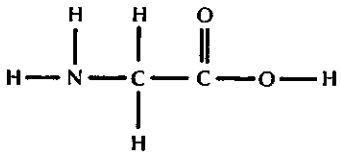


structural formula of lauric acid

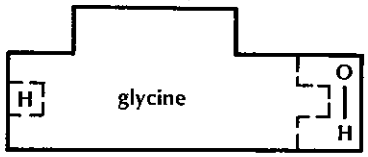


model of lauric acid

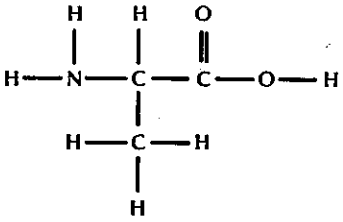
structural formula of glycine



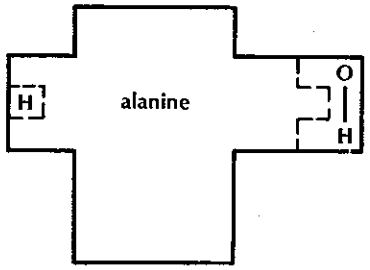
model of glycine



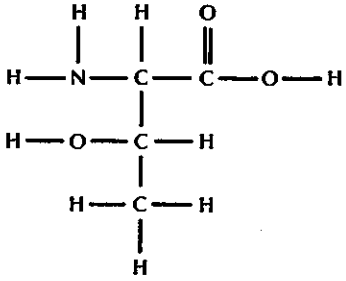
structural formula of alanine



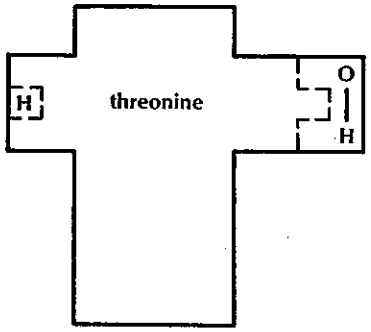
model of alanine



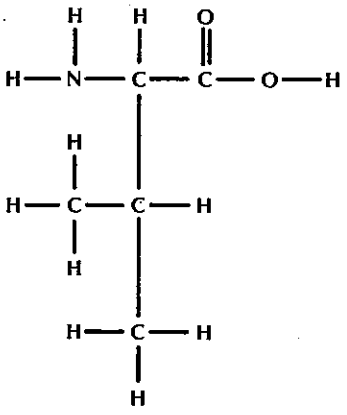
structural formula of threonine



model of threonine



structural formula of valine



model of valine