**Root Beer Fermentation Lab**

Introduction

All organisms need energy to live. **Cellular respiration** is the process they use to convert the energy stored in sugars into the quick energy of ATP. If oxygen is available, the mitochondria can perform their “energy generator” job and make a lot of ATP energy. This version of respiration is called **aerobic respiration** and it produces enough ATP energy to support large, active, multicellular animals like you and me.

If oxygen is not available, large organisms cannot produce enough energy to survive. That’s why we die if we cannot breathe. But even though there is no oxygen, some one-celled organisms can still digest sugars and make enough ATP energy to live and grow. This version of respiration is called **anaerobic respiration**. Anaerobic means “without oxygen”. Anaerobic respiration is used by bacteria and fungi and is also referred to as **fermentation**. There are two types of fermentation:

▪**lactic acid fermentation** which is used by bacteria (and how we make yogurt) and also occurs in muscle cells when they are oxygen-deprived like during a sprint race: **glucose** →**ATP + lactic acid**

▪**alcoholic fermentation**, which is used by yeast (a one-celled fungus) and how we make beer, wine, bread, and many other foods

In this lab, we are going to explore **alcoholic fermentation**. When yeast break down glucose to make ATP energy, they also make two waste products: alcohol and CO2. Unfortunately for the yeast, the alcohol eventually builds up and kills them. But unlike the yeast, humans see the alcohol as a desirable product — an entertaining beverage. We like it so much, we purposely give the yeast sugars to ferment so they make alcohol. The CO2 the yeast also produce collects in the fermenting liquid and makes it fizzy. That’s why we use the terms “carbonation” or “carbonated beverage”. This is the old-fashioned way that soda was made, like root beer, birch beer, and sarsaparilla. And that’s what we are going to recreate in this lab: producing carbonated root beer through the fermentation of sugar.

**HISTORY OF ROOT BEER:**

Root beer was made by our ancestors by soaking Sassafras (a type of tree) root in water, and adding sugar and yeast (for carbonation). In the early 1900s however, scientists discovered that safrole, a chemical found in Sassafras root, was a carcinogen (cancer-causing agent) and human consumption has been banned. Now, a mixture of other herbs and spices makes up “root beer extract” which is what is now used to make homemade root beer.

(Names of Group Members: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

Materials (Recipe)

* Clean 2 Liter plastic bottle labeled with masking tape
* Funnel
* Measuring spoons and cups
* 1 Cup cane sugar (sucrose)
* 1 TBSP (tablespoon) Root Beer Extract (homemade or otherwise)
* ¼ TSP (teaspoon) Baker's Yeast
* Cold fresh water

Procedures

You will be working in small groups of two to four with Mr. Barber's Culinary Arts class. By the end of this experiment, you will have a 2- liter bottle of root beer to share with your group mates. The procedures listed below are measurements for one cook group.

*Making the root beer mixture:*

1. Label 2 Liter bottle with group member's names and class period number.
2. With the funnel, add 1 Cup of cane sugar to the 2 Liter bottle.
3. Add 1/4 TSP powdered baker's yeast.
4. Shake to distribute the yeast grains into the sugar.
5. Swirl the sugar/yeast mixture in the bottom.
6. Add with funnel: 1 TBSP of root beer extract.
7. Fill half the bottle with fresh, cool tap water. Swirl to dissolve ingredients.
8. After ingredients are dissolved, fill the bottle up to the NECK with fresh, cool tap water. Leave an inch of space at the top.
9. Tightly close the cap on your bottle and hold upside down to check for leaks.

*Fermentation Process:*

1. Place in a cupboard at room temperature for three days or until the bottle feels hard to a forceful squeeze.
2. Refrigerate overnight to thoroughly chill before serving.
3. Enjoy!

Conclusion

1. Describe the appearance of the root beer before the fermentation process.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Describe the appearance of the root beer after three days of fermenting.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Why did we need to add yeast to the mixture?  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Why did we need to add sugar to the mixture?   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Write the formula for cellular respiration.   
     
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Was this an example of an aerobic or anaerobic process? Explain your answer.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. Was the yeast going through lactic acid fermentation or alcohol fermentation? Explain your answer.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. What kind of gas was filling the bottle to make it difficult to squeeze? \_\_\_\_\_\_\_\_\_\_\_\_
9. Explain where that gas came from.   
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_