Cellular Respiration Lab Questions

Pre-Lab Questions

1. Suppose you wanted to measure the overall rate of cellular respiration, what specific things could you measure?

2. Of the options that you listed in your answer to #1, which might be easier to measure? Which might be harder to measure and why?

3. You will be using a respirometer in this lab. It consists of a small, cylindrical glass chamber and a rubber stopper with a long graduated glass capillary tube inside of it. Draw one of the three respirometer set-ups from the diagram on the right.

4. Why is it necessary to correct the readings of the respirometers containing seeds with the readings taken from the respirometers containing only glass beads? Your answer should refer to the concepts derived from the general gas law:

   \[ PV = nRT \]

   Where:

   \[ P = \text{pressure of the gas} \]

   \[ V = \text{volume of the gas} \]

   \[ N = \text{number of moles of the gas} \]

   \[ R = \text{the gas constant (its value is fixed)} \]

   \[ T = \text{temperature of the gas} \]

5. What happens to the volume of the gas being measured (O\(_2\) consumption or CO\(_2\) production) when the temperature or pressure changes during the experiment? If pressure and temperature remain constant, will the volume of gas in the respirometers increase or decrease? Please explain.

6. Imagine that you are given 25 germinating pea seeds that have been placed in boiling water for 5 minutes. You place these seeds in a respirometer and collect data. Predict the rate of oxygen consumption (i.e., cellular respiration) for these seeds and explain your reasons.

7. Imagine that you are asked to measure the rate of respiration for a 25g reptile and a 25g mammal at 10\(^\circ\)C. Predict how the results would compare, and justify your prediction.

8. Imagine that you are asked to repeat the reptile/mammal comparison of oxygen consumption, but at a temperature of 22\(^\circ\)C. Predict how these results would differ from the measurements made at 10\(^\circ\)C, and explain your prediction in terms of the metabolism of the animals.

9. What difficulties would there be if you used a living green plant in this investigation instead of germinating seeds?
**Procedures:** The rate of cellular respiration can be measured using respirometers. Your proper materials list and directions are below (Do not use the College Board materials list or procedures).

**Materials:**
- Germinating/non-germinating peas/glass beads
- Safety goggles, aprons, and gloves
- 1 cylindrical glass chamber with metal weight
- 1 rubber stopper with graduated capillary tube inserted
- Celsius thermometer
- Water bath
- 15% solution of NaOH, Sodium Hydroxide solution

**Instructions:**

1. Insert a small plug of absorbent cotton into the glass cylinder, all the way to the bottom. You can use a glass stirring rod to push it down.
2. Have one group member obtain gloves and bring the glass cylinder to the middle lab station.
3. A pipette should be there already filled with 15% NaOH. CAREFULLY use the pipette to add **two small drops of 15% NaOH to the cotton** of the respirometer. Do not get NaOH on the inner sides of the respirometer, only on the cotton. **CAUTION:** MAKE SURE YOU ARE WEARING GLOVES AND SAFETY GOGGLES, NaOH IS CAUSTIC.
4. The individuals with the gloves should then insert a small plug of nonabsorbent cotton on top of the absorbent/saturated cotton plug. It should be about the same size of the absorbent cotton plug. They can then use the glass stirring rod to pack it in. (this is needed to protect the seeds from the NaOH)
5. Set up the other two glass cylinders, following the instructions from step 1-3. Then move on.
6. Fill a 100ml graduated cylinder with 50ml of tap water. Place enough germinated peas into the graduated cylinder to raise the volume of water 5ml. Write down the number of peas you’ve counted.
7. Empty the water from the graduated cylinder and place the counted germinated peas into the 1st respirometer, on top of the nonabsorbent cotton.
8. Repeat steps 6-7, but use non-germinated/dry peas. Add dry seeds to the 2\textsuperscript{nd} respirometer.
9. Repeat steps 6-7, but use glass beads. Add glass beads to the 3\textsuperscript{rd} respirometer.
10. Insert the rubber stoppers with the glass tubes into the respirometers.
11. Obtain a square of parafilm and peel off the paper covering. Wrap the parafilm tightly around each stopper (where it enters the vial and where the pipette is inserted. This is necessary to ensure against any leaks.
12. Make a sling by attaching tape across the water bath. Make it so that when you place the respirometer in the water, the open end of the long glass capillary tubes will rest on the tape sling.
13. Fill the bath with water using a large beaker. Place all three respirometers in the water, with the open end of the capillary tubes resting on the tape sling. Adjust the water level in the bath so that the top of the capillary tubes are out of the water. See set up on middle lab station for help.
14. Let the respirometers equilibrate for seven minutes.
15. You should create your data table while you wait. See table example below.
16. After 7 minutes, all three respirometers should be immersed entirely in the water. The capillary tube must be in a position so that the numbers can be read (facing up). When the respirometers are immersed, water will move into the capillary tube for a short time and then stop.

17. These respirometers are sensitive to environmental changes, including bumping the water bath. Once the respirometers have reached equilibrium, they should not be touched or moved, nor should anything else be added or taken out of the water bath.

18. Allow the respirometers to equilibrate for 3 more minutes and then begin recording to the nearest .01ml, the initial position of water in each tube (time 0).

19. Check the temperature and record in a data table.

20. Every 5 minutes for 20 minutes, take readings of the position of water in each tube.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Reading at time X</th>
<th>Difference</th>
<th>Reading at time X</th>
<th>Difference</th>
<th>Corrected Difference</th>
<th>Reading at time X</th>
<th>Difference</th>
<th>Corrected Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Difference = (initial reading at time 0) – (reading at time X)
- Corrected difference = (initial pea seed reading at time 0 – pea seed reading at time X) – (initial bead reading at time 0 – bead reading at time X)

**Analysis/ Post Lab Questions:**

1. Graph the results of the corrected difference columns for all items. Be sure to give it proper labels and titles.

2. Identify the hypothesis being tested in this activity. Indicate the variable factor(s), the control(s), and the purpose of each control.

3. Describe and explain the relationship between the amount of oxygen consumed and time.

4. Explain the effect of germination (vs. non-germination) on pea seed respiration.

5. What is the purpose of NaOH in this experiment?

6. Explain why water moved into the respirometer's capillary tube.