Name _____ Date _____

Fats: Chemistry And Identification

8

Fats are present in living organisms. These chemicals make up certain parts of your body. Fats are often stored when present in excess and also serve as an energy source. Fats are an important part of our diet.

In this investigation, you will

(a) learn that all fat molecules are made up of two kinds of smaller molecules, glycerol and fatty acids.
(b) use structural formulas and models of glycerol and fatty acids to determine how these molecules join to form fat molecules.
(c) learn how to use the solubility test to tell if a substance is a fat.
(d) learn how to use the brown paper test to tell if a substance is a fat.

Materials

scissors
paper models
clock or watch with second hand
dropper
glass marking pencil or labels
test tubes
test tube rack
olive, corn, or peanut oil
water
brown paper
unknown substance X
unknown substance Y
unknown substance Z
lighter fluid
test tube stoppers—2

Procedure

Part A. Models of Fats

To better understand the chemistry of fats, it is helpful to study first the small molecules which join to make up fats. Fat molecules are made up of two small "building blocks," or chemical molecules. These molecules are called glycerol and fatty acids.

Glycerol

Figure 8-1 shows the structural formula of glycerol.

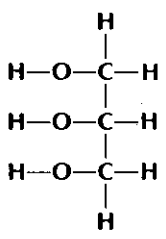


FIGURE 8-1 glycerol

1. What elements are present in glycerol?

_____

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

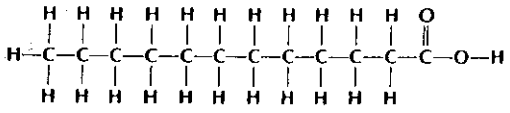
3. What is the molecular formula for glycerol? (Add the number of atoms of each element and record the totals.) C__ H__ O__

4. Are there two times as many hydrogen atoms as oxygen atoms in glycerol? _____

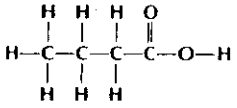
Fatty Acids

The second kind of molecule which is part of a fat is a fatty acid. Many different fatty acids exist, but all are similar in several ways. Butyric acid, caproic acid, and lauric acid are examples of fatty acids. Figure 8-2 shows the structural formulas for these three fatty acids.

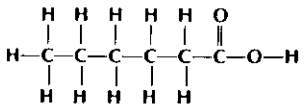
FIGURE 8-2



lauric acid



butyric acid



caproic acid

• Examine the structural formulas for these three molecules.

5. What elements are present in all fatty acids?

_____

6. (a) What is the molecular formula for butyric fatty acid? C__H__O__
   (b) What is the molecular formula for caproic fatty acid? C__H__O__
   (c) What is the molecular formula for lauric fatty acid? C__H__O__
7. How do the number of hydrogen atoms compare to the number of oxygen atoms in each fatty acid? _____
8. How many oxygen atoms are present in each fatty acid? _____
9. 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? ____
10. (a) List a similarity between glycerol and fatty acids. _____

    _____

    (b) Do fatty acids and glycerol both contain a carboxyl group? _____

Combining Glycerol and Fatty Acids to Form Fats

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

• Cut out the glycerol and fatty acid paper model molecules given to you by your teacher. **CAUTION:** *Always be extremely careful with scissors. Cut along the solid lines only.* Attempt to construct a fat molecule.

11. Will the fat molecule fit together as pieces in a puzzle? _____

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

12. (a) How many glycerol molecules are needed to form a fat molecule? _____
    (b) How many fatty acid molecules are needed to form a fat molecule? _____

• Join the leftover $-H$ and $-OH$ ends from your models.

13. 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

14. 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.

15. A change in the type of fatty acid results in a different type of a fat molecule. What molecule remains unchanged in all fats? _____

Part B. Identification of Fats

Two different tests can be used to determine the presence of a fat, the solubility test and the brown paper test.

Solubility Test on Known Fats

• Label two test tubes one and two.

• Use Figure 8-3 as a guide to filling your test tubes. **CAUTION:** *Lighter fluid is flammable. Extinguish all flames in the laboratory before proceeding. Avoid breathing fumes.*

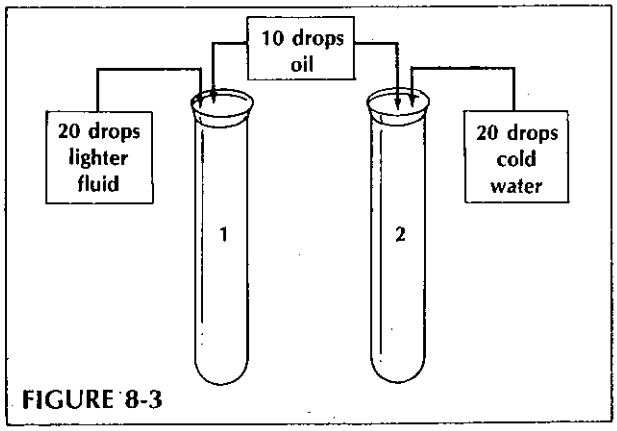


FIGURE 8-3

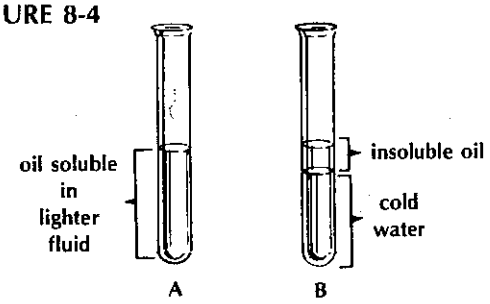
- Mix contents of each tube by placing a stopper over the opening of each tube. Place your thumb over the stopper and shake each tube 10 times.

- Wait one minute.

- Examine and compare both tubes. Fats are soluble in lighter fluid. Soluble means that they dissolve or mix. The liquid in the tube should look like Figure 8-4A in which only one liquid is seen.

- Fats are not soluble in cold water. They do not dissolve or mix. Two layers will be seen as shown in Figure 8-4B.

FIGURE 8-4

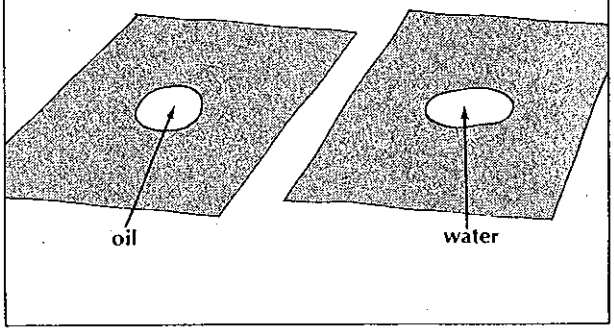


- Record in Table 8-1 how the oil appears when mixed with lighter fluid and cold water.

Brown Paper Test for Fats

- On separate pieces of brown paper, rub one drop of oil and one drop of water (Figure 8-5). Oil is a fat. Water is not.

FIGURE 8-5



- Allow the paper to dry for a few minutes.

- Hold the paper toward light. If light passes through, a translucent (semitransparent) spot has formed.

- Examine the pieces of paper to check for a translucent spot. Record in Table 8-1 how fats and water appear when spotted on brown paper. Fats should give a translucent spot, water should not.

Testing Unknown Substances for Fats

- Perform the lighter fluid solubility and brown paper tests on each of the following substances:

(a) substance X
(b) substance Y
(c) substance Z

NOTE: Use very small amounts of X, Y, and Z if they are not liquid.

- On the basis of your observations, indicate in the last column of Table 8-2 whether or not each substance contains fats.

TABLE 8-1. RESULTS OF TESTS ON FATS

TEST	RESULTS
Fats mixed with lighter fluid	
Fats mixed with cold water	
Fats rubbed on brown paper	
Water rubbed on brown paper	

TABLE 8-2. TESTING UNKNOWN SUBSTANCES FOR FATS (ANSWER YES OR NO)				
	TEST			RESULTS
SUBSTANCE	SOLUBLE IN		TRANSLUCENT SPOT FORMED ON PAPER	FAT PRESENT
	LIGHTER FLUID	WATER		
X				
Y				
Z				

Analysis

Use your results from Part A to answer questions 1 to 3.

1. Name the types of molecules and number of each type needed to form a fat molecule. _____

_____

2. List two ways that a fatty acid molecule differs from glycerol. _____

_____

3. Complete the following chart by using "yes" or "no" answers.

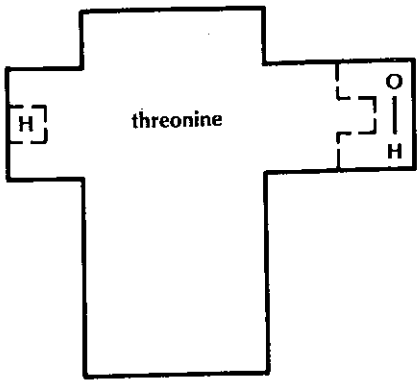
TABLE 8-3. SUMMARY OF GLYCEROL, FATTY ACIDS, AND AMINO ACIDS			
	GLYCEROL	FATTY ACIDS	AMINO ACIDS
Carbon present			
Hydrogen present			
Oxygen present			
Nitrogen present			
Double the amount of hydrogen as oxygen			
Has a carboxyl group			
Has an amino group			
Molecules join to form fats			
One molecule loses 3 OH ends			

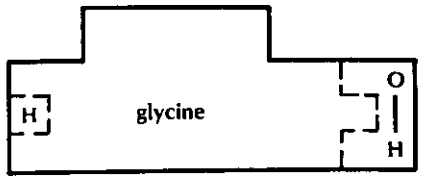
Use your results from Part B to answer question 4.

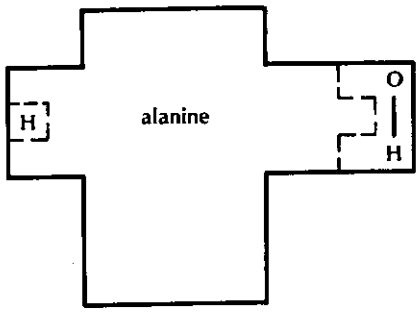
4. Explain why grease on clothing will not come out with cold water. _____

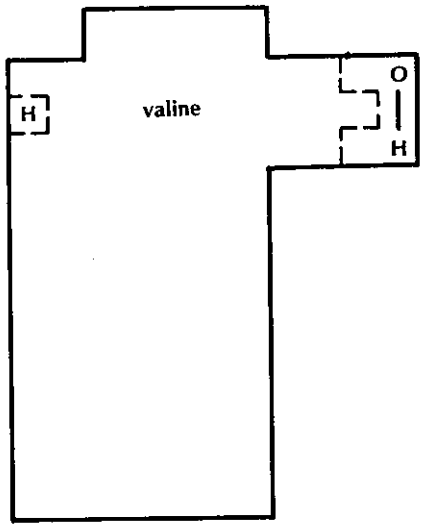
_____

MODELS FOR INVESTIGATION 7, "PROTEINS: CHEMISTRY AND IDENTIFICATION"









MODELS FOR INVESTIGATION 8, "FATS: CHEMISTRY AND IDENTIFICATION"