Mark schemes

1

(a) 0.01 / 0.0105;

(allow 1 mark for 52 500 / 5 000 000)

2

(b) (at the tissues at low pp oxygen) the shrew's haemoglobin is lesssaturated with oxygen / has reduced affinity; oxyhaemoglobin dissociates more readily / haemoglobin releases oxygen more readily / more oxygen released; allowing greater demand / respiration rate;

3

[5]

2

(a) 0.1 – 0.6 seconds;

(b) Volume (in left ventricle) increasing / ventricle filling;

2

(c) (i) 2 marks for correct answer of 75 (beats) per minute;
1 mark if heart beat correctly identified as lasting 0.8 seconds;

2

(ii) 70 cm^3;

1

(d) Multiply them;

1

(e) 750;

Accept a small increase – up to 800 cm^3

1

(f) (i) 4 : 1 / 4;
Ratio must be expressed in simplest terms

1

(ii) 18 cm^3;

1

[9]

3

(a) B – It is the 2nd contraction / occurs (immediately) after A / occurs after atrium;

Larger / more force / more pressure;

2

(b) $\frac{60}{\textit{time for 1 cycle}}$

= 37 to 38

allow 1 mark if correct working shown

max 2

2

(c) (i) (Heart rate) reduced;
(Stroke volume) no effect;

(ii) Reduced because C.O. = H.R. x S.V. / connection argument based on reduced H.R;

1

(iii) Parasympathetic;

1

(d) (i)
1. Coordination via medulla (of brain) / cardiac centre;
2. (Increased) impulses along sympathetic (/ cardiac accelerator) nerve
3. To S.A. node / pacemaker;
4. More impulses sent from / increased rate of discharge of S.A. node /pacemaker;

Not "beats"; not "speeds up"

4

(ii) In exercise – More energy release / more respiration / actively respiringmuscles / for aerobic respiration;
Higher cardiac output – Increases O_2 supply (to muscles);
Increases glucose supply (to muscles);
Increases CO_2 removal (from muscles) / lactate removal;
Increases heat removal (from muscles) / for cooling;

If no "increase" – max 2 marks

3

[15] (a) (i) Pattern described as constant / decrease to 04.00 / 06.00 **4** then rising;

1

(ii) Corresponds to ventricles contracting / systole;

1

(iii) Less / little difference between maximum andminimum / 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;

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

2

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] (a) Large surface area to volume ratio;

5

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

] (a) Structure resulting from aggregation of several polypeptide chanins / tertiary structures /

6 eq:

1

(b) Low pH / (more)H^+ ; due to (increased) CO_2 (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

[5] (a)

7

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

Mark for each correct row

2

2

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

[4] (a) Contain different / more than one tissue / type of cell;

8 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 / ventriclefilling / 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^3 is 100% = 1 mark

2

[7] (a) Caused by blood leaving the heart / entering artery;

9

As a result of ventricles contracting / systole;

2

(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.

2

(c) Both have an endothelium / epithelium / squamous cells;

1

[5] (i) Because there are big differences;

10

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]

11

(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_2 production lowering blood pH / lactate released lowering blood pH; increased heat released therefore increased temperature; increased O_2 consumption lowering tissue PO_2;

4

(d) haemoglobin has a lower affinity for oxygen;more O_2 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_2 is transported by haemoglobin / v. little transported in plasma;
EITHER
Haemoglobin is (nearly) fully saturated with O_2 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] (a) (i) 0.4(s);

12

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)

1

(b) (ii) right ventricle;
same pattern / description (as left ventricle) but lower (pressure);

2

(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;

2

[7] (a) slow decrease in speed until reaches arterioles then rapid decrease;

13 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]

14 (a) Hb (in A) has greater affinity for O_2; becomes saturated at low(er) ppO_2 / more saturated at same ppO_2 / unsaturated at very low ppO_2; able to supply enough O_2 to its tissues;

3

(b) fish B has a greater rate of respiration
(accept more O_2 needed for respiration);
Hb dissociates more readily (than A); more O_2 supplied;

2 max

[5]

15

(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 fromAVN;

(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

16

(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) $\frac{5}{8} \times 60 = 37.5$ s
correct method

1

correct answer

2

[6]

17

(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÷7 /
60 ÷ incorrect time identified from graph;

2

(d) correct answer, 0.03, *gains 2 marks*;

(allow 1 mark for correct working, 16.6 ÷ 550, if answer wrong)

2

[8]

18 (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 <u>haemoglobin</u> has lower affinity for oxygen / gives up O_2 more readily;

shrew Hb lower saturation rate than human Hb at same partial pressure / more O_2 released at same pp;

3

[9]

19 (a) (i) CO_2 isproduced (in respiration); forms carbonic

acid / hydrogen ions released;

(*lactic acid produced negates both points*)

2

(ii) low pH because high rate of respiration;
cells need more O_2;
more O_2 released / O_2 released faster;

2 max

(b) (i) high altitudes have a low <u>partial pressure</u> of O_2; high saturation / affinity of Hb with O_2 (at low partial pressure O_2); so sufficient / enough O_2 supplied to cells / tissues;

2

(ii) difficult to unload / dissociate O_2 (at tissues);

1

[7]

20

(a) endothelium / tunica intima *(accept endothelial cells)*;

1

(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);

2

(c) measuring radius / 12 mm / 12.5 mm / 1.2 cm / 1.25 cm;correct calculation / 3.14 × 12 x 12 = 452 / 3.14 x 12.5 x 12.5 = 490 / 491;
allow for magnification ÷100 = 4.52 / 4.9;
(allow 1 mark for correct calculation using incorrect radius)

3

[6]

21

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

2

[4]

22

(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;

2

(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]

23

(a) 1. rate of respiration increases (in muscle cells);

2. carbon dioxide concentration increases / pH falls / H^+ 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]

24

(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 Ψ).

2

[7]

25

(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] (a) (i) 0.3 s;

26

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]

(a) (i) arteriole;

27

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;

2

(c) (i) artery;

1

(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;

2

[7] (a) less muscle / thin(ner) wall in left atrium;

28

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] (a) (i) curve to right of curve for pH 7.4;

29

1

(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;

2

(b) (aerobic) respiration will produce carbon dioxide / anaerobic respiration produces lactate; carbon dioxide dissolves in blood forming acid; increases hydrogen ion concentration;

3

[6]

30

(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 diffusiondistance;
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