

### 3.4 ORGANISMS AND SUBSTANCE EXCHANGE – MASS TRANSPORT IN ANIMALS (3) – MARK SCHEMES

#### Q1.

- (a) Large surface area to volume ratio;  
For diffusion;  
OR  
Flat / thin;  
So oxygen can reach all haemoglobin / centre rapidly / short pathway;

max 2

- (b) (i) Partially permeable / allows water through but not sucrose;  
*Accept semi-permeable / selectively permeable.*

1

- (ii) Phospholipid (in membrane) / bilayer dissolved / broken down;  
Allows haemoglobin / contents to leak out;

2

[5]

#### Q2.

- (a) It is a measure of the concentration of a gas  
(in a mixture of gases or a liquid);

1

- (b) 37-38%

*Accept 36 – 39*

- (c) muscle contraction causes increased respiration;  
increased CO<sub>2</sub> production lowering blood pH / lactate released  
lowering blood pH;  
increased heat released therefore increased temperature;  
increased O<sub>2</sub> consumption lowering tissue PO<sub>2</sub>;

4

- (d) haemoglobin has a lower affinity for oxygen;  
more O<sub>2</sub> for respiration;

2

- (e) **3.4 times = 2 marks**

(incorrect answer in which candidate shows amount of oxygen removed at rest is 4.6 and amount removed during exercise is 15.8 = 1 mark)

2

- (f) Nearly all O<sub>2</sub> is transported by haemoglobin / v. little transported in plasma;  
**EITHER**

Haemoglobin is (nearly) fully saturated with O<sub>2</sub> at the alveoli both at rest and when exercising;

Therefore no (very little) further increase is possible;

**OR**

Haemoglobin is only 95% saturated with oxygen at the alveoli;

Therefore enriching inspired / air with oxygen will raise this to 100%;

3

- (g) increased depth / rate / pulmonary ventilation;  
increase stroke volume / heart rate / Q increases blood flow rate;

arterioles [*Accept* artery] supplying the muscles  
dilate / vasodilation / greater proportion of blood flow to the muscles;

max 3

[15]

**Q3.**

- (a) Contain different / more than one tissue / type of cell; 1
- (b) 0.8 (s) 1
- (c) 0.4 (s) as events in right ventricle same as in left; 1
- (d) (i) 0 - 0.1 / 0.4 - 0.9 because the volume increasing / ventricle filling / blood entering; 1
- (ii) from 0.9 / 0.1 – 0.4 because volume decreasing / ventricle emptying / blood leaving; 1
- Accept any two figures from within the range.*
- (e) Correct answer of 15.75 / 15.8 / 16 = 2 marks  
Incorrect answer but clear understanding that 45cm<sup>3</sup> is 100% = 1 mark 2

[7]

**Q4.**

- (a) 1. pressure receptors / baroreceptors / stretch receptors in aorta / carotid arteries / carotid sinus; (*reject carotid body*)  
2. send impulses to cardiovascular centre / medulla / cardio-inhibitory centre; (*reject signals / messages / electronic*)  
3. impulses via parasympathetic nerves / vagus; (*accept inhibitory nerve*)  
4. to SAN;  
5. release of ACh / inhibits SAN / decreases impulses from SAN;  
6. decreases impulses to AVN / decreased stimulation of AVN / decreases impulses from AVN;  
*(any reference to signals / messages / electronic disqualifies points 3 and 5 only)* 6
- (b) 1. inhibit impulses in sympathetic nerves / from cardio-acceleratory centre;  
2. SAN not stimulated / noradrenaline not released so heart rate lowers / does not increase;  
*(accept inhibits / blocks synapses);* 2

[8]

QWC 1

**Q5.**

- (a) Hb (in A) has greater affinity for O<sub>2</sub>;  
becomes saturated at low(er) ppO<sub>2</sub> / more saturated at same ppO<sub>2</sub> / unsaturated at very low ppO<sub>2</sub>;  
able to supply enough O<sub>2</sub> to its tissues; 3

- (b) fish B has a greater rate of respiration  
 (accept more O<sub>2</sub> needed for respiration);  
 Hb dissociates more readily (than A); more O<sub>2</sub> supplied;

2 max

[5]

**Q6.**

- (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);  
 (recoil linked to elastic tissues)

2

- (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

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

1

[7]

**Q7.**

- (i) Because there are big differences;  
 any correct named example e.g. lung cancer / bronchitis much lower  
 in women than in men;

2

- (ii) easier to compare if sample size effectively the same;  
 different numbers of people in each group;

2

[4]

**Q8.**

- (a) (i) 0.4(s);

1

(ii)  $\left\{ \frac{60}{0.8} \right\} = 75;$

1

- (iii) 0.26 (between 0.4 – 0.14) × 75 (or from (a)(ii)) = 19.5(s)  
 OR  
 0.25 (between 0.4 – 0.15) × 75 (or from (a)(ii)) = 18.75(s)

(no double penalty)(allow rounding only if working shown)

- (b) (ii) right ventricle;  
same pattern / description (as left ventricle) but lower (pressure);
- (c) increase in volume / size of ventricles (*accept heart*) / hypertrophy of heart / increased strength of heart muscle / increased strength of contraction; more blood leaves heart in each contraction / increase in stroke volume;

1

2

2

[7]

### Q9.

- (a) 1. permeable capillary wall / membrane;  
2. single cell thick / thin walls, reduces diffusion distance;  
3. flattened (endothelial) cells, reduces diffusion distance;  
4. fenestrations, allows large molecules through;  
5. small diameter / narrow, gives a large surface area to volume / short diffusion distance;  
6. narrow lumen, reduces flow rate giving more time for diffusion;  
7. red blood cells in contact with wall / pass singly, gives short diffusion distance / more time for diffusion;

(allow 1 mark for 2 features with no explanation)

4 max

- (b) 1. (hydrostatic) pressure of blood high at arterial end;  
2. fluid / water / soluble molecules pass out (*reject plasma*);  
3. proteins / large molecules remain;  
4. this lowers the water potential / water potential becomes more negative;  
5. water moves back into venous end of capillary (*reject tissue fluid*) by osmosis / diffusion;  
6. lymph system collects any excess tissue fluid which returns to blood / circulatory system / link with vena cava / returns tissue fluid to vein;

6

[10]

QWC 1

### Q10.

- (a) (i) curve to right of curve for pH 7.4;
- (ii) more oxygen unloaded / given up / affinity decreased / reduced saturation; oxyhaemoglobin dissociates at higher oxygen concentration / partial pressure / more oxygen unloaded at the same  $ppO_2$ ;
- (b) (aerobic) respiration will produce carbon dioxide / anaerobic respiration produces lactate;  
carbon dioxide dissolves in blood forming acid;  
increases hydrogen ion concentration;

1

2

3

[6]

### Q11.

- (a)

	glucose	sodium ions	haemoglobin
Tissue fluid	✓	✓	✗;
Blood plasma	✓	✓	✗;

Mark for each correct row

2

- (b) Hydrostatic pressure higher than osmotic "effect";  
Forces / squeezes / pushes out / water / small molecules / ions / examples;

2

[4]

### Q12.

- (a) less muscle / thin(ner) wall in left atrium;

1

- (b) (i) pressure of left ventricle higher than pressure of left atrium;

1

- (ii) closing of the semi-lunar valves / pocket valves;  
pressure in artery / aorta is higher than ventricle;

2

[4]

### Q13.

- (a) (i) 62

*ignore units*

1

- (ii) fetal haemoglobin has higher affinity for oxygen / takes up oxygen  
(becomes saturated) at lower partial pressure;  
at partial pressures when adult haemoglobin dissociates fetal  
haemoglobin takes up oxygen;

2

- (b) (i) new 'S' shaped curve draw to the right of the adult curve;

1

- (ii) haemoglobin dissociates / unloads more readily /  
more oxygen delivered to cell / muscles / respiring tissue;  
at a particular partial pressure more oxygen is released;

2

[6]

### Q14.

- (a) (i) arteriole;

1

- (ii) *any two*  
oxygen / glucose / amino acids / fatty acids / glycerol / minerals;

1

- (b) small diameter / lumen / small mean cross sectional area / increase in  
(total) cross sectional area;  
more surface in contact with blood / greater friction / resistance;

- (c) (i) artery; 2
- (ii) stretches / expands to accommodate increase in blood volume / when ventricle contracts / increase in blood pressure; recoils when blood volume decreases / when ventricle relaxes / blood pressure decreases; 1

[7]

**Q15.**

- (a) (i) 0.3 s; 1
- (ii) 0.2 - 0.4 s; 1

- (b) thicker / more muscle in the left ventricle; 1

- (c) Artery

1. thickest wall, enabling it to carry blood at high pressure / withstand pressure surges;
2. most elastic tissue, which smoothes out flow / maintains pressure;
3. most muscle which maintains pressure;
4. muscle in wall to control blood flow;

Vein

5. thin wall does not have to withstand high pressure;

Capillary

6. thin wall, allowing diffusion / exchange;
7. only endothelium present, allowing short diffusion pathway;

All vessels

8. have endothelium that reduces friction;

6 max

[9]

**Q16.**

- (a) beating / pumping of heart / contraction of ventricles / heart; 1
- (b) (at arterial end) hydrostatic pressure / blood pressure; greater than pressure of water potential gradient / greater than osmotic uptake; 2
- (c) removed by lymphatic system / lymph; returned to blood; 2
- (d) less protein in blood; water potential gradient is lower (less -ve / higher  $\psi$  ).

**Q17.**

(a) (cells) require oxygen / glucose for respiration / growth  
(cells) require oxygen / glucose to keep cells alive;  
(accept correctly named nutrient) 1

(b) (i) 65; 1

(ii) fetal haemoglobin has a greater affinity for oxygen;  
(must indicate a comparison or reference to the graph)  
loads oxygen from mother's haemoglobin / blood; 2

[4]

**Q18.**

(a) 1. rate of respiration increases (in muscle cells);  
2. carbon dioxide concentration increases / pH falls / H<sup>+</sup> increases / acidity increases;  
3. chemoreceptors in aortic / carotid bodies / medulla (accept reference to aorta / carotid arteries not sinus);  
4. (impulses to) medulla / cardioaccelerator centre;  
5. increased frequency of impulses (award only once);  
6. along sympathetic pathway to sinoatrial node / SAN (not pacemaker); 6

(b) (i) through cardiac muscle;  
to atrioventricular node;  
along bundle of His / Purkyne fibres; 2 max

(ii) sinoatrial node in the (right) atrium;  
trace from healthy person is identical to the trace for the diseased heart  
in the region of the atria / only differences seen in trace for ventricles; 2

[10]

**Q19.**

(a) (i) in case normal coffee differs in some other way /  
to control concentration of caffeine; 1

(ii) not telling them what the drink contained / purpose of experiment; 1

(b) (i) able to continue for longer; (not just increases performance)  
(disqualify if also refers to fatty acids and glycerol) 1

(ii) breakdown of fats;  
at increased rate / by mobilisation of fat stores; 2

(c) (i) idea that volumes of oxygen and carbon dioxide the same;  
reference to equal moles, or quotient as 1 divided by 1 / or 6 by 6;

- (ii) glycogen is a carbohydrate / broken down to glucose, linked to RQ;  
with no caffeine, RQ nearer 1.0 / less carbon dioxide exhaled and  
more oxygen inhaled (or vice versa) / with caffeine higher proportion of  
fats / fatty acids respired;  
increased time to exhaustion suggests slower use of glycogen:

3

[10]

**Q20.**

- (a) endothelium / tunica intima (*accept endothelial cells*);
- (b) elastic tissue allows recoil  
(*reject if wording implies a muscle e.g. contract / relax*)(*ignore expand*);  
maintains blood pressure / constant / smooth blood flow  
(*not increases blood pressure*);
- (c) measuring radius / 12 mm / 12.5 mm / 1.2 cm / 1.25 cm;  
correct calculation /  $3.14 \times 12 \times 12 = 452$  /  $3.14 \times 12.5 \times 12.5 = 490$  / 491;  
*allow for magnification  $\div 100 = 4.52$  / 4.9;*  
*(allow 1 mark for correct calculation using incorrect radius)*

1

2

3

[6]

**Q21.**

- (a) Caused by blood leaving the heart / entering artery;  
As a result of ventricles contracting / systole;
- (b) Stretch as pressure increases;  
Recoil / spring back as pressure drops;  
*Do not accept contract and relax in this context.*  
*Allow 1 mark for 'stretch and recoil' without reference to pressure.*
- (c) Both have an endothelium / epithelium / squamous cells;

2

2

1

[5]

**Q22.**

- (a) (i) CO<sub>2</sub> is produced (in respiration);  
forms carbonic acid / hydrogen ions released;  
(*lactic acid produced negates both points*)
- (ii) low pH because high rate of respiration;  
cells need more O<sub>2</sub>;  
more O<sub>2</sub> released / O<sub>2</sub> released faster;

2

2 max

- (b) (i) high altitudes have a low partial pressure of O<sub>2</sub>;  
high saturation / affinity of Hb with O<sub>2</sub> (at low partial pressure O<sub>2</sub>);  
so sufficient / enough O<sub>2</sub> supplied to cells / tissues;

(ii) difficult to unload / dissociate O<sub>2</sub> (at tissues);

2

1

[7]

**Q23.**

(a) left ventricle;

1

(b) (i) (left) ventricle / heart relaxes / diastole / filling / not contracting;

1

(ii) elastic tissue / wall;  
recoils / springs back (to maintain pressure);  
(*"contraction / muscle causing recoil" negates second point*)

2

(c) correct answer, 666 to 667 *gains 2 marks; allow 1 mark for principle;*  
correct time for 1 heartbeat as 90 (ms) or  $630 \div 7$  /  
60  $\div$  incorrect time identified from graph;

2

(d) correct answer, 0.03, *gains 2 marks;*  
*(allow 1 mark for correct working,  $16.6 \div 550$ , if answer wrong)*

2

[8]

**Q24.**

(a) (i) Pattern described as constant / decrease to 04.00 / 06.00  
then rising;

1

(ii) Corresponds to ventricles contracting / systole;

1

(iii) Less / little difference between maximum and  
minimum / less variation / constant / not pulsed / smoother;  
pressure in vein lower

2

(b) (i) The larger the molecule, the less permeable;  
Over 68 000 walls not permeable;

2

(ii) Plasma proteins / albumin and globulin too large to leave capillary;  
Water lost / Increase in concentration of proteins in blood / plasma;

2

(iii) Haemoglobin in red blood cells /  
Haemoglobin too large to pass through membrane of RBC /  
Red blood cells (containing haemoglobin) too large to pass  
through wall;

1

[9]

**Q25.**

- (a) lymph; 1
- (b) arrow drawn from right to left . no mark ( *if wrong direction disqualify* )  
correct reference to blood entering capillary having higher hydrostatic pressure; 1
- (c) HP forces water out;  
idea that HP is "higher" than WP;  
proteins remain in blood (increases WP);  
idea that WP is now "higher" than HP;  
water returns by osmosis / along WP gradient;  
water moves out at arteriole end and back in (at venule end); 4 max
- (d) high respiration rate means high demand for oxygen;  
shrew haemoglobin has lower affinity for oxygen / gives up O<sub>2</sub> more readily;  
  
shrew Hb lower saturation rate than human Hb at same partial pressure / more O<sub>2</sub> released at same pp; 3
- [9]**

**Q26.**

- (a) (i) atrioventricular valve / (bi)cuspid valve / mitral valve; 1
- (ii) (valves close) due to high blood pressure / when ventricles contract;  
Y prevent valve from being inverted / restricts / stops valve movement;  
(allow AV valve, disqualify tricuspid) 2
- (b) (i) B; 1
- (ii)  $\frac{5}{8} \times 60 = 37.5 \text{ s}$   
*correct method* 1  
*correct answer* 2
- [6]**

**Q27.**

- (a) Structure resulting from aggregation of several polypeptide chains / tertiary structures / eq: 1
- (b) Low pH / (more)H<sup>+</sup> ; due to (increased) CO<sub>2</sub> (increased) respiration;  
(ignore refs to buffering action of haemoglobin)  
(increased) dissociation of haemoglobin;  
Oxygen diffuses from r.b.c. to tissues; 3
- (c) Deaminated for use in respiration / used in protein synthesis / suitable e.g.; 1

