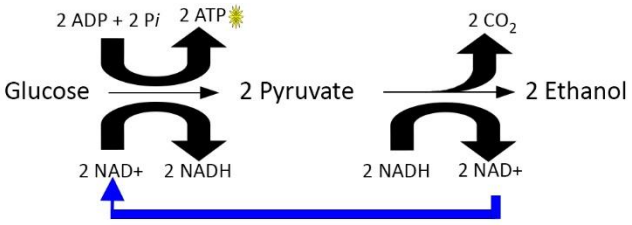
Respiration and Fermentation: Fermentation by Yeast

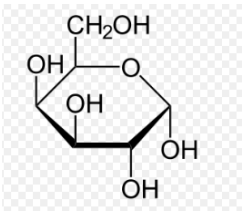
Most eukaryotic organisms derive cellular energy from aerobic cellular respiration or fermentations or both. As explained in the introduction to this module, fermentations start with pyruvate, the end-product of glycolysis and then regenerate NAD^+ and some other organic intermediate. There are many products of fermentation, but the most commonly discussed are ethanol and lactic acid. Ethanol fermentation is performed by fungi, like baker's yeast (*Saccharomyces cerevisiae*). The summary reaction is shown below:



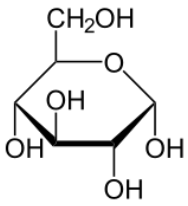
Summary Reaction of Ethanol Fermentation

The products of this fermentative process are ethanol, carbon dioxide and NAD^+. NAD^+ is a carrier molecule which transports a hydrogen ion and electrons stripped from glucose to the electron transport chain. Without NAD^+, glycolysis stops. Fermentation regenerates NAD^+ which can then cycle back to glycolysis which allows the cell to make more ATP. Carbon dioxide is released as a gas. Ethanol is also excreted.

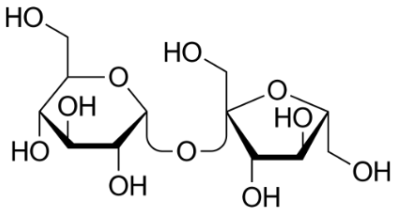
In this activity, you will test the ability of yeast to ferment different sugars. Galactose, is a monosaccharide with the same chemical formula as glucose. Glucose is also a monosaccharide and simple sugar. Sucrose (table sugar) is a disaccharide formed by dehydration synthesis of glucose and fructose.



Galactose



Glucose



Sucrose

Materials

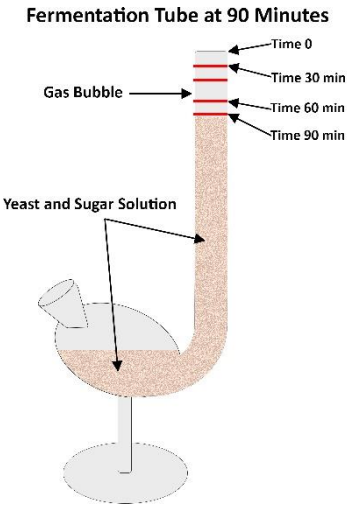
Yeast suspension (1 packet of yeast per 250 mL warm water)
Fermentation tubes (4)*
Distilled water
Graduated cylinder – 25 mL
Galactose solution
Glucose solution
Sucrose solution

*Fermentation tubes vary in size. You may have experiment with your tubes to determine the correct volumes of yeast and sugar to use.

Procedure

1. Label the base of the 4 fermentation tubes as follows: water, galactose, glucose, and sucrose.

2. Add 15 mL of distilled water to the fermentation tube marked ‘water’. Use the graduated cylinder to dispense 15 mL of each sugar solution into the correspondingly named fermentation tube. Rinse the graduated cylinder between solutions.
3. Add 20 mL of yeast suspension to each fermentation tube. Place your thumb over the mouth of the fermentation tube and invert the tube. Inversion should mix the contents of the tube and remove the air space from the top of the tube. Repeat the inversion again if necessary to remove the air space for the glass column of the tube. If the air bubble reforms immediately after inversion, add 3 more milliliters of the correct sugar solution to the fermentation tube and invert the tube again.



4. Use a different finger or wash your hands, then repeat step 3 with the other fermentation tubes.
5. Allow the reaction to continue for 2 hours. Measure gas production in each fermentation tube at 30 minutes intervals by measuring the size of the air bubble in the fermentation tube. Record your results below.

	Gas Production at each Time Interval (Use a centimeter ruler to measure the size of the air bubble.)					
	0	30	60	90	120	Was the sugar fermented?
Water						
Sucrose						
Glucose						
Galactose						

What gas is accumulating in the fermentation tube/s where fermentation is occurring?

Which sugar or sugars were fermented?

Why weren’t all of the sugars fermented?