



The heart, blood vessels and haemoglobin: practice questions

11 questions · 36 marks · mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 36

1 UNIT 1 STYLE [1 mark]

Which statement best explains why a large mammal needs a circulatory system?

- A. ☐ Its surface area to volume ratio is large
- B. ☐ Its diffusion distances are short
- C. ☐ Its surface area to volume ratio is small, so diffusion alone is too slow
- D. ☐ Its cells do not respire aerobically

2 UNIT 1 STYLE [4 marks]

A scientist models two organisms as cubes. Organism A has sides of 2 mm and organism B has sides of 8 mm. Calculate the surface area to volume ratio of each organism and explain why organism B would need a transport system but organism A would not.

Answer = ...

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3 UNIT 1 STYLE [4 marks]

Explain how the structure of an artery is related to its function.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Explain how the structure of a capillary makes it suitable for exchange of substances between blood and tissue cells.

The table shows pressures in the left side of the heart at different times during one cardiac cycle. Use the data to deduce whether each valve is open or closed at the time stated, giving a reason. (i) the atrioventricular valve at 0.1 s (ii) the atrioventricular valve at 0.3 s (iii) the aortic valve at 0.3 s (iv) the aortic valve at 0.4 s

Pressure in the left side of the heart			
Time / s	Left atrium / kPa	Left ventricle / kPa	Aorta / kPa
0.0	0.7	0.4	10.7
0.1	1.1	0.9	10.4
0.2	0.9	5.0	10.0
0.3	0.6	16.0	15.5
0.4	0.8	11.0	12.5
0.5	1.0	0.7	12.0

The table gives the percentage saturation of adult and fetal haemoglobin with oxygen at different partial pressures of oxygen. (i) Describe the differences between the two sets of data. (2) (ii) Explain the significance of the oxygen affinity of fetal haemoglobin compared with adult haemoglobin. (3)

Percentage saturation with oxygen (rounded values)		
pO ₂ / kPa	Adult haemoglobin (%)	Fetal haemoglobin (%)
2	17	33
4	57	76
6	80	90
8	90	95
10	94	97
12	96	98

.....

.....

.....

.....

.....

.....

.....

.....

Explain why the oxygen dissociation curve of haemoglobin is S-shaped.

.....

.....

.....

.....

.....

Mark scheme

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

1. [1]

C C: surface area to volume ratio is small, so diffusion alone is too slow

2. [4]

- A: surface area = $6 \times 2^2 = 24 \text{ mm}^2$, volume = $2^3 = 8 \text{ mm}^3$, ratio = 3 : 1 (1)
- B: surface area = $6 \times 8^2 = 384 \text{ mm}^2$, volume = $8^3 = 512 \text{ mm}^3$, ratio = 0.75 : 1 (1)
- B has a much smaller surface area to volume ratio / longer diffusion distance to the centre (1)
- so diffusion alone is too slow to supply all of its cells, whereas in A diffusion is fast enough (1)

3. [4]

- thick wall / collagen, to withstand high pressure / prevent bursting (1)
- elastic fibres stretch and recoil to even out the pressure surge / keep blood flowing smoothly (1)
- smooth muscle can contract to narrow the lumen / control blood flow (1)
- narrow lumen helps maintain high pressure (1)
- smooth endothelium reduces friction (1)
- Max 4

4. [3]

- wall is one cell thick / a single layer of endothelial cells, so short diffusion distance (1)
- very narrow lumen so red blood cells are squeezed close to the wall / flow is slow, giving time for exchange (1)
- large total surface area / dense network close to every cell (1)
- gaps between cells allow small molecules and fluid to pass (1)
- Max 3

5. [4]

- (i) open, as atrial pressure (1.1) is higher than ventricular pressure (0.9) (1)
- (ii) closed, as ventricular pressure (16.0) is higher than atrial pressure (0.6) (1)
- (iii) open, as ventricular pressure (16.0) is higher than aortic pressure (15.5) (1)
- (iv) closed, as aortic pressure (12.5) is higher than ventricular pressure (11.0) (1)

6. [3]

- time for one cycle = $60 \div 90$ (1)
- = 0.67 s (1)
- percentage = $0.3 \div 0.667 \times 100 = 45 \%$ (1)

7. [4]

- septum separates the left and right sides / oxygenated and deoxygenated blood (1)
- atrioventricular valves prevent backflow from ventricles to atria (1)
- tendinous cords stop the valves turning inside out / being forced back (1)
- semilunar valves in the aorta and pulmonary artery prevent backflow into the ventricles (1)
- valves open when pressure behind is higher than in front / shut when pressure in front is higher (1)
- Max 4

8. [4]

- some dissolved in plasma (1)
- some combines with haemoglobin to form carbaminohaemoglobin (1)
- most converted to hydrogencarbonate ions in red blood cells, catalysed by carbonic anhydrase (1)
- hydrogencarbonate ions diffuse out into the plasma, with chloride ions moving in (1)
- H^+ ions produced bind to haemoglobin, acting as a buffer (1)
- Max 4

9. [1]

B B: the curve shifts right (Bohr effect), so more oxygen is released

10. [5]

- (i) fetal haemoglobin is more saturated at every pO_2 (1)
- the difference is greatest at low pO_2 / 4 kPa (19 percentage points) and smaller at high pO_2 (1)
- (ii) fetal haemoglobin has a higher affinity for oxygen / curve is to the left (1)
- in the placenta pO_2 is low, so adult (maternal) haemoglobin unloads oxygen while fetal haemoglobin is still highly saturated / loads it (1)
- so oxygen passes from the mother's blood to the fetus (1)
- Max 5

11. [3]

- at low pO_2 the first oxygen molecule binds with difficulty, so the curve is shallow (1)
- binding of the first oxygen changes the shape of haemoglobin, making it easier for the next ones to bind / cooperative binding, so the curve is steep (1)
- at high pO_2 haemoglobin is almost saturated / few haem groups remain free, so the curve levels off (1)