

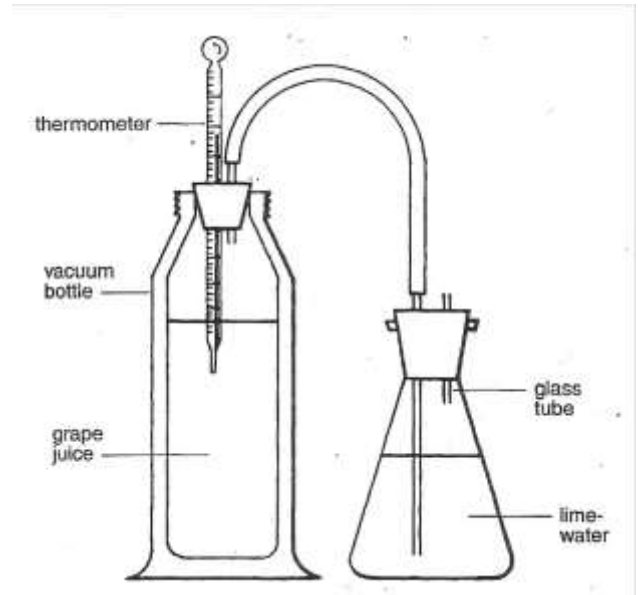
Lab: Can life gain energy from fuel without oxygen?

PURPOSE

All living things need energy in the form of ATP. We've established that most organisms obtain ATP by rearranging food (glucose) and oxygen (O₂) molecules in the process of cellular respiration. However there are and have been circumstance when oxygen is not available. How do organisms obtain ATP in the absence of one of the main reactants? To investigate this we will observe yeast, an organism that has the ability to survive in an anaerobic (no oxygen) environment.

MATERIALS

3 vacuum bottles
 Grape juice
 3 two-hole vacuum bottle stoppers
 50 ml yeast-water mixture
 50 ml boiled yeast mixture
 3 125-ml flasks each with 25 ml phenol red
 3 two-hole stoppers for flasks
 Stirring rods
 2 droppers
 6 short pieces of glass tubing
 Rubber tubing
 3 thermometers



PROCEDURE

1. Set up the apparatus as shown in the figure.
2. Pour grape juice into all 3 vacuum bottles leaving about a 3-inch space. To A add 50 ml of boiled yeast solution, to B add 50 ml of unboiled yeast solution, to C add 50 ml of water.
3. Stir the contents of each bottle well. Then mount a drop of the liquid from flasks A and B each on a slide with coverslip. Observe under both low and high magnification and draw a few cells as they appear under high power. Note about how many cells you can see in the high power field.
4. Place the stoppers in the vacuum bottles. The thermometers but not the glass tubes should dip into the liquid.
5. Place the stoppers in the flasks. Each longer glass tube should extend below the surface of the phenol red and each of the other tubes should end above the liquid.
6. Using rubber tubing, connect the glass tube coming from the vacuum bottle assembly to the longer glass tube in the flask assembly.

Name: _____ Period: _____ Date: _____

7. Record in a table the temperature of each bottle. Continue recording each hour for the remainder of the school day, and again the following day until 48 hours have passed. Note any changes that happen in the temperature and in the phenol red during the 48-hour period.
8. At the end of the 48-hour period, open the vacuum bottles and compare the odor of their contents.
9. Stir the contents of bottles A and B with a separate stirring rod. Using separate droppers, transfer a drop of the liquid from each bottle onto separate microscope slides and cover with cover slips. Observe under both magnifications. Sketch a few cells as seen under high power.
 - a. Note the approximate number of cells in the high-power field in each sample.
 - b. Note any differences in the size and shape of cells in the two samples.
10. Plot rough line graphs from the temperature data collected. Draw the lines for all three sets of readings on the same graph. Use the horizontal axis for time and the vertical axis for temperature.

DISCUSSION

1. Is there evidence that a chemical change occurred in any of the bottles? If so, which bottle and what is the evidence? (Recall our model for chemical reactions. What happens with matter? With energy?)
2. Was there change in the phenol red for any of the flasks? Which flask? What does the change in phenol red indicate is produced by the reaction?
3. Do you smell evidence that a new substance has formed in any of the bottles? Which bottle?
4. Describe the smell.
5. What evidence indicates that yeast can live, multiply and derive energy for life without using oxygen?
6. Based on your graph, what happens to the temperature in flask B over the 48 hours? State a hypothesis to explain all of the changes shown on your graph.
7. What happened to the temperatures in Flasks A and C over the course of the experiment? How can you explain any changes in the temperature of flasks A and C?
8. How can you explain any differences in the results of flasks A and B?
9. C_2H_5OH is the chemical formula for alcohol, and CO_2 is the formula for carbon dioxide. What substance in grape juice could have been converted into these products?
10. If we wanted to get the reaction in flask B started again, what could we add to the solution? Explain your thinking.