



Organisms (Form and function) practice questions

24 questions • 79 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 / 79

Gas exchange **Spec B3.1**

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]

Transport Spec B3.2

Fenestrated capillaries are found in the glomerulus of the kidney. What is the advantage of fenestrations?

- A. ☐ They prevent blood cells from leaving the capillary
- B. ☐ They allow particularly rapid exchange of fluid and solutes
- C. ☐ They increase blood pressure in the capillary
- D. ☐ They prevent backflow of blood

Distinguish between the structure of arteries and veins, relating each difference to function.

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[2 marks]

Answer =

[illegible]

[5 marks]

Saturated fat intake and CHD deaths (practice data)		
Population	Saturated fat / % of energy intake	CHD deaths per 100 000 per year
1	7	60
2	9	95
3	11	140
4	13	150
5	15	230
6	17	240

[illegible]

[illegible]

HL only

Pressures in the left side of the heart (practice data)			
Time / s	Left atrium / mm Hg	Left ventricle / mm Hg	Aorta / mm Hg
0.00	6	5	82
0.10	8	30	80
0.15	4	81	80
0.25	3	120	119
0.40	4	90	95
0.50	6	4	88

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0.10	8	30	80
0.15	4	81	80
0.25	3	120	119
0.40	4	90	95
0.50	6	4	88

HL only

Describe how tissue fluid is formed, used and returned to the blood.

HL only

Which feature is an adaptation of companion cells in phloem?

- A. ☐ Absence of a nucleus to reduce resistance to flow
- B. ☐ Sieve plates to allow sap to pass between cells
- C. ☐ Many mitochondria to supply ATP for loading sugars
- D. ☐ Lignified walls to withstand high pressure

Muscle and motility

Spec B3.3

HL only

HL only

What happens to the bands of a sarcomere during muscle contraction?

- A. ☐ The A band shortens and the I band stays the same length
- B. ☐ The I band shortens and the A band stays the same length
- C. ☐ Both the A band and the I band shorten
- D. ☐ The actin and myosin filaments both shorten

HL only

Which statement about skeletons is correct?

- A. ☐ Arthropods have endoskeletons with muscles attached to the outer surface
- B. ☐ Vertebrates have exoskeletons made of chitin
- C. ☐ Arthropods have exoskeletons with muscles attached to the inner surface
- D. ☐ Skeletons act as levers but do not provide anchorage for muscles

HL only

Explain how the internal and external intercostal muscles act as an antagonistic pair.

HL only

Outline the structure and function of a motor unit.

HL only

Students used a goniometer to measure the range of motion of the hip in three dimensions. (a) Calculate the mean range of hip flexion. (b) Identify the movement with the smallest range. (c) Suggest one reason why the measurements varied between trials. (d) Suggest why the hip has a larger range of motion in more dimensions than the knee.

Range of motion of the hip of one student / ° (practice data)

Movement	Trial 1	Trial 2	Trial 3
Flexion	118	122	120
Abduction	42	45	39
Extension	18	22	20

Answer =

HL only

Outline four reasons for locomotion in animals, giving a named example of each.

HL only

Explain how skeletal muscle contracts and how it returns to its resting length.

HL only

(a) State the roles of cartilage and synovial fluid in the hip joint. (b) Describe two adaptations of the tail and airways of a dolphin for swimming.

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 O₂ [1]
- cooperative binding: binding of one O₂ changes conformation, raising affinity of other haem groups [1]
- gives an S-shaped/sigmoid dissociation curve [1]
- high pO₂ in lungs so haemoglobin becomes (almost) saturated [1]
- steep part of curve at pO₂ of tissues so small fall in pO₂ releases much O₂ [1]
- respiring tissues produce CO₂ [1]
- CO₂ binds allosterically/at a site other than the haem group [1]
- CO₂ forms carbonic acid; hydrogen ions/lower pH also lower affinity [1]
- lowers affinity for O₂ / curve shifts to the right: Bohr shift [1]
- so more O₂ is released where respiration rate is highest [1]
- low CO₂ in lungs increases affinity, aiding loading [1]
- max 7

9. [1]

B B [1]

10. [4]

- arteries have thicker walls relative to the lumen / veins thinner walls [1]
- artery walls withstand high pressure [1]
- arteries have more elastic fibres which stretch and recoil to maintain pressure/even out flow [1]
- arteries have more smooth muscle to narrow the lumen/maintain pressure [1]
- veins have valves to prevent backflow at low pressure [1]
- veins have wider lumen / flexible walls compressed by skeletal muscle to push blood to heart [1]
- max 4

11. [2]

- mean = 25 beats per 20 s, so $25 \times 3 = 75$ beats per minute [1]
- the thumb has its own pulse, which could be counted by mistake [1]

12. [5]

- (a) positive correlation: as saturated fat intake increases, CHD deaths increase [1]
- (a) strong correlation, as r is close to +1 [1]
- (b) raises blood cholesterol which forms fatty deposits/plaque in coronary artery walls, narrowing lumen [1]
- (b) plaque rupture leads to a blood clot that blocks the artery [1]
- (c) correlation does not prove causation [1]
- (c) other factors could differ between populations, e.g. smoking, exercise, genetics, age / only six populations [1]
- max 5

13. [6]

- water evaporates from (spongy mesophyll) cell walls and diffuses out through stomata [1]
- water drawn from xylem/through cell walls by capillary action/adhesion to cellulose [1]
- generates tension/negative pressure potential in xylem [1]
- tension pulls water up xylem [1]
- cohesion between water molecules due to hydrogen bonding [1]
- keeps a continuous column of water [1]
- adhesion of water to xylem walls [1]
- xylem has no cell contents/end walls so flow is unimpeded [1]
- lignified walls prevent collapse under tension [1]
- pits allow water to enter/leave xylem [1]
- passive process / energy from evaporation (sun), not ATP [1]
- max 6

14. [4] HL only

- (a) closed, as ventricular pressure is higher than atrial pressure [1]
- (b) 0.15 s, when ventricular pressure first exceeds aortic pressure [1]
- (c) 120 mm Hg (accept 119) [1]
- (d) elastic recoil of the aorta wall maintains pressure / semilunar valve prevents backflow [1]

15. [4] HL only

- high (hydrostatic) pressure at arteriole end of capillary [1]
- pressure filtration of plasma through capillary wall [1]
- large plasma proteins/blood cells stay in capillary [1]
- substances such as O₂/glucose pass from tissue fluid to cells; CO₂/wastes to tissue fluid [1]
- lower pressure at venule end so fluid drains back into capillaries [1]
- excess drains into lymph ducts (thin walls with gaps) and returns to the blood in veins [1]
- max 4

16. [1] HL only

C C [1]

17. [1] HL only

B B [1]

18. [1] HL only

C C [1]

19. [3] HL only

- muscles can only exert force/pull when they contract [1]
- muscle fibres in the two layers have different orientations [1]
- external intercostals move ribcage up and out; internal move it down and in [1]
- contraction of one layer stretches the other [1]
- potential energy stored in titin (of stretched sarcomeres) helps recoil [1]
- max 3

20. [3] HL only

- one motor neuron and the muscle fibres it stimulates [1]
- connected by neuromuscular junctions/synapses [1]
- acetylcholine released at junctions stimulates fibres [1]
- all fibres in the unit contract together [1]
- more motor units recruited for greater force / small units for fine control [1]
- max 3

21. [4] HL only

- (a) $(118 + 122 + 120) \div 3 = 120^\circ$ [1]
- (b) extension [1]
- (c) goniometer not placed exactly on the joint centre/arms not aligned with bones the same way each time / student moved by different amounts [1]
- (d) hip is a ball-and-socket joint (allowing movement in several planes) whereas the knee is a hinge joint [1]

22. [4] HL only

- foraging for food, e.g. honeybees flying to flowers for nectar [1]
- escaping from danger, e.g. squid using jet propulsion to escape predators [1]
- searching for a mate, e.g. male moths following female pheromones [1]
- migration, e.g. Arctic terns between Arctic and Antarctic [1]
- Accept other valid named examples. Reason and example both required for each mark.

23. [7] HL only

- muscle fibre/myofibril made of repeating sarcomeres between Z lines [1]
- actin (thin) filaments attached to Z lines; myosin (thick) filaments in centre [1]
- calcium ions released expose binding sites on actin [1]
- myosin heads bind to actin forming cross-bridges [1]
- heads swivel/power stroke pulls actin towards centre of sarcomere [1]
- ATP binds causing myosin to detach [1]
- hydrolysis of ATP re-cocks/re-energises myosin head [1]
- filaments slide past each other; sarcomere shortens/Z lines closer [1]
- I band and H zone shorten, A band unchanged [1]
- muscle can only pull so an antagonistic muscle stretches it back [1]
- titin stores potential energy when stretched and recoils [1]
- titin prevents overstretching [1]
- max 7

24. [4] HL only

- (a) cartilage reduces friction/absorbs shock between femur and pelvis [1]
- (a) synovial fluid lubricates the joint/reduces friction [1]
- (b) tail forms a (horizontal) fluke moved up and down for propulsion [1]
- (b) blowhole on top of head closes during dives / allows rapid breathing at surface between dives [1]