

Exercise walk-through

15.1

Gas exchange: maintaining diffusion gradients

International Baccalaureate · IB Diploma · Biology · HL

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

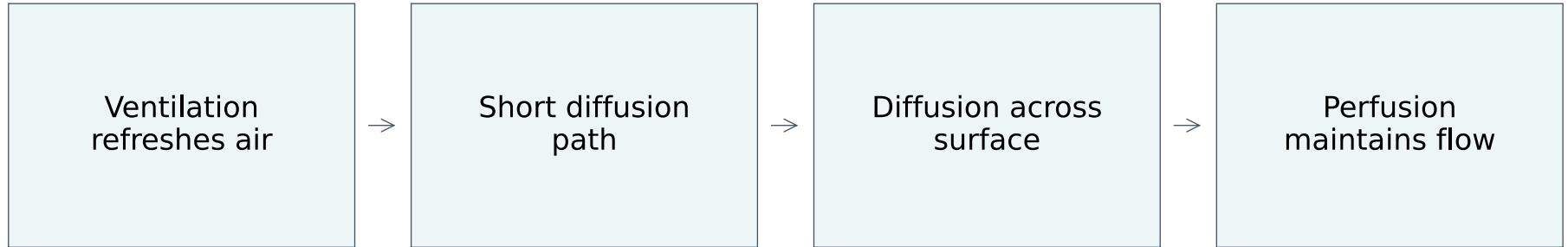
■ What would explain this observation?

- 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 $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ 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.

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

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]

2.1 A 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.

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

2.3 Decide whether this claim is true and justify: Minute ventilation directly equals oxygen uptake. [2]

2.3 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.

Exercises 2.4·3.1

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]

Exercises 2.4·3.1

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

3 Exam-style questions

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.