DETERMINATION OF THE SIZE OF
A FATTY ACID MOLECULE

Previously, you may have extracted the fat from potato chips, French fried potatoes, or even a piece of hot dog or other sausage. Most likely, you have read or heard about fats and oils and their effects on health. Since they are large molecules, they must be broken down by the body into smaller pieces to be metabolized. If there is more fat than what is metabolized, fat molecules will be rebuilt in the body for storage.   There are a number of different fats found in our foods, oleic acid is an "average" fatty acid.

Oleic acid has the chemical formula $C_{17}H_{33}COOH$. A diagram of its structure is shown in Figure 1.

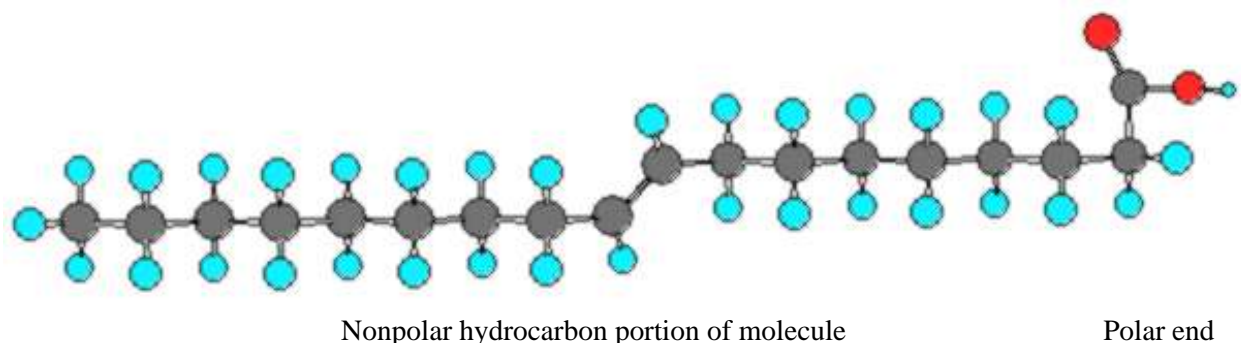Nonpolar hydrocarbon portion of molecule   Polar end

Figure 1. Oleic acid

Due to its large nonpolar portion, oleic acid is insoluble in water and, being less dense than water, it floats on the water surface. The polar –COOH end, however, is attracted to water molecules. So, a thin coating of oleic acid on the surface of water results in the molecules aligning themselves in an upright position with the polar ends oriented toward the water surface. (See Figure 2) If there is sufficient surface area for the water, the oleic acid will spread out and will form a film one molecule thick. Such a layer is known as a monolayer.

By determining the volume of oleic acid used and the size of the oleic acid monolayer, the thickness of the layer can be determined. The thickness of the layer is approximately the size of an oleic acid molecule.
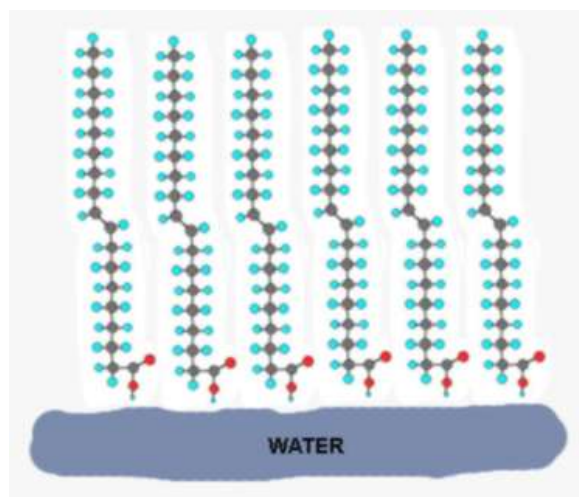

Figure 2. Oleic acid molecules on the surface of water.

Safety Precautions

Wear safety goggles at all times in the laboratory.

Ethanol is flammable. Keep it away from flames or devices that may spark.

Allergy alert: Lycopodium powder is the spores of club moss. If you have severe allergic reactions to plant spores, please inform your instructor.

Disposal

Dispose of all waste material in the proper waste containers.

Materials Needed

Oleic acid solution in ethanol. This is a 1/200 solution by volume, prepared by dissolving 1 mL oleic acid in 199 mL ethanol.
Lycopodium powder, place in salt or pepper shakers, if available.
Graduated cylinder, 10 mL
Beaker, 10 or 20 mL
Tray or baking pan: metal, glass, or aluminum foil, at least 9 inches (23 cm) in diameter.
Thin stem dropper
Ruler, 12 inch (30 cm)

Procedure

Obtain a small amount, approximately 3 mL of oleic acid solution in a small beaker.

Using a thin stem dropper and a 10 mL graduated cylinder, measure the number of drops of the oleic acid solution in 1.0 mL. Record the number of drops. Do not empty the graduated cylinder.   Repeat the procedure by counting the number of drops in another 1.0 mL of the oleic acid solution. (You will now have a total of 2.0 mL of liquid in the graduated cylinder.)

Obtain a tray or baking pan. Fill it approximately ½ with tap water. Place it on your lab bench where you will be able to work with it, but not bump it or cause it to be agitated.

Once the water in the tray is very still, sprinkle a thin layer of lycopodium powder over the water. You will need enough to cover the surface with no clumps of powder.

Add 1 drop of the oleic acid solution to the center of the tray.

After the drop has spread, and is stable for about 1 minute, measure the diameter of the oil spot in the lycopodium powder. Record your measurement.

Dispose of the liquid in the tray or baking pan. Refill it with water, and repeat the process of adding the lycopodium powder followed by the 1 drop of oleic acid solution, and measure the diameter of the oil spot.

Dispose of the liquid in the tray or baking pan.

Clean up any oleic acid residue with soapy water.

Calculations (You may complete your calculations in the spaces provided below.)

$$\text{Volume of 1 drop of oleic acid solution} = \frac{1.0 \text{ mL}}{\text{Average number of drops in 1.0 mL}}$$

$$\text{Volume of oleic acid in 1 drop of solution} = \frac{\text{Volume of 1 drop of oleic acid solution}}{200}$$

$$\text{Area of oleic acid spot} = \frac{\pi \, (\text{Average diameter of oleic acid spot})^2}{4}$$

$$\text{Thickness of oleic acid spot} = \frac{\text{Volume of oleic acid in 1 drop of solution}}{\text{Area of oleic acid spot}}$$

Conversion factor: 1 nm = 1 x 10-7 cm

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Data and Results

Name _____ Course and Section _____

Partner _____ Date _____

Data and Calculations

	Trial 1	**Trial 2**
Number of drops of oleic acid in 1.0 mL	_____	_____
Diameter of oleic acid spot	_____ cm	_____ cm
Average number of drops in 1.0 mL	_____	
Average diameter of oleic acid spot	_____ cm	
Volume of 1 drop of oleic acid solution	_____ cm^3	
Volume of oleic acid in 1 drop of solution	_____ cm^3	
Area of oleic acid spot	_____ cm^2	
Thickness of oleic acid spot	_____ cm	
Length of an oleic acid molecule	_____ nm	

Questions

1. Why is the oleic acid diluted in the solution used in this experiment?

2. What is the purpose of the lycopodium powder?

3. How large is an oleic acid molecule as compared to a water molecule? (Find the size of a water molecule in an Internet search. List your reference.)