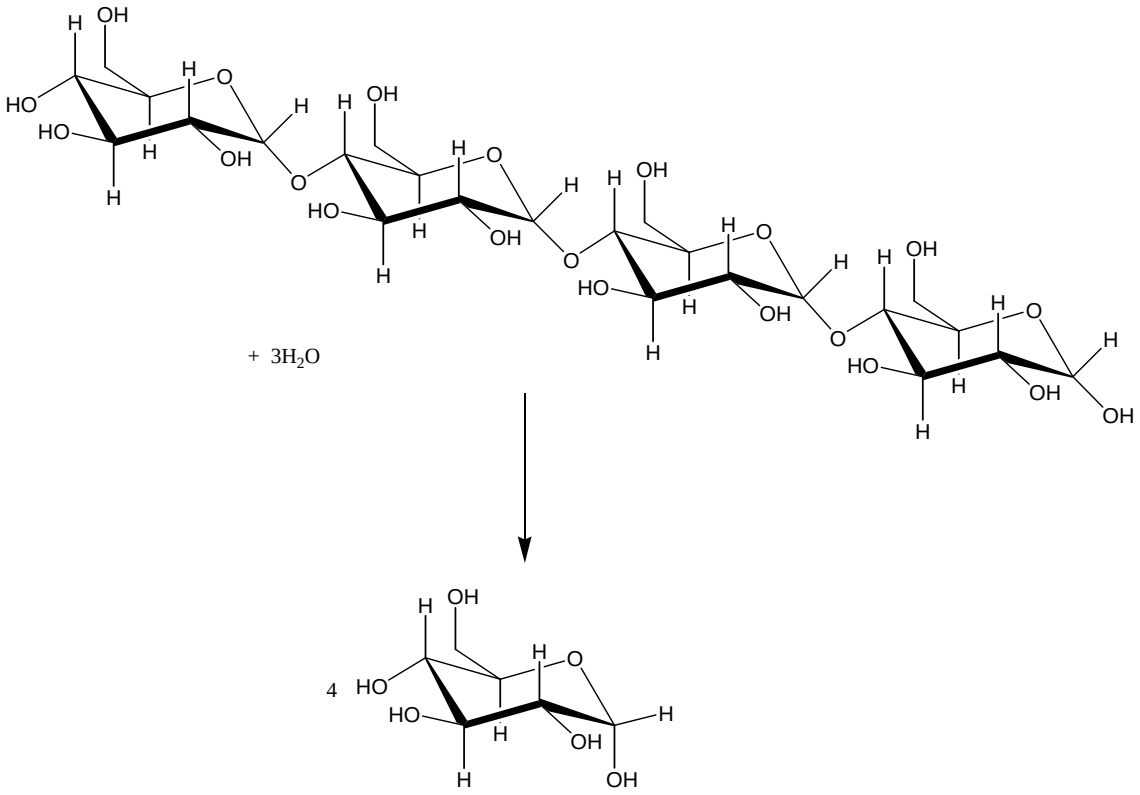
**Introduction:**

Ethanol, or ethyl alcohol, can be prepared by the fermentation of the sugars in fruit or grain. Though this process has been known for thousands of years, it is still important today for the preparation of alcoholic beverages. More important to us, however, is the use of ethanol produced in this way as a fuel blend. Much of the gasoline sold in the United States contains about 10% ethanol which has been prepared from corn. This experiment will explore some aspects of that process.

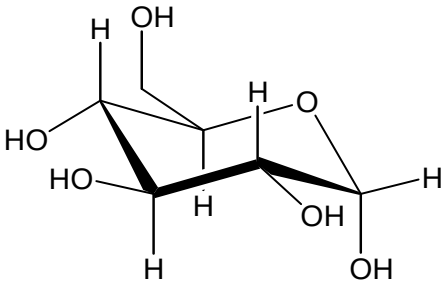
Corn, potatoes, wheat, and rice are important sources of starch, which is the reserve food supply of plants and occurs chiefly in seeds. Starch is actually composed of two substances with very similar structures called amylose and amylopectin. Amylose is a polymer, which means that it is a very large molecule with a repeating subunit. The repeating subunit in amylose is glucose, a sugar molecule with which you may be familiar. Detailed studies indicate that each amylose molecule contains about 1000 glucose subunits.

Upon treatment with acid or under the influence of enzymes, amylose is broken down into maltose (another sugar that is actually two glucose molecules linked together) and glucose. Enzymes are simply molecules in living organisms that can catalyze (speed up) chemical reaction. Without enzymes, the reactions would still tend to occur but at very slow rates.




In the first stage of this experiment, the corn kernels are boiled to extract the starch. Then the enzymes amylase and amyloglucosidase are added to break the starch (amylose) into maltose and glucose, respectively. A buffer solution, which helps to maintain the proper pH for decomposition of the maltose and optimum operation of the enzymes, is also added.

During the fermentation process yeast acts on the glucose to produce ethanol and carbon dioxide




yeast

$$2CH_3CH_2OH + 2CO_2$$

**Procedure: Part I** Preparation of the Slurry:

1. Weigh out about 50g of frozen corn, soaked rice, frozen potatoes, or other starch source.

2. Weigh a 400, 500, or 600 mL beaker. (Zero the balance first!)

3. Transfer the corn to a 400, 500, or 600 mL beaker. Add 50 mL of distilled water. Place the beaker on a ringstand (to heat with Bunsen burner) or on a hotplate and boil gently for 15 minutes. Stir the mixture occasionally with a glass rod. (If the mixture becomes too dry, more distilled water may be added.)

4. After 15 minutes remove the heat source. Add 50 mL of water to the slurry and allow the beaker and its contents to cool.

5. When the beaker has reached 30 degrees Celsius, add 5mL of the 2% aqueous amylase solution. Stir the mixture occasionally with a glass rod during the next ten minutes.

6. At the end of the 10 minute period, add 20 mL of the acetate buffer solution (to maintain a slightly acidic pH), 5 mL of the 2% aqueous amyloglucosidase solution, and 5 mL of the 5% aqueous yeast solution. Stir the mixture occasionally with a glass rod during the next ten minutes.

7. After 10 minutes perform a glucose/reducing sugars test on your slurry. Details will be given in lab.

8. Write your name on the beaker with a marker or wax pencil. Place a piece of saran wrap over the mouth of the beaker and secure it with a rubber band.

9. Weigh the beaker and contents using the ACCULAB L-Series balance—it is too heavy for our normal electronic balances—and record this weight. Zero the balance before placing your beaker on the pan.

10. Place your beaker in a safe place and allow it to sit for a week so that the enzymes can work

| 1) How is an ear of corn like an army?<br>(Answer on next page) |
|---|

**Checklist for completing the "Prelab" section: Part I**

____ *Title*.

____ *Purpose*.

*Physical constants*. Obtain a table of physical constants and safety data for the chemical compounds referred to in the procedure: http://domin.dom.edu/faculty/jbfriesen/chem254lab.htm

____ *Flowchart.* Refer to "Procedure"

____ How could the concentration of glucose be determined for your slurry (there are several possible tests)? Write a balanced chemical equation as part of your answer.

____ Safety Question: Write four Bunsen burner safety rules. Search "Bunsen Burner Safety" on the internet for web sites. Give your references.

**Experimental Observations and Data: Part I**

Hand in a copy of your experimental observations and data before you leave lab.

*Experimental Observations*: Refer to Laboratory Syllabus for guidelines.

Raw Data: *Refer to Laboratory Syllabus for guidelines.*

1) It has lots of "colonels."

http://www.nysaes.cornell.edu/pubs/press/1998/images/corn.gif