21.1 Respiration, ATP and energy transfers

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS respiration • ATP

Objective

Respiration, ATP and energy transfers. Original classroom practice for IB HL; not an official IB paper.

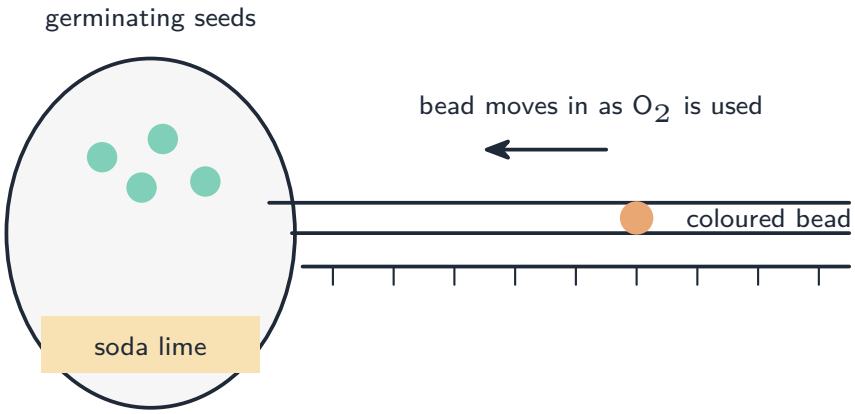
1 Key knowledge and worked examples

What would explain this observation?

- A muscle can use oxygen while you exercise without producing a flame. **Respiration** transfers energy through a controlled series of reactions.

Build the model

- Aerobic respiration uses oxygen and releases carbon dioxide and water from organic substrates.
- Energy released can support **ATP** formation.
- ATP hydrolysis can be coupled to processes such as active transport and muscle contraction.
- respiration: Cell reactions that transfer energy from substrates.
- ATP: A molecule that couples energy transfers in cells.



Choose evidence that can test it

- Anaerobic processes allow ATP production when oxygen supply cannot support the required aerobic rate, but give less ATP per glucose.
- In humans lactate can accumulate; yeast can produce ethanol and carbon dioxide.

In the lab: A respirometer can measure oxygen uptake when carbon dioxide is absorbed. Control temperature with a water bath and use a comparison containing inert material. Keep absorbent separated from organisms and follow the school risk assessment.

Work from known quantities

- Known: oxygen uptake is 0.80 cubic centimetres in 4.0 minutes for 2.0 g of tissue.
- Rate per mass = volume / (time × mass).
- Rate = $0.80/(4.0 \times 2.0) = 0.10$ cubic centimetres per minute per gram.
- Normalizing allows a fairer comparison of samples of different mass.

Your turn: 0.60 cubic centimetres are used in 3.0 minutes by 2.0 g of tissue. Find the mass-specific rate.

Check the conclusion and its limits

- Breathing ventilates the lungs; respiration consists of chemical reactions in cells.
- A moving respirometer marker can also reflect temperature or pressure changes.

Not true: Breathing and cellular respiration are the same process. Breathing is ventilation - moving air in and out of the lungs. Cellular respiration is the set of chemical reactions in cells that transfers energy from glucose. The names overlap but the processes are different.

Key:

- Aerobic respiration uses oxygen and releases carbon dioxide and water from organic

substrates.

- Anaerobic processes allow ATP production when oxygen supply cannot support the required aerobic rate, but give less ATP per glucose.
- Watch for: breathing ventilates the lungs; respiration consists of chemical reactions in cells.

■ **Write from a respiration rate of 0.16 cubic centimetres per minute per gram**

- Tissue uses 0.96 cubic centimetres of oxygen in 4.0 minutes. The tissue mass is 1.5 g.
- Find the mass-specific rate. Anaerobic routes make less ATP per glucose.

2 Practice

2.1 Why use a temperature-controlled water bath for respirometry? Choose one answer.

- **A** To stop oxygen uptake
- **B** To reduce gas-volume changes unrelated to respiration
- **C** To make every organism the same mass [1]

2.2 0.60 cubic centimetres are used in 3.0 minutes by 2.0 g of tissue. Find the mass-specific rate. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: Breathing is ventilation - moving air in and out of the lungs. [2]

2.4 Cell reactions that transfer energy from substrates: write the technical term. [1]

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3 Exam-style questions

3.1 Fictional samples use 0.8 cm^3 in 4 min for 2 g and 0.6 cm^3 in 3 min for 1 g. Compare mass-specific uptake and specify one control. [4]

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Solutions

2.1 B A water bath holds temperature constant, so gas expansion or contraction from temperature change does not move the marker; the remaining volume change reflects respiration. It cannot equalise organism mass and is not meant to stop oxygen uptake.

2.2 rate=volume/(time×mass)=0.60/(3.0×2.0)=0.10 cm^3/(min g).

2.3 True. True. Breathing is ventilation - moving air in and out of the lungs. Cellular respiration is the set of chemical reactions in cells that transfers energy from glucose. The names overlap but the processes are different.

2.4 respiration. respiration means Cell reactions that transfer energy from substrates.

3.1 0.10 and 0.20 cm^3/(min g). The second is twice as high after normalization. Control temperature and pressure changes with a suitable comparison; uptake is not the same measurement as breathing rate.

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