Name : ______________________________ *Date:* ____________ Pd: ____________

Science Methods

INTRODUCTION: A defining characteristic of science is the ***processes*** employed in order to gain understanding of natural phenomena. Some of the processes include the following:

- Observation
- Problem identification or posing of a question about the initial observation
- Hypotheses[1] construction
- Experimentation to test the hypotheses
- Analysis of data obtained, including re-representing the data for better interpretation
- Theory construction or modification and logical concluding statements based on the evidence.

When we attempt to interpret an observation or to understand the meaning of a series of events, we formulate some form of working *hypothesis* or explanation. One way to describe a hypothesis is as a logical linkage between *if* and *then*. This working hypothesis should be followed by a *controlled experiment* designed to yield data that will either support or refute the hypothesis. Notice the absence of the word "prove." When an experiment is performed to test a hypothesis, new information may or may not be useful in evaluating the hypothesis. If the investigator is alert however, new questions and new problems suggesting new experiments emerge. This is the way science progresses. Thus, science is a dynamic, on-going discipline involving the accumulation of empirical observations subject to interpretation.

In this class you will encounter several scientific problems. You will design and conduct experiments yielding observations intended to provide insight to the problem. When a problem is recognized, the investigator should (Fill in the blanks):

a. ____ then,

b. construct a _________________ ______________________that provides a possible explanation, and

c. plan and conduct a ___________ ________________ that may or may not ________________ the hypothesis.

The question: "What is the relationship between food concentration and CO_2 production in yeast?"

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Pre-lab and background information:

1. In which kingdom are yeast classified? ____________________________________

2. The question is specifically about baker's yeast, available at the grocery store. What is the genus and species of this variety? ____

3. Like all living things, yeast must convert food to usable, cellular energy. What is the name of the metabolic pathway that accomplishes this? ____________________________________

What compound do heterotrophs need to begin this process? ___________________________

What compound is produced as a waste product of the process?________________________

[1] The plural of hypothesis is *hypotheses*.

<u>Predict:</u> Describe what you think is the ideal environment in which yeast will convert food to energy most efficiently. Discuss both *biotic* and *abiotic* factors--whether they should or should not be present--**<u>and why</u>**. You many choose to set up a table, rather than use sentences. Be sure to address all parts of this item.

<u>Materials</u>: One package of dry yeast, one graduated cylinder, ten test tubes (22mm X 175mm), and ten small test tubes (14mm X 100mm), two Erlenmeyer flasks (125mm), test tube rack, two pints of commercial molasses, pippette.

<u>Procedure:</u>

A. Read through the complete procedure. Predict, by selecting the graph on page 4 that you *think* best illustrates the relationship between CO_2 production and the concentration of molasses when the same quantity of yeast is used in each test. Your choice is __________________ and your reasoning is ____

B. Prepare a yeast suspension by adding 30ml of the stock yeast suspension to 70ml of water in a 125 ml flask. This solution is called a 30% solution.

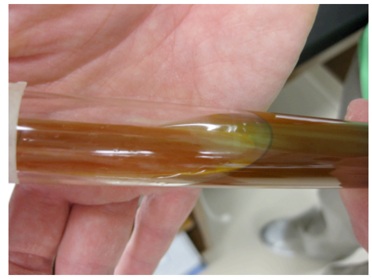
C. Prepare by ***serial dilution*** in ten large test tubes a series of molasses concentration ranging from 100% to 0.19% molasses in water. This is done as follows: Each tube will contain a total volume of 20 ml constituted partly from molasses and partly from water. Label Tube 1: 100% molasses. Using the 100ml graduate cylinder, measure 20ml of pure molasses and add this to test tube 1. Label Tube 2: 50% molasses. Measure 20ml of pure molasses in the graduate cylinder and add 20ml of water to the cylinder as well. Insure a uniform solution by pouring the molasses-water mixture back and forth between the graduate cylinder and a clean Erlenmeyer flask. Carefully pour one half, 20ml, of this well mixed solution into test tube 2. Save the remaining half in the flask for tube 3. Label Tube 3: 25% molasses. Add 20ml of water to the 20ml of molasses solution left over from the previous dilution. Again pour this molasses water mixture back and forth between the graduated cylinder and the flask. Add one half (20ml) of this dilution to tube 3.
Repeat this operation until a final dilution of 0.19% molasses in water is obtained (tube # 10).
What label goes on tube 4? ____________ Tube 5? ___________ Tube 6? ____________ Tube 7? ______________ Tube 8?____________ Tube 9? _______ and Tube 10? ______

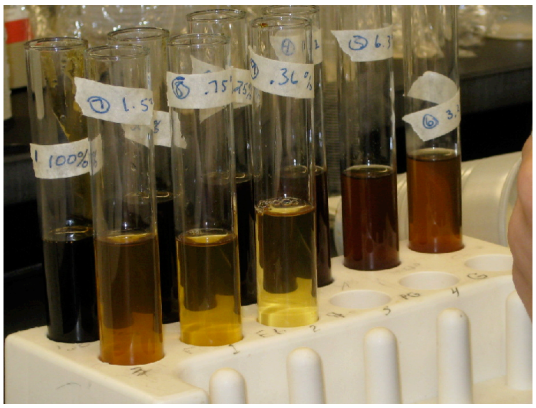
Discard the remaining 20ml of the 0.19% dilution, each of the ten tubes should be of equal levels if the procedure is prepared properly.
Thoroughly shake the flask containing the 100ml of yeast suspension and add 5ml of the yeast suspension to each to the tubes. Shake each tube to mix the yeast molasses suspension uniformly.

D. At this point, do you have a *control*? ___________ Explain:

What, if anything, do you want to do with respect to a *control* at this point in the set up?

E. Invert one small test tube into each of the 10 larger tubes containing the yeast-molasses mixture. Allow each of the small tubes to fill with the suspension by covering the tt opening with your thumb and sliding the larger tube on its side and allowing the air bubble to float over the top of the smaller tube. This skill requires some practice and patience!





Place tubes in a convenient area where they will not be disturbed for 24 hours. Make sure that you clean your area and tubes to make sure that molasses is not on the outside of the tube or on the table. This will attract ants that simply wait for such an opportunity for free food!

<u>Results:</u>

A. After 24 hours, Observe the comparative quantities of gas collected in the top of each small test tube by measuring the height of the gas column with a millimeter ruler. Set up an appropriate table in your lab notebook which will accommodate both your group's results as well as the class average.

B. What is the ***dependant variable***? ___________________________ What is the ***independent variable***? _________________________ In your lab notebook, graph the data. The different concentration of molasses should be plotted on the ________________ axis and the quantity of carbon dioxide produced in 24 hours should be plotted on the_______________ axis. Plot both your group's data and the class averages, on the same graph.

<u>Analysis and interpretations:</u>

A. How close does your curve come to your prediction made in the pre-lab section?

B. How close does the class average curve come to your prediction made in the pre-lab section?

C. Explain these observations. What can account for either a) the close similarity of predicted and observed results or b) their apparent dissimilarity? If your curve differs from the class average curve, account for that as well.

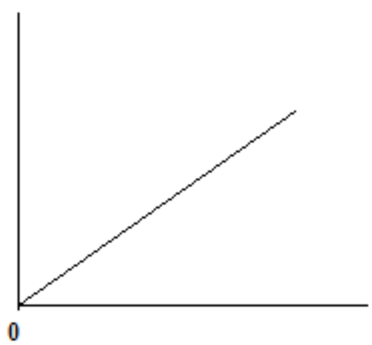
<u>Conclusion and inferences:</u>

A. Referring to the ***empirical evidence*** from this investigation, what is the relationship between the concentration of available food and the production of carbon dioxide by yeast cells?

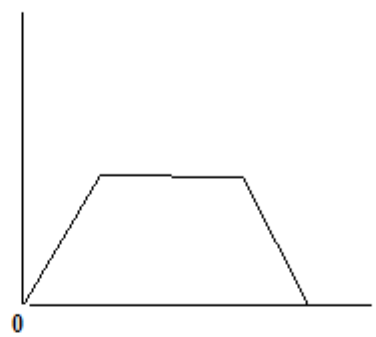
B. *Infer* causes for the observations. In other words, what accounts for the CO_2 production maximum? What accounts for the minimums? Recall what you know about the characteristics and needs of living things, particularly those in the kingdom in which yeast are found.

C. You have not reached the end of the scientific process. If time permitted, what would the scientifically minded person do next and why? Consider what you have already done and learned. (There is more than one correct way to address this.)

Hypothetical resultant curves of molasses concentration vs. CO_2 production. You should first determine the independent and dependent variables, so you know what each axis is representing.



A



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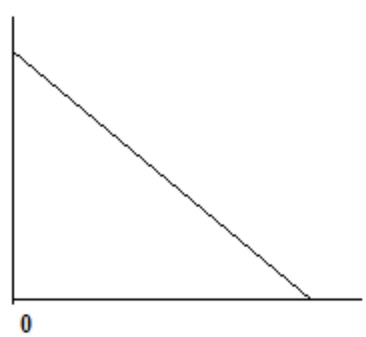

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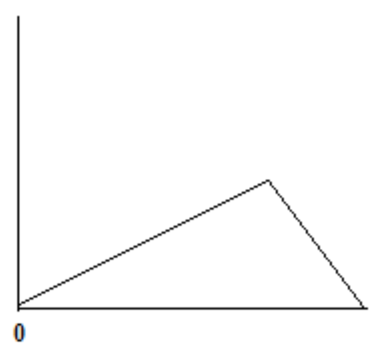

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