**Exercise & Cellular Respiration**

**Problem/Purpose**: Can you analyze the effect of exercise on cellular respiration?

## Background Information:

Cellular respiration (*see chemical reaction below*) is a chemical reaction that occurs in your cells to create energy; when you are exercising your muscle cells are creating ATP to contract. Cellular respiration requires oxygen (which is breathed in) and creates carbon dioxide (which is breathed out).

 **C6H12O6 + 6O2 6 CO2 + 6 H2O + 36 ATP (energy)**

This lab will address how exercise (increased muscle activity) affects the rate of cellular respiration. You will measure 3 different indicators of cellular respiration: breathing rate, heart rate, and carbon dioxide production. You will measure these indicators at rest (with no exercise) and after 1 and 2 minutes of exercise. Breathing rate is measured in breaths per minute, heart rate in beats per minute, and carbon dioxide in the time it takes bromthymol blue to change color.

Carbon dioxide production can be measured by breathing through a straw into a solution of bromthymol blue (BTB). BTB is an acid indicator; ***when it reacts with acid it turns from blue to yellow***. When carbon dioxide reacts with water, a weak acid (carbonic acid) is formed (*see chemical reaction below*). The more carbon dioxide you breathe into the BTB solution, the faster it will change color to yellow.

##  6 CO2 + 6 H2O 6 HCO3 + 6 H+

# **Questions:**

1. What is the equation for cellular respiration? Label which items are the reactants and the products. **(20 pts)**
2. In what part of the cell does cellular respiration occur? (**10 pts**)
3. Explain with specific examples how EACH type of muscle is used for exercising. **(30 pts)**
4. Describe what BTB is and how it works. **(10 pts)**

**Hypothesis: (20 pts)**

Make a hypothesisof how exercise will affect your body’s production of carbon dioxide (i.e. do you think your body will produce *more* or *less* carbon dioxide as you exercise?).

**Experiment:**

**Materials:**

* Beaker/Test tube/cup Bromthymol blue solution (BTB) straw
* Stopwatch

**Procedure:**

**PART A: Resting (no exercise)**

***Measuring Carbon Dioxide Production:***

* 1. Use a graduated cylinder to measure out 20 mL of tap water and pour it into a small beaker.
	2. Use a dropper to add 8 drops of bromthymol blue to make a BTB solution.
	3. Using a straw, exhale into the BTB solution. **(CAUTION: Do not inhale the solution!)**
	4. Time how long it takes for the blue solution to turn yellow. Record the time in **Table 1**.
	5. Wash out the beaker repeat steps 1-4 twice more.
	6. Average the results of the 3 trials. Record this in **Table 1**.

# **Measuring Breathing Rate:**

1. Count the number of breaths (1 breath = inhale + exhale) you take in 1 minute. Record this in **Table 2**.
2. Repeat this 2 more times.
3. Average the 3 trials to get your average breathing rate. Record this in **Table 2**.

# **Measuring Heart Rate:**

1. While you calculate your breathing rate, have your partner take your pulse.
2. Count the number of beats in 30 seconds and multiply that number by 2. Record this in **Table 3**.
3. Repeat this 2 more times.
4. Average the 3 trials to get your average heart rate. Record this in **Table 3**.

## PART B: Increased Muscle Activity (Exercise)

1. Get the BTB solution ready as in Part A.
2. Exercise for exactly 1 minute by doing jumping jacks.
3. After 1 minute of exercise, immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this in **Table 1**.
4. Then quickly calculate your **breathing** and **heart rates** as you did before. You only need to do this once.
5. Record these values in **Tables 2 & 3**. *Remake your BTB solution*.
6. Exercise as you did before, but for 2 continuous minutes.
7. Immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this in **Table 1**.
8. Then quickly calculate your breathing and heart rates as you did before. You only need to do this once.
9. Record these values in **Tables 2 & 3**.

**Data Analysis:(10 pts each table)**

**Table 1: Carbon Dioxide Production (time it takes BTB to change color)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Student 1** | **Student 2** | **Student 3** | **Student 4** | **Average** |
|  |  **Trial 1** |  |  |  |  |  |
| **Resting** |  **Trial 2** |  |  |  |  |  |
|  |  **Trial 3** |  |  |  |  |  |
|  |  **Average** |  |  |  |  |  |
|  |  **1 minute** |  |  |  |  |  |
| **Exercise** |  **2 minutes** |  |  |  |  |  |

**Table 2: Breathing Rate (breaths/minute)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Student 1** | **Student 2** | **Student 3** | **Student 4** | **Average** |
|  |  **Trial 1** |  |  |  |  |  |
| **Resting** |  **Trial 2** |  |  |  |  |  |
|  |  **Trial 3** |  |  |  |  |  |
|  |  **Average** |  |  |  |  |  |
|  | **1 minute** |  |  |  |  |  |
| **Exercise** |  **2 minutes** |  |  |  |  |  |

**Table 3. Heart Rate (beats/minute)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Student 1** | **Student 2** | **Student 3** | **Student 4** | **Average** |
|  |  **Trial 1** |  |  |  |  |  |
| **Resting** |  **Trial 2** |  |  |  |  |  |
|  |  **Trial 3** |  |  |  |  |  |
|  |  **Average** |  |  |  |  |  |
|  | **1 minute** |  |  |  |  |  |
| **Exercise** | **2 minutes** |  |  |  |  |  |

# **Conclusion Questions:** ANSWER THE QUESTIONS IN COMPLETE SENTENCES.

1. How did exercise affect the time needed for the solution to change color? Explain why the color change occurred. **(10 pts)**
2. What can you conclude about the effect of exercise on the amount of carbon dioxide that is present in your exhaled breath? **(10 pts)**
3. What can you conclude about the effect of exercise on breathing rate? (**10 pts)**
4. What can you conclude about the effect of exercise on heart rate? What do your muscles need during exercise that the blood brings? (**20 pts)**
5. Write a conclusion paragraph describing the relationship between the muscular, circulatory, and respiratory systems. **(30 pts)**