Respiration Exercise Lab

Introduction
What happens when you exercise? As you know, increasing your activity level will cause an increase in your respiration rate. What you may not know is that this is closely tied to cellular respiration in your cells. As you increase your activity, mitochondria in your cells use oxygen to break down sugars to charge up ATP molecules; ATP is then used for energy directly elsewhere in your cells, including muscle work. A waste product of the breakdown of sugars is carbon dioxide gas, which you exhale. When your body breaks down glucose, carbon dioxide is produced. Too much carbon dioxide can result in damage to muscles or other body parts, so there must be some way to get rid of this carbon dioxide. When you inhale, this brings fresh air with high oxygen levels into your lungs. When you exhale, this moves air with high carbon dioxide levels out of your lungs.

For quick energy, the body uses already-stored ATP and new ATP made by lactic acid fermentation also called anaerobic respiration because it does not require oxygen. Aerobic cellular respiration releases energy more slowly than fermentation (anaerobic respiration), which is why you have to pace yourself during long sessions of exercise. Glucose is a common fuel for the process of cellular respiration. The complex sugar, starch, is broken down into a simple sugar, glucose, by the digestive system. Although in the lab we cannot physically see this breakdown, we will examine how exercise and physical exertion affects cellular respiration.

All parts of your body need energy to do their work. For example, muscles need energy to contract, and your body requires energy to synthesize needed molecules. Your body gets the energy it needs by combining food molecules with oxygen in a process called cellular respiration. The sugar glucose is combined with oxygen to release carbon dioxide, water, and ATP. ATP is the energy your body can use. This is shown in the following chemical reaction, which is called aerobic cellular respiration.

\[
\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{ATP}
\]

You know that a fire needs fuel and oxygen from the air to keep burning. Similarly, your muscles and other parts of your body need to have a continuous supply of glucose (or other high-energy molecules) and oxygen to make ATP, or energy, for muscle contractions and other body functions. Since the chemical reaction above requires oxygen, it is considered aerobic respiration.

During intense or long periods of exercise you may not be able to inhale enough oxygen to produce enough energy (ATP) to continue. The tissue without enough oxygen may still make ATP by anaerobic respiration (fermentation) but this chemical reaction is produces less energy. Additionally anaerobic respiration results in the production of lactic acid, a waste product that builds up in muscles and causes cramps. The body will only use the anaerobic respiration reaction when oxygen is not available because of it is much less efficient at making ATP and produces lactic acid which can inhibit physical activity. The chemical reaction for anaerobic respiration is shown to the right.

Experimental Question: How does your body respond to the demand for energy during exercise?

Hypothesis:

Procedure
1. Working in groups of 3 or 4, select a student that will be able to do jumping jacks well and will be able to keep jumping for 8 minutes. The group member jumping will stop just long enough for the needed measurements and observations to be collected.
2. Record the resting observations and values of the person doing jumping jacks for the following:
- perspiration level (none, mild, medium, high)
- external body temperature (place the thermometer under the subjects arm pit for 1 minute; the thermometer should have a probe cover on the tip and be placed directly against the skin)
- breathing rate (count the number of breaths in 1 minute)
- heart rate (find the pulse at the wrist and count the number of beats in 1 minute)

3. Make observations and measurements of the person doing jumping jacks and while they are sitting down and resting. Record your observations on the data table.

4. The student exercising should begin jumping when the person watching the clock gives the signal. After 2 minutes quickly make observations and measurements and record them on the data table.

5. The student will continue jumping at 2 minute intervals until the 8 minute time period has been completed. After each 2 minute interval observations and measurements should be made.

6. Make a separate graph for each of the following:
   - **Breathing Rate at Various Intervals of Exercise**
   - **Heart Rate at Various Intervals of Exercise**

7. Answer the questions in the conclusion section to describe and explain the results of the lab.

### Data

**Observations and Measurements During Various Intervals of Exercise**

<table>
<thead>
<tr>
<th>Time Intervals</th>
<th>Perspiration Level (none, low, medium, high, dripping)</th>
<th>Body Temperature (degrees Celsius)</th>
<th>Breathing Rate (breaths per minute)</th>
<th>Heart Rate (beats per minute)</th>
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</thead>
<tbody>
<tr>
<td>Rest</td>
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<tr>
<td>2 Minutes</td>
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<td>6 Minutes</td>
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<td>8 Minutes</td>
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</tbody>
</table>

### Conclusions

1. Describe the connection between cellular respiration and exercise?
2. Summarize the process of aerobic and anaerobic cellular respiration.
3. How does your body respond to the increased demand for energy during exercise? Explain any changes in:
   a. Body temperature
   b. Perspiration
   c. Breathing Rate
   d. Pulse
4. Why does an increased breathing rate accompany exercise?
5. Why does an increased heart rate accompany exercise?
6. During exercise, which cellular organelle in muscle tissue functions more rapidly to meet the demands for useable energy (ATP)?
7. Describe any possible sources of experimental error and how they could have affected the results.

### Extension

1. Compare and contrast aerobic and anaerobic respiration.
2. If the oxygen demand of muscle tissue exceeds supply how is the tissue adapted to continue producing ATP? What are some of the advantages and disadvantages of this adaptation?