Exercise & Cellular Respiration
CO₂ & Photosynthesis

Purpose:
The purpose of this lab activity is to analyze the effect of exercise on cellular respiration as well as the effect of CO₂ amounts on photosynthesis. You should have completed your “Pre-Lab” reading and “Pre-Lab” questions prior to doing this activity.

Guiding Question:
How does exercise affect the rate of cellular respiration and how does the amount of CO₂ affect the rate of photosynthesis?

Materials you may use:
3 test tubes
bromothymol blue solution (BTB) 1 straw per person
3 small beakers 3 funnels
Elodea (water plant) stop watch (or clock)
Graduated cylinder

Safety Precautions:
1. Safety glasses are required for this activity
2. Use caution when working with chemicals and blowing into the solutions
3. Be aware of others if exercising in the classroom
4. Wash hands with soap and water after completing the lab
5. Follow all normal lab safety rules

Getting Started:
The first step in developing your model is to design and carry out a series of experiments to determine how exercise affects cellular respiration. You will need a way to compare the cellular respiration of a person at rest to a person exercising.

1. Place two test tubes (A: resting test tube) and (B: exercise test tube) on your table.
2. Fill one of your beakers with 20mL of BTB solution.
3. Carefully pour equal amounts of the BTB solution into your graduated cylinder and then each test tube.
   NOTE → Carbon Dioxide (CO₂) causes Bromthymol Blue to turn YELLOW/GREEN.
4. YOUR PARTNER WILL TIME YOU DURING THIS STEP:
   a. When your partner says “GO” SLOWLY blow air through a straw into the bottom of test tube A. Do not blow hard enough to cause splashing!  CAUTION: DO NOT INHALE THROUGH THE STRAW!!!!!!!!!!!!
   b. When the solution changes color to yellow, your partner should say “STOP”.
   c. Record how long it takes (in seconds) for the BTB to change from blue → yellow. Write your results in your data table.

5. Now perform physical exercise for 2 minutes (run up and down the stairs, run outside, jump in place, etc.).
   CAUTION: DO NOT do this if you have a medical condition that interferes with exercise. If you feel dizzy, stop immediately and sit down!
6. Repeat step 3 using test tube B – don’t forget to record your results! Match the color of the solution to the color that was produced in the “rest” breath.
7. Rinse your test tubes thoroughly and repeat steps 1 to 4 two more times.
Part Two:
The second step in developing your model is to design and carry out a series of experiments to determine how the amount of available CO$_2$ affects photosynthesis. You will need a way to compare the rate of photosynthesis with limited CO$_2$ to the rate of photosynthesis with more available CO$_2$.

Fill both of your beakers with 150 mL to 300 mL of tap water (the amount must be equal in BOTH beakers and a portion of the stem of each funnel needs to be under water.

1. Using your straw blow into one of your beakers of water for 3 minutes. This will add a higher percentage of CO$_2$ to the beaker. Label your beakers with tape.
2. Obtain a sprig of Elodea. You need approximately 2 inches of Elodea in the bottom of each beaker under the cup of your funnel. Invert the funnel and place it on top of the Elodea in each beaker. Make sure all the Elodea is under the funnel. The beakers should be full enough to cover the cup of the funnel and a portion of the funnel stem. See image.
3. Fill one of your test tubes with water, the less air the better. Place your thumb over the top to seal it as you invert the test tube and QUICKLY place it over the end of the funnel. Be careful! You want to keep as much water in the tube as possible. See image.

4. Use a sharpie to mark the water line meniscus (the bottom of it) on your test tube to show how much air is in the test tube at the beginning of the experiment.
5. Draw both setups as “before” images on your lab paper. Label all parts.
6. Place your setups in the window designated by your teacher. Make sure you have marked the beakers with tape to identify them as yours and what the contents are.
7. Check the setups in 24 hours and record the amount of Oxygen produced through photosynthesis.

After 24 hours . . .

1. Before moving your beakers, look at both test tubes and see which one gained more oxygen gas over the last 24 hours.
   a. Take both beakers back to your lab table.
   b. Draw the “after” pictures for both setups. Be sure your diagrams reflect any changes in your setups.
   c. Thoroughly rinse the beakers, test tubes and funnels and place them in the designated area to dry.
   d. Thoroughly rinse you Elodea and place it in the designated area. Remember, these are LIVING organisms, be gentle.
2. Return to your lab table and answer the following questions as a group. Share your ideas and discuss possible answers then on your own and in your own words, write your answer on your paper.
Exercise & Cellular Respiration
CO₂ & Photosynthesis

Purpose:
The purpose of this lab activity is to analyze the effect of exercise on cellular respiration as well as the effect of CO₂ amounts on photosynthesis. You should have completed your “Pre-Lab” reading and “Pre-Lab” questions prior to doing this activity.

Guiding Question:
How does exercise affect the rate of cellular respiration and how does the amount of CO₂ affect the rate of photosynthesis?

CELLULAR RESPIRATION DATA TABLE:

<table>
<thead>
<tr>
<th>Trial</th>
<th>Time (sec) Needed to Change Color Beaker A (Resting)</th>
<th>Time (sec) Needed to Change Color Beaker B (Exercise)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Time (add and divide by 3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PHOTOSYNTHESIS DIAGRAMS:

Before:

After:
Post Lab Questions:

Cellular Respiration and Exercise:
1. Why does Bromthymol Blue change to a yellow/green color?

2. Why were you asked to exercise prior to blowing in to one of the test tubes?

3. Which test tube turned yellow the quickest? ________________ Why?

4. How does exercise affect the amount of CO$_2$ produced in your cells?

5. Why did you have to use the same amount of Bromthymol Blue in each test tube?

6. Write a conclusion statement summarizing what you learned from this portion of the lab.

Photosynthesis and CO2 Levels:
7. What caused the buildup of gas in the test tubes?

8. Why were you asked to blow into one sample of water but not the other prior to placing the Elodea in it?

9. You have now seen the effect of light and CO$_2$ on photosynthesis. What other variables may affect photosynthesis?

10. What is photosynthesis and how did your setup demonstrate the requirements necessary for the process to occur?

11. How would your results have been affected if you used twice the amount of Elodea?

Conclusion:
12. What can you conclude about photosynthesis and respiration in relation to each other? Include in your answer an explanation of what is going on at the cellular level during both of these processes.