

15.1 Gas exchange: maintaining diffusion gradients

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS ventilation • perfusion

Objective

Gas exchange: maintaining diffusion gradients. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

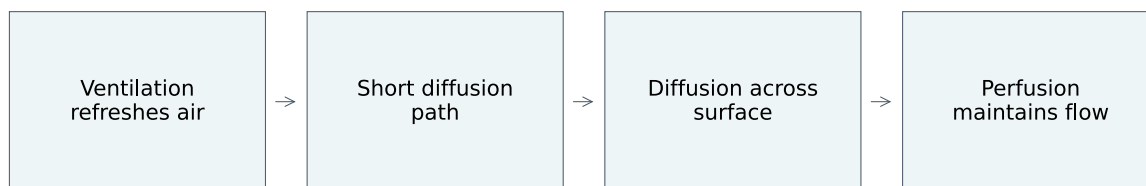
1 Key knowledge and worked examples

■ What would explain this observation?

- An exchange surface can be very thin yet fail to deliver enough oxygen when **ventilation** or blood flow falls.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Gas exchange occurs by diffusion across a surface. Large area, short diffusion distance and maintained concentration gradients support transfer. Ventilation refreshes the external medium; **perfusion** carries gases to and from the exchange surface.
- ventilation: Movement of air or water over an exchange surface; perfusion: Blood flow through tissue or an exchange surface.



■ **Choose evidence that can test it**

- Distinguish movement of the whole medium from diffusion across the membrane. Ventilation and perfusion work together, while haemoglobin helps transport oxygen in blood. A change in breathing rate alone does not measure oxygen uptake.
- Use an approved model or published respiratory data. Compare exchange surface area, diffusion path and flow. For human demonstrations use voluntary resting measurements; do not induce breathlessness or hyperventilation.

■ **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: tidal volume is 0.50 L and breathing rate is 12 breaths/min. Minute ventilation = $0.50 \times 12 = 6.0$ L/min. This includes dead-space ventilation and is not identical to alveolar ventilation.

Example:

Tidal volume is 0.60 L and breathing rate is 10 breaths/min. Find minute ventilation. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ **Check the conclusion and its limits**

- Air entering the lungs is not all exchanged with blood. Oxygen and carbon dioxide diffuse in opposite net directions because their own gradients differ.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Minute ventilation directly equals oxygen uptake. This claim is false: Air entering the lungs is not all exchanged with blood. Oxygen and carbon dioxide diffuse in opposite net directions because their own gradients differ.

Key:

Gas exchange: maintaining diffusion gradients: Distinguish movement of the whole medium from diffusion across the membrane. Ventilation and perfusion work together, while haemoglobin helps transport oxygen in blood. A change in breathing rate alone does not measure oxygen uptake.

2 Practice

2.1 What maintains an oxygen gradient across the lung exchange surface? Choose one answer.

- **A** Ventilation and blood flow
- **B** Stopping all blood flow
- **C** Making the diffusion path longer

[1]

2.2 Tidal volume is 0.60 L and breathing rate is 10 breaths/min. Find minute ventilation. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Minute ventilation directly equals oxygen uptake.

[2]

2.4 Movement of air or water over an exchange surface: write the technical term.

[1]

3 Exam-style questions

3.1 Fictional patterns use $0.50 \text{ L} \times 12/\text{min}$ and $0.30 \text{ L} \times 20/\text{min}$. Given dead space 0.15 L per breath, compare minute and alveolar ventilation in this simplified model. [4]
