INTRODUCTION

The conversion of pyruvate to ethanol is carried out by yeast. It takes place naturally in grapes left to ferment on vines, as well as fermentation vats containing crushed grapes. When the ethanol concentration reaches about 12%, its toxic effects kill yeast. Yeasts produce alcohol only when there is little or no oxygen present. When there is enough oxygen present, yeasts break sugar down completely to release water and carbon dioxide.

When a vat of wine is fermenting rapidly, it produces carbon dioxide fast enough to drive off the air over the wine, thus preventing oxygen from dissolving in the wine. When fermentation slows down, wine must be sealed up immediately, before oxygen can enter. If fermentation continues, vinegar is formed.

Yeasts are also used in baking. When bread is rising, the carbon dioxide released from the metabolic process of respiration causes the dough to rise. Unleavened bread is merely dough that has not risen. Regardless of the respiration, aerobic or anaerobic, yeasts release carbon dioxide as metabolic waste.

While there are an infinite number of variables that could be tested using the procedure described below, this lab will focus on temperature as the independent variable.

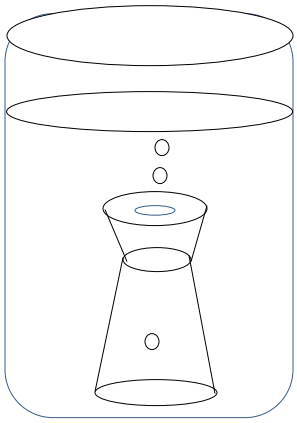
MATERIALS

- small vials that will remain upright under water (respirometers)
- one-hole rubber stoppers to fit respirometers
- five large (1000 ml) beakers large enough to submerge respirometers
- sugar (50 grams)
- thermometers
- stopwatch or watch with second hand
- one packet of yeast
- ice
- hot plate or hot tap water
- one large (1000 ml) beaker for yeast solution

PRE-LAB

Prepare yeast/sugar water solution before class to allow for yeast incubation. One packet of active dry yeast in a 1000 ml of warm (40oC) water will suffice.

PROCEDURE



1. Place a consistent volume of yeast/sugar water solution in each respirometer as it is being used, filling it approximately 10mL with 10 m yeast-sugar water solution.
2. Place a one-hole rubber stopper in the respirometer.
3. Set up a large beaker with 10 ^{o}C water, filling the beaker enough to cover a stoppered vial (respirometer).

4. Submerge the respirometer in the beaker and allow the respirometer to equilibrate for two minutes. No bubbles get counted during the equilibration time.
5. After the period of equilibration, count the number of bubbles that emerge from the respirometer in 90 seconds.
6. Using fresh yeast solution, repeat a total of four times for each temperature in 5°C or 10°C increments, going no higher than 70°C.

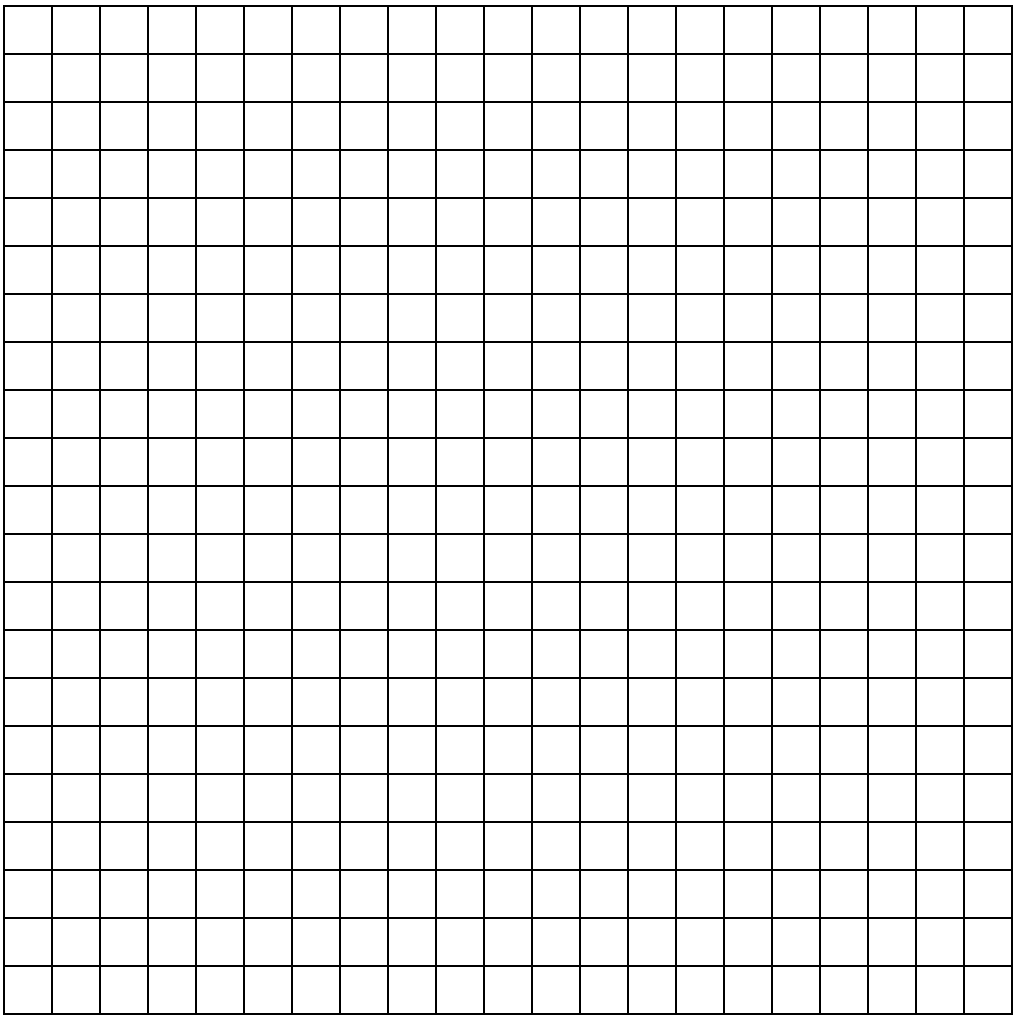
Remember to allow respirometer to equilibrate for <u>two</u> minutes.

TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS	TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS
	1			1	
	2			2	
	3			3	
	4			4	
	AVERAGE			AVERAGE	

TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS	TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS
	1			1	
	2			2	
	3			3	
	4			4	
	AVERAGE			AVERAGE	

TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS	TEMPERATURE (°C)	TRIAL	BUBBLES IN 90 SECONDS
	1			1	
	2			2	
	3			3	
	4			4	
	AVERAGE			AVERAGE	

Temperature (oC)	Group 1 Avg.	Group 2 Avg.	Group 3 Avg.	Group 4 Avg.	Group 5 Avg.	Group 6 Avg.	Group 7 Avg.	Group 8 Avg.	Group 9 Avg.	Group 10 Avg.	Group 11 Avg.	Group 12 Avg.	CLASS Avg.
10													
20													
30													
40													
50													
60													



CONCLUSION – Questions to Consider in Write-Up

1. Draw an appropriate graph of all data.
2. What was in the bubbles?
3. Did temperature affect the number of bubbles in five minutes? If so, explain why.
4. How did the number of bubbles correspond to the rate of respiration? Rate of metabolism?
5. Was your hypothesis correct? Explain why or why not using data from the experiment.
6. Which set up was the control group?
7. What is the independent variable (what was changed) in this experiment?
8. What is the dependent variable (what was measured) in this experiment?
9. Explain how the experiment may have produced data that was incorrect (sources of error).
10. What experiment would you test in the future that relates to the ideas in this lab?

LAB EXTENSION

Design a lab using yeast and the respirometer using a variable other than temperature. Don't forget to include the following:

- Purpose
- Hypothesis
- Materials/Setup
- Control
- Elimination of variable(s)
- Way to measure data
- Observations
- Conclusion
- Was your hypothesis supported?
- Ways to improve lab
- Use of data to support conclusion(s)
- Don't forget to HyDE