Final Experiment Cell Respiration Lab by C. Kohn, Waterford WI

Name: Hour Date:

Date Assignment is due: Why late? Score: + ✓ -  
 Day of Week Date If your project was late, describe why

# Lab Overview

In this lab, you will be using yeast to measure the rate of cellular respiration. Yeast is a single-celled eukaryotic organism that utilizes carbohydrates for ATP production in the same way that plant and animal cells utilize carbohydrates. Yeast will convert a carbohydrate into water and carbon dioxide during cellular respiration. The greater the carbon dioxide production, the greater the rates of cellular respiration. In groups of four, you will be determining the impact of adrenaline on cellular respiration by using a Waterford Fermenter to measure the CO2 production of the yeast.

# Needed Materials

Waterford Fermenter (7 for 24 students and instructor), tap water, a yeast packet (such as those sold for baking in grocery stores), an electrical outlet, titration materials (KOH, phenolphthalein, 37% hydrochloric acid, pipette or eyedropper, 1 molar strontium chloride (SrCl­2), and a graduated cylinder), 1 mg/L adrenaline solution, a magnetic stirrer, safety equipment (gloves, goggles, and aprons). Note: you can also use a CO2 probe to determine carbon dioxide production in lieu of titration.

# Safety Warning

This lab involves dangerous laboratory chemicals – wear gloves, goggles, and aprons/lab coats at all times when conducting this lab. The chemicals used in this lab can produce dangerous fumes – work only in a well-ventilated area or a fume hood. If you spill a chemical on bare skin, flush immediately with lots of water while asking your instructor for help. Do not let chemical spills or broken glass go unnoticed – notify your instructor immediately if you have any spills or broken glassware.

# Itinerary

**Wednesday**: Experimental design & set-up.

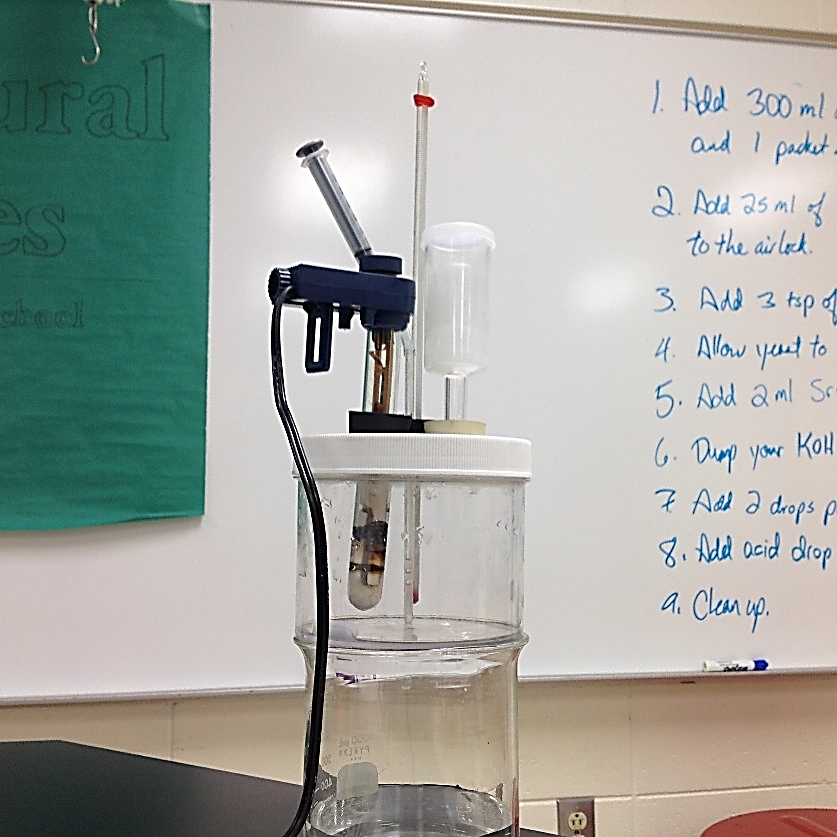
**Thursday**: Conduct Experiments; Complete questions and lab reports

**Friday**: Prepare Oral Presentations; Peer Reviews

**Monday-Tuesday**: Deliver Oral Presentations.

# Expectations

1. This is a lab that involves dangerous chemicals. Safety gear should be used whenever open chemical containers are present.
2. This lab requires you to follow instructions; all instructions are clearly written in this packet. Consult your directions first, then ask your instructor if you still have questions.
3. You will have to understand and think about the unit content to complete this activity. Use your brains!

Days 1-2 – Effect of Adrenaline on Respiration

# Overview

Thermometer

Airlock w/ KOH

In this lab, you will be testing the effects of adrenaline (epinephrine) on cellular respiration. You will use yeast, which is a single-celled eukaryotic organism (yeast cells have organelles like plant/animal cells do). You will determine if adrenaline affects the rate of cellular respiration in yeast by measuring CO2 production in treated vs. untreated solutions. You will let your yeast digest the sugar in a for 15 minutes and then measure CO2 escaping through the airlock on your fermenter.

The airlock of the fermenter will have a KOH solution inside. As the escaping CO­2­ bubbles move through the KOH solution, it will change the pH of the solution and make it more acidic. After 15 minutes has passed, you will add SrCl2 to “freeze” the reaction of your KOH at its current pH. You will add a pH color indicator and then add a strong acid drop-by-drop to determine the actual pH change. The less acid you need, the more the KOH was acidified and the greater the CO­2 production.

CO2 will change the pH of the KOH solution, making it more acidic. The less acid needed to cause a color change, the more CO2 that was produced

Yeast w/ Sugar

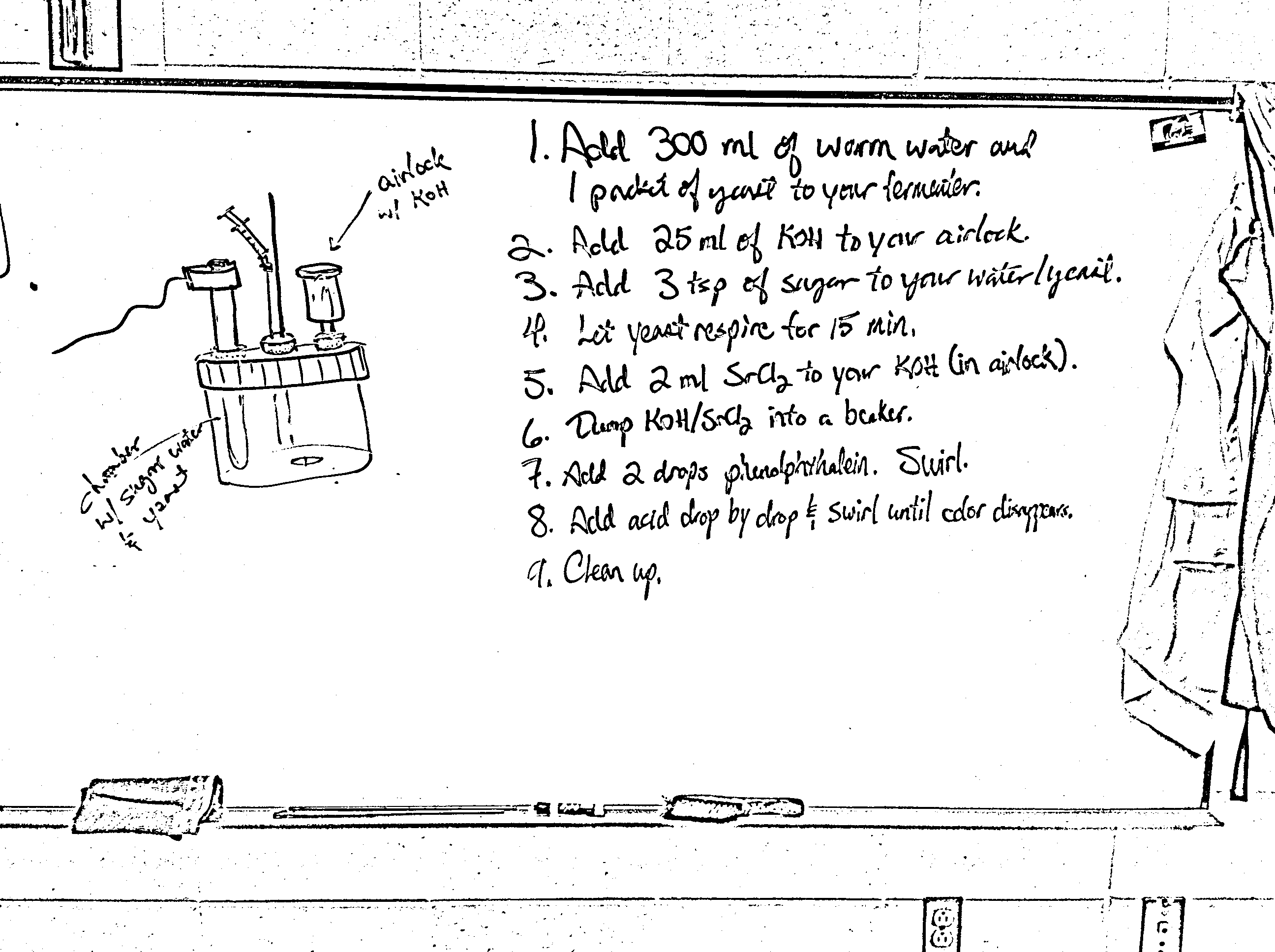
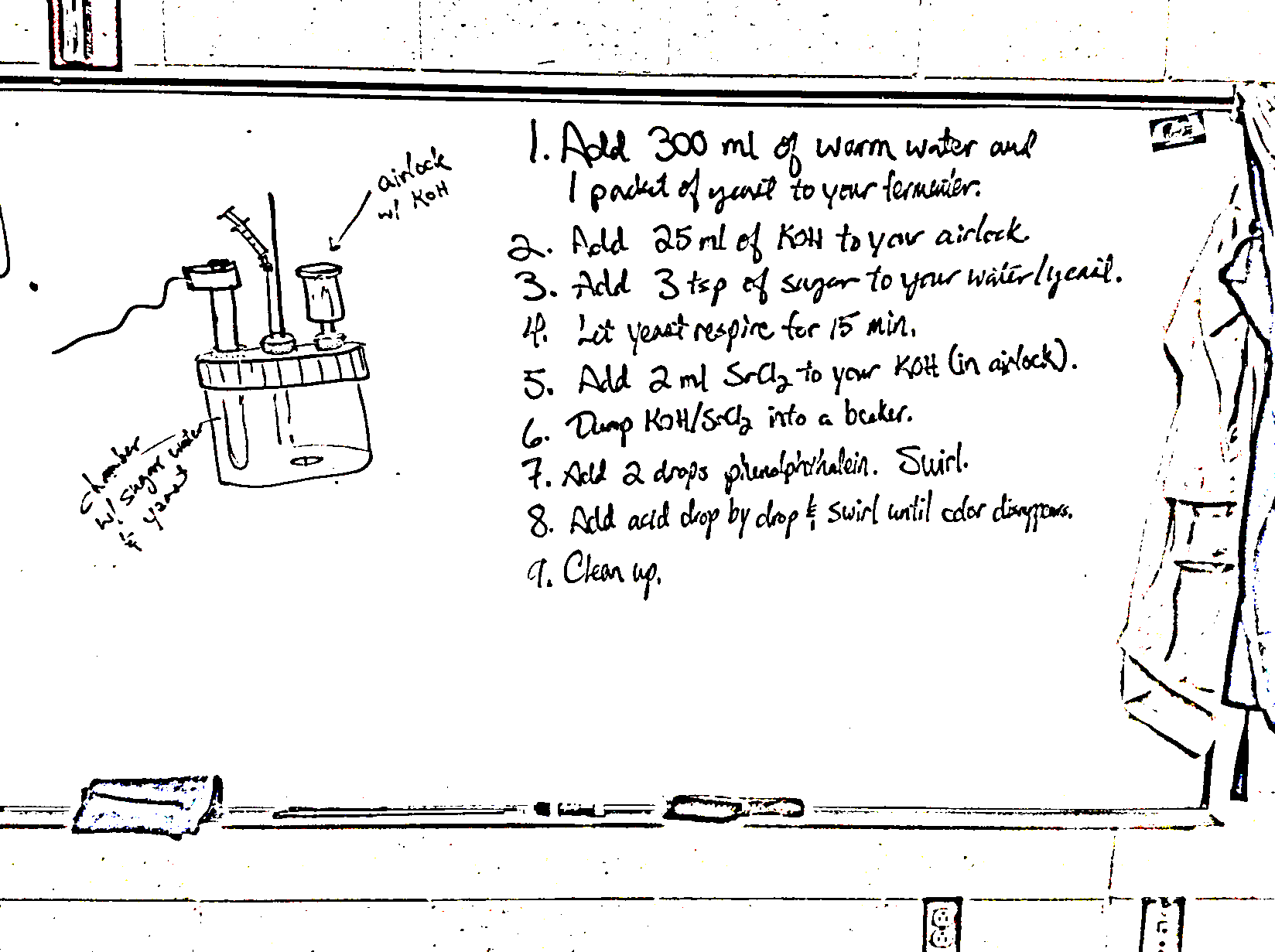
# In a nutshell…

1. Yeast will eat sugar and produce CO­­2 which will bubble out through the airlock.
2. The airlock contains KOH (a strong base); CO2 will make the KOH more acidic
3. After 15 minutes passes, you will measure how much the pH of the KOH changes using a color indicator and acid

# Methods

1. Prior to starting, watch your instructor demonstrate the methods in front of your class.
2. For your group of 4, obtain a Waterford Fermenter and a packet of yeast.
3. Add 300 ml of warm (35-40o) tap water to your fermenter chamber; allow this water to sit in contact with your glass heater so that the temperatures of each can acclimate. IF NEEDED, plug in your heater and heat to 380 C[[1]](#footnote-1) . (If your water is already at an appropriate temperature, you do not need to use your heater.)
4. Add the yeast and place the fermenter on a magnetic stirrer. With the magnetic stir bar in the chamber, turn on the stirrer and rapidly stir the solution for up to 5 minutes so that the yeast become absorbed and re-activated.
5. Answer the questions on the following page while your yeast is being re-activated.
6. After answering the questions, carefully add 25 ml of 1 M KOH solution[[2]](#footnote-2) to your fermenter’s airlock chamber (NOTE: you need gloves, goggles, and aprons and a well-ventilated area for this!).
7. Add 3 teaspoons of sugar to your yeast and water. Keep mixing the solution on the magnetic stirrer. Seal the fermenter securely so that it is airtight (air should only be able to escape through the airlock).
8. After 15 minutes has passed, add 2 ml 1 molar SrCl2[[3]](#footnote-3) to the KOH solution in the airlock (the clear chamber on top). This is necessary to “freeze” the reaction occurring between the KOH solution and the CO2.
9. Dump the KOH and the SrCl2 into a beaker or similar container. A group member can now clean the fermenter.
10. Add two drops of phenolphthalein. Swirl. The solution should turn pink. Recap your phenolphthalein bottle.
11. Add 37% hydrochloric acid drop by drop until the pink color disappears. Gently swirl the KOH solution in between drops of acid. The less acid that is needed to turn the solution clear, the more CO2 that was produced.
12. Record this data and answer the remaining questions. Wash your equipment and dry it.
13. **Repeat this experiment by adding 5 ml of an adrenaline solution added at the same time as the sugar.**

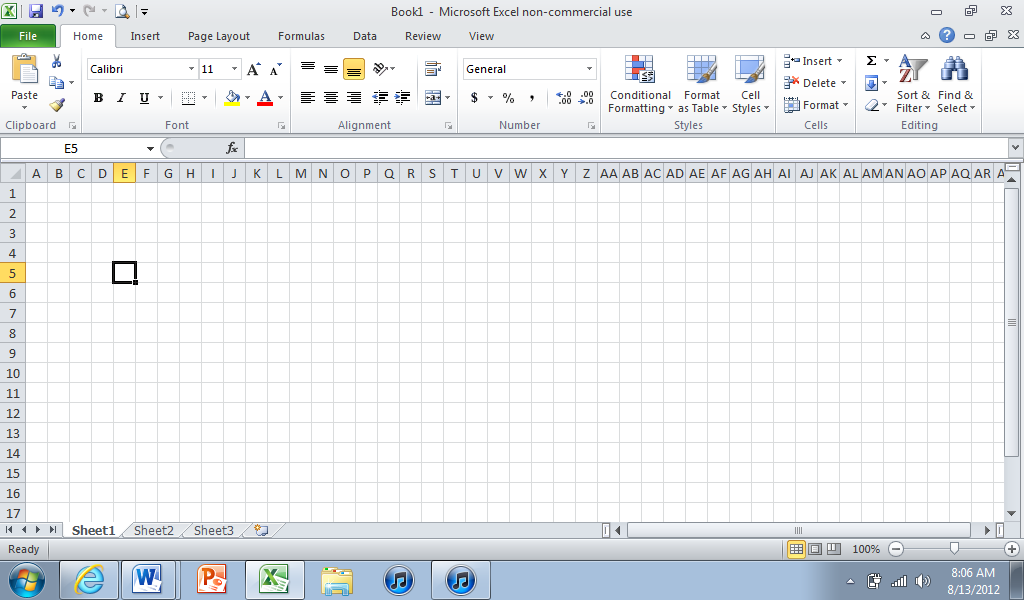
# Summary of Methods



# Pre-Experiment Questions (answer while activating yeast and during respiration)

1. What is adrenaline (epinephrine)? Complete a Google search of credible sources and summarize below:  
     
   \_   
     
   \_   
     
   \_
2. What is your research question for this experiment? Write it below. See the Overview for more details.  
     
   We are unsure if   
     
    \_
3. What is your hypothesis for this experiment? Write it below:   
     
   We predict that   
     
    \_
4. What is your rationale for your hypothesis? We think that that this will happen because   
     
    \_   
     
   \_
5. What is your independent variable (the thing you purposely changed) for this experiment? Write it below:  
     
   Our independent variable is
6. What is your dependent variable (the thing you measure) for this experiment? Write it below:   
     
   Our dependent variable is
7. How will you measure your dependent variable? ATP production/CO2 production will be measured using titration; the less acid needed for a color change, the more CO2 / ATP that was produced
8. What is your control for this experiment? The untreated fermenter’s results (w/o adren.).

**Results: Data & Observations (complete after your experiment is finished)**

1. How many drops of acid did it take to change the color of your control KOH solution?
2. How many drops of acid did it take to change the color of the adrenaline KOH solution?
3. Which fermenter required more acid to cause a color change, yours or the control?   
   1. What does this indicate about adrenaline and yeast respiration?   
        
      \_   
      *Reminder that the fewer drops of acid needed for a color change (from pink to clear), the greater the CO2* *production.* ***More acid needed = less CO2* = *less respiration = less ATP produced.  
      Less acid needed = more CO2  = more ATP produced.***
4. Did anyone in your class have drastically different results than your own? Explain:   
     
   \_   
     
   \_
5. Create a graph in the space below comparing the amount of acid you needed to use compared to the results of the control.

# Conclusion (complete after your experiment is finished)

1. What was your original hypothesis? We predicted that   
     
    \_
2. What is your rationale for your hypothesis? We thought that that this would happen because …  
     
    \_   
     
   \_
3. Was your hypothesis supported by your data?   
     
   \_
4. If you repeated your experiment again, do you think you would get the same results? Yes / No   
     
   Explain:   
     
   \_
5. Why do you think you saw the results that you did, and how do you think adrenaline affected cellular respiration? Answer by relating adrenaline to specific aspects of respiration (such as glycolysis, ATP synthase, etc.).  
     
   \_   
     
   \_   
     
   \_

Day 3-4 Final Experiment Presentation Guide

**Directions:** in teams of 3-4, you will be creating and delivering a presentation that addresses the following topics:

**Partner 1: Introduction**

1. Begin by stating the research question, hypothesis, and rationale.
2. Next, summarize background information that your audience will need to understand in order to comprehend and appreciate your work. Use information from at least 3 or more credible sources.
   1. *For example, if you are discussing how caffeine affected radish growth, you should probably provide some background information on what caffeine is and how it affects other living organisms.*
   2. *Cite ALL your sources using both parenthetical and bibliographical citation.*

**Partner 2: Methods**

1. Begin by stating all the materials that were needed to conduct your experiment.
2. Conclude by summarizing the steps used to conduct your experiment.
3. Continue by stating your independent variable and dependent variable and describe your control.
4. Be sure to address how you kept all other variables (besides the independent variable) constant in your experiment.

**Partner 3: Results**

1. Begin with a graph of your data (create one using a spreadsheet program such as Excel). Summarize what the graph is showing. Be sure to explain how the x-axis and y-axis are labeled to aid your audience.
2. Next, state the significance of these results and how they relate to your hypothesis (do they support it? do they refute it?). Include error bars or other statistical methods of evaluating the quality of your data.
3. Conclude by addressing other observations made during the experiment that might not be reflected by this data.

**Partner 4: Conclusion**

1. Begin by restating the hypothesis.
2. Next, explain whether your team has decided that your hypothesis is correct or incorrect based on your data (or if you are unable to know at this moment).
3. Third, state the confidence you have in your results. Is this enough to answer your research question once and for all? Or is more data needed to come to be sure?
4. Continue by stating what would should happen next in order to answer your question. Is more research needed? Should it be the same kind of research and/or should other questions be explored that might have arisen during your work?
5. Conclude be describing the value of your research. Who will this help? Why was this necessary?

Your work should be prepared in a PowerPoint document (or similar program). You will be presenting your work with your instructor in your teams of 3-4, so most of your presentation should be delivered orally (i.e. do not write paragraphs of information on each slide; provide bullet points and summarize the information orally). You can use notecards to help with your oral presentation. Your grade will be based primarily using the rubric on the next page.

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | *Plus (100%)* | *Check (70-90%)* | *Redo (0%)* |
| **Accuracy** | No errors were detected in this presentation | This presentation contained a few errors, but overall was very accurate. | This presentation contained considerable errors. |
| **Thoroughness** | No important information was omitted. | This work was detailed, but more detail was possible and would have helped. | Major topics were omitted that should have been included. |
| **Professionalism (lack of errors, style, delivery, spelling/grammar, design, etc.)** | The instructor would allow this presentation in its current state to be delivered to a group outside of the school. | This is good work for high school students but room exists for improvement. | The professionalism of this group needs improvement to be at a high school level or greater. |
| **Group Involvement** | Every member was involved with the development of the presentation as well as its delivery. | At least one more group member could have been more involved than they were. | Multiple group members clearly could have been more involved. |
| **Parenthetical and Bibliographical Citation** | Every source was cited accurately using both parenthetical and bibliographical citation. | One or two errors involving citation were found. | Multiple errors regarding citation were found. |
| **Reliability of Conclusions** | All conclusions were based on sound data, and all data was properly evaluated using standard statistical measurements. | Authors can reasonably argue the validity of their results but more is needed to make a concrete case for the reliability of their work. | Authors cannot reasonably state how they know they are not wrong or assess the predictability of their work. |
| **Effort** | Effort exceeds what would be expected of a high school student. | Effort is acceptable for a high school student but room exists for improvement. | Level of effort could have been much greater than what was presented. |

**Notes and suggestions:**

* You will be asked to evaluate your group’s performance and the feedback that you provide will be factored in your final grade.
  + Be prepared to submit this form with where you feel you rank for each item on the rubric.
* Be aware that your grade is partly dependent on the involvement of all group members in your presentation.
  + If you feel a group member cannot adequately allow you to demonstrate your understanding, please speak with your instructor if you need to have that member removed.
  + The removed group member will then be expected to perform this assessment on their own with the instructor.
* You can ask your instructor to review your work before the day of your presentation. This is recommended.

Research Presentation Checklist

1. **Title: Does your title have…**
   1. The study subject (the plant, animal, organism, or whatever it is that you worked with)
   2. The independent variable and the dependent variable(s)
   3. The final results
   4. Your names, class, hour, and school
2. **Introduction: does your introduction include…**
   1. A summary of relevant background information (*the general scientific information the reader needs to know about your study subject and independent variable)* as compiled from other credible sources.
      1. *Use 3 or more credible sources (.gov or .edu sources).*
      2. *Each source should be cited parenthetically (for example:* (Johnson, 2011) *). .*
   2. The research question (*We wondered if…)*
   3. The hypothesis (*We hypothesized that…)*
   4. The rationale, or reason for your hypothesis (*We thought this would be the case because…)*
   5. Overview/summary of your methods (*To test this hypothesis, we…)*
3. **Methods: does your methods section include…**
   1. A materials list, identified variables (independent and dependent), and a description of the control.
   2. A cook-book recipe-style description of how you will conduct this experiment
4. **Results: does this section include…**
   1. A summary of your results, data, and observations
   2. A graph/chart/table with results and…
      1. A legend explaining all symbols or abbreviations and the x axis and y axis are both labeled
      2. A caption with a description that allows it to stand alone and also includes the important trends in the data
5. **Discussion…**
   1. First restate your hypothesis (*We hypothesized that…)*
   2. Next, explain how this experiment affects your hypothesis
      1. (*i.e. how does your data support/reject/not impact your hypothesis?)*
   3. Third, describe why you think the data supports/refutes/does not affect your hypothesis
      1. *What data or general trends have you considered that have led you to make this conclusion.*
   4. Fourth, describe if you think your results are consistent or if there is a possibility that the results could be different if the experiment were run again or if it were done by other people.
   5. Follow up with a discussion about what to do next.
      1. *What should be done next to answer the research question? More research? Different research?*
      2. *Why is this work beneficial? What is the value of this experiment and why was it necessary?*
6. **Bibliography: does this section include…**
   1. All sources used should be listed and each should include the…
      1. Author’s name (last name first, first name last)
      2. Date of publication
      3. Name of document
      4. Publishing agency
      5. Website and date accessed (*if from online*)
         1. E.g. *Badger, Bucky. 2012. “The Mechanisms of Gatorade.” UW-Madison –* [*www.wisc.edu*](http://www.wisc.edu)
         2. Use <http://www.calvin.edu/library/knightcite/index.php> as a guide
   2. The sources should be alphabetized listing by author’s last name (e.g. Arthur, J. would precede Baker, T.)

Peer Review – Agricultural Sciences

**Name: Date: Hour:**

**Directions**: Please evaluate your group as well as yourself on the basis of contributions and effort on a scale of 1 to 5. A group member who makes an outstanding contribution and did their best would receive a score of 5. A group member who did very little might score around a 3, and a group member who did little or nothing might get a one or a two. Be sure to provide a reason for your score – why did you assign the score that you did? *(5’s need no reason)*

**1. Group Member’s Name: Score: 1 2 3 4 5**

Reason:

**2. Group Member’s Name: Score: 1 2 3 4 5**

Reason:

**3. Group Member’s Name: Score: 1 2 3 4 5**

Reason:

**4. Your Name: Score: 1 2 3 4 5**

Reason:

**Additional comments or concerns:**   
  
   
  
   
 **Changes you would recommend for this activity:**

1. The heater is only on or off; if the orange light is on, it is heating. Adjust the knob on top so that the light turns off at 38o [↑](#footnote-ref-1)
2. Instructors: To make 1 M KOH, dissolve 1.1 g KOH in 100 ml of water in an Erlenmeyer flask or beaker. [↑](#footnote-ref-2)
3. 1.6 g SrCl2 per 10 ml of water [↑](#footnote-ref-3)