

21.1 Respiration, ATP and energy transfers

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS respiration • ATP

Objective

Respiration, ATP and energy transfers. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

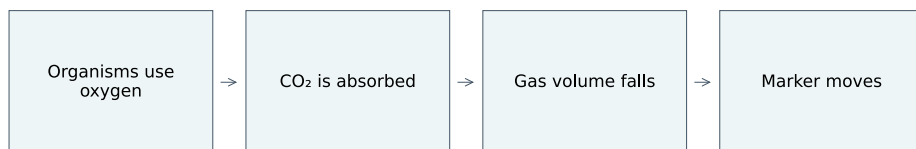
1 Key knowledge and worked examples

■ 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.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ 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.
- 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

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- 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.

Example:

0.60 cubic centimetres are used in 3.0 minutes by 2.0 g of tissue. Find the mass-specific rate. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ 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.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Breathing and cellular respiration are the same process. This claim is false: Breathing ventilates the lungs; respiration consists of chemical reactions in cells. A moving respirometer marker can also reflect temperature or pressure changes.

Key:

Respiration, ATP and energy transfers: 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.

2 Practice

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

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

[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 and cellular respiration are the same process.

[2]

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

[1]

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]

Solutions

2.1 B 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.

2.2 $\text{rate} = \text{volume} / (\text{time} \times \text{mass}) = 0.60 / (3.0 \times 2.0) = 0.10 \text{ cm}^3 / (\text{min g})$.

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

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

3.1 0.10 and 0.20 $\text{cm}^3 / (\text{min g})$. 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.