15.1 Gas exchange: maintaining diffusion gradients

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

KEY WORDS ventilation • perfusion

Objective

Gas exchange: maintaining diffusion gradients. Original classroom practice for IB HL; not an official IB paper.

1 Key knowledge and worked examples

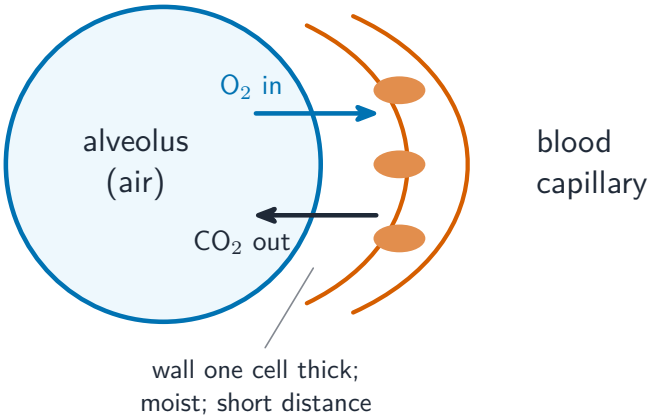
What would explain this observation?

- An exchange surface can be very thin yet fail to deliver enough oxygen when **ventilation** or blood flow falls.

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.

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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.

In the lab: 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

- 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.

Your turn: Tidal volume is 0.60 L and breathing rate is 10 breaths/min. Find minute ventilation.

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.

Not true: Minute ventilation directly equals oxygen uptake. Ventilation moves air into the lungs; oxygen uptake is what crosses into the blood. Dead-space air never reaches the exchange surface, and uptake depends on diffusion and blood flow, so the two quantities differ.

Key:

- Gas exchange occurs by diffusion across a surface.

- Distinguish movement of the whole medium from diffusion across the membrane.
- Watch for: air entering the lungs is not all exchanged with blood.

■ **Write from a minute ventilation of 12 litres per minute**

- Tidal volume is 0.80 L and the breathing rate is 15 breaths per minute.
- Find minute ventilation. It includes dead space.

2 Practice

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

- **A** Ventilation and blood flow
- **B** Making the diffusion path longer
- **C** Stopping all blood flow [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: Ventilation moves air into the lungs; oxygen uptake is what crosses into the blood. [2]

2.4 Movement of air or water over an exchange surface: write the technical term. [1]

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3 Exam-style questions

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

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