Unit 2

The Variety of Living Organisms

Transport in Animals

Practice Exam Questions

1. (a) An increase in respiration in the tissues of a mammal affects the oxygen dissociation curve of haemoglobin. Describe and explain how.

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(2 marks)

(b) There is less oxygen at high altitudes than at sea level.

(b) (i) People living at high altitudes have more red blood cells than people living at sea level. Explain the advantage of this to people living at high altitude.

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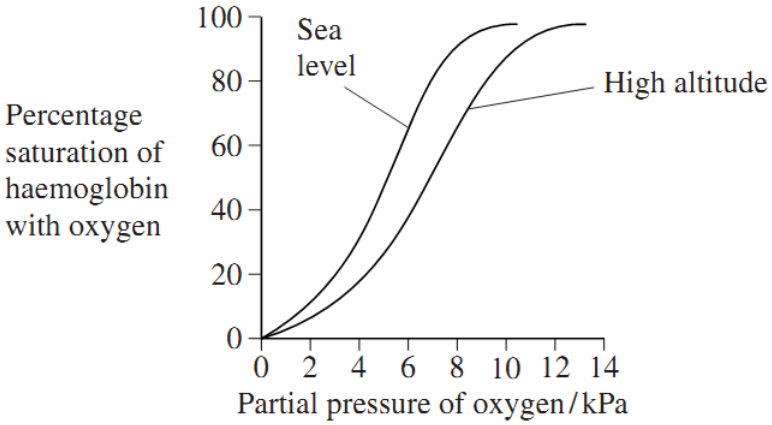
(2 marks)

(b) (ii) The graph shows oxygen dissociation curves for people living at high altitude and for people living at sea level.



Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

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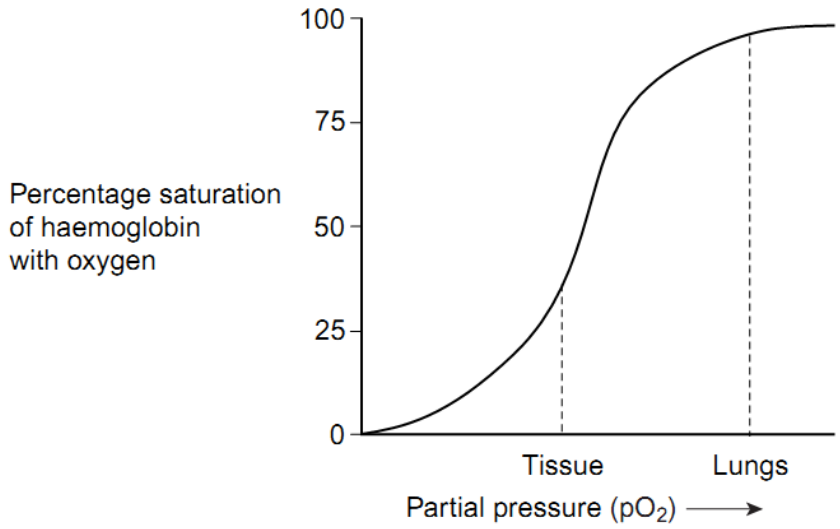
(2 marks)

2

(a) **Figure 6** shows the oxygen dissociation curve for human haemoglobin.

Figure 6



Use **Figure 6** to describe how haemoglobin loads and unloads oxygen in the body.

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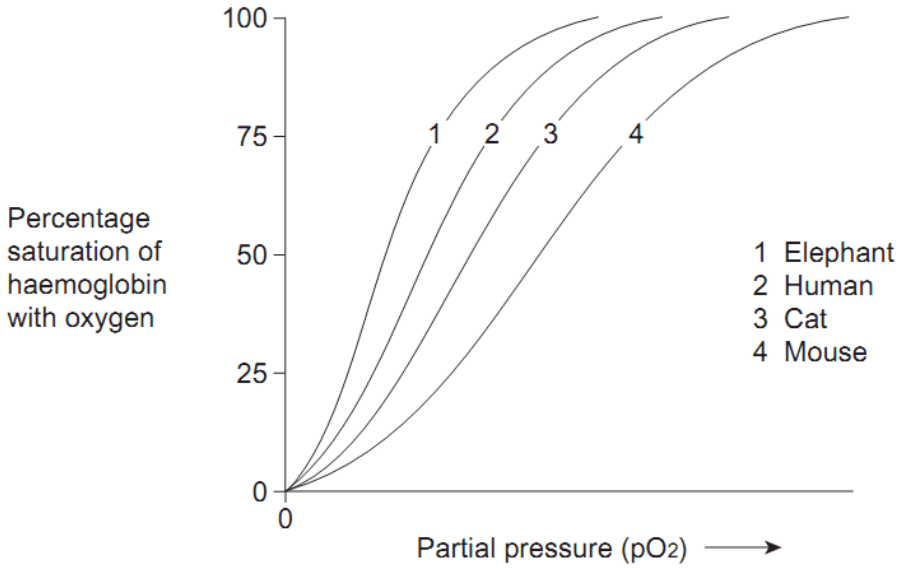
(3 marks)

(b) **Figure 7** shows oxygen dissociation curves from mammals of different size.

Figure 7



(b) (i) Describe the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

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(1 mark)

(b) (ii) Heat from respiration helps mammals to maintain a constant body temperature. Use this information to explain the relationship between the surface area to volume ratio of mammals and the oxygen dissociation curves of their haemoglobins.

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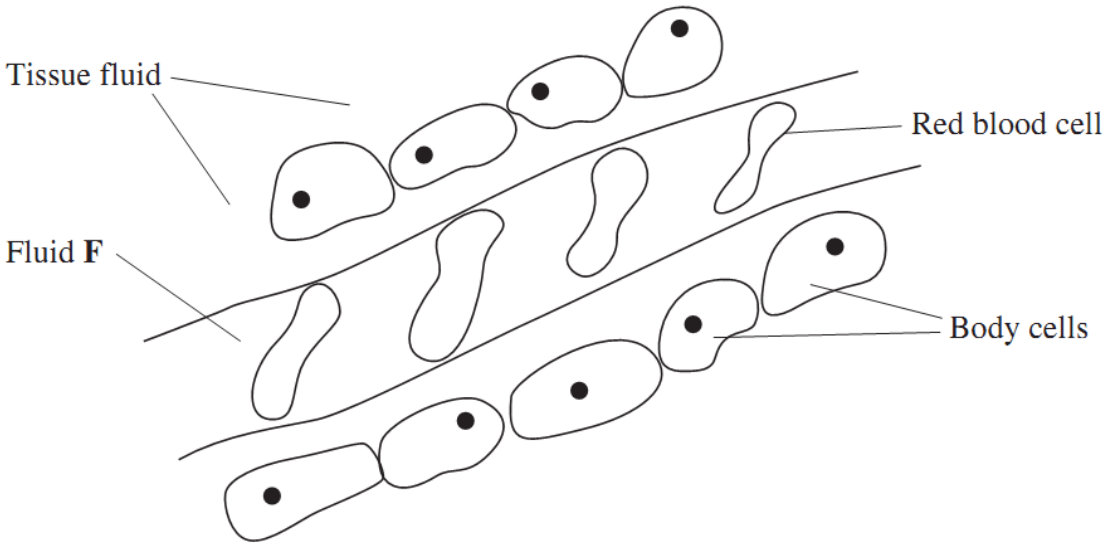
(4 marks)

3

The diagram shows tissue fluid and cells surrounding a capillary.



(a) Name fluid **F**.

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(1 mark)

(b) Give **one** way in which fluid **F** is different from tissue fluid.

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(1 mark)

(c) (i) The blood pressure is high at the start of the capillary. Explain how the left ventricle causes the blood to be at high pressure.

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(1 mark)

(c) (ii) The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

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(1 mark)

(d) In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

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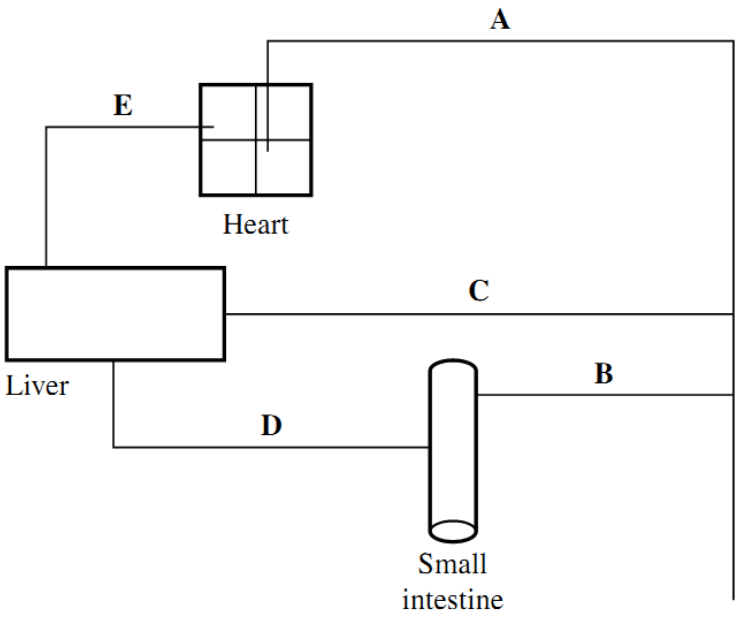
(3 marks)

4

The diagram shows some of the large blood vessels in a mammal.



(a) Add arrows to the diagram to show the direction of blood flow in each of the blood vessels **A** to **E**. *(1 mark)*

(b) (i) Which of blood vessels **A** to **E** is the hepatic portal vein?

(1 mark)

(b) (ii) Which of blood vessels **A** to **E** contains blood at the lowest pressure?

(1 mark)

(c) Complete the table to show **two** differences between the structure of vessel **C** and the structure of vessel **E**.

Structural feature	Vessel C	Vessel E

(2 marks)

(d) Blood vessel **B** contains smooth muscle in its walls. Explain how this muscle may reduce the blood flow to the small intestine.

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(2 marks)

(e) Elastic tissue in the walls of blood vessel **A** helps to even out the pressure of blood through this vessel. Explain how.

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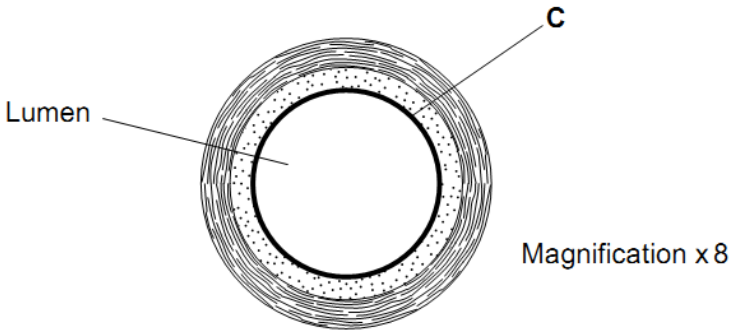
(2 marks)

5 The diagram shows a cross-section of a blood vessel.



(a) Name layer **C**.

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(1 mark)

(b) Calculate the actual diameter of the lumen of this blood vessel in millimetres. Show your working.

Answer ..... mm

(2 marks)

(c) The aorta has many elastic fibres in its wall. An arteriole has many muscle fibres in its wall.

(c) (i) Explain the importance of elastic fibres in the wall of the aorta.

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(2 marks)

(c) (ii) Explain the importance of muscle fibres in the wall of an arteriole.

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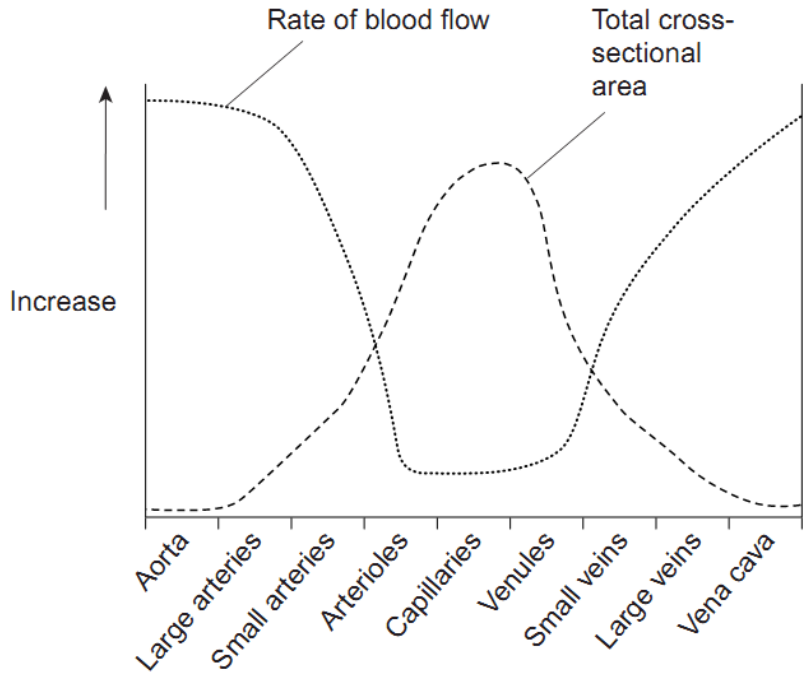
(2 marks)

(d) The graph shows the rate of blood flow in different blood vessels. It also shows the total cross-sectional area of these blood vessels.



(d) (i) The rate of blood flow decreases from the aorta to the capillaries. Use information from the graph to explain why.

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(1 mark)

(d) (ii) Efficient exchange of substances in the capillaries is linked to the rate of blood flow. Explain how.

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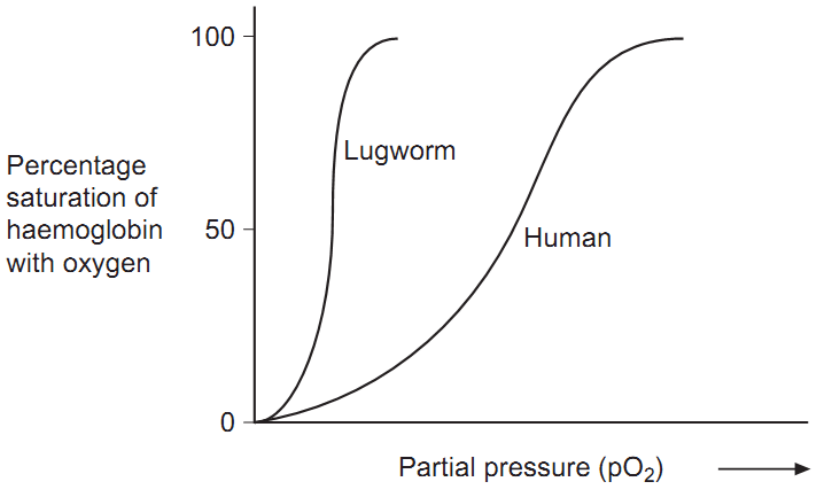
(1 mark)

6 Lugworms live in mud where the partial pressure of oxygen is low. The graph shows oxygen dissociation curves for a lugworm and for a human.



(a) Explain the advantage to the lugworm of having haemoglobin with a dissociation curve in the position shown.

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(2 marks)

(b) In humans, substances move out of the capillaries to form tissue fluid. Describe how this tissue fluid is returned to the circulatory system.

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(3 marks)

7 (a) Describe and explain **four** ways in which the structure of a capillary adapts it for the exchange of substances between blood and the surrounding tissue.

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(4 marks)

7 (b) Describe and explain how tissue fluid is formed and how it is returned to the blood.

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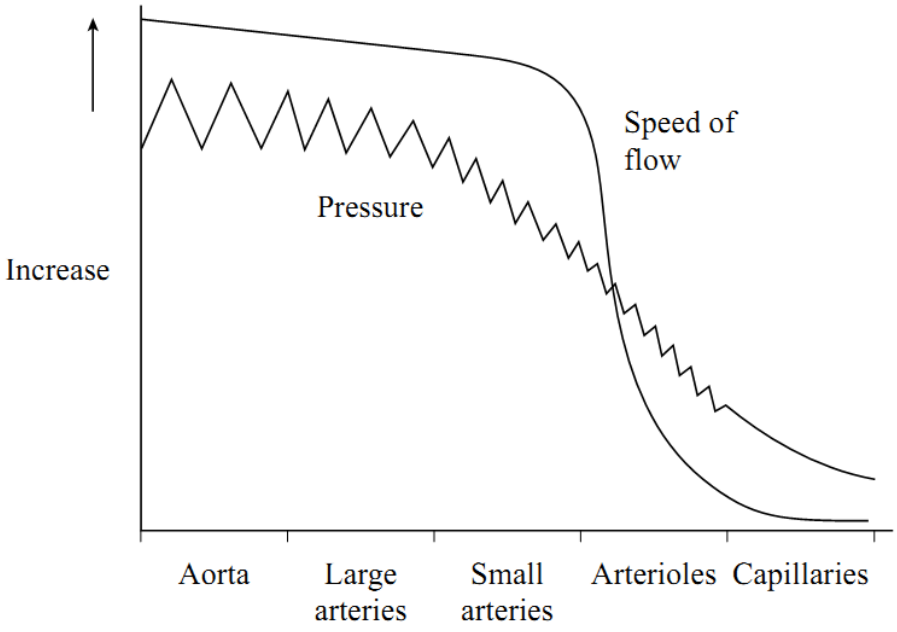
(6 marks)

8

The chart shows the change in the speed of flow and pressure of blood from the start of the aorta into the capillaries.



(a) Describe and explain the changes in the speed of flow of the blood shown in the chart.

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(2 marks)

(b) Explain how the structure of the arteries reduces fluctuations in pressure.

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(2 marks)

(c) Explain how the structure of capillaries is related to their function.

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(2 marks)

(d) In one cardiac cycle, the volume of blood flowing out of the heart along the pulmonary artery is the same as the volume of blood returning along the pulmonary vein. Explain why the volumes are the same although the speed of flow in the artery is greater than in the vein.

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(1 mark)

9

Haemoglobin is a globular protein.

Describe the structure of a haemoglobin molecule.

In your answer, you should include details of the secondary, tertiary and quaternary structure of the molecule.

[7]

10

Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(a) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

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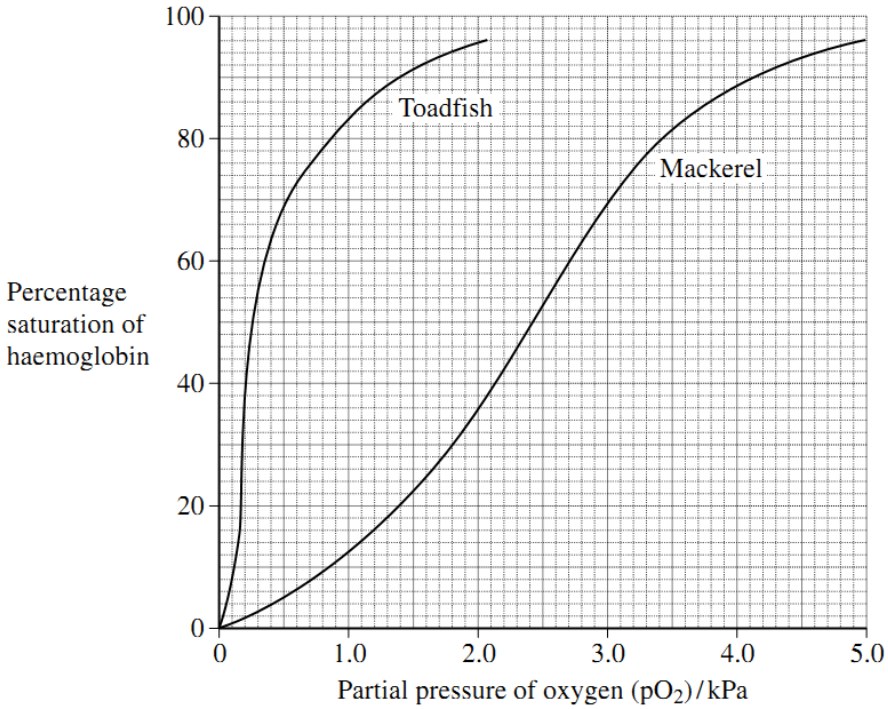
(2 marks)

The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



(b) Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

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(2 marks)

Total 4 marks

Transport in Animals Answers and Markscheme

Question 1

Part	Marking Guidance	Mark	Comments
(a)	Increase in/more carbon dioxide; Curve moves to the right/depressed;	2	**Q** Any reference to haemoglobin increasing affinity for oxygen disqualifies second mark point.
(b)(i)	More haemoglobin; So can load/pick up more oxygen (in the lungs);	2	**Q** Second mark point must relate to idea of loading oxygen. Answers referring only to transport of oxygen should not be credited this mark.
(b)(ii)	(Haemoglobin) has lower affinity for oxygen / more oxygen released; In/to the cells/ tissues;	2	

Question 2

(a)		Loading/uptake/association of oxygen at high p.O_2; In lungs (haemoglobin) is (almost) fully saturated / in lungs haemoglobin has a high affinity for oxygen; Unloads/releases/dissociates oxygen at low p.O_2; Unloading linked to higher carbon dioxide concentration;	1 1 1 1	3 max Allow converse for second marking point in tissues i.e. haemoglobin has low affinity / releases most of its oxygen. Mark for haemoglobin having high affinity for oxygen must be 'in lungs'.
(b)	(i)	Larger the mammal the more to the left/steeper/'higher' is the curve / the higher the affinity for oxygen;	1	Allow converse. Ignore references to Bohr shift
(b)	(ii)	Smaller mammal has greater surface area to volume ratio; Smaller mammal/larger SA:Vol ratio more heat lost (per unit body mass); Smaller mammal/larger SA:Vol ratio has greater rate of respiration/metabolism; Oxygen required for respiration; (Haemoglobin) releases more oxygen / oxygen released more readily / haemoglobin has lower affinity;	1 1 1 1 1	4 max Allow converse explanation for larger mammals or lower surface area to volume ratio. Allow suitable named mammal as alternative to smaller or larger mammal.

Question 3

Part	Marking Guidance	Mark	Comments
(a)	(Blood) plasma;	1	
(b)	More/larger proteins / less urea/carbon dioxide / more glucose/amino acids/fatty acids/oxygen/ high(hydrostatic) pressure;	1	**Q** Reference to blood cells/water potential = neutral **Q** No Protein should not be credited
(c)(i)	Contracts;	1	**Q** Do not accept pumping of heart/heart beating
(c)(ii)	Loss of fluid/volume; Friction/resistance (of capillary wall);	1 max	**Q** Reference to a narrow lumen is not sufficient to gain a mark unless friction or resistance is mentioned.
(d)	Water potential (in capillary) not as low/is higher/less negative / water potential gradient is reduced; More tissue fluid formed (at arteriole end); Less/no water absorbed (into blood capillary); by osmosis; (into blood capillary);	3 max	**Q** The last two marking points must be in context of movement into the blood capillary

Question 4

<table>
<tr><th>Part</th><th>Sub Part</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>(a)</td><td></td><td>Arrows on all five vessels in correct direction;</td><td>1</td><td></td></tr>
<tr><td>(b)</td><td>(i)</td><td>D;</td><td>1</td><td></td></tr>
<tr><td>(b)</td><td>(ii)</td><td>E;</td><td>1</td><td></td></tr>
<tr><td>(c)</td><td></td><td><table><tr><th>Feature</th><th>Vessel C</th><th>Vessel E</th></tr><tr><td>Valves</td><td>Absent</td><td>Present</td></tr><tr><td>(Relative) thickness of walls</td><td>Thicker</td><td>Thinner</td></tr><tr><td>Elastin/elastic tissue/fibres</td><td>More</td><td>Less</td></tr><tr><td>Muscle</td><td>More</td><td>Less</td></tr><tr><td>Lumen</td><td>Narrow</td><td>Wide</td></tr></table></td><td>2 max</td><td>Two marks for two correct rows

Accept any pair of contrasting terms with same meaning as those used.</td></tr>
<tr><td>(d)</td><td></td><td>Contracts;

(Causing) vasoconstriction/narrows lumen;</td><td>2</td><td></td></tr>
<tr><td>(e)</td><td></td><td>(Elastic tissue) stretches when pressure is high;

Springs back/recoils/returns to normal;</td><td>2 max</td><td>Q Do not credit references to contracting, relaxing or expanding</td></tr>
</table>

Question 5

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		Endothelium/epithelium;	1	Allow endothelial/epithelial Reject - epidermis/endodermis
(b)		Measurement divided by 8; Allow answer in range of 3-3.3 for two marks;	1 1	Correct answer gains 2 marks.
(c)	(i)	Stretches/'expands' under high pressure/when ventricle contracts / systole; Recoils/'springs back' under low pressure/when ventricle relaxes / diastole; Smooths blood flow / maintains blood pressure / reduces pressure surges;	1 1 1	2 max ***Q*** References to aorta contracting or relaxing negates marks for stretch and recoil. Stretch and recoil without reference to blood pressure etc. = one mark. Stretch and recoil to smooth blood flow etc. = two marks Ignore references to aorta withstanding blood pressure or not being damaged.
(c)	(ii)	(Muscle) contracts; (Arteriole) constricts / narrows/alters size of lumen / reduces/regulates blood flow (to capillaries);	1 1	'It' in answer = muscle Allow converse (muscle) relaxes and (arteriole) dilates etc / increase blood flow etc. Ignore references to pressure
(d)	(i)	Large/increase in (total) cross sectional area / friction / resistance;	1	
(d)	(ii)	(More) time for exchange of substances;	1	

Question 6

Question	Marking Guidance	Mark	Comments
6(a)	High(er) affinity for oxygen / absorbs/loads more oxygen; At lower partial pressure (of oxygen) / lower pO_2;	2	Accept: Loads oxygen 'quicker', 'more readily', 'higher saturation', use of figures from graph for first point. Neutral: References to unloading.
6(b)	1. (Hydrostatic) pressure lower in capillary/blood / higher in tissues/tissue fluid; 2. Water (returns); 3. By osmosis; 4. Water potential lower/more negative in blood/capillary / higher/less negative water potential in tissues / via water potential gradient; 5. Due to protein (in blood); 6. (Returns) via lymph (system/vessels);	3 max	First marking point must be in context of between blood and tissue fluid. Neutral: References to hydrostatic pressure and water potential at arteriole end of capillary.

Question 7

Question	Part	Sub Part	Marking Guidance	Mark	Comments
7	(a)		Wall/endothelium one cell thick, reduces diffusion distance; Flattened/squamous cells, reduced diffusion distance; Narrow (lumen) / small diameter, reduces flow rate/ more time for diffusion / exchange; Narrow/small diameter, large SA/V ratio / short diffusion distance; Narrow/small diameter, RBC in contact with wall / pass singly; Gaps/pores/ in the wall between cells/fenestrations, faster filtration/movement out/large molecules through;	4 max	
7	(b)		Arterial end blood high (hydrostatic) pressure; Fluid/water/soluble substances forced out; Proteins/large molecules remain behind; Water potential become more negative; Friction /resistance to flow; Reduces hydrostatic pressure; Water moves in my osmosis; Excess water taken up by lymph capillaries; Returned to blood stream (via blood vessels) in the neck/into vein;	6 max	

Question 8

(a) slow decrease in speed until reaches arterioles then rapid decrease;
increase in total cross-sectional area of blood vessels / more friction; 2

(b) elastic tissue/fibres/wall;
expands/recoils/springs back (to smooth the pressure surges); 2
(recoil linked to elastic tissues)

(c) walls / endothelium one cell thick / made of flattened cells;
short diffusion pathway

OR

narrow lumen;
reduces rate of flow / more time for diffusion;

OR

gaps / pores between cells *(accept fenestrations between cells);*
increased rate of diffusion / fluid movement out of vessel; 2 max

(d) larger/wider lumen so greater volume carried; 1

Total 7

Question 9

			CREDIT marking points from a clearly labelled diagram
1	sequence / chain, of amino acids ;		**1 IGNORE** polypeptide
2	(amino acids) joined by peptide bonds ;		
	secondary		
S1	alpha / α, helix ;		
S2	small regions of, beta / β, pleated sheet / fold ;		
S3	hydrogen / H, bonds ;		**S3** Must be in context of secondary structure
	tertiary		
T1	secondary structure / helix / polypeptide chain, undergoes further, coiling / folding ;		**T1 ACCEPT** polypeptide chain folds further
T2	*3 bonds / interactions from:* disulfide / ionic / hydrogen / hydrophobic or hydrophilic ;		**T2 IGNORE** if clearly in context of secondary or quaternary structures **T2** H bond must be in context of tertiary structure
T3	hydrophilic R groups on outside (of molecule) / hydrophobic R groups on inside (of molecule) ;		
	quaternary		
Q1	4, polypeptides / subunits ;		
Q2	2, alpha / α, chains **and** 2, beta / β, chains ;		'contains 2 α and 2 β polypeptides' = 2 marks (Q1 and Q2)
Q3	1 haem (group) per polypeptide / 4 haems (per molecule) ;		**Q3 IGNORE** protein in ref to 1 haem (group) per polypeptide
3	prosthetic group (is) haem, (which) contains Fe^{2+} ;		**3 ACCEPT** iron ion / Fe^{+} / Fe^{3+} **3 DO NOT CREDIT** iron / Fe unqualified
		6 max	
	QWC - correct refs to secondary, tertiary and quaternary structure ;	**1**	1 **S** mark and 1 **T** mark and 1 **Q** mark

Question 10

(a)		Mixing of air and water (at surface); Air has higher concentration of oxygen than water; Diffusion into water; Plants/seaweeds near surface/in light; Produce oxygen by photosynthesis;	2 max
(b)		Not much oxygen near sea bed; Toadfish haemoglobin (nearly) saturated/loads readily at /has higher affinity for oxygen at low partial pressure (of oxygen);	2