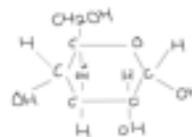


NAME: \_\_\_\_\_

Date: \_\_\_\_\_

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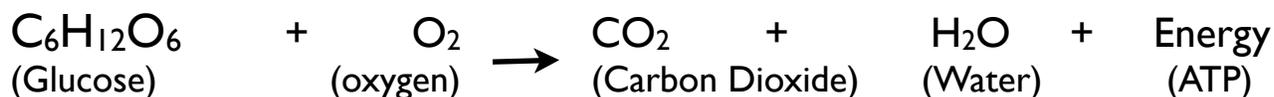


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## Exercise and Cellular Respiration

**Purpose:** To determine the effect of exercise on the rate of cellular respiration.

**Background:** Cellular respiration is a process that involves the breakdown of **glucose** when combined with **oxygen** to **release usable energy for the cell**. This process occurs in the **mitochondria** of most eukaryotic cells. The overall equation of cellular respiration is as follows:

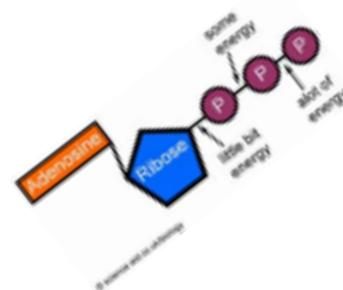
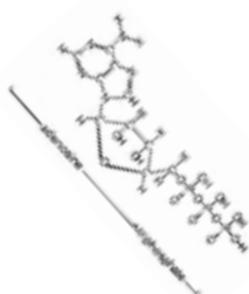


The waste products of cellular respiration are **carbon dioxide** (CO<sub>2</sub>) and **water** (H<sub>2</sub>O). Carbon dioxide is a gas that is released from the cells and the body during exhalation. When carbon dioxide is combined with water, it forms **carbonic acid** (H<sub>2</sub>CO<sub>3</sub>).

In this lab, you will form carbonic acid by bubbling your breath through water. You'll then test for the presence of carbonic acid with the indicator, **phenolphthalein**. This indicator is *pink* in the presence of a base, such as **sodium hydroxide** (NaOH), and *clear* in the presence of an acid, such as carbonic acid (H<sub>2</sub>CO<sub>3</sub>). **By recording the time it takes to neutralize a basic solution with your breath**, one can determine the *relative amount of carbon dioxide being exhaled*. This also indicates the relative rate at which cellular respiration is occurring in the body.

### Pre-lab Questions:

1. What are the waste products of cellular respiration? \_\_\_\_\_ & \_\_\_\_\_
2. What does carbon dioxide become when mixed with water? \_\_\_\_\_
3. How are you going to form (make) carbonic acid in this lab?
4. What color is phenolphthalein in the presence of a base (NaOH)? \_\_\_\_\_
5. What color is phenolphthalein in the presence of an acid (H<sub>2</sub>CO<sub>3</sub>)? \_\_\_\_\_
6. How can phenolphthalein be used to determine the rate at which cellular respiration is occurring in the body?



### **Materials:**

Each lab station will be equipped with the following on your lab trays. Keep things organized, clean, and glorious...please and thank you.

- |  |  |
|--|--|
| <input type="checkbox"/> Clean straws - in beaker            | <input type="checkbox"/> distilled water                   |
| <input type="checkbox"/> NaOH solution - square              | <input type="checkbox"/> Waste Jar - to dump used solution |
| <input type="checkbox"/> droppers                            | <input type="checkbox"/> stop watchers or second hand      |
| <input type="checkbox"/> Phenolphthalein solution - cylinder |  |
| <input type="checkbox"/> 250 ml flask                        |  |

### **PROCEDURE:**

1. **Pour 100 ml of distilled water** into a 250 ml flask.
2. Add **3 drops of phenolphthalein** to the water.
3. *If the water turns pink, there is no CO<sub>2</sub> present and you may move on to step 5.*
4. Add **2 drops of NaOH** to the solution and gently swirl. The solution should turn a bright, deep pink color. *You are neutralizing any CO<sub>2</sub> that is present by adding NaOH, and turning the solution basic.*  
*If the solution does not turn pink, add a additional single drop of NaOH until the water in your flask stays a deep pink color. Record the number of drops of NaOH used.*
5. **Starting with a DEEP PINK solution** now, sit very quietly for two minutes without moving.
6. Place the end of a soda straw into the deep pink solution you've prepared. Breathe in deeply and **start timing** when you **slowly exhale** through the straw **into the solution**. Continue to exhale as long as you can **without taking a new breath** (plug your nose so you don't sneak any breaths) until the **solution is clear** and **no longer pink**.
7. **Record your results in your data table.**
8. **Prepare a new water sample** as you did before, adding the same number of drops of NaOH. Solution should be deep pink.
9. **Exercise for two minutes by walking in place.** Following the same procedure, start timing as you EXHALE your breathe into the solution until it is no longer pink. **Record the time.**
10. **Prepare a third new water sample** as before.
11. **Exercise vigorously for two minutes** by running in place, doing push ups, jumping jacks or squat thrusts. Again, take one deep breath, plug your nose, and exhale continuously through the straw into the solution. Record the time again.
12. Have your partner repeat the above procedure.
13. Record your results and class data in the table below.
14. Make a bar graph for you, your partner and the class average for neutralization time for each exercise.



**Post-Lab Discussion/Analysis:**

1. How did the intensity of exercise affect the time required to neutralize the NaOH solution?
2. Did this result support your hypothesis? Explain.
3. How is the production of carbon dioxide related to the cellular respiration rate in the body?
4. Which type(s) of cells in the body do you think require the most energy during vigorous exercise?
5. What is the relationship between the amount of exercise you do and the amount of glucose your cells use?
6. Why do you think endurance athletes eat meals high in carbohydrates on the night before a big race?
7. What factors other than exercise might affect the rate of cellular respiration in our cells?
8. Write at least three (3) knowledge statements that you learned about the effect of exercise on the rate of cellular respiration. You may include what cellular respiration is and where it takes place as part of your knowledge.