



Gas exchange: practice questions

8 questions • 25 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 25

1 PAPER 1A STYLE [1 mark]

Which change happens as an organism of the same shape increases in size?

- A. ☐ Surface area increases and the surface area-to-volume ratio increases
- B. ☐ Surface area increases and the surface area-to-volume ratio decreases
- C. ☐ Volume decreases relative to surface area
- D. ☐ The distance from the centre to the exterior decreases

2 PAPER 1A STYLE [1 mark]

What is the role of surfactant in the alveoli of mammalian lungs?

- A. ☐ It dissolves oxygen so that it can diffuse into the blood
- B. ☐ It kills bacteria that enter the alveoli with inhaled air
- C. ☐ It reduces surface tension so that the alveoli do not collapse
- D. ☐ It increases the thickness of the alveolus wall to prevent damage

3 PAPER 2A STYLE [3 marks]

Outline how concentration gradients are maintained at the gas-exchange surface of a mammal.

4 PAPER 1B STYLE

[5 marks]

A student measured her lung volumes with a spirometer at rest. The values are practice data. (a) Calculate her vital capacity. (b) Calculate her total lung volume. (c) State which value in the table cannot be measured with a spirometer and explain why. (d) Explain how contraction of the external intercostal muscles and diaphragm causes inspiration.

Lung volumes of one student at rest (practice data)	
Volume	Value / dm ³
Tidal volume	0.5
Inspiratory reserve volume	2.6
Expiratory reserve volume	1.0
Residual volume	1.2

Answer =

5 PAPER 2A STYLE

[3 marks]

Explain why plants cannot avoid losing water by transpiration.

6 PAPER 1B STYLE

[4 marks]

Leaf casts were made of the lower epidermis of two species. Stomata were counted in five fields of view at $\times 400$. The field of view diameter was 0.45 mm. (a) Calculate the mean stomatal density of species X. Give your answer in stomata per mm^2 . (b) Suggest why five fields of view were counted. (c) Species Y lives in a hot, dry habitat. Suggest how its stomatal density helps it survive.

Number of stomata per field of view (practice data)					
Species	Count 1	Count 2	Count 3	Count 4	Count 5
X	31	35	29	33	32
Y	12	15	11	14	13

Answer =

7 PAPER 1A STYLE

[1 mark]

HL only

Why can foetal haemoglobin take up oxygen from maternal blood in the placenta?

- A. ☐ Foetal haemoglobin has a lower affinity for oxygen than adult haemoglobin
- B. ☐ Foetal haemoglobin has a higher affinity for oxygen than adult haemoglobin
- C. ☐ Foetal blood has a higher partial pressure of oxygen than maternal blood
- D. ☐ Foetal haemoglobin binds carbon dioxide instead of oxygen

HL only

Explain how the structure and properties of haemoglobin allow oxygen to be loaded in the lungs and released in actively respiring tissues.

[illegible]

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B [1]

2. [1]

C C [1]

3. [3]

- dense network of capillaries close to the alveoli [1]
- continuous blood flow carries oxygenated blood away / brings deoxygenated blood [1]
- ventilation replaces air in alveoli / brings fresh air with high O₂ concentration and removes CO₂ [1]
- keeps O₂ concentration higher in alveoli than in blood / CO₂ higher in blood than in alveoli [1]
- max 3

4. [5]

- (a) $0.5 + 2.6 + 1.0 = 4.1 \text{ dm}^3$ [1]
- (b) $4.1 + 1.2 = 5.3 \text{ dm}^3$ [1] ECF from (a)
- (c) residual volume, because this air always remains in the lungs / cannot be breathed out into the spirometer [1]
- (d) ribs move up and out and diaphragm flattens/moves down, so thorax volume increases [1]
- (d) pressure in the thorax/lungs falls below atmospheric so air flows in [1]

5. [3]

- stomata must be open to allow CO₂ to enter for photosynthesis [1]
- water evaporates from (moist) mesophyll cell walls into air spaces [1]
- water vapour diffuses out through open stomata down a concentration gradient [1]
- gas exchange surface must be moist/permeable so water is lost from it [1]
- max 3

6. [4]

- (a) mean count = $160 \div 5 = 32$ [1]
- (a) area = $\pi \times 0.225^2 = 0.159 \text{ mm}^2$; density = $32 \div 0.159 = 201$ stomata per mm^2 (accept 200-202) [1]
- (b) stomatal number varies across the leaf/biological variability, so replicates give a reliable mean [1]
- (c) fewer stomata so less water vapour lost by transpiration [1]

7. [1] **HL only**

B B [1]

8. [7] **HL only**

- haemoglobin has four polypeptides/subunits each with a haem group [1]
- each haem group (iron) binds one O_2 [1]
- cooperative binding: binding of one O_2 changes conformation, raising affinity of other haem groups [1]
- gives an S-shaped/sigmoid dissociation curve [1]
- high pO_2 in lungs so haemoglobin becomes (almost) saturated [1]
- steep part of curve at pO_2 of tissues so small fall in pO_2 releases much O_2 [1]
- respiring tissues produce CO_2 [1]
- CO_2 binds allosterically/at a site other than the haem group [1]
- CO_2 forms carbonic acid; hydrogen ions/lower pH also lower affinity [1]
- lowers affinity for O_2 / curve shifts to the right: Bohr shift [1]
- so more O_2 is released where respiration rate is highest [1]
- low CO_2 in lungs increases affinity, aiding loading [1]
- max 7