

Exercise walk-through

12.1

Gas exchange: maintaining diffusion gradients

International Baccalaureate · IB Diploma · Biology · SL

12.1 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 SL; not an official IB paper.

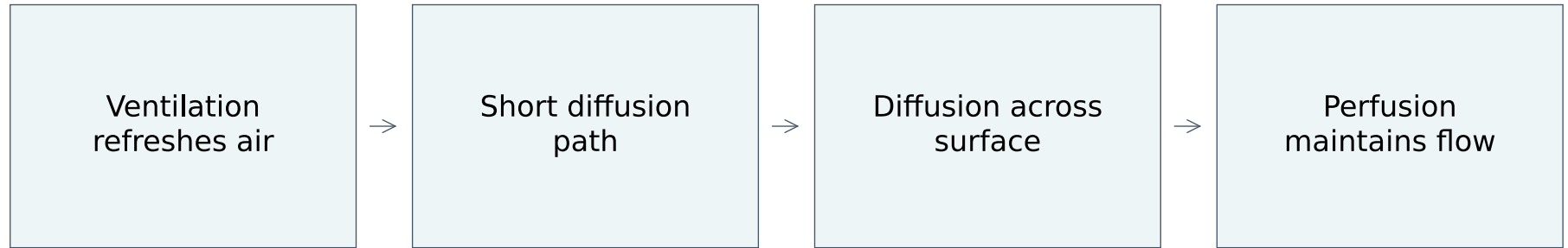
1 Key knowledge and worked examples

- 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.



■ **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 gra-

dients 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 7.0 litres**

- Tidal volume is 0.50 L and the breathing rate is 14 breaths per minute.

- Find minute ventilation. Ventilation is not the same as oxygen uptake.



Exercises 2.1·2.2

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]

Exercises 2.1·2.2

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]

2.1 A Ventilation refreshes alveolar air and blood flow carries oxygen away, so both sides of the surface keep the partial-pressure gradient steep. Stopping blood flow would let equilibration flatten it, and a longer path would slow diffusion.

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]

2.2 minute ventilation = $0.60 \text{ L/breath} \times 10 \text{ breaths/min} = 6.0 \text{ L/min}$.

Exercises 2.3-3.1

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]

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]

Exercises 2.3-3.1

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]

2.3 True. True. 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.

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

2.4 ventilation. ventilation means Movement of air or water over an exchange surface.

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]

3.1 Both minute ventilations $6 \text{ L}/\text{min}$. Alveolar values $= (0.50 - 0.15) \times 12 = 4.2$ and $(0.30 - 0.15) \times 20 = 3.0 \text{ L}/\text{min}$. This model illustrates the distinction and is not a clinical judgement.