8. Transport in Mammals

8.1 The Circulatory System

Paper 2

Marking Scheme

Q1.

(a)	*any **three** from:* **1** water is a, good / universal / AW, solvent ; **A** dissolves many substances / description of solvent action **A** solvent for / dissolves, (named) ions **and** (named) polar molecules **2** transport of one named substance for a correct reason ; e.g. urea for excretion **3** high specific heat capacity ; **A** a full description e.g. the amount of heat that must be added to, one unit of mass of the substance / 1 gram *or* 1 cm^3 of water, to increase the temperature by, one unit / 1 °C **4** so temperature of blood remains (fairly) constant / heat is dispersed throughout the body ; *must be linked to mp3* **I** temperature of water is constant AVP ; e.g. water is (di)polar	**3**
(b)(i)	**P** - aorta **A** dorsal aorta **Q** - vena cava ; **I** superior and inferior	**1**
(b)(ii)	**1** aorta / **P**, transports / delivers / AW, oxygenated blood to the, organs / body / respiring tissues / systemic circulation **or** aorta / **P**, transports / AW, blood at high pressure to, organs / body / respiring tissues / systemic circulation ; **2** vena cava / **Q**, transports / returns / AW, deoxygenated blood to the, right atrium / heart (from systemic circulation) **or** vena cava / **Q**, transports / AW, blood at low pressure to the, right atrium / heart ; **A** vena cava / **Q**, collects blood from, veins / systemic circulation *alternative* **3** aorta / **P**, transports oxygenated blood and, vena cava / **Q**, transports deoxygenated blood ; **4** blood in aorta to, organs / body / respiring tissues / systemic circulation, and blood in vena cava to, right atrium / heart ;	**2**

(b)(iii)	*closed* blood is contained within vessels ; **A** at least three from heart, arteries / arterioles, veins / venules, capillaries *double* blood flows twice through the heart in, one / each, (complete), circuit/circulation (of the body) ; **A** pulmonary circulation and systemic circulation **A** described	**2**
(c)(i)	*any **two** from:* (blood at high pressure) will, burst / damage, capillaries ; **A** cannot withstand high pressure capillaries have thin walls / capillary walls are composed of one (thin) layer of (endothelial) cells ; **A** capillary walls are one cell thick **R** capillaries have cell walls *idea that* at low pressure blood flows slowly to allow, exchange / diffusion, of substances (in capillaries) ; **A** efficient exchange (of substances) AVP ; e.g. *idea that* pressure will be low at venous end of capillaries so that tissue fluid is reabsorbed	**2**

(c)(ii)	*any **three** from:* ***I** functions* *similarities* **1** (both have) endothelium / tunica intima ; **A** tunica interna **2** both have) tunica media / <u>smooth</u> muscle ; *differences* *muscular artery – accept **ora** for arteriole* **3** smaller lumen to wall thickness / ratio of wall thickness to lumen width is smaller ; **A** thicker wall ; **I** artery is 'bigger / thicker / wider', unqualified **4** wider lumen ; **5** more <u>smooth</u> muscle (layers) / thick (layer) v thin (layer), <u>smooth</u> muscle ; **A** thicker tunica media **6** more / presence of, elastic, fibres / tissue ; **A** no elastic lamina **7** more / presence of, collagen (fibres) ; **8** AVP ; e.g. *ref. to* blood vessels in wall of artery (vasa vasorum) e.g. no vesicles in endothelium e.g. artery has, tunica externa / adventitia **A** tunica externa not (clearly) visible in arteriole	**3**

Q2.

(c)(i)	*any **two** from:* wall, of one layer / is one cell thick ; **I** capillary is one cell thick **A** thin wall / endothelial cells are a single layer **A** endothelium is, a single layer (of cells) / one cell thick *idea that* red blood cells transported in single file ; *idea that* red blood cells diameter (approximately), as large / same, as capillary (lumen) ; **A** if diameter (e.g. 7μm) stated as being similar to capillary size *idea of* diameter of capillary narrower than smooth muscle cell ; AVP ; e.g. no muscle and elastic layer muscle fibres / elastic fibres / collagen, not present *ref. to* different shapes of red blood cell / red blood cell showing flexibility, to pass through (narrow) capillary	**2**

(c)(ii)	*allow tissue fluid / fluid surrounding cells, instead of (smooth muscle) cells* *allow, blood / plasma, for capillary* *allow O_2 for oxygen and CO_2 for carbon dioxide* *any **three** from:* *capillary function* **1** named, substance / type of substance, that is supplied to smooth muscle cells or is a product removed from the cells ; e.g. (supply) oxygen / nutrients / glucose / amino acids / cell-signalling molecule e.g. (removes) carbon dioxide / lactic acid / waste **A** exchange of respiratory gases (between capillary and cells) **I** plasma proteins into tissue fluid *structure to function* **2** thin wall / AW, so short distance ; **R** capillary is thin **3** endothelial pores / fenestrations, for more efficient passage / AW ; **A** gaps, between / within, (endothelial) cells (of capillary wall) **A** increases, quantity / rate of supply (of substances) **A** endothelial pores for formation of tissue fluid (around cells) **R** if blood leaves to make tissue fluid **4** (endothelial) pores / AW, for passage of, phagocytes / monocytes / macrophages / neutrophils ; **5** small (size) / narrow diameter, to reach cells / so (all) cells are close ; **A** value in range 5–10 μm **A** small size / narrow lumen, slows (rate of) blood flow **6** detail about red blood cell and, respiratory gases / gas exchange / oxygen / carbon dioxide ; e.g. narrow lumen slows red blood cell movement for uptake of oxygen slows red blood cell movement to increase time for exchange of gases only one red blood cell fits (at a time) so short diffusion distance red blood cells are close to (muscle) cells for gas exchange red blood cells squeeze through, (so) distance for oxygen to reach cells is minimised	**3**

Q3.

(c)(ii)	can withstand high(er) blood pressure / less likely to burst ; **R** collapse **A** *idea that* blood pressure is now higher (so) blood vessel may last longer ; **A** otherwise unlikely to last a long time (in tunica media) more (smooth) muscle / thicker (smooth) muscle layer / more elastic fibres ; detail ; e.g. helps, onward movement / faster flow, of blood / AW **A** otherwise does not have enough, (smooth) muscle / elastic fibres, for onward movement / required speed of flow, of blood thicker tunica, externa / adventitia ; **A** more collagen	**2**

Q4.

(a)	arteriole/s ; venule/s ;	**2**

Q5.

(a)	*any **two** from:* no nucleus ; no organelles / uniform appearance / homogenous cytoplasm ; (some are) biconcave shape / described ; **A** cells have different shapes same, width / size, as the lumen of the capillary ; **A** same width as capillary / diameter of cells is 6 - 7 μm **R** colour / shading / AW	**2**
(b)	*any **three** from:* **1** (wall is) thin / one cell thick / 1–2 μm in thickness ; **R** 'thin cell wall' ***I*** tunica intima **2** *ref. to*, endothelial cells / endothelium ; ***I*** squamous / epithelium **3** short distance for diffusion ; **4** endothelial pores / fenestrations **or** pores / gaps, between / within, (endothelial) cells of the wall ; **5** for passage of, (named) small molecules / AW, from / to, plasma / blood / tissue fluid ; **A** phagocytes **A** ultrafiltration **6** AVP ; *ref. to* pinocytosis across endothelial cells	**3**

Q6.

(b)(i)	*any **one** from:* *context is using gaps for movement between, hepatocyte / tissue fluid, and, blood / sinusoid* **I** *ref. to* red blood cells **I** shorter diffusion, distance / pathway higher rate of / easier for / AW, exchange / movement / AW, of substances **;** **A** named substances / nutrients substances do not have to cross, a cell layer / into and out of endothelial cells **;** larger molecules / plasma proteins, can pass through **;** Kupffer cells can pass through (into tissue fluid) **;** AW **A** *ref. to* other phagocytic cells **R** Kupffer cells can diffuse through **R** if stated as entering hepatocytes	**1**

Q7.

(e)	*any **three** from:* *allow elastic tissue for elastic fibres* 1 loss of / damage to, elastic fibres (and smooth muscle) from tunica media **;** **A** scar tissue replaces, elastic fibres / smooth muscle, in tunica media **A** middle layer for tunica media 2 loss of / damage to, collagen (fibres), in / damage to, tunica, externa / adventitia **;** **A** outer layer for tunica, externa / adventitia *mp1 and mp2 if layers not named, use diagram to confirm location of elastic fibres in (thicker) middle layer and collagen fibres in (thinner) outer layer* *any **two** from mp3-5* **;** 3 cannot withstand, high pressure / increase in pressure / pressure of blood **;** 4 overstretching / over-expansion / described **;** **A** cannot, stretch / expand 5 impaired / poor / no / AW, recoil **;** *in context of loss of elastic fibres*	**3**

Q8.

(c)	closed, double (circulation / circulatory system) **;**	**1**

(e)	*note: only one mark for both pulmonary vessels*	**3**

function of blood vessel	name of blood vessel
carries blood from the heart to the lungs carries blood to the heart from the lungs	pulmonary, artery / arteries **;** pulmonary, vein / veins
carries blood from the heart to the rest of body	aorta **;** **I** artery
carries blood to the heart from the rest of body	**I** superior and inferior or anterior and posterior **I** vein venae cavae / vena cava **;**

Q9.

(a)	pulmonary (circulation) ; systemic (circulation) ; **R** systematic vena cava / inferior vena cava / superior vena cava ; **A** venae cavae	**3**
(b)	venule / venules ;	**1**

Q10.

(a)(i)	*closed circulation because* blood is contained within blood vessels ; *double circulation because* blood flows through the heart twice for one complete, circuit of the body / circulation ; **A** described **A** pulmonary circulation **and** systemic circulation	**2**
(a)(ii)	**Q** = vena cava **and** **R** = aorta ;	**1**

(a)(iii)	**I** *ref to* valves *any* ***three*** *from:* ***Q*** *has a*: thinner wall ; **A** thinner middle layer wider lumen relative to thickness of wall ; thinner tunica media ; (proportionately) less smooth muscle ; (proportionately) less / very few, elastic fibres ; *allow* ecf from Q2(a)(ii)	**3**

Q11.

<table>
<tr><td>(a)(i)</td><td>accept from either column for mark and assume blood if not stated
any three from
<table>
<tr><th>blood</th><th>tissue fluid</th><th></th></tr>
<tr><td>has red blood cells</td><td>has no red blood cells</td><td>;</td></tr>
<tr><td>more, white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes
or
fewer macrophages</td><td>fewer white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes
or
more macrophages</td><td>;</td></tr>
<tr><td>has platelets</td><td>has no platelets</td><td>;</td></tr>
<tr><td>has, more protein / large proteins
or
has, plasma proteins / named example e.g albumin / fibrinogen / globulin
these are large proteins</td><td>has, fewer / no large, proteins
or
has no, plasma proteins / named example e.g. albumin / fibrinogen / globulin
only allow <u>fewer</u> plasma proteins if clear the proteins present are small enough to leave blood</td><td>;</td></tr>
<tr><td>higher, concentration / AW, oxygen
A more oxygenated</td><td>lower, concentration / AW, oxygen
A less oxygenated</td><td>;</td></tr>
<tr><td>higher, concentration / AW, glucose / amino acids / fatty acids</td><td>lower, concentration / AW, glucose / amino acids / fatty acids</td><td>;</td></tr>
<tr><td>lower, concentration / AW, carbon dioxide A urea, in liver / muscles
I waste</td><td>higher, concentration / AW, carbon dioxide A urea, in liver / muscles
I waste</td><td>;</td></tr>
<tr><td>higher pressure</td><td>lower pressure</td><td>;</td></tr>
</table></td><td>3</td></tr>
<tr><td>(a)(ii)</td><td>lymph ; A lymphatic fluid</td><td>1</td></tr>
</table>

Q12.

<table>
<tr><td>(e)</td><td>any two from
1 <u>only</u> oxygenated blood passes through left side of heart ora
or
oxygenated blood in left side and deoxygenated blood in right side of heart ;

2 septum in heart separates (oxygenated and deoxygenated) blood ;

3 oxygenated blood is in pulmonary, venules / veins <u>and</u> deoxygenated blood is in, pulmonary arteries / arterioles ;

4 (because mixing prevented by) double circulation / double circulatory system / pulmonary and systemic circulations ;</td><td>2</td></tr>
</table>

Q13.

(a)	too large / large size ; **A** not small enough cannot pass through endothelial, pores / gaps **I** holes **A** fenestrations / AW **or** cannot, pass across / cross the membranes of, endothelial cells ; **A** epithelial cells *in context of entering an endothelial cell and exiting to the tissue fluid*	**2**

(d)	*any **three** from:* **A** Ψ for water potential **A** plasma for blood *mp1 and mp2 = consequence in blood of lower blood albumin than normal* **1** *idea that* low blood albumin means, less / AW, solute ; **2** (so) higher water potential (in blood); *must be in context of blood context can be anywhere along the capillary* **A** high water potential *if ref. to low albumin is made* **A** steeper water potential gradient (than normally, at arterial end) *mp3 and mp4 = return of water to blood from tissue fluid (capillary venous end)* **3** less steep water potential gradient (than normal) / little difference in water potentials ; **4** less / little, water returns to, blood / capillary (from tissue fluid) ; **A** (tissue) fluid *for water* **R** plasma *for water* *additional ideas* **5** *idea that* more, water / plasma / fluid, enters tissue fluid (than normal) **R** tissue fluid *for fluid* **A** more, water / fluid, enters tissue fluid than exits (to the capillary or lymph system) ; *(compared to normal)* **6** AVP ; e.g. water can enter tissue fluid for a longer time than normal less albumin than normal to act as an osmotic force for return of water / AW too much excess, water / fluid / tissue fluid, to be taken up into lymph, capillaries / vessels / system	**3**

Q14.

(a)(i)	red blood cell ; **A** erythrocyte / red blood corpuscle	**1**
(a)(ii)	*any valid difference one mark* *fluid **R** / tissue fluid, has,* *one from* fewer (named) proteins / no large proteins / no plasma proteins ; **A** no named plasma proteins (albumen / fibrinogen) **A** fewer plasma proteins only if stated, they are small / leave the blood fewer / no, white blood cells ; **A** more macrophages no red blood cells ; no platelets ; *explanation to match difference 2 marks* *(red blood cells, platelets, proteins, white blood cells)* too large ; *(fewer white blood cells)* ref to some, white blood cells / phagocytes / macrophages monocytes, are able to move through ; cannot be, filtered / fit, through gaps / AW, between endothelial cells / in endothelial wall / in capillary wall ; idea that not filtered out under pressure from, plasma / blood ; **or** *fluid **R** / tissue fluid, has* *one from* higher partial pressure / AW, of, carbon dioxide ; **A** higher concentration / more *explanation to match difference 2 marks* produced by / waste of, (surrounding respiring) cells ; **A** (waste) product of respiration diffuses / AW, from cells to, (fluid) **R** / tissue fluid (before entering blood) ; idea that blood has come from lungs, where carbon dioxide has been excreted ; AVP ; e.g. diffusion through cells in capillary wall	**3**

(c)(i)	*any **two** from:* increases heart rate ; increases blood pressure ; makes platelets stick together / makes blood more likely to clot ; damage to, endothelium / endothelial wall / capillary wall ; reduces blood flow to extremities / ref. vasoconstriction ;	**2**

Q15.

(c)	*any four from:* alveoli / alveolar walls, stretch / expand, during, inspiration / AW ; arteries / arterioles / blood vessels, stretch / expand, as blood, volume / pressure, increases ; stretch to prevent (alveoli / arteries), bursting / rupture / AW ; **A** prevent overstretching recoil during expiration / AW, to help, expel / force out, air ; ***AW** in context of alveoli* recoil to apply pressure to blood so maintaining blood pressure ; *in context of arteries* AVP ; e.g. allows trachea / bronchus / bronchioles, to expand during inspiration	**4**

(d)(i)	$\frac{50}{86} \times 100$; 58(%) ; *if extracted values are different allow ecf for calculated answer* *accept ± 1 mm when reading from graph (49 to 51 and 85 to 87)*	**2**

Q16.

(a)(i)	blood, travels through the heart twice for every one complete, circuit (of the body) / circulation **or** blood, travels through the heart twice and through pulmonary and systemic, circulations / systems / circuits ; **A** description of both circulations	**1**

Q17.

(a)	**A** neutrophil ; **A** polymorphonuclear, leucocyte / granulocyte **B** lymphocyte ;	**2**
(b)(i)	<table><tr><th>substance</th><th>concentration in lymph compared to the concentration in blood</th></tr><tr><td>oxygen</td><td>lower</td></tr><tr><td>carbon dioxide</td><td>higher</td></tr><tr><td>red blood cells</td><td>lower</td></tr></table> three rows correct = 2 marks one row or two rows correct = 1 mark	**2**

Q18.

(b)	*max 1 (tar data mark or nicotine makes platelets sticky) if tar / CO also stated any two from:* (AFRO) has more nicotine ; **R** has more, tar / tar and nicotine / CO and nicotine (*see below)* nicotine makes platelets sticky / AW ; **A** damages endothelial lining (so turbulent blood flow) so increases clotting risk **R** if also state tar makes platelets sticky 0.92 and 0.77–0.79 mg (per cigarette) **or** 9.2 v. 7.7–7.9 mg (per cigarette) **or** (AFRO) 1.3–1.5 mg (per cigarette) higher ; *correctly extracted numerical data for tar is alternative to gain mp 3 ecf* 12.5–12.7 v. 11.3–11.5 mg / (AFRO) 1.0–1.4 mg higher	**2**

Q19.

(b)	*any three from:* **1** (shape of) red blood cell is biconcave *accept biconcave from a diagram* **or** (shape of) erythroblast is, cuboidal / spherical / not biconcave / irregular / AW ; **2** red blood cell has no nucleus / erythroblast has nucleus ; **3** erythroblast has, mitochondria / organelles / named organelles **or** red blood cell has no, mitochondria / organelles / named organelles ; **4** red blood cell has more haemoglobin / erythroblast has less haemoglobin ; **I** *ref. to* haem *statement only about erythroblast*: **A** erythroblast has no haemoglobin *statement only about rbc: must say <u>more</u> haemoglobin* *statement with both:* **A** red blood cell has haemoglobin, erythroblast has no haemoglobin **5** AVP ; e.g. erythroblast, is larger / basophilic red blood cell is more flexible	**3**

Q20.

(a)	*closed* blood flows through, (blood) vessels; **A** three of heart, arteries, veins, capillaries *double* blood flows through the heart twice in one complete circulation (of the body) / AW ; **A** *ref. to* pulmonary and systemic circuits / to lungs and rest of body	**2**

Q21.

(a)	**C** =neutrophil ; **A** polymorphonuclear leucocyte **A** basophil **A** eosinophil **D** = lymphocyte ; B / T *is neutral* **E** = monocyte ; **A** macrophage **I** *leucocyte / white blood cell, throughout*	**3**