Act 6: Respiration – Aerobic and Anaerobic

Background information:
Respiration is the chemical reaction in the cell which releases energy from the oxidation of glucose. There are two types of respiration: aerobic and anaerobic.
Acrobic respiration occurs in the presence of oxygen. Glucose is completely broken down to carbon dioxide and water. It is the only reaction in the body that uses elemental oxygen. The first part of this reaction is called glycolysis where the glucose molecule is split into two pyruvate molecules. These are then metabolised into carbon dioxide and water releasing most of the available energy in glucose.
Anaerobic respiration occurs when oxygen is NOT available. The glucose is broken down to pyruvate (glycolysis) but then pyruvate is converted to lactic acid and carbon dioxide. Much less energy is released in anaerobic respiration because the energy is still tied up in the chemical bonds in the lactic acid molecule.
Lactic acid produced during anaerobic respiration can build up in tissues can cause cramps or muscle stiffness the day after strenuous exercise.
For more detailed information on the steps in the respiration reaction see the following:
http://www3.gettysburg.edu/~metrje01/Cellularrespirationdiagram.htm
Cellular respiration concept map

Purpose:

- to measure the rate of anaerobic respiration.

Materials:

4 zippered plastic bags approximately 15 cm x 15 cm
4 labels
warm tap water
4 sachets of dried yeast
2 sachets of sugar
1 sachet of sugar-substitute sweetener
rule
2 L beaker filled with water
baking tray
measuring cylinder
access to a fridge

Procedure:

a. Label the bags 1 - 4.

b. **Bag 1** - add 20 mL of warm water and the contents of 1 yeast sachet.

c. **Bags 2 and 3** - to each bag add 20 mL of warm water and the contents of 1 yeast sachet and contents of 1 sugar sachet.

d. **Bag 4** - add 20 mL of warm water and the contents of 1 yeast sachet and content of 1 sweetener sachet.

e. Smell the contents of each bag before sealing it.

f. Seal the bags making sure that there is the minimum amount of air in the bag.

g. Measure the volume of each bag by the water displacement method.

Displacement method
Fill the 2 L beaker with water. Sit it in a baking tray. Carefully put the zippered plastic bag into the beaker until it is completely submerged. Water will have spilled out of the beaker into the baking tray. The volume of water displaced into the tray is the volume of the bag and its contents.

h. Dry the bags and place Bags 1, 2 and 4 in a warm position where they will not be disturbed.

i. Place Bag 3 in the fridge.

j. Record the volume of the bags at five minute intervals.

Results:

Bags	Time (minutes)					
	0	5	10	15	20	25
1						
2						
3						
4						

k. Graph your results.

Questions:

1. In which bag(s) did respiration occur? What evidence do you have for your answer?

2. What was the purpose of including Bag 1?

3. What was the gas that accumulated in the bags? How could you determine this?

4. Why were Bags 2 and 3 set up in the same way? (Hint: think of your experimental design.)

5. What happened in Bag 4? Explain if this was what you expected to happen.

6. What is the difference between sugar and the sweetener?

7. Compare the results of Bags 2 and 3. Suggest an explanation for the difference.

8. Which bag do you think would have released the most energy? Explain why you think so.

9. This activity shows the production of carbon dioxide from anaerobic respiration. If the yeast had been respiring aerobically, how would the amount of gas produced in the bags change? Why?

l. Carefully open the bags and smell the contents.

10. Which bag(s) had a different odour? Explain why the odours changed in some bags and not others.

11. Find out from texts or another source, what are the products of anaerobic respiration in

    a. plants? _____

    b. animals? _____

12. How could you determine if the contents in the bag contain either of these products?

13. Try your test. What do the contents of the odoriferous bags now contain?

Except for red blood cells, which can only respire anaerobically (thus sparing the oxygen they carry), anaerobic respiration provides only a **temporary** energy supply for tissues that have energy needs above their aerobic ability. Anaerobic respiration can only occur for a limited time (longer in skeletal muscles and shorter for the heart) when the ratio of oxygen supply to oxygen needed falls below a critical level. Anaerobic respiration is an emergency procedure that provides some energy until the emergency (oxygen deficiency) has passed. Increased lactic acid concentrations contribute to muscle fatigue.

14. Explain what may happen if human cells produced alcohol as a product of anaerobic respiration instead of lactic acid.

15. Suggest why cardiac muscle of the heart has a lower lactic acid tolerance than skeletal muscles.

16. Compare the results of Bags 2 and 3. Suggest a possible explanation for the difference.

17. The independent variable for Bags 2 and 3 was temperature. Can the results of this part of the investigation be applied to humans? Explain your answer.

18. Calculate the rate at which carbon dioxide was produced for each bag.

19. Does the rate of carbon dioxide production indicate the rate of respiration occurring in the bag? Explain your answer.

20. Could this measure of respiration be useful in determining respiration rate in humans? Explain your answer.