

### 3.4 ORGANISMS AND SUBSTANCE EXCHANGE – MASS TRANSPORT IN ANIMALS (1) – MARK SCHEMES

#### Q1.

(a)

	open	closed
Semi-lunar valves	2	3
Atrioventricular valves	4	1

*One mark for each correct column*

*General marker*

2

(b) (Acceptable range is) 6315.79 to 6400;

*Allow one mark for (SV = 120 – 40 =) 80 (cm<sup>3</sup>)*

**OR**

*(1 cycle = 1.24 – 0.48 =) 0.76 (s)*

**OR**

*79 / 80 (beats minute<sup>-1</sup>)*

2

- (c) 1. Contraction of ventricle(s) produces **high** blood / hydrostatic pressure;  
 2. (This) forces water (and some dissolved substances) out (of blood capillaries);

*1. Do not accept contraction / pumping of the heart*

*1. Reject blood / plasma / tissue fluid forced out*

2

(d) Excess tissue fluid cannot be (re)absorbed / builds up;

*The idea of excess is important*

*Accept 'drained' for absorbed*

1

[7]

#### Q2.

(a) Any **two** from:

- People outside age range
- Women
- Those unable to exercise;

***Two** of these categories needed to gain **one** mark.*

*Accept examples for outside age range e.g. those under 25 or those over 54*

*Accept examples of those unable to exercise (e.g. those in wheelchairs, those with non-heart related issues).*

1

(b) 1. (Stop because) medication could affect heart rate;

*Accept descriptions of how the heart rate may be affected e.g. stopping medication could cause the heart rate to speed up*

2. (Continue because) stopping could put the patient at too great a risk;

Accept '(continue because) stopping could result in the patient dying'

2

[3]

### Q3.

1. Obtain pulse rates for a large number of students;  
*Accept this idea for carrying out the investigation or for collecting data from other scientists work / published data*
2. (belonging to) a range of different sexes / ethnic groups/from different parts of the country / employment groups;  
*Accept suitable alternative variables but the idea of a range must be included*  
*Reject generic references to controlling these variables*
3. Calculate mean and standard deviation (of students their age);  
*Allow 'calculate standard error / 95% confidence limits / t test / statistical test'*
4. See if their mean lies within the standard deviation;  
*Accept 'see if my mean lies within the 95% confidence limits'*  
*If statistical test used, accept 'see if there is a significant difference between means'*

[3 max]

### Q4.

- (a)
  1. Length of time of exercise;
  2. Difficulty of exercise;
  3. An environmental factor;  
*Answers about variables relating to the subjects themselves are not valid.*  
*2. E.g. speed of treadmill / running, incline on treadmill.*  
*3. E.g. temperature / humidity / clothing worn.*

2 max

- (b) 0.89;

Ranges correct – level 3 range of 40 and level 1 range of 45 = 1 mark;  
*If value of 1.125 (level 1: level 3) is calculated award 1 mark*  
*Accept any number significant figures as long as rounding is correct*

2

[4]

### Q5.

- (a)
  1. (Overall) outward pressure of 3.2 kPa;
  2. Forces small molecules out of capillary.
- (b) Loss of water / loss of fluid / friction (against capillary lining).

2

1

- (c) 1. High blood pressure = high hydrostatic pressure;  
 2. Increases outward pressure from (arterial) end of capillary / reduces inward pressure at (venule) end of capillary;  
 3. (So) more tissue fluid formed / less tissue fluid is reabsorbed.  
*Allow lymph system not able to drain tissues fast enough*
- (d) 1. Water has left the capillary;  
 2. Proteins (in blood) too large to leave capillary;  
 3. Increasing / giving higher concentration of blood proteins (and thus wp).

3

3

[9]

**Q6.**

- (a) (Molecule contains) more than one polypeptide (chain).

*Accept: has four polypeptides*

1

- (b)  $\frac{\text{oxygenated haemoglobin}}{\text{maximum saturation}} \times 100$

1

- (c) 1. At low partial pressure of oxygen, little increase in saturation as oxygen increases;  
 2. (then) rapid rise as it gets easier for oxygen to bind.

*Accept use of appropriate numbers from graph*

2

- (d) Ensures rapid / more intake of oxygen in lungs / release of oxygen in tissues.

1

- (e) Volume of blood leaving heart =  $(0.6 \times 0.6) \text{ dm}^3 \text{ minute}^{-1} = 3.6 \text{ dm}^3 \text{ minute}^{-1}$

Mass of haemoglobin in this volume of blood =  $(3.6 \times 150) \text{ g} = 540\text{g}$

Volume of oxygen at 100% saturation of this haemoglobin =  $(540 \times 1.35) = 729 \text{ cm}^3$

The graph shows 60% of this volume of oxygen has been released to the tissues, so final answer is  $(729 \times 0.6) = 437.4 \text{ cm}^3 \text{ minute}^{-1}$

3

[8]

**Q7.**

1. Pulse counted for 15/30 seconds;  
 2. Beats counted were multiplied by 2 or 4;

1 max

**Q8.**

- (a) First oxygen binds (to Hb) causing change in shape;  
 (Shape change of Hb) allows more O<sub>2</sub> to bind (easily) / greater saturation with O<sub>2</sub>  
**OR**  
 Cooperative binding;

2

- (b) 1. (HbA has) lower affinity for O<sub>2</sub> at low partial pressures;  
**OR**  
(HbA has) lower affinity for oxygen at pp found in tissues;  
2. Easier unloading of O<sub>2</sub> for (aerobic) respiration;

2

- (c) 1. A large/significant increase in HbF;  
2. (HbF has) higher affinity for O<sub>2</sub> (than faulty HbA);  
3. Higher proportion of HbF in blood so more oxygen carried;  
**OR**  
More oxygen carried after treatment;

3

[7]

### Q9.

- (a) 1. Time taken to reach maximum blood flow varied widely/significantly;  
*Must be emphasis on idea of 'widely'. Mention only of 'vary' is insufficient. Ignore use of numbers unless a comparison is given*  
*Ignore any mention of a correlation between maximum percentage increase in blood flow and time taken to reach maximum increase in blood flow*  
2. Quickest after a carbohydrate-only meal;  
**OR**  
Slowest after a protein-only meal;

2

- (b) 1. More blood flows to (skeletal) muscles (during exercise);  
2. (supplying) more oxygen / glucose / removing more carbon dioxide/ lactic acid/ heat;  
*1 and 2. Idea of 'more' is needed*  
*More blood to muscles delivering oxygen = 2 marks*  
3. For high (rate of) respiration / to meet increased demand for energy/ATP;  
**OR**  
Prevents anaerobic respiration/lactic acid build up;  
*Accept: reduces/delays for prevent*

3

- (c) **Immediate effect of exercise after meal**  
1. Meal increases blood flow in (mesenteric) artery AND exercise decreases blood flow in (mesenteric) artery;  
*1. Will relate to information given in the tables*

#### **Overall effect on blood circulation**

2. Insufficient blood (flow to small intestines / muscles);  
*2. Accept: blood diverted away/shunted*  
*Ignore references to 'strain on heart', 'heart disease', 'cardiovascular diseases'*  
*Ignore references to controlling variables and reliability*

#### **Effect on blood flow of type of meal**

3. Carbohydrate meal quick(er) / during exercise;  
**OR**  
Protein/fat meal slow(er) / after exercise;

**Effect of reduced blood flow on cells**

4. (More) anaerobic (respiration) / lactic acid produced;  
OR  
less aerobic respiration;

**Consequence for person of changed blood flow**

5. Less absorption (of digested food) / faeces contains digested food;  
6. Cramp / indigestion / discomfort / fatigue;

*Look for **ideas** in each of 5 areas*

*MP1 might be spread throughout the answer*

*6. Ignore references to digestion*

Max 4

- (c) 1. (blood flows from kidney along) renal vein to vena cava;  
2. (along) vena cava to right atrium/side of heart;  
3. (along) pulmonary artery to lungs;  
4. (along) capillaries to pulmonary vein;  
5. (along) pulmonary vein to left atrium/side of heart;  
6. (along) aorta to renal artery (to kidney);  
7. Blood may pass through several complete circuits before returning to kidney;

*Reject: 'blood vessel pumps' only once*

*Ignore references to valves*

*Ignore references to heart action/cardiac cycle*

*Accept labelled diagram must include directional arrows*

Max 6

[15]

**Q10.**

1. Pressure gradient / moves from high to low pressure;  
2. Valves stop backflow;

*Accept 'valves close when pressure gradient is 'the wrong way' for 2 marks*

*2. Accept 'one way valves'*

*2. 'Valves' on its own is insufficient*

[2]

**Q11.**

- (a) 53-70 / 70-53 / 17 (beats per minute).

1

- (b) 13.6 / 13.58 / 14;

*If answer is incorrect, 1 mark for the principle of difference (11) divided by initial heart rate (81).*

$$\frac{70-81}{81} \text{ or } \frac{81-70}{81} \text{ for 1 mark}$$

*Ignore + or - signs*

2

- (c) 1. Allows comparison;

2. (Initial / resting) heart rates different (between males and females). 2
- (d) 1. Cardiac output = stroke volume × heart rate  
1. *Accept CO = SV × HR*
2. (So) stroke volume increases / increased size or volume of ventricles.  
2. *Neutral: more blood leaves heart*  
2. *If the term stroke volume is not used, it must be defined*

2 max

[7]

**Q12.**

- (a) 1. (Carry) oxygen / glucose;  
*Accept: oxygenated blood*  
*Ignore references to removing waste products*  
*Ignore references to arteries 'pumping' blood*
2. (To) heart muscle / tissue / cells / myocytes.  
*Must be supply to heart or cardiac* 2
- (b) (i) **A**;  
*Accept: A on its own even if outside box*  
*Reject if two (or more) letters given* 1
- (ii) **H**;  
*Accept: H on its own even if outside box*  
*Reject if two (or more) letters given* 1
- (c) (Aorta)
1. (is) close / directly linked to the heart / ventricle / pressure is higher / is very high;
2. (Aorta has) elastic tissue;  
*Accept elasticity*  
*Ignore reference to muscle*
3. (Aorta has) stretch / recoil.  
**Q Reject: contracts / relaxes / pumps**  
*Accept: for mp 2 and mp 3, converse for small arteries if qualified by little / less*

3

[7]

**Q13.**

- (a) Quaternary (structure);  
*Accept phonetic spelling eg quarternary/quarternery /4°*  
*Award no mark for quaternary as part of a list* 1
- (b) 423; 1

- (c) 1. Oxyhaemoglobin formed/ haemoglobin is loaded/  
uptakes/associates/binds with oxygen in area of higher  
ppO<sub>2</sub> / in gas exchange surface/lungs/gills;  
*Reference to "react with" = max 1*  
*Accept: reversible interaction with oxygen*  
*Ignore: haemoglobin is carried / contained in red blood cells*
2. (oxygen) unloaded/dissociates from/released (in area  
of lower ppO<sub>2</sub> / in capillaries/to cells/tissues);
- (d) (i) 56(%);  
*Accept responses in the range 54-58(%)*
- (ii) 1. (Anaemia curve shifted to right) haemoglobin has  
lower affinity for oxygen / binds less tightly;  
*Assume reference is to haemoglobin of anaemia unless  
stated*
2. releases more oxygen / oxygen is released quicker /  
oxygen dissociates/ unloads more readily to  
muscles/tissues/cells;
3. (For) respiration;  
*Accept: even with a lower haemoglobin concentration / meet  
demand for ATP/energy;*

2

1

3

[8]

#### Q14.

- (a) 1. Elastic tissue to allow stretching / recoil / smoothes out flow of blood /  
maintains pressure;
2. (Elastic tissue) stretches when ventricles contract  
**OR**  
Recoils when ventricle relaxes;
3. Muscle for contraction / vasoconstriction;
4. Thick wall withstands pressure **OR** stop bursting;
5. Smooth endothelium reduces friction;
6. Aortic valve / semi-lunar valve prevents backflow.
- (b) 1. Curve to the right so lower affinity / % saturation (of haemoglobin);
2. Haemoglobin unloads / dissociates more readily;
3. More oxygen to cells / tissues / muscles;
4. For greater / more / faster respiration;  
*Idea of a higher rate of respiration*
- (c) 16.5–18 (cm<sup>3</sup> minute<sup>-1</sup>);  
*Allow 1 mark if heart rate wrongly calculated but then  
multiplied by 0.03*

4 max

4

2

**Q15.**

- (a) (i) C;

*Ignore name of vessel*

1

- (ii) A;

*Ignore name of vessel*

1

- (b) Strongest/stronger contractions;

*Accept most muscle in wall / thickest/thicker muscular wall**A comparative statement is needed**Answer must be in context of producing force and not resisting it*

1

- (c) 1. Blood flows from left ventricle to right ventricle/ mixing of oxygenated and deoxygenated blood;  
 2. Lower volume of (oxygenated) blood leaves left ventricle/flows into aorta/C  
 OR  
 Lower pressure in blood leaving left ventricle/flowing into aorta/C  
 OR  
 Less oxygen in blood leaving left ventricle/aorta/C;

2

[5]

**Q16.**

- (a) 1. Ventricle pressure rises
- then**
- blood starts to flow into aorta because pressure causes (aortic / semilunar) valve to open;

*Accept times, eg ventricle pressure rises at 0.3 (25) seconds, followed by blood flow into aorta at 0.35 / 0.4 seconds****Idea of sequence is essential****Accept times*

2. Ventricle pressure starts to fall
- so**
- blood flow falls;

***Idea of sequence is essential***

2

- (b) 1. Thickness of wall increases
- because**
- ventricle (wall) contracts;

*Must be idea that increase in thickness is linked to contraction**Accept muscle for ventricle and systole for muscle contraction*

2. Contraction
- causes**
- the increase in pressure;

*Accept thickening of wall*

2

- (c)
- 2 marks for correct answer*

1. Between
- $120 \pm 5$
- ;;

*Length of cycles varies slightly*

2. Length of cardiac cycle correct but final answer wrong;  
*Length of cardiac cycle = 0.45 - 0.52*

2

[6]

### Q17.

(a) 66.7;

1

(b) 70;

1

(c) 1. More fluid forced/filtered out of capillary/blood (due to high pressure);

*Accept: water for fluid.*

*Must convey idea of 'more'.*

*Reject: more tissue fluid is forced out.*

*Do not credit 'more plasma forced out'.*

2. Less return of fluid (into capillary/blood) due to pressure

**OR**

Lymph(atic) (system) cannot drain away all excess fluid;

*Accept: water for fluid.*

2

(d) 1. Larger lumen/volume (of blood vessels);

*Accept: more 'space' or more 'room' (in blood vessels).*

*Accept: more blood flow (in blood vessels).*

*Accept: reduces stroke volume or less blood in ventricle.*

2. Reduces (blood) pressure (in blood vessels);

3. Less friction/resistance (in blood vessels);

2

[6]

### Q18.

(Maintaining constant pH to avoid)

1. Named protein / enzyme (in blood) sensitive to / affected by change in pH;

*Accept converse for MP2 and MP3.*

*Named example should be a protein that might be affected (by change in pH) eg haemoglobin, carrier protein in plasma membrane.*

*Accept 'change in H<sup>+</sup> concentration' for 'change in pH'.*

2. (Resultant) change of charge / shape / tertiary structure;

*The change in charge idea relates to the enzyme / protein and not the blood (plasma) or red blood cells.*

*'Denaturation' alone is insufficient.*

3. Described effect on named protein or enzyme.

e.g. less oxygen binds with haemoglobin / less transport across membranes / fewer substrates can fit active site / fewer enzyme-substrate complexes.

*Idea of 'less' or 'fewer' required. Ignore suggestion of 'no' or 'none'.*

**Q19.**

- (a) 1. Many / more capillaries (than arterioles);  
2. (Cross-sectional) area of capillaries (much) greater (than of arterioles).

*Note: maximum of 1 mark for this question*

1 max

- (b) 1. Short pathway / short distance between blood and outside of capillary;  
*Reference to blood and cells required*

2. Large surface area (of blood) in contact with walls of capillaries;  
*Idea is per unit volume of blood but candidates need not say this*

3. Fast exchange / fast diffusion / fast osmosis.  
*Must relate to increased speed*

2 max

- (c) Width / size / diameter of blood cell.

*Accept named blood cell*

*Reject platelet*

*Accept idea that below a certain diameter friction becomes too great for blood to flow*

1

- (d) (Fluid) in tissue fluid / (fluid) in lymph.

1

[5]

**Q20.**

By osmosis (no mark)

*No mark awarded for naming terms e.g. osmosis, facilitated diffusion, active transport, co-transport etc.*

1. From a high water potential to a low water potential / down a water potential gradient;

2. Through aquaporins / water channels;  
*QWC ignore large / small WP*

By facilitated diffusion (no mark)

*QWC ignore reference to high / low concentrations of water or high / low concentration of solution*

3. Channel / carrier protein;

4. Down concentration gradient;

By active transport (no mark)

*QWC ignore 'along' concentration gradients*

5. Carrier protein / protein pumps;

6. Against concentration gradient;
7. Using ATP / energy (from respiration);  
*Co-transport subsumed into mark scheme for active transport and facilitated diffusion*

By phagocytosis / endocytosis (no mark)

*Can award MP2, 3, 5 for 3 marks with no context given*

8. Engulfing by cell surface membrane to form vesicle / vacuole;  
*Ignore lipid diffusion as in stem of question*

By exocytosis / role of Golgi vesicles (no mark)

9. Fusion of vesicle with cell surface membrane;

5 max

[5]

## Q21.

- (a) One suitable factor;

*Not health or lifestyle*

E.g. Age / no heart condition / not on medication;

*Accept BMI / smokers / diet / fitness / race etc. – has to affect heart rate or blood pressure*

1 max

- (b) Patients were at rest / not moving / not using muscles / in standardised position / controlled conditions;

*Accept same position as sleeping*

*Ignore relaxed*

1

- (c) 1. Caused by pressure / surge of blood;  
*Ignore pulse rate equals heart rate*

2. From (one) contraction / beat of (left) ventricle / heart;

*Reject right ventricle*

*Ignore pumps / pumping*

2

- (d) 1. Monitor records heart rate over long period of time / all the time / more data collected;

*Ignore reference to continuously as in stem*

*Ignore anomalies can be discarded*

2. Anomalies in recording have less effect;

*Ignore more accurate / reliable mean*

3. Recording pulse rate for one minute only may give an anomalous / atypical result;

4. Errors when trying to count pulse for one minute / human error;

5. Monitor records HR over a range of activities during the day / pulse rate only records for a single set of conditions;

2 max

- (e) 1. Men with condition always have higher heart rates;  
*Accept blood pressure references for heart rate*
2. But no direct measurements of blood pressure;  
*Accept – no stats analysis to show significance*
3. Only one investigation / test / need more studies;  
*Ignore references to 'yes' and 'no' throughout*
4. Using different recording methods / conditions (in each case so cannot compare results);
5. Men without condition also have increased / higher heart rate in doctor's surgery;

2 max

[8]

## Q22.

- (a) 1. (Curve for) dog falls rapidly at the start but (curve for) sheep falls slowly at first;  
*Do **not** allow curve for dog falls more steeply (since from 0.5% NaCl fall in sheep is just as steep as fall in dog)*
2. Sheep doesn't fall rapidly until 0.5 (but dog falls rapidly from 0);
3. (Trend shows that) for any concentration of sodium chloride haemolysis is lower in the dog;  
*The idea of a trend is required. Statement of individual values alone is insufficient, eg 'at 0.2, 34% in dog and 98% in sheep' is insufficient*  
*Accept dog reaches 0 at lower concentration of sodium chloride than for sheep / dog reaches 0 at 0.38% compared to 0.84 % in sheep;*

2 max

- (b) 74 to 76;  
*Accept a value within this range*

1

- (c) 1. (Red) colour is due to haemoglobin;  
*Note: a correct response to marking point 2 also scores marking point 1*
2. The more haemoglobin released the more red the solution;  
*Need idea of haemoglobin release before giving credit*

2

- (d) 1. (Use of 0.9%) will not cause haemolysis in any (of the mammals);  
*Full credit requires statement of marking point 1 and any approach from marking point 2*
2. (So) will not kill any of the animals;

or

Only need to use / store / buy one concentration of sodium chloride solution / cheaper to have one concentration of sodium chloride solution

/ can buy in bulk;

or

Anyone can give it / no need to find out what concentration any animal requires;

*Different approaches available for this marking point*

2 max

[7]

**Q23.**

- (a) (i) Made of (different) tissues / more than one tissue; 1
- (ii) 1. (Muscle) contracts;  
*Assume that 'they' or 'it' = muscle*
2. (Arteriole) narrows / constricts / reduces size of lumen / vessel / vasoconstriction;  
*Ignore: references to pressure*  
*Q Correct context for muscle contracts, vessel constricts* 2
- (b) (i) Short diffusion distance / pathway;  
*Accept: thin diffusion pathway* 1
- (ii) (More) time for exchange / diffusion (of substances);  
*Accept: example of more time for specific substance to be exchanged* 1
- (c) 1. Water potential (in capillary) not as low / is higher / less negative / water potential gradient is reduced;  
*Accept: 'blood or plasma' instead of 'capillary'*
2. Less / no water removed (into capillary);  
*Accept converse: water remains in the tissue*
3. By osmosis (into capillary);  
*Q Marking points 2. and 3. must be in the context of movement into the capillary*  
*Neutral: reference to more tissue fluid being formed as in the question stem*  
*Neutral: reference to lymphatic drainage* 3

[8]

**Q24.**

- (a) Aorta; 1
- (b) 1. Left ventricle pumps to whole body (except lungs) / pumps blood further;  
*Accept converse for right ventricle*  
*Reject 'push'*

2. Left ventricle does most work / produces a greater pressure / produces a greater force;

2

(c) 1. (Valve **A**) atrioventricular valve;

*Accept bicuspid / mitral*

2. Semi-lunar valve;

*Accept aortic valve*

*Ignore references to left and right*

2

(d) **X** because (no mark)

*Accept other valid calculations - probabilities*

1. 52.1% survived without replacement compared to 12.1% / difference of 40%;

*If correct figures written in table, award marks*

2. 10.9% required repair or replacement of artificial heart compared to 41.4% / difference of 30.5%;

*Max 2 if incorrect rounding of values*

3. 37% died compared to 46.6% / difference of 9.6%;

**OR**

(X / Y = 119 divided by 58 = 2.05)

14.4; 49.2; 55.4;

*Note that this ratio could be reversed i.e. 58 divided by 119 multiplied by numbers in top row*

*Accept rounded to 14; 49; and 55;*

3

[8]

**Q25.**

(a)

Statement	Haemo-globin	Cellulose	Starch
Has a quaternary structure	✓		
Formed by condensation reactions	✓	✓	✓
Contains nitrogen	✓		

*One mark for each correct row*

- (b) 16; 1
- (c) 1. Higher affinity / loads more oxygen at low / same / high partial pressure / pO<sub>2</sub>;  
2. (Therefore) oxygen moves from mother / to fetus; 2
- (d) 1. Low affinity / oxygen dissociates;  
*Assume 'it' is adult haemoglobin*  
*1. Accept: converse if 'fetal haemoglobin' is clearly stated*  
2. (Oxygen) to respiring tissues / muscles / cells;  
*2. Q: Neutral 'respirate'* 2
- (e) Enough adult Hb produced / enough oxygen released / idea that curves / affinities / Hb are similar / more red blood cells produced;  
*Neutral: 'adult Hb is also produced' as in the question stem*  
*Reject: curves / affinities / Hb are the same* 1

[9]

**Q26.**

- (a) 1. SAN sends wave of electrical activity / impulses (across atria) causing atrial contraction;  
*Accept excitation*  
2. Non-conducting tissue prevents immediate contraction of ventricles / prevents impulses reaching the ventricles;  
3. AVN delays (impulse) whilst blood leaves atria / ventricles fill;  
4. (AVN) sends wave of electrical activity / impulses down Bundle of His;  
*4. Allow Purkyne fibres / tissue*  
5. Causing ventricles to contract from base up; 5
- (b) 1. Atrium has higher pressure than ventricle (due to filling / contraction) causing atrioventricular valves to open;  
*Start anywhere in sequence, but events must be in the correct order.*  
*1. Accept bicuspid, reject tricuspid*  
*1. Allow: blood passes through the valve = valve open / blood stopped from passing through the valve = valve closed*  
2. Ventricle has higher pressure than atrium (due to filling / contraction) causing atrioventricular valves to close;  
3. Ventricle has higher pressure than aorta causing semilunar valve to open;  
*Points 1, 2 and 3 must be comparative: eg higher 3. Allow aortic valve*

4. Higher pressure in aorta than ventricle (as heart relaxes) causing semilunar valve to close;  
4. Allow aortic valve
5. (Muscle / atrial / ventricular) contraction causes increase in pressure;

5

[10]

**Q27.**

- (a)
  1. (Because) same water potential (as valve);
  2. (So) prevents loss or gain of water by osmosis / down water potential gradient;  
*Loss or gain and method of loss or gain must both be in the answer*
  3. (So) cells / tissues in the valves aren't damaged;  
**2 max**
- (b)
  1. Kills / stops growth of bacteria that could cause infection / disease (in patient);
  2. Kills / stops growth of bacteria that could damage the valve;  
*'Kill / stop growth of bacteria' is insufficient without further explanation.*  
**1 max**
- (c) (After surgery) valve closes fully / correctly / works so preventing blood flowing back into the heart;

**OR**

(After surgery) valve closes fully / correctly / works so preventing blood flowing out of the artery;

*Do not credit the converse here*

1

- (d)
  1. (For maximum) mean decreases, to within the normal range;
  2. (For minimum) mean increases to within normal range;
  3. No overlap in the (means  $\pm$ ) standard deviation for minimum pressure so there is a real difference;  
*Ignore references to the differences in maximum pressure*  
*Accept idea of significant difference for 'real difference'*
  4. Includes wide range of ages of patients;  
**3 max**
- (e)
  1. Standard deviation shows that some of the patients will be outside normal pressure range (after surgery);  
*Accept this as a general statement or in relation to maximum or minimum pressures*
  2. Small group;

3. Short follow up times;
4. No comparison with other treatments;

2 max

(f) Don't know the range;

1

[10]

### Q28.

- (a)
1. Co-transport;
  2. Uses (hydrolysis of) ATP;
  3. Sodium ion and proton bind to the protein;
  4. Protein changes shape (to move sodium ion and / or proton across the membrane);
    3. *Accept 'Na<sup>+</sup> and H<sup>+</sup> bind to protein' but do not allow incorrect chemical symbols*

3 max

- (b)
1. Tenapanor / (Group)B / drug causes a significant increase;  
**OR**  
There is a significant difference with Tenapanor / drug / between **A** and **B**;
  2. There is a less than 0.05 probability that the difference is due to chance;
  3. (More salt in gut) reduces water potential in gut (contents);
  4. (so) less water absorbed out of gut (contents) by osmosis  
**OR**  
Less water absorbed into cells by osmosis  
**OR**  
Water moves into the gut (contents) by osmosis.  
**OR**  
(so) water moves out of cells by osmosis.
    1. *and 2. Reject references to 'results' being significant / due to chance once only.*
    2. *Do not credit suggestion that probability is 0.05% or 5.*
    2. *Accept 'There is a greater than 0.95 / 95% probability that any difference between observed and expected is **not** due to chance'*

4

- (c)
1. (Higher salt) results in lower water potential of tissue fluid;
  2. (So) less water returns to capillary by osmosis (at venule end);  
**OR**
  3. (Higher salt) results in higher blood pressure / volume;
  4. (So) more fluid pushed / forced out (at arteriole end) of capillary;  
*For 'salt' accept 'sodium ions'.*  
*Do not allow mix and match of points from different alternative pairs*
    3. *Accept higher hydrostatic pressure.*

2

[9]

### Q29.

- (a) Three of chromosome 13 / an extra chromosome 13;  
*Accept trisomy 13*  
*Accept circle around three chromosomes or any other*

correct indication on **Figure 1**

Do not allow references to any other chromosomes.

Do not accept chromatids for chromosomes.

1

- (b) 1. In meiosis;  
2. Homologous chromosomes / sister chromatids do not separate;  
2. *Accept non-disjunction*

2 max

- (c) 1. Mutation / extra chromosome in gamete / egg / sperm (that formed zygote);  
2. All cells derived (from a single cell / zygote) by mitosis;  
**OR**  
3. All cells derived from a single cell / zygote by mitosis;  
4. Mitosis produces genetically identical cells / a clone;  
*Mark points 1 and 2 OR 3 and 4*  
4. *Accept: have same DNA / same alleles*

2

- (d) 1. (Some) oxygenated blood (from the aorta) flows into pulmonary artery;  
**OR**  
Less oxygenated blood flows out through aorta;  
**OR**  
Lower blood pressure in aorta;  
2. Less oxygen delivered to cells / tissues / organs / named organ / via named blood vessel;  
3. So less / not enough oxygen for aerobic respiration (in cell / tissue / organ);  
4. Tissue / organ doesn't grow / develop properly (causing death);  
**OR**  
Tissue dies / organ stops working (causing death);  
1. *Accept mixing of deoxygenated with oxygenated blood in pulmonary artery*  
2. *Do not accept "no oxygen"*  
3. *Do not accept "produce energy"*

3 max

[8]

### Q30.

- (a) Records every heart beat / does not miss heart beats / gives more precise / accurate measurements;

*Qualified reference to human error e.g. in counting*

1

- (b) (i) 1. 67 / 69.2 / the same;  
*All that is required here is a connection to be established between heart rate and pulse rate*  
2. There is one surge in pressure / pulse each time the heart contracts / beats;

2

- (ii) Two marks for correct answer in range 90.0 – 113.0;;

One mark for incorrect answer in which duration of one heart beat is clearly identified as between 0.53 and 0.66 seconds;

- (c) Allow two marks for quantitative statement: e.g. filling time decreases from  $0.55 \pm 0.1$  to  $0.30 \pm 0.1$  s;;

Allow one mark for qualitative statement: e.g. Filling time decreases;

*Accept other quantitative statements such as those based on proportion of cardiac cycle*

2

- (d) One mark for more general answer, e.g. increase exercise;

*This is the general principle. Detail may vary if centre uses different exercise*

Two marks for detailed answer, e.g. increase frequency / duration of exercise;;

*Reject comments not related to method used*

2

[9]

### Q31.

- (a) 1. (Risk) decreases, then increases;

2. (Risk) increases from 2 (drinks per day);

*Accept increases risk above 3*

2

- (b) Age affects heart disease / age affects how alcohol affects the body;

*Accept age affects results*

*Accept 'removes confounding variable'*

*Accept 'controlling a variable'*

1

- (c) *To gain 3 marks candidates must have mp1 and 2 from mps 2-5*

1. (True because) studies show decreased risk up to 3 drinks per day;

*Accept any evidence from graph*

1

2. (False because) eg all show an increased risk above 5 drinks / day, eg **A** and **B**, show increased risk (of heart disease) above 4 per day;

*Accept any evidence from graph*

3. Data only about heart disease / alcohol causes other diseases / social problems;

4. Amount of alcohol per drink may vary;

5. May be due to other factor

2 max

[6]

### Q32.

- (a) (i) Identifies anomalies / minimises effect of anomalies / unusual results / results more likely to be representative / more reliable mean;

*Accept likely to see side effects*

1

- (ii) Minimises / avoids regional bias / effects;  
*This is the basic principle. Accept examples that make this basic point, e.g.*  
*There may be factors that affect people living in different areas* 1
- (b) 1. Treated the same as those on ivabradine / experimental group;  
 2. Given dummy pill / placebo;  
*Do not accept: given no pill* 2
- (c) (i) Increases filling time; 1
- (ii) 1. Maximum / large amount of blood leaves heart / ventricles / increases stroke volume / cardiac output;  
*Must be in context of blood leaving the heart*  
 2. More blood / more oxygen to heart muscle / heart tissue;  
*Accept wall of heart*  
 3. Via coronary arteries;

3 max

[8]

**Q33.**

- (a) 1. Lower affinity for oxygen / releases more oxygen / oxygen is released quicker / oxygen dissociates / unloads more readily;  
*Q Neutral: the organism / body has a lower affinity for oxygen / releases more oxygen*  
 2. (To) muscles / tissues / cells  
 3. (For) high / rapid respiration;  
*Q Reject: 'produces more energy' on its own*  
*Neutral: reference to partial pressure*  
*Accept: (for) respiration to produce more energy in the form of ATP / release more energy* 3
- (b) (i) 1. Small SA:VOL;  
*Neutral: small limbs / small ears / extremities*  
*Neutral: small SA*  
*Accept: large VOL:SA*  
*Neutral: reference to fat / blubber / insulation*  
 2. (So) reduces heat loss / (more) heat retained;  
*Note: MP2 is independent of MP1* 2
- (ii) 1. Brain is the same, others fall;  
*Note: 1. might not be given in the same sentence*  
*Assume that 'other organs fall' = all three organ categories fall*

*Accept: 'blood flow is reduced to all organs except for the brain'*

2. Brain controls other organs / remains active / needs constant supply of oxygen;  
*Accept: 'seal would die' = brain remains active*
3. Lungs not used / are used less / seal is not breathing / heart rate decreases / heart pumps less / blood diverted to muscles;  
*Reject: seal is not respiring*

3

[8]

**Q34.**

- (a) (i) 1. Stomata open;  
*Allow converse*
2. Transpiration highest around mid-day as middle of day warmer / lighter;  
*2. Allow 'Sun is at its hottest'*
3. (Increased) tension / water potential gradient;  
*Ignore 'pull, suck'*
- (ii) (Inside xylem) lower than atmospheric pressure / (water is under) tension;  
*Accept cohesion tension. Ignore vacuum*
- (b) (i) High pressure / smoothes out blood flow / artery wall contains more collagen / muscle / elastic (fibres) / connective tissue;  
*Accept converse for pulmonary vein*  
*Incorrect function of artery disqualifies mark*
- (ii) 1. (Aorta wall) stretches because ventricle / heart contracts / systole / pressure increases;  
*1. Allow expand*
2. (Aorta wall) recoils because ventricle relaxes / heart relaxes / diastole / pressure falls;  
*2. Allow spring back*  
*Reject any reference to contract / relax in MP1 and 2*
3. Maintain smooth flow / pressure;
- (iii) Aorta 1.2 / largest SD;  
*Allow pulmonary vein provided candidate relates standard deviation to mean*
- (c) Formation
1. High blood / hydrostatic pressure / pressure filtration;

3

1

1

3

1

2. Forces water / fluid out;  
*2. Reject plasma, ignore tissue*

3. Large proteins remain in capillary;

Return

4. Low water potential in capillary / blood;

5. Due to (plasma) proteins;

6. Water enters capillary / blood;

7. (By) osmosis;  
*7. Osmosis must be in correct context*

8. Correct reference to lymph;

6 max

[15]

**Q35.**

(a) (Simple) diffusion;

*Reject: facilitated diffusion.*

1

(b) 1. Thin/small **so** short diffusion pathway;

*Reject: thin membrane/wall/cells.*

2. Flat/long/small/thin **so** large surface area to volume ratio/surface area : volume;

*Accept: small volume to surface area ratio.*

2

(c) 1. High/50% saturation (with oxygen) below (pO<sub>2</sub> of) 0.2 kPa;

*Accept: fully saturated or above 50% saturation below 0.2kPa.*

*Accept: any number between 0.08 and 0.2 kPa*

2. (Oxygen) for respiration;

2

(d) 1. Water potential higher in worm

**OR**

Lower water potential in seawater;

*Accept: correct reference to water potential gradient if direction of water movement is given.*

*Accept:  $\psi$  for water potential.*

2. Water leaves by osmosis (and worm dies);

*Reject: worm/cells burst.*

2

[7]

