Chemistry of Foods
Esters Lab

Introduction/Pre-lab

We are currently studying sensory evaluation in class. Did you know that chemists can make chemicals to "trick your brain" into thinking you are smelling something that isn't really there? Or tasting something that isn't there? The combination of these senses is what gives a food its **flavor**.

Taste buds alone do not determine the flavor of a food! If this was the case, you wouldn't be able to tell foods with similar chemical makeup (apples and pears, for example) apart.

Esters are chemicals with a very distinct smell. Some esters can be found in nature – the very distinct smell of an orange or a banana comes from the ester molecules in the food making their way to your nose!

You have probably eaten foods with these flavors that don't actually have "oranges" or "bananas" in their ingredient list, however. Scientists recreated those aromas in the lab.

In this lab, we will be mixing various kinds of **acids** with various kinds of **alcohols**. The product of the reaction will be an **ester**.

The general reaction for making esters is:

Carboxylic Acid + Alcohol → Water + Ester

Generally a fruit or flower may only contain a few drops of ester, giving it a very subtle odor. When prepared in the laboratory in relatively large amounts, the ester may seem to have an overwhelmingly strong chemical odor, and it may be difficult to recognize the fruit or flower that has this aroma.

Chemicals we will be using today:

Alcohols: Methanol, ethanol, isobutyl alcohol and isopentyl (isoamyl) alcohol

Acids: Acetic acid, propionic acid, butyric (butanoic) acid, salicylic acid, sulfuric acid

Safety

Goggles must be worn at all times during this lab – no exceptions! If you take them off, you will be asked to sit down and will not be allowed to participate the rest of the day.

You will be working with some very hazardous substances in this lab. Pay close attention to the following information:

•All chemicals you are using today should be considered highly flammable. Use small quantities and keep them away from open flames.

•Assume that all chemicals you are using today are toxic. Wash your hands if you spill anything on them, and tell Mrs. Carlson if anything spills!

•Sulfuric acid is used to speed up the ester formation reactions. Sulfuric acid is dangerous and can burn skin very badly. If it is spilled, wash *immediately* before the acid has a chance to cause a burn, and tell Mrs. Carlson!

•The vapors of the esters produced in this experiment may be harmful. Use the fume hood as much as possible. When determining the odors of the esters produced in this experiment, *do not* deeply inhale the vapors. Merely waft a small amount of vapor from the ester toward your nose.

Procedure:

Mrs. Carlson will start a hot water bath in the fume hood. This hot water bath will be kept at approximately 70 ^{0}C. We are using the hot water bath instead of Bunsen burners because many of the substances we are using today are flammable.

There are 4 different possible esters to make in this lab. You should make **1** of them today.

1. Mix 1 mL (or approximately 0.5 g if the acid is a solid) of the appropriate acid with 2 mL of the indicated alcohol in a clean dry test tube. (See table on the next page).
2. Add 2 drops of concentrated sulfuric acid to the test tube (*Caution!*), and heat for 10 minutes in the 70°C water bath on the hotplate in the hood.
3. When ten minutes is over, waft the fumes gently toward your nose and note the odor.
4. If you can determine what the odor is, you are done! If you cannot determine what the odor is, move on to step #5.
5. If the odor is still difficult to determine, it might help to dilute the ester because your nose is not used to smelling it in such a concentrated form. If and only if you cannot determine what the odor is, pour the ester into a small beaker of warm water. Then, cautiously waft the vapors towards your nose.
6. **SUPER DUPER IMPORTANT! DO NOT DUMP ANYTHING DOWN THE SINK TODAY – PLEASE DUMP ALL LIQUIDS IN THE GARBAGE CAN WHEN YOU ARE FINISHED!**

Here are the 4 possible combinations of acids and alcohols. **Your job is to make one ester today.**

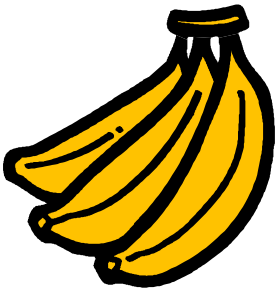
Combination	Acid (1 mL or 0.5 g)	Alcohol (2 mL)
A	Butanoic Acid (Butyric Acid)	Ethanol (Ethyl Alcohol)
B	Ethanoic Acid (Acetic Acid)	Isopentyl (Isoamyl) Alcohol
C	Propanoic Acid (Propionic Acid)	Isobutyl (Methyl 1-propanol) Alcohol
D	Salicylic Acid	Methanol (Methyl Alcohol)

To help your brain identify the smells (since you are used to smelling them in a more diluted form), here are your four choices of smells:

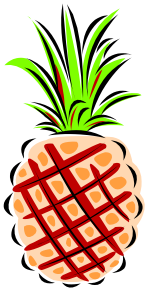
Wintergreen

Rum

Banana



Pineapple



Name_____

Pre-lab Questions

1. What is **flavor?**

2. Where have you already seen esters in processed foods?

3. Why might food manufacturers use synthetic esters (instead of extracting the esters from the foods in nature)?

Data

Put the combination letter you did with the smell you think you made below.

Combination Letter You Did	Smell You Observed

Post Lab Questions

Go to the following website to find out how your brain interprets smells and how esters are used in food products.

http://health.howstuffworks.com/mental-health/human-nature/perception/smell1.htm

1. What does volatile mean?

2. Why do some things have smells while others (like steel) don't? (Hint: What is different about the molecules)?

3. Why are smells so strongly linked to memories?

http://www.businessinsider.com/facts-about-natural-and-artificial-flavors-2014-1

4. Many people think that only processed foods contain chemicals. What is wrong with this statement?

5. What chemical gives cinnamon its trademark flavor and aroma?

6. What is the difference between natural and artificial flavorings?

7. Vanillin is the chemical responsible for the smell and flavor of vanilla. What gross way did scientists discover to produce vanillin – a way that does *not* require orchids from Mexico?

8. Which has more chemicals – a strawberry flavored milkshake from McDonalds, an actual strawberry, or are they about the same?

9. What is soy sauce made from? Why don't they just boil soybeans?

Click on the link at the bottom of the article – "What would it look like if your banana came with an ingredient list?" or click here: http://www.businessinsider.com/ingredient-list-for-natural-products-2014-1

10. List three ingredients that sound like "scary chemicals" that would be found on an ingredient list of a banana, blueberry or egg (if they came with them).