An Investigation into the effect of oxygen on the rate of Carbon Dioxide Production by Yeast

«««« By Seonaid Davis

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Introduction

In the Metabolic Processes unit in SBI4U, students investigate the cellular reactions involved in aerobic and anaerobic respiration. The culminating activity for that section of the unit involves an independent investigation into the effect of oxygen on the production of carbon dioxide in yeast. This investigation is based on the ideas of Larry Reinking at the University of Millersville.[1] In his article, he encourages teachers to have students investigate fermentation and cellular respiration using very simple equipment. The fermentation tube that he recommends is a 15 mL plastic centrifuge tube, which has uses in other labs, where students can collect gases produced during a reaction. This investigation allows students to compare and contrast cellular anaerobic and aerobic respiration and consider the effect of the enzyme phosphofructokinase on the reactions. Students have to measure reaction rates and compare the rate of carbon dioxide for each reaction. Students are investigating the Pasteur effect, or the decrease in carbon dioxide production in the presence of oxygen. I have used his basic method but have changed the instructions and provided evaluation criteria for a full experimental write up.

Student Instructions:

You are a young research assistant in Louis Pasteur's laboratory in Paris. He has gone on holidays for a week and has left you with an important question to answer. He expects you to determine how yeast extract energy from glucose and how oxygen affects their cellular reactions. You look around the lab to see what you can use to help you. In the lab are the 15 mL fermentation tubes you had to use last time Pasteur left you with an experiment to conduct on your own. (Remember the enzyme experiment from *Crucible*, March 2006 issue?). He has also left you with yeast and glucose. Before he left Pasteur reminded you to use 8% yeast and 10% glucose for the best results and to conduct the experiment at 40^{o}C because yeast enzymes work best at that temperature. Pasteur is expecting a fully written formal lab report when he returns at the end of his holidays. He will read your report before deciding to submit it to a peer-reviewed journal. You will need to follow the criteria for a formal report.

Before you panic, you sit down to think. What do you already know that will help you with this problem?

How do yeast extract energy from glucose? What waste products do they produce? What types of cellular reactions do you know that might help you solve the problem?

[1] Reinking, Larry et al. "Fermentation, Respiration and Enzyme Specificity., 2000" In *Biology Labs That Work: The Best of How-to-do-Its, Volume 11*. National Association of Biology Teachers. Reston. Pgs. 47-51.

Some hints:

1. An 8% suspension of baker's yeast is one package of active dry yeast in 100 mL of tap water or 8 grams of yeast/100 mL water. Due to settling, the yeast suspension should be agitated immediately before use. Let the yeast sit for 10 minutes before using it.
2. A 10% glucose solution is 10 g glucose in 100 mL of water, mixed well to dissolve.
3. Use 8 mL of the 10% glucose solution and 8 mL of the 8% yeast suspension as your test materials. Remember to let the tubes equilibriate in the water bath before you start and periodically mix the tubes by gentle inversion.
4. After you collect your data, calculate rates of reactions at regular intervals.
5. The aerobic yeast has been made for you by bubbling air through an 8% yeast solution and a 10% glucose solution separately using two aquarium pumps.

Questions to consider:

1. What are you investigating? What are the key cellular reactions you need to consider?
2. What were your results?
3. What interpretation can you make about the data? What do you know about cellular respiration and fermentation that can help you explain your results?

An Investigation into the effect of oxygen on the rate of carbon dioxide production by yeast: Evaluation

Your lab was handed in on time. ***Knowledge/Understanding*** _____***/10***

Introduction

The introduction provides a context for the investigation and states the question asked and the hypothesis tested in the experiment. It begins by reviewing the background information that will enable the reader to understand the objective of the experiment and the significance of the problem. You should include information that directly prepares the reader to understand the question being investigated. You should provide enough information so that the reader understands why you chose the hypothesis that you did.

Inquiry /10

In this section, you explain how you conducted the experiment and the data you collected. Any data you plan to include in the discussion section must be presented in the results section. Do not include data in the results section that you do not mention in the discussion.

Materials and Methods /5

You described your experiment in such a way that it can be repeated and included trials, controls and control group, the materials used. Your solution to the problem is appropriate.

Results /5

You included properly formatted tables and graphs, a sample calculation if appropriate as well as a summary paragraph, which directs the reader to look at the data and refers to the tables and figures directly. The summary paragraph ***does not*** *interpret the data.*

Making Connections /12

This section emphasizes interpretation of data, relating the data to existing theory and knowledge. It provides a context for understanding the significance of the results. You must explain why you observed the results and how these results contribute to your knowledge.

Discussion

What Happened and what it means /10

You discussed what happened in the lab and used the data that you collected to support your description. You explained ***why*** *you got the results that you did and included the research you did to help you explain your results. You interpreted your results and used them to answer the initial question you were trying to answer.*

Implications of your results /2
What is the importance or significance of your results in the "real" world? Why should anyone care about your results? What applications are there to your results?

Communication /5
You communicate clearly and precisely and obey appropriate writing conventions (spelling, punctuation and grammar, scientific referencing) and aspects of formatting.

Aspects of Formatting
You have a header with the course code, your name and date and your partner's name.
Your title is bold and centre justified.
Your headings and subheading are bold and left justified.
Your font style and size are both appropriate and readable.
You have indented your text under the subheadings.
You have used appropriate scientific referencing
If you e-mailed the lab, you named the report correctly with your last name.

Factors that Affect the Rate of Carbon Dioxide Production by Yeast: Evaluation Criteria

Your lab was handed in on time. ***Knowledge/Understanding _____/10***

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