AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.3.4.1 MASS TRANSPORT IN ANIMALS

SCORE	PERCENTAGE
/734	%

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Q1.

(a) D;
G;
F;

3

(b) Coronary arteries;

Accept coronary artery

Ignore aorta, arteriole and capillary

Reject coronary veins

Do not accept coronary by itself

Accept phonetic spelling

1

(c) 1. No sketched / hanging / crossing lines / shading;

Ignore stippling

2. Must look similar;
3. Matrix **and** crista correctly labelled;

Ignore any other labels

4. Correct scale stated (x 62 800);

Accept other suitable scale given

4

[8]

Q2.

(a) 1. Binding of first oxygen changes tertiary / quaternary (structure) of haemoglobin;

Ignore ref. to 'positive cooperativity' unqualified

Ignore ref. to named bonds

Accept conformational shift caused

2. Creates / leads to / uncovers second / another binding site
OR
Uncovers another iron / Fe / haem group to bind to;

Reject ref. to active site

2

(b) 5.6×10^6 (red blood cells per mm^3);;

Award 1 max for **one of**

2.8×10^4 (standard form but ignoring dilution)

OR

5 600 000 (correct but not standard form)

OR

5.6×10^5 (failure to use depth of liquid on slide);

2

(c) 1. To avoid dealing with parts of cells;

2. To avoid counting same cells twice / more than once;

3. To be consistent / get comparable results;

Accept more accuracy

Ignore reliability / repeatability / reproducibility / precision / validity

2 max

(d) There are fewer white cells, **so** no need to dilute (further to see enough);

Accept converse of too few to see if greater dilution / at 200 times

Do not accept ref. to numbers of red and white cells unqualified

Ignore ref. to white cells larger

1

(e) White cells have a nucleus (that stains but red cells do not);

Accept converse for red cells

1

[8]

Q3.

(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^3)

OR

(1 cycle = 1.24 − 0.48 =) 0.76 (s)

OR

79 / 80 ($beats\ minute^{-1}$)

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]

Q4.

(a) First oxygen binds (to Hb) causing change in shape;
(Shape change of Hb) allows more O_2 to bind (easily) / greater saturation with O_2
OR
Cooperative binding;

2

(b) 1. (HbA has) lower affinity for O_2 at low partial pressures;
OR
(HbA has) lower affinity for oxygen at pp found in tissues;
2. Easier unloading of O_2 for (aerobic) respiration;

2

(c) 1. A large/significant increase in HbF;
2. (HbF has) higher affinity for O_2 (than faulty HbA);
3. Higher proportion of HbF in blood so more oxygen carried;
OR
More oxygen carried after treatment;

3

[7]

Q5.

(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 <u>aerobic</u> 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]

Q6.

(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$^+$ and H$^+$ bind to protein' but do not allow incorrect chemical symbols

3 max

(b) 1. Tenapanor / (Group)B / drug causes a <u>significant</u> increase;
OR
There is a <u>significant</u> difference with Tenapanor / drug / between **A** and **B**;
2. There is a less than 0.05 <u>probability</u> that the difference is due to <u>chance</u>;
3. (More salt in gut) reduces water potential in gut (contents);
4. (so) less water absorbed out of gut (contents) by <u>osmosis</u>
OR
Less water absorbed into cells by <u>osmosis</u>
OR
Water moves into the gut (contents) by <u>osmosis</u>.
OR
(so) water moves out of cells by <u>osmosis</u>.

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 low<u>er</u> water potential of tissue fluid;
2. (So) less <u>water</u> returns to capillary by osmosis (at venule end);
OR
3. (Higher salt) results in high<u>er</u> 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]

Q7.

(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.

4 max

(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

4

(c) 16.5–18 (cm^3 $minute^{-1}$);
Allow 1 mark if heart rate wrongly calculated but then multiplied by 0.03

2

[10]

Q8.

(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 × 0.6) dm^3 $minute^{-1}$ = 3.6 dm^3 $minute^{-1}$

Mass of haemoglobin in this volume of blood = (3.6 × 150) g = 540g

Volume of oxygen at 100% saturation of this haemoglobin = (540 × 1.35) = 729 cm^3

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

3

[8]

Q9.

(a) 1. (Overall) outward pressure of 3.2 kPa;
2. Forces small molecules out of capillary.

2

(b) Loss of water / loss of fluid / friction (against capillary lining).

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

3

(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

[9]

Q10.

1. Pulse counted for 15/30 seconds;

2. Beats counted were multiplied by 2 or 4;

1 max

Q11.

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]

Q12.

(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]

Q13.

(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]

Q14.

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]

Q15.

(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 ±) 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]

Q16.

(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_2 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: ψ for water potential.

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

Reject: worm/cells burst.

2

[7]

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.

(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]

Q19.

(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_2 / 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_2 / in capillaries/to cells/tissues);

2

(d) (i) 56(%);

Accept responses in the range 54-58(%)

1

(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;

3

[8]

Q20.

(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]

Q21.

(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).

$\frac{70-81}{81}$ *or* $\frac{81-70}{81}$ *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]

Q22.

(a) 1. (Carry) oxygen / glucose;

Accept: oxygenated blood

Ignore references to removing waste products

Ignore references to arteries 'pumping' blood

2. (To) heart <u>muscle / tissue / cells / myocytes</u>.

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 <u>if</u> qualified by little / less

3

[7]

Q23.

(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]

Q24.

(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^+ 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'.

[3]

Q25.

(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 <u>thickening</u> of wall

2

(c) *2 marks for correct answer*

1. Between 120 ± 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]

Q26.

(a) 1. Low<u>er</u> affinity for oxygen / releases <u>more</u> oxygen / oxygen is released quick<u>er</u> / oxygen dissociates / unloads <u>more</u> readily;

***Q** Neutral: the organism / body has a lower affinity for oxygen / releases more oxygen*

2. (To) <u>muscles / tissues / cells</u>

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]

Q27.

(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]

Q28.

(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]

Q29.

(a)

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

One mark for each correct row

3

(b) 16;

1

(c) 1. Higher affinity / loads more oxygen at low / same / high partial pressure / pO_2;

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]

Q30.

(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]

Q31.

(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 <u>one minute only</u> 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]

Q32.

<u>By osmosis (no mark)</u>

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

<u>By facilitated diffusion (no mark)</u>

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]

Q33.

(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 <u>osmosis</u> (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]

Q34.

(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 <u>evidence</u> 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 <u>evidence</u> 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]

Q35.

(a) (i) 1. Stomata open;

Allow converse

2. Transpiration highest around mid-day as middle of day warm<u>er</u> / light<u>er</u>;

2. Allow 'Sun is at its hottest'

3. (Increased) tension / water potential gradient;

Ignore 'pull, suck'

3

(ii) (Inside xylem) lower than atmospheric pressure / (water is under) tension;

Accept cohesion tension. Ignore vacuum

1

(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

1

(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;

3

(iii) Aorta 1.2 / largest SD;

Allow pulmonary vein provided candidate relates standard deviation to mean

1

(c) Formation

1. High blood / hydrostatic pressure / pressure filtration;

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]

Q36.

(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;

2

(c) Allow two marks for quantitative statement: e.g. filling time decreases from 0.55 ± 0.1 to 0.30 ± 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]

Q37.

(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]

Q38.

(a) (i) Left ventricle;

1

(ii) Thick muscle / thick walls;
Accept more muscle / more muscular.
Ignore stronger muscle.

1

(b) (i) 85.7 / 86;
Accept 85
Ignore additional decimal places.

1

(ii) Two marks for correct answer of 7905 - 7998;
Accept either formula or illustration with figures from table.

One mark for incorrect answer in which candidate provides evidence of multiplying heart rate by stroke volume;

2

(c) 1. Closed open;

2. Open closed;

2

[7]

Q39.

(a) Amino acid / amino acids ;
If anything else is given as well do not award mark.

1

(b) (i) 1. Affects one monomer / amino acid;
i.e. What is affected

2. Not found in all <u>active</u> <u>sites</u>;
i.e. Where it is found.
2. Must relate to active site. Enzyme is insufficient.

2

(ii) 1. **X**;

2. Enzyme in both pathways;

2. Award independently

2

(c) 1. Occupies / blocks / binds to active site;

i.e. What it does in terms of the active site.

2. Substrate will not fit / does not bind / no longer complementary to / enzyme-substrate complex not formed;

1. Ignore references to change in shape and shape of aspirin molecule.

Ignore reference to competitive inhibitor i.e. Consequence required

2

[7]

Q40.

(a) 1. Haemoglobin carries oxygen / has a high affinity for oxygen / oxyhaemoglobin;

2. Loading / uptake / association in lungs;

3. at high $p.O_2$;

4. Unloads / dissociates / releases to respiring cells / tissues;

5. at low $p.O_2$;

6. Unloading linked to higher carbon dioxide (concentration);

6. Ignore reference to incorrect pH in relation to effect of higher carbon dioxide concentrations for marking point

6

(b) 1. Allows comparison;

Do not credit 'temperature affects results' on its own;

2. (Different temperature) affects enzymes;

2. Allow reference to denaturation of enzymes.

3. (Different temperature) affects respiration / metabolism;

4. (Different temperature) affects amount of dissolved oxygen;

2 max

(c) 1. Increases then levels out / stops increasing / fluctuates slightly;

2. At 5 ($cm^3\ dm^{-3}$) / 320 ($cm^3\ g^{-1}h^{-1}$);

Allow description of 'fluctuates slightly' in terms of candidate quoting figures after 320.

2

(d) 1. *Chronimus longistylus* has higher uptake at low (oxygen) concentrations;

Chronimus longistylus has higher uptake to (oxygen concentration of) 2 / lower uptake after 2; (= 2 marks)

2. (Higher uptake) up to 2 $cm^3\ dm^{-3}$;

2. Award mark if candidate uses figures from table e.g.

higher at concentration 1 (220) <u>or</u> concentration 2 (285).
Higher uptake at concentration 1 <u>or</u> 2 = 2 marks.

2

(e) (i) More (than in African) lost via gills in Australian lungfish / less (than African) lost via lungs in Australian lungfish;

1

(ii) 1. More / most exchange is via lungs (in African lungfish);
1. Allow converse for first point.

2. Gills will not function / function less efficiently (in air);
2. Allow water is required for gills to function.

2

[15]

Q41.

(a) 0.1 and 0.5;

Pressure in ventricle greater (than pressure in atrium);
Both figures must be correct.
Comparison needed.

2

(b) 1. (Ventricle has) thick wall / more muscle;

2. So <u>contractions</u> are stronger / harder;
Neutral: Contracts to produce more pressure.
Neutral: Pump harder.
Neutral: Reference to a need to pump blood further / round the body.

2

(c) 85 / 86 / 85.7;
Ignore additional decimal places

1

[5]

Q42.

(a) (i) <u>Protein</u> on (surface of) <u>chlamydia</u>;

That initiates an immune response (in mice) / causes antibody production;
Neutral "foreign protein"
Do not accept glycoprotein.
2. Accept description of initiating immune response.

2

(ii) 1. Antibodies / memory cells against chlamydia (protein / antigen) are present;

2. Protein on heart (muscle) similar to chlamydia protein / antigen so T cells / antibodies (attack heart muscle cells);

2. Look for idea that both proteins are similar

2. Detail of what is attacking the heart muscle cells

2

(b) **FOR**

1. Prevents / reduces heart disease / attacks;

2. Cheaper to vaccinate than treat heart disease;

AGAINST

3. Vaccination costly;

4. Don't know frequency of chlamydia infection;

5. Research in mice might not be replicated in humans / humans might have a different protein;

6. Vaccine could cause heart disease or immune response against heart (muscle);

2 max for arguments against

Accept other valid answers

3 max

[7]

Q43.

(a) High(er) affinity for oxygen / absorbs / loads more oxygen;

At lower partial pressure (of oxygen) / lower pO_2;

Accept: Loads oxygen 'quicker', 'more readily', 'higher saturation', use of figures from graph for first point.

Neutral: References to unloading.

2

(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);

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.

3 max

[5]

Q44.

(a) More red blood cells;

More haemoglobin;

2

(b) Given (only) salt solution;

(Otherwise) treated the same way;

Accept: 'Placebo' in salt solution.

Reference to salt solution is essential for first marking point.

2

(c) Allows comparison to be made;

Different masses / weights (of volunteers) / different weeks / lengths of treatment;

Accept: 'Both were different' for one mark.

Neutral: Size for second marking point.

2

(d) To determine (most effective) dose / length of treatment / to find the most cost effective treatment;
Investigate long term effect / toxicity / side effects;

Do not credit marks for descriptions of the information in the table in terms of dose and length of treatment.

2

(e) More haemoglobin / more red blood cells;

(More) oxygen can be absorbed / transported (for) respiration / to respiring tissues / cells;

(More) energy released / more ATP for muscle <u>contraction</u>;

Delays <u>anaerobic</u> respiration / delays build up of lactate / lactic acid;

Reject: 'Energy produced or made' but allow 'energy made in form of ATP'.

4

(f) Large sample / wide range (of individuals tested);
Random (sampling);

Tested at different times / more than once;

Mean / average value determined;

Idea of establishing a range for the normal concentration / reference to use of standard deviation;

2 max

(g) Blood thicker / denser / more viscous / more 'concentrated' / heart <u>contraction</u> greater / increases volume of blood;

Accept: More blood cells in same volume / 'space'.

Neutral: 'more red blood cells' / 'more blood' on its own.

Neutral: 'Heart pumps / beats more / harder'.

1

[15]

Q45.

(a) (i) **G**;

Neutral: name of blood vessel

1

(ii) **E**;

Neutral: name of blood vessel

1

(b) Pressure is greater below valve / in ventricle than (artery);

Must be comparative

Reject: pressure is greater in ventricle than atrium

Neutral: pressure in ventricle increases

*Accept: **E** / **F** / named artery*

Accept: converse argument

1

(c) Allow atria to empty / contract / ventricles to fill;

Before ventricles contract;

OR

Delays contraction of ventricles;

Until after atria have contracted / ventricles have filled;

Neutral: 'to pump blood'

2

(d) (i) Two marks for correct answer of 91 / 90.9;;

One mark for incorrect answers which clearly show understanding of the relationship between SV = CO / HR;

Correct answer = 2 marks outright

5000 divided by 70, 55 or 15 = 1 mark for principle

2

(ii) Increase in size or volume of heart / ventricles / increased heart muscle / increased strength of contraction / hypertrophy;

Cardiac output is the same (before and after training) so must be increase in stroke volume / more blood leaves heart in each beat;

Accept: increased strength of heart muscle

Neutral: heart muscle contracts more

***Q** Do not allow 'heart is stronger'*

Neutral: more blood leaves the heart

If the term 'stroke volume' is not used, it must be defined

2

[9]

Q46.

(a) More that one polypeptide / chain;

Ignore references to haem / other groups

1

(b) (i) 141;

1

(ii) 1. Stop / start sequences;

2. Non coding DNA (in the gene) / introns / multiple repeats / junk DNA;

Do not credit "some bases repeated"

3 Two chains / a non-coding strand / complementary base pairs;

4. Addition of base by mutation;

2 max

(c) Different primary structure / amino acids / different number of polypeptide chains;

Question is about haemoglobin so do not credit differences in DNA

1

(d) 1. Low partial pressure of oxygen in lungs;

2. (Llama) haemoglobin able to load more oxygen / (llama) haemoglobin saturated (at low / particular partial pressure of oxygen);

3. Higher affinity for oxygen;

The terms used in the graph (or near approximations) should be used in this answer.

Ignore references to unloading

The answer must relate to llamas

3

[8]

Q47.

(a) (i) 1. Removes water vapour / moisture / saturated air;

2. Increases water potential gradient / more diffusion / more evaporation;

2

(ii) 1. Increases kinetic energy so water molecules move faster;

2. Increases diffusion / evaporation;

2

(b) (i) Positive correlation / as light intensity increases so does rate of water movement / follows same pattern / directly proportional;

1

(ii) 1. Stomata open and photosynthesis increases / transpiration increases;

2. More water pulled up due to cohesion between water molecules / by cohesion tension;

2

(iii) 1. Water pulled up trunk / moves up at fast rate under tension;

2. Sticking / adhesion (between water and) cells / walls / pulls xylem in;

Adhesion is not a specification requirement.

Accept cohesion in this context

2

(c) **Elastic tissue**

1. Elastic tissue stretches under pressure / when heart beats then recoils / springs back;

2. Evens out pressure / flow;

Do not allow credit for expands / contracts / relaxes in this context.

From a marking viewpoint ignore all specific references to arteries and arterioles. Consider all points as applying to both.

2 Do accept controls

Muscle

3. Muscle contracts to reduce diameter of lumen / vasoconstriction / constricts vessel;

4. Changes flow / pressure;

Epithelium

5. Epithelium smooth;

6. Reduces friction / blood clots / less resistance;

6

[15]

Q48.

(a) (i) Healthy volunteers have 'normally' functioning vessels;

OR

Blood vessel / lumen / diameter not affected by other factors / is of normal size;

Accept: a valid ethical argument
e.g. treatment does not harm healthy volunteers

Reject: ref. to change in artery thickness

Accept: converse arguments for unhealthy volunteers

Must be related to this investigation

Neutral: to ensure that that the results are due to the independent variable

1

(ii) Avoids bias / selection (by scientists);

Neutral: ref. to having the same number / gender / age of people in each group;

1

(b) (i) Same as experimental group;

Chocolate with no flavenoids;

Neutral: no dark chocolate

Neutral: placebo

Reject: milk chocolate

Neutral: ref. to fair testing

2

(ii) (To ensure that results are) not due to some other substance in the chocolate / due to flavenoids (only);

Must be related to this investigation

Neutral: to ensure that the results are due to the independent variable

Neutral: to show results are not due to other factors

Neutral: to show results are only due to the chocolate

Neutral: to compare results for people who did and did not have flavenoids

1

[5]

Q49.

(a) Endothelium / epithelium;

Allow endothelial / epithelial

Reject: epidermis / endodermis

1

(b) Measurement divided by 8;

1

Allow answer in range of 3-3.3 for two marks;

Correct answer gains 2 marks.

1

(c) (i) Stretches / 'expands' under high pressure / when ventricle contracts / systole and recoils / 'springs back' under low pressure / when ventricle relaxes / diastole;

***Q** References to aorta contracting or relaxing negates marks for stretch and recoil.*

Smooths blood flow / maintains blood pressure / reduces pressure surges;

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.

2

(ii) (Muscle) contracts;

'It' in answer = muscle

1

(Arteriole) constricts / narrows / alters size of lumen / reduces / regulates blood flow (to capillaries);

Allow converse (muscle) relaxes and (arteriole) dilates etc / increase blood flow etc.

Ignore references to pressure

1

(d) (i) Large / increase in (total) cross sectional area / friction / resistance;

1

(ii) (More) time for exchange of substances;

1

[9]

Q50.

(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;

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'.

3 max

(b) (i) Larger the mammal the more to the left / steeper / 'higher' is the curve / the higher the affinity for oxygen;

Allow converse.

Ignore references to Bohr shift

1

(ii) Smaller mammal has greater surface area to volume ratio;

Smaller mammal / larger SA:Vol ratio more heat lost (per unit body mass);

Allow converse explanation for larger mammals or lower surface area to volume ratio.

Smaller mammal / larger SA:Vol ratio has greater rate of respiration / metabolism;

Allow suitable named mammal as alternative to smaller or larger mammal.

Oxygen required for respiration so (haemoglobin) releases more oxygen / oxygen released more readily / haemoglobin has lower affinity;

4

[8]

Q51.

(a) (i) Faster / greater / more effective response in children;

Do not accept children have more haemoglobin

1

(ii) Use line of best fit;

1

Extrapolate / extend line (and read from graph);

Allow calculation using rate of increase per day = one mark. However for both marks this must be linked to line of best fit.

1

(iii) More than one polypeptide chain;

Allow many polypeptide chains.

'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.

1

(b) (i) Has same water potential;

Allow converse for effect of using distilled water or a concentrated solution.

1

No (net) water movement / osmosis;

1

Cells will not swell / burst / change size;

No osmotic lysis = two marks

1

(ii) Pernicious anaemia (cells) greater range / spread / variation of diameters / widths;

Some pernicious anaemia (cells) wider than 9 (μm) / some less than 5.5 (μm) / without pernicious anaemia none more than 9 (μm) / none less than 5.5 (μm);

Pernicious anaemia (cells) peak / most frequent at 8.5 (μm) / peak / most frequent at higher diameter / / without pernicious anaemia peak / most frequent at 7 (μm) / peaks at lower diameter;

There are several alternatives for marking points 2 and 3

2 max

[9]

Q52.

(a) Diet including saturated fats leads to higher plasma cholesterol concentrations;
Higher in all age groups;
But sample size is very small;
Standard deviations overlap / suggest wide variation;

3 max

(b) The sex of individual is a risk factor for high cholesterol;
To remove a / one variable / to establish a fair test;

2

(c) Monkeys and humans closely related therefore similar conclusions might be drawn;
High concentrations of plasma cholesterol lead to an increased risk of cardiovascular disease in humans;
Don't know if diet has the same effect in monkeys (as in humans) / could have different effects because not the same species;

3

[8]

Q53.

1. SAN initiates heartbeat / acts as a pacemaker / myogenic;

   ***Q** Must be in context*

2. (SAN) sends wave of electrical activity / impulses (across atria) causing atrial contraction;

   Reject: signals / electronic / messages / <u>nerve</u> impulses once only

3. AVN delays (electrical activity / impulses);

   Neutral: reference to non-conducting tissue delaying impulses instead of the AVN

4. (Allowing) atria to empty before ventricles contract / ventricles to fill before they contract;

5. (AVN) sends wave of electrical activity / impulses down Bundle of His / Purkyne fibres;

6. (Causing) ventricles to contract (from base up) / ventricular systole;

5 max

[5]

Q54.

(a) Increase in / more carbon dioxide;

Curve moves to the right / depressed;

***Q** Any reference to haemoglobin increasing affinity for oxygen disqualifies second mark point.*

2

(b) (i) More haemoglobin;

So can load / pick up more oxygen (in the lungs);

***Q** Second mark point must relate to idea of loading oxygen. Answers referring only to transport of oxygen should not be credited this mark.*

2

(ii) (Haemoglobin) has lower affinity for oxygen / more oxygen released;

In / to the cells / tissues;

2

[6]

Q55.

(a) (Blood) plasma;

1

(b) More / larger proteins / less urea / carbon dioxide / more glucose / amino acids / fatty acids / oxygen / high(hydrostatic) pressure;

Q *Reference to blood cells / water potential = neutral*
Q *<u>No</u> Protein should not be credited*

1

(c) (i) <u>Contracts</u>;

Q *Do not accept pumping of heart / heart beating*

1

(ii) Loss of fluid / volume;

Friction / resistance (of capillary wall);

Q *Reference to a narrow lumen is not sufficient to gain a mark unless friction or resistance is mentioned.*

1 max

(d) <u>Water potential</u> (in capillary) not as low / is higher / less negative / water potential gradient is reduced;

More tissue fluid formed (at arteriole end);

Less / no <u>water</u> absorbed (into blood capillary) by <u>osmosis</u>; (into blood capillary);

Q *The last two marking points must be in context of movement into the blood capillary*

3

[7]

Q56.

(a) Sends out electrical activity / impulses;
Initiates the heartbeat / acts as a pacemaker / (stimulates) contraction of atria;

Q *Ignore reference to ventricles.*

2

(b) Fluctuation and overall decrease;

Steep decrease first / after two years and then gradual decrease;

2

(c) Diet low in cholesterol / LDLs;

Less absorbed into blood / from intestines;

2

(d) Diet has greater effect in decreasing blood cholesterol concentration;

Difficult to judge effect of drug as it is used at same time as diet / drug is not used on its own;

Decrease in blood cholesterol concentration linked to reduced risk of heart disease;

Q *Allow converse for third marking point.*

2 max

[8]

Q57.

(a) Arrows on all five vessels in correct direction;

1

(b) E;

1

(c)

Feature	Vessel C	Vessel E
Valves	Absent	Present
(Relative) thickness of walls	Thicker	Thinner
Elastin / elastic tissue / fibres	More	Less
Muscle	More	Less
Lumen	Narrow	Wide

Two marks for two correct rows

Accept any pair of contrasting terms with same meaning as those used.

2 max

(d) Contracts;

(Causing) vasoconstriction / narrows lumen;

2

(e) (Elastic tissue) stretches when pressure is high;

Springs back / recoils / returns to normal;

Q *Do not credit references to contracting, relaxing or expanding*

2 max

[8]

Q58.

(a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;;

Q *Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two*

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;

4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;

5. Circulation replaces blood saturated with oxygen;

6. Ventilation replaces water (as oxygen removed);

6

(b) 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

(c) Not much oxygen near sea bed;

Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low <u>partial pressure</u> (of oxygen);

2

(d) The chimpanzee and the bonobo are more closely related (than to the gorilla);

They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12]

Q59.

(a) (i) plasma;

1

(ii) tissue fluid;

1

(b) fluid **Y** contains little / no protein; *reject blood cells*
molecules too large (to pass through capillary wall);

OR

fluid **Y** contains less glucose;
some will have entered tissue cells;
accept any other biologically correct difference marked in a similar way.

2 max

(c) hydrostatic pressure / blood pressure / arterial pressure;
greater than osmotic effect which forces molecules / fluid out;
ignore references here to diffusion or osmosis.

2

[6]

Q60.

(a) (i) the atrioventricular / mitral / bicuspid / tricuspid valves (closing);

1

(ii) pressure in artery greater than pressure in ventricle;

1

(b) correct answer 5250 = 3 marks;
where answer incorrect:
one heart beat identified as taking 0.8 s;
heart rate calculated as 75 (beats per minute);
cardiac output = heart rate x stroke volume;
marking points to be awarded independently but onus on candidate to show clearly what has been done

3

[5]

Q61.

(a) correct answer: 77 - 78 ;; *allow 75 - 80* = 2 marks
OR Use of 55 AND 17 saturation / fall = 38; = 1 mark
OR (Fall = y % +) use of $\frac{200y}{98}$; = 1 mark

2

(b) (in exercise) - faster respiration rate meaning more CO_2 production;
CO_2 is acidic / forms carbonic acid / lactic acid production;
release of H^+ ions;

3

[5]

Q62.

(a) (variation in) temperature will affect the solubility of oxygen / rate of respiration / use of oxygen by cells / diffusion / gas exchange;
to gain credit point made must concern oxygen

1

(b) (i) there is no difference between the partial pressure of oxygen in the two groups / the partial pressure of oxygen is the same in each group;

1

(ii) results may have been due to <u>chance</u> and statistical test allows us to determine the <u>probability</u> of this / of the difference between results being significant;
enables acceptance or rejection of null hypothesis;
The key points here are chance and probability used in the correct context.

2

(c) **A**;
because partial pressure of oxygen only reduced when zinc in water / in **Y** / because when injected zinc / in **X** has no effect on partial pressure of oxygen in blood;

2

(d) less oxygen transport to cells / in fish / in blood;
anaerobic respiration;
lactic acid produced / less carbon dioxide removed (from gills);
more H^+;

3 max

(e) (i) copper;
calculation based on comparing concentration in woodlice with that in leaves;

accept any suitable method here, giving marks for the method and explanation. For example, calculating ratio of concentration in woodlice to concentration in leaves.

2

(ii) not absorbed from gut / passes out in faeces / egested / urine / excreted;

1

(iii) woodlice eat large amount of leaves;
copper stored / accumulates in body;

2

(f) (i) mutation;

1

(ii) (as a component of) nucleic acids / DNA / RNA / nucleotides;
phospholipids;
ATP / ADP;

2 max

(iii) arsenic-tolerant plants would not be able to take up phosphates / take up a little phosphate;
since likely to involve same mechanism / same carrier / protein;
(process of) growth would be poorer than non-tolerant plants;

3

[20]

Q63.

(a) The muscle in the wall / sphincter contracts;

Accept converse

Reducing blood flow / narrowing / closing arteriole;

The muscle to which the candidate is referring must be clearly in the wall of the arteriole.

2

(b) (i) Blood flow increased in humans / reduced in seals;

1

(ii) Less oxygen / blood taken to muscles;

None is incorrect

(More) oxygen available for organs / brain;
Can stay under water longer (without breathing);

max 2

[5]

Q64.

(a) 0.1 / 0.9 (s);

1

(b) Two marks for correct answer of 75 (beats per minute);

One mark for incorrect answer based on cardiac cycle taking 0.8 seconds;

2

(c) (i) Pressure in ventricle higher than pressure in atria;

1

(ii) Prevents backflow of blood / prevents flow from ventricles to atria;

1

(d) Increase (in stroke volume) as blood pressure increases, remains constant / plateaus; after 3 kPa / when stroke volume = 82cm^3

2

(e) Two marks for correct answer of 80;
One mark for incorrect answer recognising that ventricle contracts once every cardiac cycle / stroke volume = 70 cm^3

2

(f) 1 Muscles (surrounding veins) contract and press on (walls of) vein and squeezes blood along veins;

2 Valves prevent backflow / ensure flow in one direction;

3 Systole / contraction of heart pumps blood (through arteries) into veins / residual arterial pressure / negative pressure in chest due to inspiration;

4 Recoil of heart muscle during diastole / after contraction;

5 Draws blood from veins into atria;
Accept sucks

6 Wide lumen little resistance / friction

6

[15]

Q65.

(a) (i) 1 Reduces heart rate;
2 Keeps heart rate stable / reduces variation in heart rate;
3 Nullifies external stimulus;
Individual points must be supported with information from the graph
If no information quoted max 1 mark

2

(ii) To ensure change in heart rate due to beta blocker and not person's behaviour / knowing may affect heart rate;

1

(b) (i) Beta blockers reduce mortality (following myocardial infarction) / Greater reduction in the older group;

1

(ii)

$$\frac{\text{Deaths with placebo - deaths with beta blocker}}{\text{Deaths with placebo}} \; ; \qquad \frac{\text{Extra deaths}}{\text{deaths with placebo}}$$

x100;

2

[6]

Q66.

(a) (i) **C** and **D**;

1

(ii) left ventricle with thicker wall / more muscle / (muscle in) left ventricle contracts <u>more</u> forcefully / beats more strongly;

1

(b) higher in atria / lower in ventricles;
atrioventricular valves / valves between atria and ventricles open;

(position of valves must be identified.

Do not accept an unqualified reference to valves.

Assume pronouns refer to atria.)

2

(c) (i) allows blood to pass into ventricles / from atria / so that atria can empty; before ventricles contract;

2

(ii) ventricle contracts from base / upwards;
blood pushed through **B** and **C** / arteries / all blood ejected;

2

[8]

Q67.

(a) made of (different) tissues / specified tissues;

1

(b) (i) 20 µm as it consists of endothelium only / does not contain muscle, connective tissues and elastic tissue;

(consider other answers and credit understanding.)

1

(ii) 1 mark calculation derived from diameter - (2 × wall thickness) / answer of 3mm;
2 marks 2mm / 2000µm;

2

(c) stretches as a result of high pressure / surge of blood;
then recoils;

2

[6]

Q68.

(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 less saturated with oxygen / has reduced affinity;

oxyhaemoglobin dissociates more readily / haemoglobin releases oxygen more readily / more oxygen released;
allowing greater demand / respiration rate;

3

[5]

Q69.

(a) 0.1 – 0.6 seconds;
Volume (in left ventricle) increasing / ventricle filling;

2

(b) (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

(c) Multiply them;

1

(d) 750;

Accept a small increase – up to 800 cm^3

1

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

1

(ii) 18 cm^3;

1

[9]

Q70.

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

2

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

= 37 to 38

allow 1 mark if correct working shown

max 2

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

2

(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 respiring muscles / 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]

Q71.

(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]

Q72.

(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]

Q73.

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

Q74.

(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]

Q75.

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

Q76.

(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^3 is 100% = 1 mark

2

[7]

Q77.

(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]

Q78.

(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]

Q79.

(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)

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]

Q80.

(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]

Q81.

(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]

Q82.

(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

Q83.

(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]

Q84.

(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_2 more readily;

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

3

[9]

Q85.

(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]

Q86.

(a) (i) CO_2 is produced (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]

Q87.

(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]

Q88.

(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]

Q89.

(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]

Q90.

(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]

Q91.

(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]

Q92.

(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]

Q93.

(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]

Q94.

(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;

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]

Q95.

(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]

Q96.

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

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]

Q97.

(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

Q1.

Questions (a) and (b) were designed to assess Assessment Objective 1 and expected recall of basic knowledge. Question (a) allowed students to score well, with just over 50% of them scoring all three marks, and 93.3% scoring at least one mark. Question (b) was less well answered with only 31.6% of students scoring the mark.

Question (c) tested practical drawing skills that students should have acquired, and there is guidance for drawing in the practical handbook. This was poorly answered, with just 2.4% scoring all four marks. Most drawings were sketches, and did not look similar to **Figure 2**, despite the question asking students to draw the mitochondrion shown. The question also asked students to label the matrix and a crista. Very few did, and most did not include a scale of any sort.

Q2.

In question (a), only 11% of students gained both marks. These students wrote about the binding of oxygen leading to a change in the tertiary/quaternary structure of haemoglobin, which then led to the formation/uncovering of a second/another oxygen binding site. Nearly 40% obtained one mark, usually for reference to the change in tertiary/quaternary structure. Many who failed to score wrote about changes in the shape of haemoglobin, making it easier for more oxygen to bind. The first part of this statement contains terminology simpler than expected from A-level students. The second part re-states the stem of the question. Quite a few students only stated that this is due to ‘positive cooperativity’ and failed to score. Some good answers described a change in tertiary structure, leading to the unmasking of a second oxygen binding site and then stated, “This is an example of positive cooperativity.” These answers rather neatly illustrated the point that simply naming a process is not explaining it. The question discriminated well.

For question (b) (and (c)), it was not assumed that students would have used a haemocytometer; in fact, it was hoped they had not. About 11% of students were able to calculate the correct answer and express it in standard form. Some 40% obtained one mark for answers that were not in standard form, ignored the dilution factor, or failed to use the depth of liquid. Use of powers of 10 caused problems for many and quite a few answers had negative powers of 10.

Questions (c), (d) and (d) required students to evaluate methods used by a doctor (AO3), on the basis of information provided. In question (c), 46% of students gained one mark, usually for correctly deducing that the method would avoid counting cells twice. The second mark was harder to achieve and only 12% obtained both marks, usually by reference to getting consistent/more accurate results. A few did correctly deduce that the method avoids dealing with counting fractions of cells.

Question (d) required students to recall that there are (many) fewer white blood cells than red blood cells. Quite a large number did, but did not link that to this context, where enough white cells would be seen with only 20 times dilution; or too few would be seen with 200 times dilution. Some 35% did make the required link and obtained the mark. Many students tried to associate the dilution factor with the size of white blood cells compared with red cells but this would not affect the number of cells visible for counting, which is the key point.

Students were more successful with (d). Nearly two thirds knew that white blood cells have a nucleus (and red cells do not) and would thus be made clearly visible by the stain.

Q3.

The graph was a deviation from the pressure change graph that has appeared previously on AQA exam papers. This seemed to cause the majority of students some difficulty; 55% failed to score any marks on question (a).

Question (b) clearly represents the level of maths expected of AS Biology students, and clearly showed that many students are not capable of this, with 56% scoring zero marks. There seemed to be little comprehension of what to do, with seemingly any numbers being added, subtracted, multiplied or divided.

Question (c) tested simple recall of knowledge but 74% of students scored zero marks. The language used by students was very poor, with most simply repeating the stem, i.e. “the heart pumps forcing out tissue fluid”. Very few students were able to limit themselves to ‘water’, incorrectly indicating that ‘tissue fluid’, ‘fluid’, ‘plasma’, or even ‘blood’ left the capillaries. The mark scheme represents the standard expected.

The answers to question (d) showed a lack of understanding of what the lymphatic system does in terms of draining excess tissue fluid; 73% of students scored zero marks. Many students saw the word ‘blockage’ and wrote about blood clots and atheroma. Its frequency in answers seems to suggest that atheroma is being taught despite not being in the specification.

Q4.

Some very good answers were seen to question (a), with almost 30% of students gaining both marks for giving a detailed account of cooperative binding of oxygen to haemoglobin. Others failed to take account of the question stem and went on to compare HbA with HbF.

In answering question (b) only 2% of students gained both marks, with 64% scoring no marks. Often students described the advantage to the fetus in having HbF rather than the advantage to the baby of having HbA, as asked. Those who did state that HbA would have a higher affinity for oxygen rarely recognised that this would be important at low partial pressures of oxygen; those who realised that this would allow more oxygen to unload in the tissues often did not explain that this would be advantageous as it would allow more aerobic respiration.

In answering question (c), students followed the instruction to use information from the figure and the table in their answer but often referred to just one of these. Many students were able to state that more oxygen would be carried after treatment, but not many used the data in the table to comment on the size of the increase as being large or significant. Only a few students related the increased transport of oxygen correctly to the higher affinity of HbF for oxygen.

Q5.

Almost 60% of the students correctly identified the trisomy of chromosome 13 in question (a). Most of the incorrect answers referred to there being no Y chromosome.

In answers to question (b), there was evidence that students are less confident in their knowledge of mutation involving a change in chromosome number. There was an assumption made by some that, as this was a mutation, it must involve a change in the base sequence – answers of this type gained no marks. At the other end of the spectrum, some excellent answers were seen in which students wrote about non-disjunction during meiosis.

Most students knew, in question (c), that body cells are produced by mitosis and often gained a mark for explaining that all cells are derived from a single cell, the zygote.

Relatively few (17%) gained a further mark either for pointing out that the mutation would have been present in one of the gametes used in the formation of the zygote, or that mitosis produces genetically identical cells.

In answers to question (d), it was again evident that some students did not use the information given in the diagram, which clearly showed the direction of the blood flow. Some students wasted a lot of time writing about the functions of the aorta and pulmonary artery. The vast majority gained at least one mark for stating that there would be less oxygen delivered to the tissues, but fewer went on to explain that there would be less oxygen available for aerobic respiration, which would reduce growth or development of the tissue or organ.

Q6.

(a) There were some excellent answers here, but many students did not gain marks because their answers failed to focus on the NHE3 carrier protein. Many tried to explain why the ions would move, often describing how movement of one ion would generate an electrochemical gradient allowing the other to move (by facilitated diffusion), rather than sticking with the question of **how** the active transport (as stated in the stem of the question) of these two ions could work.

(b) This question was the first test of AO3 skills in this paper and gave students their first opportunity to interpret and evaluate scientific information. There were two parts to the mark scheme. The first required students to explain why an increase in mean mass of contents in the gut would allow scientists to reach the conclusion that salt absorption had been reduced. Many students successfully achieved these two marks, although some showed confusion between the contents in the lumen of the gut and in the cells lining the gut wall. The second required students to interpret the statistical test; this was often not attempted by students and those who did were rarely completely successful. Even though the stem contained a statement to help students (The scientists carried out a statistical test to see whether the difference in the means was significant), many referred to significant ‘results’, and very few could correctly describe what the P value showed with appropriate use of the words ‘probability’ and ‘chance’.

(c) This question required students to apply their knowledge of topic 3.3.4.1 and only 15% could do this with sufficient detail to score both marks. The question was carefully worded to lead students to the high salt concentration in the blood entering the capillaries, with the hope that an explanation linked to decrease in water potential of the tissue fluid would be given. Those who went down this route often scored this mark, but then referred to less ‘tissue fluid’ being reabsorbed at the venule end, rather than less water reabsorbed by osmosis. Students are not expected to have knowledge of how salt affects the blood, but may have some knowledge of the fact that a high salt diet can lead to an increase in blood pressure. Any explanation of how a high salt concentration increased blood pressure was ignored, and only the part of the answer focusing on what happens at the capillary bed to cause a build-up of tissue fluid was marked. Consequently, many students scored one mark for salt increasing the blood pressure (although it had to be clearly high**er** than normal; statements referring to ‘high’ pressure at the arteriole end were insufficient to gain credit). Only a few could go on to suggest that, as a result, **more** fluid would move out at the arteriole end of the capillary.

Q10.

Most students scored this mark. Occasional errors included references to rounding or human error.

Q11.

The most common score for this question was 1 or 2 out of 4. Most students understood that pulse rates from a large group would be required but fewer could go on to suggest how this group would be selected to include different sexes / ethnic groups etc. to score mark point 2. Nearly all students included the need to calculate a mean for this large group but surprisingly few also referred to calculating the standard deviation. Answers relating to mark point 4 were not well expressed and this mark point was rarely awarded. Many answers included vague references to comparing the results or comparing the means but few fully expressed the need to see if their mean lay within the standard deviation for the group.

Q12.

(a) Some students did not read the question carefully enough (the variables were controlled <u>during</u> the exercise test) so gave responses relating to the subjects or to their activities prior to the test. Many responses had some idea of the length of time of the exercise although “time” alone was insufficient. Some students struggled to express the idea of “difficulty of exercise”, only referring to the “type of treadmill”. Some responses included two environmental variables (only one could be given credit) and some of these were learnt responses rather than those relevant to this investigation, for example “oxygen concentration”.

(b) Nearly all students correctly identified the ranges to score 1 mark but many then went on to make rounding errors (resulting in max 1 as with Question 5(a)) or to calculate 45/40 to give the answer 1.125.

Q13.

(a) Care was required in the marking of this question as it required two responses for one mark. An example of “people outside age range” and “women” were the most common responses. Some students just gave two examples of people outside the range and so could not be given credit.

(b) The vast majority achieved mark point 1, although some only gave answers relating to “affecting the results” rather than specifying heart rate. Mark point 2 was more difficult to achieve with many responses referring simply to stopping medication being unethical or that medication was needed to “remain healthy”. These were not sufficient to fulfil the minimum requirement set out in the Marking Guidelines.

Q14.

The vast majority understood that valves stop backflow (mark point 2) but few gave the idea of pressure gradient.

Q15.

(a) Most gave good answers including correct reference to water potential and to osmosis. Mark point 2, however, required reference both to osmosis and that loss or gain of water would be prevented; this detail was missed by some. Mark point 3 was less often awarded as “so the valves aren’t damaged” does not fulfil the mark point and some responses did not include reference to cells or tissues as required.

(b) As stated at the beginning of this report many responses did not meet the minimum requirement set out in the mark point, both “kills / stops growth of bacteria” and “that could cause infection” or “that could damage the valve” were needed. Many partial responses were seen without fully using understanding of the action of antibiotics

and why this was important in this situation.

(c) Again, partial responses were common here. The Marking Guidelines required both "(new) valve closes fully" idea and "so preventing blood flowing back into the heart / out of the artery".

(d) Many descriptions of the data did not go into sufficient detail to fulfil mark points 1-3. Mark points 1 and 2 required reference to the mean increasing or decreasing and coming within the normal range in order to gain credit. Many students achieved mark point 3, although some did not pick out that this statement only referred to the minimum pressure. Mark point 4 was least commonly awarded with students only making use of the data in the tables when writing their responses rather than using all the information provided in the resource as suggested in the question stem.

(e) Mark points 2 and 3 were the most commonly awarded here, with mark points 1 and 4 being rarely achieved.

(f) Students generally found it difficult to use their knowledge of the definitions of standard deviation and range to give a correct response to this question.

Q16.

(a) The vast majority of students correctly identified the process as diffusion. The most common incorrect responses were osmosis and facilitated diffusion.

(b) Almost two thirds of students gained at least one mark for this question. Often this was achieved by explaining that the small/thin body of a tubifex worm would provide a short diffusion distance. A significant number of students named specific features of the body of a tubifex worm but did not explain how they allowed efficient gas exchange. Conversely, some students referred to a large surface area to volume ratio without relating this to a specific body feature.

(c) Less than 5% of students gained both marks for this question. The vast majority of students did not refer to the percentage saturation of haemoglobin in relation to the partial pressure of oxygen. Most students simply stated that the haemoglobin had a high affinity for oxygen at low partial pressures of oxygen. Approximately, a third of students gained one mark, invariably for referring to the use of oxygen for respiration.

(d) Most students gained one mark for correctly stating that seawater would have a lower water potential than the tubifex worm. Almost a third of students then gained the second mark by explaining that the worm would lose water by osmosis. However, many students did not gain this second mark as they either attempted to relate water potential to oxygen uptake or failed to refer to osmosis. A significant number of students suggested that the tubifex worm would 'burst' in seawater despite correctly identifying the water potential gradient.

Q17.

(a) Approximately half the students correctly calculated the heart rate as 66.7 beats per minute.

(b) 40% of students correctly determined the stroke volume as 70 cm3. There was a vast range of incorrect answers indicating that many students had little idea of how to use the information provided to determine the stroke volume.

(c) Almost two thirds of students failed to obtain a mark in this question. Many of these

students provided descriptions of how tissue fluid is formed rather than explaining why the tissue fluid actually builds up. Most answers which were credited only gained one mark for mentioning more fluid being forced out of the capillaries, or less being reabsorbed due to the high pressure. Very few students mentioned both points for 2 marks. A few students mentioned limiting drainage via the lymphatic system. A frequent misconception was that a higher ventricular pressure forces out 'more tissue fluid' rather than more fluid.

(d) Generally this was well answered with almost 90% of students gaining at least one mark. Most students understood that widening of blood vessels would provide a larger lumen or volume through which blood could flow. Many students linked this to a reduced blood pressure within the blood vessels to gain the second mark. Very few students referred to reduced friction or resistance due to widening of the blood vessel.

Q18.

(a) (i) Almost 90% of students correctly named blood vessel C.

(ii) Almost 90% of students correctly named blood vessel A.

(b) Most students recognised that a comparative statement was required and correctly wrote about stronger contractions or a thicker muscular wall. There was evidence of students misinterpreting the question, often writing about why high pressure is "needed" or not making a comparison with the right ventricle.

(c) The question required students to understand that blood would flow from higher to lower pressure. Few students understood this and those who were awarded this marking point usually referred to the mixing of oxygenated and deoxygenated blood. Some students appeared confused about the difference between diffusion and mass flow and wrote about oxygen diffusing from left to right ventricle. Many then went on simply to restate the question stem so could not be awarded the second mark point.

Q19.

(a) Most correctly identified 'quaternary' as the appropriate term to describe the protein's structure with 'tertiary' being a common misconception.

(b) The triplet nature of the DNA nucleotide code for amino acids is well understood. Very few failed to achieve the mark, although some students divided by three instead of multiplying by three.

(b) Detailed accounts of haemoglobin's allosteric properties, its structure, the Bohr shift or the number of oxygen molecules loaded per molecule were common, demonstrating where students had not read carefully enough the detail required in this question. Where students achieved only a single mark, they had usually not referred precisely to the location where haemoglobin associates with oxygen.

(d) (i) A vast majority of students successfully used the graph to find the correct difference in percentage saturation of haemoglobin with oxygen. A few failed to gain the mark despite having identified the correct values on the graph because they calculated a percentage change, rather than the difference.

(ii) This question discriminated well. Students who understand the transport of oxygen topic gave good responses that made clear a link to the context of anaemia with a sense that the shortage of haemoglobin molecules would, to some extent, be compensated for by the reduced oxygen affinity. Some did not

make a direct reference to ‘reduced affinity’ although they demonstrated a good understanding of the principle. Occasionally students went off at a tangent by referring to the effects of altitude differences and some erroneously described the curve’s shift to the right as representing an ‘increase’ in affinity.

Q20.

(a) In this question, students were required to look critically at the results of other scientists. Unfortunately, many insisted on making comments about the maximum increase in percentage blood flow despite being told not to do this. Most achieved one mark for correctly identifying the kind of meal that caused the quickest or slowest changes in blood flow, but very few looked at the data sufficiently closely to notice that there was wide variation between the values.

(b) This question differentiated very well and many students demonstrated a secure understanding about the principles of demand and supply in the context of cellular respiration. Many answers were full and logically sequenced. A common misconception was that respiration ‘stops’ in the gut if exercise occurs because blood is ‘not required’ there, or respiration ‘begins’ in muscles when they are involved in exercise. Sadly, once again, some students referred to the production of energy rather than to its release.

(c) Students achieved a good mix of all the marking points available for this question without often combining them into a logical sequence. The best answers were seen when students looked directly at the values given in both the table and also the figure and made comparisons between them, but they rarely extended their answer further than this. Many wrote at length using poorly punctuated long sentences, the meaning of which examiners found challenging to decipher. Rather than focus on the information given, many students discussed the design of the investigations, which was not required. Unfortunately, good answers were commonly spoiled when students suggested a reduced blood flow would affect digestion rather than restrict absorption. Comments on the effect of a meal on the time taken to change blood flow tended not to be linked with precision to the timings shown in the graph.

Q21.

(a) 82% of students gave the correct range of resting heart rates. Those who failed to score usually either misread the scale on the graph or gave the range for females rather than males.

(b) More than half the students carried out the calculation correctly, although some worked out the percentage in comparison with the heart rate after the exercise programme rather than before. Some students did several different calculations, got several different answers, and then left it to the examiner to choose which one was the right one. Obviously this did not score any marks, even if one of the calculations was correct. A minority of students failed to gain one of the marks through incorrect rounding of the answer.

(c) The majority of students recognised that using percentage change would allow comparison but a significant number wrote generic answers rather than relating their answer to this question. It was not uncommon for students to write about different sample sizes or that they all had different heart rates with only about half the students correctly stating that the mean initial resting heart rates of the two groups was different.

(d) This question discriminated well with most students recognising that the stroke volume would have increased. There was some confusion over terminology- some

students did not know what cardiac output was and confused it with stroke volume, so were trying to explain the wrong thing. Weaker students wrote about ventilation rates and tidal volume rather than heart rate and stroke volume.

Q22.

(a) and (b) These questions involved factual recall in a frequently tested topic area. Despite this, part (a) discriminated quite highly, with students who scored highly on the paper as a whole tending to get the highest marks. About half obtained both marks but 20% failed to score. Most students obtained one mark for noting that the blood in the coronary arteries is oxygenated, or supplies oxygen. They were much less secure about where the blood was going, with many thinking these arteries supplied the rest of the body. Part (b) was better answered by most students.

(c) For this part, many obtained 1 mark for noting that the aorta is the nearest artery to the heart. Relatively few noted that the aorta has a lot of elastic tissue that stretches and recoils, allowing large changes in pressure. Some incorrectly wrote about elastic tissue contracting.

Q23.

(a) Many students could answer this successfully and both mark point 1 and 2 were seen.

(b) This question required students to explain one advantage. Many answers stated an advantage (e.g. ‘so there is a shorter diffusion pathway’) without giving a full description and accompanying explanation linked to the function of the capillary. Some answers relating to the short diffusion pathway did not demonstrate AS level understanding of the importance of this being between the blood inside the capillary and the surrounding tissues with which exchange is occurring. Without this further description, mark point 1 could not be awarded.

(c) Most students achieved this mark.

(d) Most students successfully answered this question either suggesting fluid remains in the tissue fluid or returns in the lymph. Some suggested blood was left in the tissue fluid which is the incorrect context and so negates the mark point. Better answers gave a full explanation of fluid remaining in the tissue fluid and then draining into the lymph.

Q24.

Although this question tested familiar ground, many students could not gain more than two marks, as answers were either not of an A2 standard or appreciative that discussing digestive enzymes was not appropriate in the context of the blood. Besides ‘enzymes’, haemoglobin was the most commonly named protein. Students generally lost marks for weak descriptions of the effect of a change of pH on the (named) protein or the belief that a change in pH would mean that enzyme− substrate complexes would no longer be formed or that haemoglobin could no longer carry oxygen. In this context, some felt that death would be the result, a rather drastic outcome for a fluctuation of blood pH.

Q25.

(a) The most noticeable features of answers to (a) and (b) were the failure to use the information in the figure and attempts to use rote answers based on, often flawed, factual recall. A few very good answers to (a) were seen where students noted the

delay between increase in pressure in the ventricle and flow into the aorta. These went on to link this to the pressure gradient required to open the (semilunar) valve. Most students wrote simple and incorrect descriptive statements along the lines of, 'pressure and flow go up together'.

(b) More correct responses were seen than in (a). About 20% of answers correctly related the increase in thickness to contraction of the wall of the ventricle and this contraction to increase in pressure. Many students wrote that thickness of the ventricle wall increases to cope with pressure, or drifted into accounts of the relative thicknesses of the walls of the left and right ventricle.

Q26.

Parts (a) and (b)(i) proved to be good discriminators.

(a) 70% of students related the shift to the right of the curve for haemoglobin with a lower affinity, enabling oxygen to be released to tissues. However, some thought that this shift gave haemoglobin a higher affinity, so that more oxygen could be carried to muscles. A minority of students 'hedged their bets' and mentioned both. Many students were aware that oxygen is released to respiring tissues. However, the ability to relate vigorous exercise with a high rate of respiration was only seen in the best responses.

(b) (i) 70% of students scored full marks. Those who did not typically referred to surface area only, a *larger* SA:VOL, a *smaller* VOL:SA, fat or small extremities.

(ii) Half of students scored at least two marks. This was usually for describing how the rate of blood flow to the different organs changed during the dive and appreciating that the brain needs to remain active. The weakest responses usually did no more than state the values shown in the graph for each organ. However, better responses did appreciate that these changes in blood flow were to enable oxygen to be conserved. Similarly, they also explained the reduced blood flow to the lungs in terms of the seal not breathing when underwater. Surprisingly, a minority of students thought that seals use gills when diving and therefore less blood needs to flow to the lungs. Many students noted the reduced blood flow to the heart. However, relatively few linked this to a reduced heart rate. The suggestion that blood flow is diverted to muscles was rarely seen.

Q27.

(a) Students do need to refer to the Resource(s) when answering questions in this section. This question referred to differences between the curves for dog and sheep. This meant describing patterns within the curves and the overall trends. Some assessors incorrectly gave credit for statements suggesting that a higher percentage of dog cells haemolysed at lower concentrations of sodium chloride.

(b) Few had difficulty with the calculation in this question.

(c) It is generally the rule that repeating information given in a question stem, or in this case, the Resource material, attracts little or no credit. It was not enough to say that the red colour was due to a red pigment; identifying haemoglobin was vital. Furthermore, an expression of the relationship between depth of colour and the release of haemoglobin from ruptured cells was essential if full credit was to be achieved.

(d) Many students scored the first marking point, appreciating that the 0.9% sodium

chloride solution does not cause haemolysis in any of the mammals. Not all assessors took into account all of the various approaches that were possible for achieving the second marking point.

Q28.

(a) Well-prepared students were able to gain very good marks on this question, giving detailed and logically-written responses. The most commonly missed mark was mark point 2, concerning the band of non-conducting tissue between atria and ventricles that prevents the spread of impulses immediately down to the ventricles. Weaker answers contained fundamental errors, including muddling aorta with atria and the SAN and AVN opening valves to allow blood to pass through.

(b) Again, well-prepared students often gained full marks for this question, giving clear, sequential descriptions of the one-way flow of blood through the left side of the heart. A very small number of responses clearly described movement of blood through the right side of the heart and, having specified right atrium, tricuspid valve and right ventricle, did not gain any marks. Weaker students knew the sequence of events but were not able to explain the movement of blood in terms of changes in the pressure gradients caused by cardiac muscle contraction. Others assumed that since the stem of the question asked for movement of blood from left atrium to aorta that the two structures were directly connected.

Q29.

(a) This proved to be a good discriminator. Half of students gained at least two marks and a wide range of incorrect answers were seen. However, it was evident that many students did not know that proteins contain nitrogen or that polymers are formed by condensation reactions.

(b) Most students gave the correct answer of **16**.

(c) Many students were aware that fetal haemoglobin has a higher affinity for oxygen than adult haemoglobin. However, the ability to link this to partial pressure of oxygen discriminated well. Very few students directly stated that oxygen moves from mother to foetus.

(d) Many students were aware that adult haemoglobin has a lower affinity for oxygen. However, the ability to link this to respiring cells, tissues or muscles proved to be a good discriminator.

(e) It was disappointing that only a quarter of students gained this mark. Many simply repeated the question stem and stated that ‘adult haemoglobin is also produced’. Only the best responses conveyed the idea of ‘enough’, or that the curves are similar.

Q30.

(a) Two-thirds of students were able to identify the aorta.

(b) Students had difficulty expressing their ideas. However, nearly fifty percent obtained both marks. Some students failed to score one of the marks because they made vague references to ‘pushing’ by the left ventricle, rather than pressure.

(c) The majority of students correctly identified the valves with the same function. The commonest error was to put semi-lunar for both; perhaps students focused more on the appearance of the valves, rather than their function.

(d) This produced a full range of marks. Some students ignored the instruction to use calculations and just described the results. Others made vague references to percentages but without calculating any. Another approach seen was to approximate on the basis that there were about twice as many patients given X than Y. These approaches were not given credit. There were many good answers where students calculated percentages based on the columns of data in the table. Some students failed to gain one mark through incorrect rounding of percentages. There was a minority of students who calculated both percentage survival and percentage mortality, without appreciating that they are converse expressions of the same point. A third of students obtained all three marks and twenty-five percent scored zero.

Q31.

This proved to be the most challenging question on the paper, probably because of its high How *Science Works* content.

(a) This question was answered correctly by almost all students.

(b) On the other hand, only sixty percent of students obtained a mark in this question, usually for some reference to the men being 'at rest'. Many students thought it was to negate the effect of gravity, or because surgery is always carried out with people lying down.

(c) About half of students obtained one mark, usually for linking pulse rate to beats of the heart. Few got a second mark for the idea that each beat produces a pressure surge in arteries.

(d) This question produced quite a large number of answers where the stem of the question was repeated, in that the monitor was more reliable because it recorded continuously. A significant number of students also thought, wrongly, that it would allow one to discard anomalous results. Marks were most commonly awarded for ideas of obtaining more data, or avoiding human error in recording the pulse. The other mark points were seen. About a quarter of students obtained both marks and sixty percent obtained one mark.

(e) This question was most notable for the use of apparently rote answers; "there's no control", "there's no placebo", "there are other factors, ...". Relatively few students appeared to make efforts to use the information and consider the study in the question. About half of students obtained one mark. The commonest observations were that the men with the condition always had higher heart rates, or that this involved only one study and more investigations were needed. Very few noted that blood pressure itself was not measured in the study.

Q32.

In this question there was some confusion between channel and carrier proteins and their roles in facilitated diffusion and active transport. Quite a large number attempted to write about co-transport and obtained credit via the mark points for facilitated diffusion and active transport. Some who took this approach got themselves rather confused about what moved where, and how. About a third of students scored five marks.

Q33.

(a) (i) Most students were aware that an organ consists of more than one tissue. Students who failed to score, usually described a tissue rather than an organ.

(ii) This proved to be a good discriminator. Just over half the students gained full

marks for being aware that muscles contract, causing vasoconstriction of an arteriole. Weaker responses often used scientific terms in the wrong context. It was not uncommon in such responses to read that muscles 'constrict' or that arterioles 'contract', 'stretch' or 'recoil'. Similarly, some students did not seem to remember which way around these events occur in the context of *reducing* blood flow. Consequently, some students stated that muscles contract *and* relax, and arterioles constrict and dilate but did not make clear which of these *reduced* blood pressure.

(b) (i) Most students were aware that a thin wall provides a short diffusion pathway. Weaker responses often referred to a diffusion gradient being maintained or faster diffusion occurring.

(ii) Most students correctly linked slow blood flow in capillaries to more time for exchange. Again, weaker responses usually referred to faster diffusion occurring.

(c) It was disappointing that just over 40% of students scored zero. Many were aware that the water potential in the capillary would increase. However, the ability to tell the rest of the story proved to be an excellent discriminator. Weaker responses usually lacked precision or were out of context. They often referred to the movement of tissue fluid, rather than water. Similarly, some students described the movement of water out of the capillary, rather than less water moving into the capillary. It was clear that some students had difficulty in applying their knowledge of tissue fluid to an unfamiliar context and simply wrote all they knew about how tissue fluid is formed and reabsorbed.

Q34.

(a) Students had been well prepared for this type of question and many gained both marks for identifying the trends and referring correctly to figures from the graph. Students should be encouraged to limit their answer to the question asked – a significant number attempted to explain the data or to comment on the data from the other investigations.

(b) Most students correctly stated that age was a risk factor for heart disease. There were, however, many who gave vague generic answers rather than relating what they wrote to the actual question, with answers such as 'making it a fair test', without explaining why it would be fair

(c) The better students had clearly examined the data presented in the graph and provided evidence from specific investigations both in support of, and against, this claim. Weaker answers referred vaguely to few or many drinks and therefore failed to score. Some students correctly suggested that the data were only about heart disease and that other effects of alcohol were not considered. Students should be encouraged to quote data from the graph when asked to use this information.

Q35.

(a) (i) There were many approaches used in trying to explain this. Better students were precise in answering, relating data given to stomatal action and transpiration. Some did not read the stem carefully and wrote about changes in pressure. Many others failed to make the link between flow in the xylem and transpiration. The idea of increased tension occured only rarely but most students showed an understanding of cohesion.

(ii) Most students made an attempt at this question but often made incorrect

reference to root pressure and osmosis. There were some imprecise general discussions of water flow and transpiration, but there were also good answers showing clear understanding of principles. Again the best answers addressed the context of the question rather than producing generalisations. Many incorrect answers linked the negative values of water potential to negative pressure in the xylem.

(b) (i) Generally answered well, but answers often only described rather than explained the difference in wall thickness. A significant number of students wrongly referred to the artery wall as 'needing thick layer of muscle to pump the blood'.

(ii) There were frequent incorrect references to the aorta wall contracting or relaxing and to thickness increasing due to contraction. There were also many very general references to vasodilation or constriction. A frequently expressed incorrect idea was that the wall would become thicker with increasing pressure.

(iii) This question was answered well by the majority of students. Frequent inappropriate responses involved relating the function of the vessel to wall thickness rather than to the variations in wall thickness.

(c) The majority of students were able to score high marks on this question. Many gave well reasoned answers, although some failed to include precise detail. There were often good discussions relating to hydrostatic, water and osmotic pressures. Many students made good references to the role of the lymphatic system, although a common error was to state that the lymph nodes returned the surplus fluid to the circulatory system.

Q36.

(a) Most students could gain credit here for the idea that the ECG does not miss beats or gives more accurate (nearer the true value) or precise (low variation between repeats) measurements. Again, there was some confusion over the terms accurate and reliable.

(b) (i) It was surprising how many students failed to gain the first marking point. Having been given the value of 69.2, some students gave an incorrect figure due to the fact that it was not possible to have 0.2 of a beat. Some carried out calculations. Only better students could score the second marking point by relating the pulse to the contraction of the heart.

(ii) Most students scored highly on this question.

(c) Most students score one mark for the idea that filling time decreases and better students provide a correct quantitative statement for 2 marks. Some provided a reason for the decrease and failed to score the second mark.

(d) The part of the question that stated 'the method you used' was ignored by many and they tended to describe use of treadmills or walking, jogging and running instead of remaining with 'squats'. Other answers discriminated well, with lower level responses referring to a general idea of increasing the exercise and better ones adding references to duration or frequency of the squats.

Q37.

(a) (i) Many students scored here. Some responses simply referred to 'results' rather

than the ‘mean’ being reliable and others had the erroneous idea that anomalies should be simply discarded.

(ii) Most students understood the principle here and had pollution, diet and lifestyle as the most common factors that could affect people living in different areas. The term ‘regional bias’ tended not to be used but students could correctly use examples to illustrate the point.

(b) Very few students failed to score full marks here. The only problem arose when students did not fully understand the term placebo. Weaker responses simply referred to the control group being given no pill.

(c) (i) Most students gave a correct response here, though some simply repeated the idea that more blood enters as heart rate slows rather than explained why.

(ii) This question provided a range of responses. Very few students achieved 3 marks. Good students referred to more blood or oxygen reaching the heart muscle, although weaker responses failed to mention heart muscle and simply referred to the heart in general. Only better students could link this to more blood leaving the heart or used terms such as stroke volume or cardiac output. It was disappointing to note how few students referred to the blood reaching the heart muscle via the coronary arteries, generally a standard marking point in questions related to angina.

Q38.

(a) Most students correctly identified the left ventricle in their answers to part (i) and many progressed to describe the importance of the thick muscular wall of this chamber in producing high pressure. There were many, however, who confused cause and effect and attempted to explain why high pressure was necessary.

(b) Most students were aware that cardiac output could be calculated by multiplying heart rate by stroke volume, although there was occasional use of terms more appropriate to calculating pulmonary ventilation. Heart rate was frequently calculated correctly but the figures were sometimes transposed in transfer to the answer space. More difficulties were experienced, however, with determining stroke volume as 148 - 55 or 93. Errors here fell into a number of categories but it was particularly disturbing to see so many responses in which the correct figures were selected but subtraction errors resulted in credit being withheld.

(c) There were many correct answers to this question but some students failed to heed the instructions and attempted to answer with ticks and crosses. Credit could not be awarded in these cases.

Q39.

There was much evidence from the answers to different parts of this question of the difficulties that many students experience with comprehension questions. It appeared that many of those of more limited ability took very little note of the information in the passage or of instructions embedded within the questions. They identified this question as relating to enzyme inhibition and sought refuge in set responses, many of which were largely irrelevant. Further evidence of the difficulties that the question presented was provided by the number of answers that were crossed through and rewritten on extra sheets.

(a) Most students correctly identified the monomers concerned as amino acids.

(b) Students, who read the question carefully and noted the information to which the

lines referred, should have been able to point out in their answers to part (i) that aspirin would bind to one of the amino acids making up the active site and that different enzymes would have different amino acid sequences. Responses along these lines were made by disappointingly few students. Better students produced economical answers to part (ii) in which they correctly identified enzyme **X** and explained that it was involved in the production of both prostaglandins and thromboxane. Others wrote at great length with tortuous logic and often included detailed quotes from the passage of marginal relevance.

(c) Many students appeared to be of the opinion that aspirin was a non-competitive inhibitor and described it binding at some site on the enzyme other than the active site. Most of these students, however, were able to gain some credit for correctly pointing out that the substrate itself could not bind and produce an enzyme-substrate complex.

Q40.

(a) This question produced a good spread of marks. Most students referred to haemoglobin combining with oxygen in red blood cells and appreciated that loading took place in the lungs. Some students then described the unloading of oxygen at respiring tissues and these students often linked this to the increase in carbon dioxide. Generally, only better students referred to high and low partial pressures of oxygen and gained maximum marks. A significant minority of responses ignored loading and unloading of oxygen and described the passage of oxygenated blood through the circulatory system.

(b) Almost half the students failed to gain a mark as they often simply referred to it being a 'fair test' without an explanation. Most answers gaining credit mentioned enzymes and better students linked this to respiration to gain two marks. Answers relating to the temperature affecting the amount of dissolved oxygen were fairly infrequent as were references to enabling 'comparisons' between the larvae of both species.

(c) Most students appreciated that the mean rate of oxygen uptake increased and then levelled out with an increase in oxygen concentration in the water. However, only better students specifically referred to where oxygen uptake levelled out. Students gaining zero marks often stated that there was a positive correlation between the variables.

(d) Many students noted, for one mark, that Chironomus longistylus has a higher oxygen uptake at lower concentrations of oxygen. However, less than 25% of students used the data to support their observation and gain a second mark.

(e) (i) Almost 80% of students gained this mark, often by stating that more oxygen is lost via the gills in Australian lungfish than in African lungfish.

(ii) Most students were aware that more exchange is via the lungs in African lungfish. However, far fewer students gained a second mark by mentioning that gills would not function in air.

Q41.

(a) Candidates did not answer this question well. Only the most able understood that the valve would be closed when the ventricular pressure exceeds that in the atrium. Many simply stated that the pressure in the ventricles was high or increasing, making no comparison with atrial pressure. Consequently few gained the first marking point for giving the times the valve would be closed.

(b) Many candidates did not explain what causes the higher pressure in the ventricle with many trying to relate the answer to the distance the blood 'has to travel'. More able candidates were able to relate the higher pressure to the increased thickness of the wall of the ventricle which would be able to contract more strongly. As in previous unit tests, credit was only given to answers referring to muscle contraction and not to "pumping".

(c) A large number of candidates answered correctly, although many did not seem to know how to use the data in the table to calculate the rate and left this question blank.

Q42.

(a) (i) Many candidates gave a generic answer, failing to refer to the passage as instructed. These candidates often scored only one mark for explaining that an antigen causes an immune response. Candidates who scored both marks used the information given to explain that, in this example, the antigen was a protein on Chlamydia.

(ii) In this question, candidates were more confident in using the information from the passage and most gained at least a mark for explaining that the proteins on the Chlamydia cell and the heart were similar. There were candidates who confused antigens with antibodies and even enzymes but many candidates gained a second mark, usually by explaining that antibodies would attack the heart muscle cells. There were a number of excellent answers that showed a clear understanding of the immune response.

(b) A number of candidates did not go further than the information given in the question, simply stating that the vaccination would prevent Chlamydia infection. This was not credited. Candidates who considered the information in the passage wrote about the possibility of preventing atheroma or, if the human proteins were similar to those in the mouse, the risk of causing heart disease. There were also creditworthy references to the cost of a vaccination campaign being higher than alternative methods of reducing the incidence of Chlamydia. Unfortunately, many limited their answer to just one factor rather than evaluating the suggestion as instructed.

Q43.

(a) Most candidates obtained at least one mark for stating that the haemoglobin of a lugworm has a higher affinity for oxygen than has human haemoglobin. It was pleasing to note that compared with previous years many candidates referred to low partial pressure of oxygen rather than low oxygen concentration. This enabled them to access the second mark.

(b) There were some very impressive responses to this part of the question with almost a third of candidates obtaining maximum marks. Candidates obtaining a single mark often did so by referring to the role of the lymphatic system in returning tissue fluid to the circulatory system. A significant number of candidates wasted time by explaining the formation of tissue fluid at the arteriole end of the capillary. There was some confusion by weaker candidates about the effect of protein on the water potential inside blood capillaries. Many candidates did refer to osmosis but not always in the correct context.

Q44.

(a) This was well answered with almost eighty percent of candidates obtaining both marks for explaining that EPO would increase the number of red blood cells and

consequently the concentration of haemoglobin. Less than five percent of candidates scored zero.

(b) Most candidates gained at least one mark by stating that the control group would be treated in exactly the same way as the experimental group apart from being given EPO. Approximately a third of candidates gained the second mark by indicating that the control group would be injected only with salt solution. Many candidates simply referred to a placebo without mentioning the salt solution.

(c) This proved quite challenging with over forty percent of candidates scoring zero. Many of these candidates limited their response to the idea that the investigators would be able to see if EPO was effective. The idea of allowing a 'comparison' was the most common marking point awarded. Relatively few candidates considered the different masses of the volunteers or the different weeks of treatment.

(d) Over half the candidates failed to gain any marks on this question because they limited their answers to descriptions of the data in the table. Better candidates realised that the information provided would enable the investigators to determine the most effective dose and length of treatment.

(e) This question was well answered with over seventy five percent of candidates gaining three or more of the four marks available. Candidates realised that EPO would increase the amount of oxygen being transported to the respiring tissues because of an increase in the number of red blood cells. This was often linked to an increase in the energy released. Better candidates had often gained maximum marks before mentioning that this energy would be available for muscle contraction or that anaerobic respiration could be delayed.

(f) This question proved more demanding than expected. Most candidates did gain at least one of the two marks available but a significant number of responses lacked detail. These answers often suggested testing one or two athletes or one athlete and a non-athlete. The most common scoring marking points related to random sampling, determining a mean value and testing a large sample of individuals. It was pleasing to see some high quality answers which included the use of standard deviation when establishing the normal concentration of EPO.

(g) Most candidates failed to gain this mark as they simply referred to 'more blood' being present. Better candidates often suggested that an increase in blood pressure would be due to an increase in the volume of the blood or 'thicker' or 'denser' blood.

Q45.

(a) (i) 71% of candidates gave the correct response G.

(ii) 70% of candidates gave the correct response E.

(b) Many candidates gave a comparative response that clearly showed that the pressure was higher below the valve. However, weaker candidates often failed to make a comparison and often simply stated that 'the pressure in the ventricles increases'. Where a comparison was made, this was often between the ventricles and the atria.

(c) Many candidates gained one mark for stating that the delay allows the atria to empty or the ventricles to fill. However, it was usually only better candidates who were able to take this further and explain that it delayed contraction of the ventricles. Weaker candidates often thought that the delay allows valves to close or gave unnecessary detail involving the Bundle of His and Purkyne fibres.

(d) (i) 75% of candidates gained full credit on this question. However, most candidates were aware how to calculate stroke volume and gained one mark. The minority of candidates who failed to score typically multiplied cardiac output and heart rate. This gave a stroke volume of 275,000 cm^3. Candidates should be encouraged to check that their final answer does not seem unreasonable.

(ii) Many candidates scored at least one mark. Better candidates had no trouble in relating training to an increase in heart muscle or size. They usually then went on to explain the consequence of this in terms of an increase in the stroke volume. Weaker candidates were often let down by poor expression. Vague statements such as 'the heart is stronger' and 'the heart pumps more blood' were common. Some of these candidates related a lower heart rate to less oxygen being needed after exercise. It was clear that a minority of candidates thought that the term 'after exercise' referred to a single training session, rather than a prolonged training programme, as stated in the stem of the question. A minority of candidates related a lower heart rate to ventilation.

Q46.

(a) Although there were various interpretations of the diagram, most candidates correctly indicated the presence of more than one polypeptide chain.

(b) In part (i), many candidates correctly identified the number of amino acids coded by this piece of DNA as 141. Incorrect responses were usually centred on multiplying the number of bases either by two or by three. In part (ii), the single mark that was most frequently awarded was for a reference to introns. Many candidates, however, interpreted the question as asking about the nature of the genetic code. There were many responses centred on there being "more than one code for an amino acid".

(c) Despite the mark allocation shown for this question, there were some very extensive answers involving the DNA base sequence and protein structure. Many of these accounts also reflected much confusion between the terms base and amino acid. There were occasional unfortunate references to the environment causing the difference in haemoglobin structure.

(d) Better candidates were able to identify the principle involved here and suggested an explanation based on the ability of haemoglobin to load more oxygen at lower partial pressures. Where these candidates used the information from the graph and wrote of the partial pressure of oxygen and the percentage saturation of haemoglobin, they were usually able to gain full credit. There was, however, much imprecise wording and accounts were often marred by such phrases as there was "less air in mountains" and "the llama carries more oxygen". Less able candidates frequently twist the wording of questions round. This question, for example, was occasionally answered as requiring an explanation of the adaptations of horses to living at low altitudes. Such an interpretation failed to gain credit.

Q47.

(a) Many candidates appeared to understand the principles that were being tested in the two parts of this question but explanations often fell short of the required standard. In part (i) a reference was required to the dispersal of water vapour and the consequences of this on the diffusion or water potential gradient. Many less able candidates offered explanations in terms of moving air forcing water out of the leaf or involving water moving out of the leaf by osmosis. Those who appreciated, in part (ii), that an increase in temperature increased kinetic energy usually progressed to refer to an increase in the rate of movement of water molecules. Others, perhaps

inevitably, attempted to link temperature with enzyme activity

(b) Most candidates followed the instruction in part (i) and described the relationship with sufficient precision to gain the mark. They were also able to link movement through the xylem to increased light intensity and stomatal opening with some success. However, by far the most popular response to part (ii) was to suggest that there would be an increase in the rate of photosynthesis and therefore more water would be needed by the plant. The terms cohesion and tension were frequently used in such a way as to suggest little real understanding. It was not uncommon to read about water molecules being pulled through the xylem because “they stick to each other by cohesion-tension”. The idea conveyed in part (iii) appeared to be unfamiliar to all but the best candidates. The structure of the question should have lead candidates to realise that it was testing the same basic principle. The question was worded in such a way as to encourage candidates to explain the lower diameter at 12.00. Many opted however to explain the converse of this and based their answers on suggestions involving storage of water in the xylem.

(c) Responses to this question were very disappointing as evidenced by the large number of candidates who were unable to gain credit. Many answers were very general and did little more than suggest, often at great length, that “strong” walls meant that blood vessels did not burst under pressure. Such answers often established this point for arteries, then repeated it for arterioles. Only the very best candidates appeared aware of the presence of muscle and elastic tissue within the walls and could describe the roles of these particular tissues. There was also much emphasis on valves. They were correctly described as not being present in arteries and arterioles but then discussed in terms of what they would have done if they had been present. Those candidates who referred to the endothelium were generally able to point out its functions in reducing friction. There were others, however, who considered the lumen to be a fundamental component of the wall.

Q48.

(a) (i) Only the most able candidates gained this mark for suggesting that the blood vessels of healthy volunteers would not be affected by other factors or would be of normal size. Very few candidates noted that the blood vessels of healthy volunteers would function normally. Credit was given for valid ethical arguments, providing that they were qualified. However, a number of candidates failed to score through not relating their answers to the investigation. Weaker candidates tended to echo the need for ‘reliable results’ or ‘a fair test’.

(ii) Nearly 65% of candidates were aware of the need to avoid bias or selection. However, some candidates thought the volunteers were divided randomly to ensure that both groups contained the same number of people, or the same number of males and females. As in part (a)(i), weaker candidates tended to confine their answers to 'reliable results' or 'a fair test'.

(b) (i) Most candidates noted that the control group should have been treated in the same way as the experimental group. However, it was only better candidates who stated that the control group should have been given chocolate with no flavenoids. The most common incorrect response was ‘do not give any dark chocolate’. Weaker candidates sometimes made vague references to using a placebo but this was not usually taken any further.

(ii) Candidates were asked why it was important to have a control group in this investigation. Hence, this question tested the ability of candidates to apply their knowledge to an unfamiliar context. They were required to do more than

define the term ‘control group’. For this reason, general answers such as that ‘results are not due to other factors’ and ‘results are due to the independent variable’ were not credited. Better candidates related their answers to this investigation. They were aware that a control group was used to ensure that the results obtained were due to the flavenoids or that they did not result from other substances in the chocolate. Many candidates were aware of the need to compare both groups. However, relatively few explained why this was necessary.

Q49.

(a) Just over half the candidates correctly identified layer C as the endothelium or epithelium. Common incorrect responses included elastic layer, endodermis and epidermis.

(b) Most candidates scored the principle mark by dividing a measured diameter by eight (the magnification). Over half the candidates gained both marks. A significant minority of candidates measured the diameter of the blood vessel across the outer walls rather than the diameter of the lumen. These candidates usually gained the principle mark.

(c) (i) Compared with responses to a similar question on the June 2009 paper, it was pleasing to note that fewer candidates mentioned elastic fibres contracting or relaxing. There were more correct references to ‘stretch and recoil’ and to the role of elastic fibres in smoothing blood flow. However, some weaker candidates did refer to elastic fibres contracting and suggested that the aorta pumps blood around the body.

(ii) Surprisingly, a significant percentage of candidates did not obtain a mark in this question. Candidates often referred to muscle fibres constricting and dilating and to arterioles contracting and relaxing. The importance of muscle fibres in arterioles was often related to the prevention of arterioles bursting. Nevertheless, over half the candidates were able to obtain at least one mark. Only a relatively small percentage, however, was able to describe precisely how muscle fibres regulate blood flow.

(d) (i) Most candidates gained this mark by referring to the increase in the total cross- sectional area from the aorta to the capillaries.

(ii) Only a third of candidates gained this mark. Candidates often referred to the decrease in the rate of blood flow in the capillaries but did not link this with more time for efficient exchange of substances.

Q50.

(a) Almost a third of candidates obtained maximum marks by clearly describing how haemoglobin loads and unloads oxygen in different parts of the body. Other candidates often lost marks by failing to refer to partial pressure of oxygen or to the percentage saturation of haemoglobin in the lungs and tissues. Weaker candidates tended not to use the graph and often demonstrated a lack of understanding of the terms dissociation and affinity.

(b) (i) Most candidates gained this mark for correctly describing the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

(ii) Most candidates correctly related the size of mammal to a large or small

surface area to volume ratio and appreciated that oxygen was required for respiration. However, weaker candidates had difficulty explaining the relationship between the surface area to volume ratio of mammals and the position of the oxygen dissociation curves of their haemoglobins. There was also some confusion between the size of a mammal and the amount of heat lost from its surface area.

Q51.

(a) (i) Most candidates gained this mark by indicating that the response was more effective in children. However, a significant minority of candidates interpreted the graph as showing that adults had a more effective response to the treatment.

(ii) Considering a similar question was asked on the January 2010 paper it was disappointing to note that less than half the candidates gained both marks. Most candidates did refer to a line of best fit but many then failed to explain that the line should be extended to predict the haemoglobin content after 40 days. Credit was also given for detailed answers using the rate of increase per day to predict haemoglobin content.

(iii) Only a third of candidates clearly explained what is meant by a quaternary structure. Most candidates suggested that it meant four polypeptide chains or many proteins were present.

(b) (i) Almost a third of candidates obtained zero on this question, suggesting these candidates had not revised relevant principles from unit 1. A significant number of candidates interpreted isotonic as meaning a constant pH. Candidates who did know what isotonic meant were often able to provide a suitable explanation to gain at least two out of the three marks. However, there was still some confusion over the term osmosis with weaker candidates referring to salt moving by this process.

(ii) Most candidates were able to describe one difference between the two blood samples, often in relation to the variation in diameters. Many incorrectly referred to a difference in number of red blood cells, or their descriptions were too vague to gain a second mark point.

Q52.

(a) Few candidates scored high marks for this question. The majority recognised the pattern in the data and provided simple accurate descriptions of the relationship. It was pleasing to see some good answers about the overlapping standard deviation values, but some candidates experienced difficulty with this concept. In their attempt to express the idea of large variation between the groups, they inadvertently suggested that the standard deviation values were themselves large. Many centres gave credit for such comments.

(b) A few centres marked this question severely while others marked it extremely leniently. The idea of the sex of an individual being a risk factor for high cholesterol was poorly expressed by the vast majority. Candidates had greater success with the idea of removing a variable so that a fair test was carried out.

(c) To achieve the first mark, candidates had to imply that the two similar species were closely related to each other; therefore similar conclusions could be drawn. The third marking point required a reference to the two species responding differently to the same diet. A large number of centres marked this question with considerable

leniency, especially in relation to marking point three.

Q53.

There were many excellent answers to this question, with many candidates scoring at least three marks. Both questions proved to be good discriminators.

Most candidates understood the role of the SAN in initiating the heartbeat and generating electrical impulses, which cause contraction of the atria. Similarly, there were numerous references to the passage of impulses along the Bundle of His or Purkyne fibres and the subsequent contraction of the ventricles. However, there were some inventive spellings of 'Purkyne'. It was encouraging to see only a small number of candidates referring to electrical impulses as 'signals', 'messages' or 'electronic pulses'. It was usually only the most able candidates, who correctly referred to the delay at the AVN and described its significance. A number of candidates described the delay in the wrong context. This was usually in terms of a delay in impulses reaching the AVN or the non-conducting tissue of the heart causing the delay. Weaker candidates often gave a muddled sequence of events or gave a description of the cardiac cycle in terms of blood flow, valves and pressure changes.

Q54.

(a) Most candidates had little difficulty obtaining at least one mark by referring to an increase in the production of carbon dioxide. However, candidates were far less successful in describing the effect of an increase in respiration on the oxygen dissociation curve of haemoglobin. There were almost as many responses indicating that the curve would move to the left as there were correct answers indicating a shift to the right. Unfortunately, many candidates disqualified a correct description by suggesting that this would increase the affinity of haemoglobin for oxygen.

(b) (i) Most candidates did gain a mark for referring to an increase in the haemoglobin content of the blood. However, most candidates then linked this to an increase in the oxygen carrying capacity of the blood rather than to an increase in the oxygen uptake in the lungs. The latter being the main advantage to people living at high altitudes where there is less oxygen in the air.

(ii) As expected this question proved more demanding with approximately one in four candidates obtaining both marks. These candidates used the information provided on the graph to explain that haemoglobin would release more oxygen to the tissues as its affinity for oxygen decreases.

Q55.

(a) Most candidates correctly named fluid **F** as plasma or blood plasma. A common response not credited was blood.

(b) Very few candidates obtained this mark despite the large number of alternative answers available on the mark scheme. A very common error was to state that tissue fluid has no protein rather than less or smaller proteins. References to blood cells were not credited as fluid **F** is plasma rather than blood, the latter consisting of plasma and blood cells.

(c) (i) Many candidates did not obtain this mark as most referred to 'pumping' or 'beating' of the ventricle rather than using the precise term contraction.

(ii) Unfortunately many candidates simply stated that the pressure decreases as

distance from the heart increases. Better candidates explained the reason for this decrease in pressure in terms of friction or loss of fluid from capillaries.

(d) Answers to this question were very disappointing with very few candidates obtaining all three marks and many candidates scoring zero. Candidates gaining credit often appreciated that a decrease in the concentration of protein in the blood would increase the water potential in the capillary. However, candidates often failed to use the term osmosis in the correct context, describing the movement of a wide range of substances by osmosis. Even better candidates often failed to gain credit by referring to fluid rather than water moving by osmosis. Additionally, there was considerable confusion in the direction of movement of water between the tissue fluid and plasma.

Q56.

(a) The vast majority of candidates gained at least one mark for stating that the sinoatrial node (SAN) sends out a wave of electrical activity. Answers which simply referred to 'signals' or a 'wave of excitement' were not credited. Approximately half the candidates obtained a second mark by referring to the role of the SAN in stimulating the contraction of the atria or initiating the heart beat.

(b) There was a tendency for candidates to provide exhaustive details on the numerical changes in the concentration of cholesterol in the blood without describing the overall pattern of the data. Despite this, most candidates obtained a mark for describing the fluctuations and overall decrease in the blood cholesterol concentration over the ten-year period. However few candidates gained a second mark for describing the steep decrease in blood cholesterol concentration after two years followed by a gradual decrease over the remaining years.

(c) Rather than provide an explanation, most candidates provided a detailed description of the overall change in blood cholesterol concentration in the first two years. Inevitably these candidates scored zero. Candidates who did attempt to explain the data often suggested that the diet was 'low in fatty food' rather than 'low in cholesterol'. Very few candidates appreciated that less cholesterol would then be absorbed into the blood.

(d) Many candidates linked the decrease in blood cholesterol concentration to a reduced risk of coronary heart disease. However, only better candidates suggested that the diet had a greater effect in reducing blood cholesterol or indicated that it was difficult to determine the effect of the drug as it was used at the same time as the diet.

Q57.

(a) Most candidates revealed a sound understanding of the direction of blood flow through the vessels shown in the diagram. Such errors that arose usually concerned the hepatic circulation.

(b) As was expected of a question targeted at grade E candidates, there were many correct answers to this part. There was, however, a failure to appreciate that blood always flows from a higher to a lower pressure and this led to a number of incorrect responses.

(c) In the many cases where vessels **C** and **E** were correctly identified as an artery and a vein, candidates were usually able to complete the table with two appropriate differences. There were, however, references to the vein having no muscular or elastic layer. Examiners expressed concern over the inability of some to complete

the table unambiguously.

(d) Many candidates failed to address the question. Instead of explaining how the muscle in the wall of the blood vessel reduced blood flow, they offered general answers covering both vasoconstriction and vasodilation. The term ‘smooth muscle’ also appeared unfamiliar and there were numerous attempts to describe its function in terms of providing a friction-free surface or as being devoid of ribosomes.

(e) Although knowledge of the role of muscle contraction and the resulting vasoconstriction was sound, the same could not be said of the function of elastic tissue. Many of the problems that candidates experienced with this question came from poor use of terminology. The concepts of stretch and recoil were frequently confused with contraction and relaxation.

Q58.

(a) Candidates showed a good understanding of the adaptations of gills for efficient gas exchange. Although there were some who wrote in very general terms about ‘gills’, most candidates linked surface area to the possession of gill filaments or lamellae and to diffusion. The principle of counter-current flow was frequently mentioned and it was clear that most candidates had an excellent understanding of this concept. Some illustrated their answers with diagrams and these were occasionally very helpful.
Candidates should be aware, however, that marks can only be awarded for diagrams that are properly labelled. There were numerous sketches on which were written figures that might have represented anything. Some points were made less frequently or less convincingly. There was relatively little mention of the roles of ventilation and circulation in maintaining the concentration gradient and many struggled to describe the short diffusion path in sufficient detail to gain credit. There were also a number of frequent misconceptions. These included references to air passing over the gills; to diffusion only being able to take place in water, and to the presence of carbon dioxide being essential for the diffusion of oxygen.

(b) Successful responses to this part of the question usually referred to photosynthesis or to the diffusion of oxygen from the higher concentration in the air. There were many answers, however, that involved fanciful ideas about generation of oxygen at depth and this bubbling to the surface, or incorporated the concept of need, such as that there was less oxygen at depth because the toadfish did not need it.

(c) This answer illustrated a common failing among less able candidates in answering questions that involve application of knowledge. They were often inclined to rely on recall and, while most were able to indicate that the toadfish environment was low in oxygen, they not infrequently related this to high altitude. There was also a tendency to give answers that were too brief, omitting reference to the context of low partial pressure when describing the high affinity of toadfish haemoglobin for oxygen.

(d) Answers to this question tended to fall into two categories. Either candidates gave very good answers that made the points in the mark scheme succinctly, or they wrote at length about the three organisms without ever quite answering the question. However, it was encouraging to see many excellent answers to a question set in a context which is new to the specification.

Q59.

(a) Although the responses given by some candidates suggested very limited knowledge of the role of capillaries in the formation of tissue fluid, answers were generally correct. The only incorrect response that occurred with any frequency was

confusion between the terms plasma and blood.

(b) Some candidates clearly experienced difficulties over the meaning of the term “composition” and wrote about plasma being “stickier” or “thicker”. For others, poor quality of written communication was reflected in their responses with it proving difficult to determine whether specific references were to fluid X or to fluid Y. Those candidates who targeted lower concentrations of proteins were usually able to link the difference correctly to molecule size although some answers that followed this approach were over-general and simply discussed “nutrients”. On the other hand, those who discussed smaller molecules frequently encountered difficulties in maintaining the converse argument, that there would be a lower concentration of substances with small molecules in the tissue fluid.

(c) Although there was scope here for most candidates to gain some credit, the examiners were not always convinced that the conflict between hydrostatic pressure and osmosis had been understood. Answers frequently described a water potential gradient that would supplement hydrostatic pressure. Others equated the idea of fluid being forced through the capillary wall with diffusion and osmosis. A significant minority of candidates totally failed to interpret the question and attempted to explain how fluid passed along the length of the capillary.

Q60.

(a) Although there were many correct answers to part (i), incorrect responses were frequent. These generally stemmed from failing to note the information provided in the question. Thus “opening of the atrioventricular valves” was not infrequently given. Part (ii) was deliberately worded to encourage candidates to respond in terms of cause rather than effect. In spite of this, many explained that the valves shut to prevent backflow. Others again failed to note the requirements of the question and described the relative pressures in the atria and the ventricles, rather in arteries and ventricles as was required.

(b) Questions requiring the calculation of rates from information similar to that provided in part (b) are not uncommon. In spite of this, candidates experience considerable difficulties in identifying recurring patterns. Such was the case here, and relatively few were able to determine 0.8 seconds as the starting point for the calculation. Converting this to a rate provided an additional set of problems with many electing to multiply by 60. Having determined the heart rate, most were then able to calculate cardiac output by multiplying heart rate by stroke volume. Candidate’s working frequently failed to show sufficient annotation to indicate to what the various figures referred. It proved difficult to award credit in such cases.

Q61.

(a) It was evident that some of the better candidates were well prepared for dealing with data from oxyhaemoglobin dissociation curves. Errors included misreading the figures from the graph and not knowing how to deal with the 98% saturation figure. Many weak candidates did not even attempt the calculation.

(b) This was very well answered, with full marks being quite common. Since the question referred to a greater fall in pH of the blood during vigorous exercise, a comparative answer was required: thus more carbon dioxide would have been produced due to a faster respiration rate. Most knew that carbon dioxide formed an acid in water and chemical equations showing the formation of carbonic acid and ET ions were quite common. Those for whom vigorous exercise was the immediate clue for the involvement of anaerobic respiration had lactic acid production as a mark-worthy point. However, such candidates often forgot that glucose catabolism in such

circumstances would usually be via a mixture of aerobic and anaerobic processes and so they failed to mention carbon dioxide production and tended to score less well. Some referred to the interaction of ET ions and haemoglobin. Unfortunately, this was irrelevant here as the EE ions would actually be combining with oxyhaemoglobin in the muscle, helping to displace oxygen and hence this would hardly contribute to an increase in ET ion concentration.

Q62.

Unit 8

(a) Most candidates were able to explain that an increase in water temperature would influence a relevant feature such as oxygen solubility or respiration. Answers based on the effect of temperature on the rate of enzyme activity or on metabolism were, however, a little too general, failing to relate to the specific investigation described in the question. There were a few references to ensuring “a fair test”, an entirely inappropriate response at this level.

(b) The responses to this section formed a sharp contrast to the high marks frequently awarded for statistical analysis in coursework. Answers to part (i) were often centre-dependent, some candidates being able to produce a sound null hypothesis; others clearly had little idea. These candidates frequently lacked understanding of the purpose of the investigation or of the concept of a null hypothesis. The weakest responses usually involved equating the expression with an inappropriate statistical formula. In part (ii), many candidates were aware that statistical tests are related to chance, but fewer were able to explain that such tests give a measure of the probability that chance might account for the results obtained.

(c) Most candidates correctly identified A as the more likely explanation and were able to justify their choice.

(d) Better candidates were able to produce in a logical account in which they successfully linked a lower oxygen concentration to anaerobic respiration and the production of lactic acid. Others revealed a disturbing lack of understanding of respiratory biochemistry, suggesting that the evolution of carbon dioxide was entirely independent of the consumption of oxygen. They inevitably based their answers on an argument that, despite reduced oxygen, fish must continue to respire aerobically, so there would be an increase in carbon dioxide. There were occasional references to supposed chemical effects of zinc.

(e) The best candidates used common sense in part (i) and, realising that the only elements that were concentrated were copper and cadmium, calculated appropriate ratios for these ions. Credit was also given to those who supported their conclusions by calculating the inverse. A significant number, however, merely subtracted the relevant values from each other, an approach which inevitably led to an incorrect answer. The examiners were instructed to be generous in marking the calculations and undertook much work in interpreting confusing presentation. Centres would do well to advise candidates that it is their responsibility to present material sufficiently clearly that the logic of the response can be followed. In part (ii), most recognised that lead ions would be egested or excreted, although there was some incorrect usage of these terms. Most candidates were aware, in part (iii), that woodlice would concentrate copper. The principle of bioaccumulation was often correctly described but not always related to eating a large number of leaves. Weaker candidates frequently referred to additional sources of copper ions or to the intriguing possibility of copper ions multiplying within the body of the woodlouse.

(f) Mutation figured widely in the responses to part (i), although there were occasional

incorrect references to natural selection or to the presence of arsenic causing the allele to first arise. Although there were a number of rather vague references to growth and formation of new cells, the majority of candidates were able to identify two specific effects of phosphates in part (ii). Answers to part (iii) were frequently marred by a failure to answer the question and explain why arsenic-tolerant plants were unable to compete in the conditions described. Candidates referred to both arsenic-tolerant and non-tolerant plants as “they” and it was often far from clear as to which they were referring. However, it was encouraging to note that, although this question was targeted specifically at Grade A candidates, many others were able to suggest that arsenic-tolerant plants would not grow as well because they were unable to take up sufficient phosphates.

Unit 9

(a) Candidates offered a range of explanations, suggesting that the air mixed the water, that it affected the zinc, and that it was needed to make the test fair. Few candidates earned a mark; those that did suggested that oxygen would no longer be a limiting factor. Links were rarely made with the effect it would have on the saturation of the haemoglobin.

(b) (i) A large number of individuals know from their coursework that the term ‘null hypothesis’ implies ‘no difference’, but they did not always recognise where this lack of difference might lie. Weaker candidates made comments about chance. The commonest error was to devise a hypothesis relating to gas exchange and respiration.

(ii) Many commented on the need to look for effects that are due to chance. Some quoted significance levels, but failed to mention probability. Many referred to establishing levels of accuracy, and a few made statements about the null hypothesis. It was disappointing to note that large numbers of candidates are able to suggest null hypotheses in their coursework but are unable to apply these statistical skills to material presented in an unfamiliar context.

(c) Most candidates recognised the answer as A, and were able to use the graph to explain their choice. Those that could not were vague in their answers.

(d) Unless candidates recognised that there was less oxygen available to the cells they were inclined to answer irrelevantly. The best recognised the anaerobic respiration that would ensue, and therefore lactic acid would be produced. Some wrote of haemoglobin as a buffer, but failed to recognise that it would be the extra hydrogen ions which affected the pH not those absorbed through the buffer. Weaker candidates were confused over the numbering of the pH scale. They thought that zinc affected the pH of the water, or that zinc caused haemoglobin to pick up fewer hydrogen ions from the water.

(e) (i) The calculations were absent in some cases, and very varied where present. Simple ratios were the best idea, but some even calculated standard deviations. Subtractions were also fine. Many candidates had no idea what to calculate. The commonest response was to find the mean concentration of cadmium and copper in shrews, without any reference to the levels in the source of food. Many gave calculations without saying what they were, leaving the examiner to guess. The weakest candidates mis-read the data as numbers of shrews or numbers of ions. Despite poor performances on the supporting mathematics, many candidates could comment on the relative concentrations.

(ii) The fate of the ions was mixed. There appears to be widespread confusion over egestion and excretion and the fact that ions have to be absorbed before

they can be used appears to have escaped some. Weaker candidates were of the opinion that the copper ions could be broken down.

(iii) Candidates had little understanding of the ways in which ions accumulate through diet.

(f) (i) Most candidates correctly identified mutations as the cause of the allele arising, but some offered a choice to the examiner regarding natural selection.

(ii) Likewise, most candidates were able to name two functions of phosphates. A few were confused with protein synthesis. Some answered too vaguely with 'membranes', iii). This part of the question presented difficulties to many and only the better candidates directed their responses appropriately. There were many vague references to "fogs" and inappropriate set-piece answers on inheritance.

Q63.

(a) The better candidates described the role of arterioles in terms of vasoconstriction and the contraction of muscle in the walls. Many answers however, lacked appropriate detail, often offering little more than the fact that arterioles transported blood to capillaries.

(b) Part (i) was usually well answered with most candidates able to describe the difference in blood flow in the organisms concerned. Those marks that were withheld usually resulted from uncertainty over which animal was being considered. In part (ii), better candidates built on their previous answer and were able to suggest that this led to seals being able to stay under water for longer even though the physiological explanation did not always impress. The main reasons for failing to gain credit here were either through contradiction of the point that had clearly been made in the answer to part (i), or in failing to add significantly to information already provided in the question. Thus there were many references to a reduction in blood flow to the swimming muscles but few to oxygen supply.

Q64.

(a) Those candidates who understood the diagram correctly selected times of 0.1 or 0.9 s. Others demonstrated their lack of understanding by producing a variety of single values and ranges.

(b) This question was not well answered. Those who correctly identified the length of a single cardiac cycle as 0.8 s frequently encountered difficulty in converting this figure into a rate, often arriving at the value of 48 by multiplying the length of the cycle by 60. Candidates would be well advised to test their answers against their everyday experience. It is possible that by doing this some might recognise an unlikely figure as resulting from an error in calculation.

(c) Those who offered a comparative statement in part (i) generally produced correct answers. Part (ii) was also answered well.

(d) Although some, often more able, candidates offered an explanation rather than a description, it was encouraging to note the considerable number who gave a clear description of the relationship between stroke volume and venous blood pressure, and were able to relate the change in gradient of the curve to precisely quoted values from the axes. However, there were also many candidates who either failed to understand the data provided, equating, for example, stroke volume with the likelihood of suffering from a stroke. Others simply misread the graph.

(e) Given the reassurance of a formula, many candidates answered this question correctly. There were, however, a number of bizarre answers which defied explanation other than mathematical ineptitude. There were also some candidates who clearly did not appreciate the relationship between the cardiac cycle and ventricular contraction and divided an otherwise correct answer by two.

(f) There were two main approaches adopted to this question. A considerable number of candidates took the question as an opportunity to display their knowledge of the pathways by which the blood circulates in the body. Such answers were often very poor, and the paths described involved the return of the blood through sundry named veins, organs and arteries. Others attempted a more sensible approach. These candidates were generally aware of the action of muscle pumps and the role of valves in preventing backflow. The best answers incorporated considerable extra detail about, for example, the role of residual arterial pressure and of negative pressure in the chest resulting from inspiration.

Q65.

(a) Although candidates clearly understood what the graph showed, only the minority actually used it to quantify their answers in part (i). There were many very vague responses to part (ii). Few candidates correctly linked the effect of the men's knowledge of which pill they had taken on their subsequent heart rate. Many vague answers simply stated it would affect results.

(b) Part (i) produced many correct responses. One common error involved statements linking reduction in mortality and age that went well beyond the table provided. Examiners were looking for a statement that related to the age groups shown in the table. Part (ii) proved a bridge too far for most candidates and they could not explain the calculation that should be performed.

Q66.

The examiners were pleased to note some evidence of an improved understanding of those aspects of physiology tested in this question. With the notable exception of part (a) (ii), there were many excellent answers.

(a) (i) Most candidates were able to select the relevant blood vessels although, occasionally, the only reference was to vessel **C**.

(ii) It was hoped that the wording would have steered candidates towards identifying the difference in the musculature of the ventricle walls as the cause of the pressure difference. A significant number of responses, however, were based on the importance of the difference.

(b) Candidates clearly need more guidance from centres in approaching questions which require an explanation of cause. There were also errors associated with a poor grasp of the underlying physiology with references either to the contraction or pumping of blood vessels, or to differences in oxygen concentration as the significant factor. The majority of candidates correctly identified the atrial pressure as being higher than that in the ventricles and could usually refer to the open atrioventricular valves as providing the necessary evidence.

(c) It was encouraging to note the many excellent answers which conveyed a sound understanding of the mechanism of coordination and control of the heart beat. There were occasional references to blood flowing from the ventricles to the atria but credit was generally only withheld from those candidates who were able to provide part of the answer.

(i) References to allowing time for the ventricles to fill were not always followed by a comment on their subsequent contraction.

(ii) The less convincing answers tended to rephrase the question instead of referring to the significance of the ventricles contracting from the base.

Q67.

(a) Answers emphasised that the term “organ” is better defined in terms of structure than function.

Answers such as that an organ has a “specific function” are true of all levels of organisation from molecule to system.

(b) (i) Required candidates to draw on the information in the table and their understanding of the structure of capillary walls to suggest the required figure. Better candidates had no difficulty in arriving at an answer of 20 μm. Those candidates who appreciated that this was considerably larger than the value they might have expected were also given credit, as long as their responses were suitably explained.

(ii) Incorrect answers were frequent, commonly resulting from either the inability to convert micrometres to millimetres, or to a failure to appreciate that the wall completely surrounds the lumen.

(c) Produced numerous answers which were based on the use of inappropriate terminology.

Candidates should be advised to refer to elastic tissue stretching and recoiling, reserving the terms contracting and relaxing for muscle.

Q68.

(a) Many candidates obtained the correct answer and were awarded both marking points. The problems encountered by the others usually involved converting the units. Most had the right numbers but the decimal point was in the wrong place in nearly half of them. A small proportion of candidates reversed numerator and denominator.

(b) Most candidates were on the right lines here but few expressed themselves well enough to get all three marks. There were many poorly expressed answers which often failed to make the necessary comparative statement. Shrews living at high altitudes and flying shrews featured in a number of scripts as did the Bohr shift, despite the information given. Generally candidates understood the principle but experienced difficulties expressing it.

It is worth noting that the better candidates usually produced succinct answers which gained all three marks.

Q69.

(a) Most candidates recognised that contraction of the atrium would be accompanied by an increase in the volume of the ventricle and identified this as happening between 0.2 and 0.6 seconds.

(b) What should have been two straightforward calculations proved too demanding for many. In part (i), there appeared to have been a variety of reasons for this. Some

candidates clearly did not understand what was meant by heart rate or stroke volume and were also seemingly unaware that the required figures could be obtained from the graph. Others experienced difficulty in recognising that a repeated pattern of volume changes represented a single heart beat. Even where this was determined as 0.8 seconds, they were at some loss as to know how to convert this figure to heart rate and, more often than not, multiplied by 60. Part (ii) was a simple matter of reading the difference between 60cm^3 and 130 cm^3. There were very few correct answers, many of the incorrect responses falling into one of two categories, either misreading the maximum volume as 125 cm^3 or neglecting to subtract the volume of blood remaining in the ventricle.

(c) Most gave the correct answer here, usually phrased in terms of 'timesing' one by the other.

(d) Most candidates realised that the blood flow to the brain remains fairly constant and suggested a rate of flow of 750 cm^3 $minute^{-1}$. However, there were those who were of the opinion that it was substantially increased or decreased.

(e) Most candidates simplified the figures in calculating the ratio but then reversed them. This particular question clearly stated that the ratio required was that of blood flow during exercise to blood flow at rest. As such, the correct answer was 4 : 1 not 1 : 4. It should have been possible to have used this figure in part (ii) to calculate the flow to the heart muscle during vigorous exercise. Although there were many correct answers, many failed to take note of the condition of exercise and produced an answer of 4.5 cm^3.

Q70.

Unit 6

(a) While the vast majority recognised that peak **B** on the graph represented contraction of the ventricle, their stated reasons often lacked clarity. Most did observe correctly that it contracted with more force than that shown in peak **A** and that it occurred immediately after peak **A** (i.e. the atrium).

(b) Here, most candidates were unable to measure accurately from the graph the time taken for a single cardiac cycle. Since individual cycles varied slightly in length, the wisest move would have been to measure the time taken for all 5 cycles printed on the graph in order to determine a mean value which could then have been used to find the heart rate per minute. Additionally, some made basic arithmetic errors.

(c) In (i), most deduced correctly that heart rate was slowed down by acetylcholine, but many thought that the stroke volume was also reduced (or, occasionally, even increased) rather than remaining unchanged. In (ii), many referred correctly to the simple formula, cardiac output = heart rate x stroke volume and, provided their answer was consistent with that from part (i), credit was given. In (iii), most knew that acetylcholine was the neurotransmitter for the parasympathetic branch of the autonomic nervous system.

(d) Although most had the right idea in section (i), many gave a very incomplete account and filled the given space with irrelevancies. Many also gave greater prominence to the hypothalamus than to the medulla oblongata as the coordinating centre in the brain. Many insisted that 'an impulse' (rather than many) was sent along the sympathetic nerve (which was confused with the 'vagus' and even the 'phrenic' nerve). Most knew the SAN was involved, a few that noradrenaline was released from the nerve endings (although some confused this with 'adrenaline' from the blood). Very few mentioned that the SAN would increase its rate of

discharge, but most knew that the heart rate and, for some, the stroke volume would be increased.
In (ii), most concentrated, as ever, on the need for increased oxygen supply during exercise. A fair proportion did remember to include also the removal of carbon dioxide, lactate, or heat. Often, as in question 2 (b), the purpose of extra energy release from an increased rate of respiration, was overlooked.

Unit 7

(a) The correct identification of B as the ventricles was necessary to obtain either of the two marks available for this section. Some candidates stated that the higher peak of B showed the greater pressure developed in the ventricles displaying that they had not read the axis labels on the graph with sufficient care.

(b) This calculation was attempted by more candidates than the first and more correct answers were observed. Although the question clearly required data to be extracted from the first graph some candidates based their calculations on data they had obtained from the second graph.

(c) In part (i), heart rate was usually identified as decreasing but stroke volume was often incorrectly referred to as increasing. It appeared that candidates were looking at the relative differences in the peaks of A and B instead of judging the position of peak B against the y axis. As part (ii) relied on answers given in part (i), correct explanations of incorrect initial responses were able to obtain the mark and often did. Several candidates did not offer any more detail than the statement 'it went down' and were not able to obtain the mark as they had clearly been asked to use their answers from (i) to produce an explanation. Part (iii) was answered correctly by many candidates.

(d) Some candidates lost credit through wrongly associating the responses with the hypothalamus. Many good answers were seen to this question though the context of the release of noradrenaline was not always clear. Part (ii) produced many three-mark responses and weaker candidates were usually able to obtain marks here. Some obtained two of the marks but failed to obtain the third because removal of carbon dioxide or an equivalent waste material was not considered.

Q71.

(a) A number of candidates either failed to read the question with sufficient care, or chose to ignore the instruction about shape, and produced inappropriate answers relating to the absence of a nucleus or the possession of haemoglobin. Those who confined their answers to relevant points usually referred to the surface area of the cell, unfortunately frequently stopping short of a reference to the all-important principle of the surface-area to volume ratio. The role of diffusion in the uptake of oxygen was seldom mentioned.

(b) Although it was clear from the answers to part (i) that most candidates recognised that osmosis accounted for the shrinkage of the cells in the sample, few were able to draw the conclusion that the plasma membrane was partially permeable. Candidates seldom went further than to explain that the observation resulted from water loss, or reflected a thin membrane. Less able candidates also attempted to explain the role of detergent in terms of osmosis. Of those who recognised that a lipid solvent would dissolve the phospholipids present in the plasma membrane, few provided a satisfactory explanation of the result. There were a number of incorrect references to the leakage of organelles from the cell accounting for the red coloration.

Q72.

(a) Although many candidates gained the mark in part (i), others failed either to identify the trend or offered interpretations not in keeping with the data provided. Thus there were numerous answers which were based on highly regimented views of sleeping and waking hours, but made no reference to specific times. The answer to part (ii) should have been straightforward, but many clearly interpreted the term cardiac cycle as referring to long-term events associated with the heart. Others clearly understood the underlying concept but confused atria and ventricles, or systole and diastole. Part (iii) produced some sound answers, although a number of candidates simply produced the converse statement for the second point. There were, for example, numerous references to a lower pressure in the vein for the first point and a higher pressure in the artery for the second. A popular misconception was that the pressure in the vein varied more as a result of valve action.

(b) QCA's performance descriptors for candidates expected to gain a grade E indicate that they should be able to describe trends and patterns shown in data presented as tables and graphs. The answers to part (i) indicated that candidates across the entire ability range have difficulties with this skill. Most noted a decrease in permeability with increasing relative molecular mass, but many either described this in terms of cell walls or failed to note that the capillary wall was completely impermeable to molecules of the size of albumin and above. The concept of tissue fluid formation is still poorly understood by many and in the case of part (ii) this was compounded by a failure to take sufficient note of the requirements of the question. Many candidates clearly sought to repeat earlier mark schemes and often described at considerable length the formation and reabsorption of tissue fluid. There was also much confusion over which end of the capillary was under consideration and a widespread failure to use any of the information provided. In part (iii), those candidates who were aware that red blood cells contain haemoglobin could generally offer a sensible explanation for its absence from tissue fluid. Others attempted a functional approach and displayed an alarming lack of understanding.

Q73.

(a) A good number of candidates knew that the quaternary structure of a haemoglobin molecule involved the association of four polypeptide chains. Some failed to gain the mark by stating that four *proteins* were associated and some just wrote four 'units', which was clearly insufficient. A few candidates suggested that the quaternary structure is the fourth dimension of protein structure.

(b) There were some very good accounts of how hydrogen ions (produced as a result of the increased carbon dioxide concentration in active tissues) lead to the increased dissociation of oxyhaemoglobin; the oxygen so released diffuses down a concentration gradient from the cell, through the plasma and into the respiring cells.

(c) Most candidates knew that the amino acids formed as a result of the breakdown of haemoglobin are used to synthesise new proteins. Some gave examples and some also knew that these amino acids may be deaminated and the keto acid formed used as a respiratory substrate. Some displayed a basic lack of understanding by suggesting that the amino acids could be used to from urea.

Q74.

(a) Candidates experienced difficulties here and few were able to obtain full credit. Even the best candidates occasionally failed to appreciate that plasma did not contain haemoglobin. It was surprising, however, how many other incorrect responses were also given.

(b) A pleasing number of candidates recognised the relationship between hydrostatic pressure and the effect of osmosis, and many appreciated that the result of this was to force something from the blood. Understanding of the composition of tissue fluid, however, left much to be desired and few could describe precisely what was forced from the blood.

Q75.

(a) Candidates who were aware of the basic structure of the heart and the events of the cardiac cycle had little difficulty in equating the increase in arterial blood pressure with ventricular contraction. Incorrect responses usually centred round atrial contraction.

(b) There were inevitably many references to the contraction and relaxation of elastic fibres and this was sometimes associated with pumping blood through the arteries. Relatively few expressed their answers in terms of stretching and recoiling. The relationship between the structure of blood vessels and their function remains an area of the specification where there is much uncertainty.

(c) Perhaps half of the candidates who entered for this Unit test included an appropriate reference to endothelia (or epithelia). Others identified the lumen as part of the wall structure and there were occasional references to the presence of muscle in both artery and capillary walls.

Q76.

(a) Problems only arose where candidates attempted to define organs in terms of function. Such definitions were either too general in that they could apply to any level of organisation from molecule upwards, or they were only related to the circulatory system. Organs are better defined in terms of tissues. Better candidates almost invariably adopted this approach.

(b) Many candidates clearly approached this question by simply identifying times when the volume of blood in the left ventricle was the same. Applying this principle without appreciating the overall pattern of change led to a range of incorrect answers including 0.2, 0.7 and 1.0 seconds. Others attempted to convert the cycle length to a rate.

(c) Although many candidates were aware of the synchronous beating of both sides of the heart, a considerable number gave an answer of 0.9 seconds. They reasoned that the time when there was least blood in one side of the heart would correspond to the period of maximum volume in the other.

(d) There were two major sources of error in this part of the question. Many of the less able candidates were unable to find an appropriate way of expressing the required range of times and produced a string of figures which were open to various interpretations. Others failed to link their answers to the information provided. They offered explanations which either were not associated with a change in volume or were expressed in terms of consequence, using such phrases as that the valves were open “to prevent backflow”.

(e) Many candidates were able to arrive at the correct answer to this question, albeit by circuitous means on some occasions. A sizeable minority gave the answer as 22.2% as they had subtracted 35 from 45 and calculated this difference as a percentage of 45.

Q77.

In part (i) most candidates were aware that there are differences in the figures for men and women. However, despite being asked to use an example from the tables, many failed to do so. In part (ii) many candidates were aware that percentages lead to ease of comparison, but few referred to differing sample sizes.

Q78.

(a) A wide range of descriptions was accepted, though some candidates failed to be precise enough to be awarded a mark.

(b) Few candidates answered this question correctly and, from the working given and marks made on the graphs, there was clear evidence that many were not comfortable with analysing information presented graphically.

(c) The question clearly required consideration of the differences shown in the table. This caused problems for the candidates because only three values in the table showed differences, therefore responses should have been restricted to explaining these three differences. Very few candidates scored four marks for this question because they simply gave an explanation for the four factors in the table and did not provide the additional depth required on any of the three differences.

(d) The principle of the Bohr shift was well explained and two marks were commonly awarded. Some candidates made an attempt to relate affinity to curve position but failed to show real understanding of the processes involved.

(e) It was good to see many candidates recording their working clearly. They were able to score a mark for working despite in some cases producing incorrect answers. The most common error was only to take into account oxygen transported as oxyhaemoglobin.

(f) There were few answers worthy of credit given in response to this question. In general candidates failed to appreciate that haemoglobin is saturated with oxygen in the lungs whilst exercising and breathing normal atmospheric air. Failure to start from this point meant few scored marks here.

(g) A well answered question. References to veins redistributing blood flow were common, particularly from weaker candidates.

Q79.

(a) Most candidates were able to use the graph to determine the time when the semilunar valves close and to calculate heart rate. The most common error was inaccurate reading of the graph when calculating heart rate. Only the more able candidates were able to calculate the total time that blood flows out of the left side of the heart in part (iii).

(b) Many candidates incorrectly identified curve **X** as being the left atrium. Better candidates were able to identify curve **X** as the right ventricle and explain this in terms of the curve having the same pattern as the left ventricle but with a lower pressure.

(c) The majority of candidates were able to attain the two marks by explaining how training leads to an increase in stroke volume because of an increased strength or size of heart muscle. However, weaker candidates made vague references to the heart getting stronger with no mention of heart muscle or strength of contraction.

Q80.

(a) Many candidates were unable to provide an accurate description of the changes in speed of blood flow. Many answers incorrectly referred to the speed of flow decreasing in capillaries rather than arterioles as shown in the graph. More able candidates provided a clear description in terms of a slow decrease in speed and then a rapid decrease as blood reaches the arterioles. Very few candidates went on to explain how increased friction or an increase in cross sectional area affects the speed of flow.

(b) Many candidates were able to explain how fluctuations in pressure are reduced by the stretch and recoil of the elastic tissue in artery walls.

(c) This was well answered by most candidates. However, candidates frequently failed to gain marks by a lack of accuracy such as referring to 'thin capillaries' or 'capillaries are one cell thick' with no mention of the capillary wall. Some candidates even referred to 'thin cell walls'. Better candidates linked the one cell thick endothelium to a short diffusion pathway.

(d) Many candidates were confused by this question. Only the most able candidates linked the larger lumen of the pulmonary vein to an increase in blood volume.

Q81.

(a) As in previous years, many candidates had difficulty explaining oxygen haemoglobin dissociation curves. Most candidates explained that the haemoglobin of species **A** has a greater affinity for oxygen. Few went on to state that this enables species **A** to supply enough oxygen to its tissues even in a low oxygen environment. Contradictory statements such as 'haemoglobin of species A has a high affinity therefore dissociates more readily' indicated the lack of understanding of this topic.

(b) Most candidates were able to explain that the oxyhaemoglobin in species **B** dissociates more readily. Only the very able candidates related dissociation to species **B** being more active and therefore having a greater rate of respiration requiring more oxygen.

Q82.

(a) This was a very well answered question with many good candidates scoring full marks. Most candidates explained how high pressure stimulates pressure receptors which send impulses to the cardio-inhibitory centre. More able candidates developed their answer to explain how the sino atrial node is affected by impulses carried by parasympathetic nerves and how this leads to decreased stimulation of the atrioventricular node.

(b) Most candidates recognised that the drugs reduced blood pressure by lowering heart rate. Better candidates were able to use the information in the question to explain that the drugs operate by inhibiting impulses in sympathetic nerves, so that the sinoatrial node is not stimulated.

Q83.

(a) Part (i) was correctly answered by most candidates. A common error was naming the structure as a semi-lunar valve. Most candidates were able to score half marks in part (ii) by correctly explaining how the valve closes. Only the most able candidates were able to explain how the heart cords prevented the valve opening the wrong way. Many candidates answered the question by referring only to the valve with no reference to structure Y. Weaker answers confused the cords with the valve

(b) The majority of candidates correctly identified the heart as being in stage B in part (i). While many candidates scored full marks in part (ii), a very common error was the failure to recognise that the ventricles were contracting for 0.5 seconds in a cycle that lasts for 0.8 seconds and, consequently, an incorrect answer of 30 seconds was relatively common.

Q84.

(a) This was correctly answered by most candidates, although a significant number identified X as tissue fluid or even plasma.

(b) Most candidates gained a mark, although a number correctly drew the arrow but then failed to give an adequate description of the evidence, therefore failing to gain credit.

(c) This was a high scoring question. Many candidates showed a good understanding of how water is exchanged. However, only the most able gave explanations relating hydrostatic pressure changes with the changes in water potential along the capillary. Similarly, only the better candidates explained the role of plasma proteins in venous return.

(d) This topic appeared poorly understood with only the best candidates scoring full marks. Many candidates had difficulty explaining the differences in the two curves with regard to unloading tensions. Many candidates correctly explained that shrew haemoglobin has a lower affinity to oxygen, but only the more able went on to explain the significance of this is terms of saturation and partial pressure, and how this gives the shrew an advantage. Confused references to the relative affinity of haemoglobin to oxygen were common.

Q85.

This question discriminated well, rewarding those who knew the basics of heart anatomy and heart function and those who could apply this understanding in a novel context.

(a) A surprisingly high proportion of candidates failed to state ‘left’ ventricle, which was needed to achieve the mark. Many confused ventricles with atria.

(b) (i) This was answered well by the majority of candidates. Some correctly referred

to ‘diastole’ in their answer, which is not a term required in this specification.

(ii) Relatively few candidates achieved both marks, often by incorrectly involving elastic tissue in muscle function. Many failed to apply their understanding to the action of the aorta, but tried to explain how heart activity prevented blood pressure falling or how the closing of heart valves somehow maintained blood pressure.

(c) Many candidates understood how to perform this calculation, including the need to convert the time unit from milliseconds to seconds, but using the graph to determine the time of a single heartbeat proved to be the downfall for many.

(d) This calculation was much more accessible to many candidates, and it was often the only marks achieved on this question. It appears the mathematical skill required to rearrange the components of an equation is understood well by most candidates.

Q86.

(a) Very few candidates considered the full context of this question in their answer. Most gained credit for making an appropriate link between the reduction in haemoglobin’s affinity for oxygen and its ability to unload oxygen more readily, but why it is advantageous to tissue cells for oxygen to be readily unloaded when the pH of plasma is low was not often considered.

(b) (i) The increased affinity of haemoglobin for oxygen in animals whose habitats occur at high altitudes is understood well by the majority of candidates. Unfortunately, very few candidates were able to apply this understanding to the context of the question, i.e. that it is essential if sufficient oxygen is going to reach (respiring) tissue cells when the partial pressure of oxygen in the air breathed by the animal is low.

(ii) This was answered well by the majority of candidates.

Q87.

(a) Few candidates gave the correct answer, with a strong centre-dependent effect. Candidates’ incorrect answers included endodermis, epithelium, mucosa, muscle layer or pericycle.

(b) Most candidates were able to describe the role of the elastic tissue in maintaining blood pressure, or in smoothing the flow of blood by elastic recoil. In some poorly expressed answers, the role of elastic tissue was too similar to that for a muscle for a mark to be awarded. The concept of ‘contraction’ was used loosely by some candidates, whilst others had the misconception that elastic tissue is able to contract.

(c) Most candidates measured the diameter of the artery lumen accurately but many then used this in the calculation, rather than the radius. Only the most able candidates made allowance for the magnification (factor) given in the diagram. For many candidates a correct calculation was the only mark achieved for this question. Only the most able candidates were able to gain all three marks because they allowed for the magnification given in the diagram.

Q88.

(a) Most candidates understand why blood must be continually delivered to tissue cells. Many identified oxygen or glucose as requirements for respiration or to allow growth

in the developing lung. Vague answers that failed to state the purpose of the blood supply were not uncommon. The presence of gas exchange in the lungs of a fetus was quite a common misconception.

(b) (i) The majority of candidates did not read the graph with enough care. If interpolation lines were used, they tended to obscure the fine detail of the graph and helped to generate inaccuracies in the readings taken from the graph. The answer, 64%, was a common error resulting from a lack of precision when reading the graph.

(ii) As in previous years, many candidates had difficulty explaining the significance of the relative position of dissociation curves. More able candidates could relate the position of the fetal haemoglobin dissociation curve to its greater affinity for oxygen, but few went on to explain how this enabled the loading of oxygen from the mother's haemoglobin.

Q89.

(a) Many candidates achieved maximum marks for this question. The large number of good answers indicated that the topic of heart rate control is well understood by the majority of candidates. Most candidates were able to relate the increase in respiration to an increase in blood carbon dioxide concentration and go on to explain how this is detected and coordinated. Only the most able candidates were able to relate the increase in heart rate to the increased frequency of impulses along the sympathetic nerve supply to the SAN.

(b) (i) Most candidates gained full marks for this question by being able to describe the role of the AVN and the bundle of His.

(ii) Many candidates observed from the ECG traces that there was no change in the electrical activity of the atria. Only more able candidates linked this to the location of the SAN in the wall of the right atrium.

Q90.

It was pleasing to find a higher proportion of candidates performing well on this question than had been anticipated, and a considerable number gained at least 6 or 7 marks. In particular, an encouraging number managed to get to grips with part (c), although often the weakest candidates made no attempt.

(a) Most candidates answered both parts well.

(b) (i) The majority gained a mark, but a significant number merely stated that caffeine improved performance without describing how. Some recited all the results from the table, including the glycerol and fatty acid concentrations, and were disqualified from the mark.

(ii) A good proportion recognised that the glycerol and fatty acids would have been derived from the breakdown of fats, for which they gained credit. Very few appreciated that the fats would be likely to have come from fat stores in the body rather than from, for example, the caffeine. A number proposed explanations in terms of more fats or fatty acids being 'needed' in order to be able to exercise for longer.

(c) (i) Many realised that the equation showed that the volume of oxygen absorbed was the same as the volume of carbon dioxide given out. Not all went on to explain how this ratio gave an RQ value of 1.0. It was encouraging, however,

to see that many candidates explained their answer in terms of moles. Inevitably, a proportion of candidates ignored the equation altogether and suggested, for example, that a value of 1.0 was chosen because glucose is what is normally used in respiration.

(ii) Many of the better candidates provided good explanations, citing the evidence that the RQ being closer to 0.7 when caffeine was taken, showed that fatty acids were being respired. Fewer actually pointed out that glycogen would be broken down to glucose, and that an RQ closer to 1.0 would suggest that the glycogen stores would be used more rapidly. Credit was awarded for those who pointed out that the longer time to exhaustion would in itself suggest that glycogen stores were being used more slowly. Weaker candidates often ignored reference to the data and tried to offer explanations based on time spent on anaerobic respiration, or the overall rate of respiration being slower after drinking coffee. Many confused glycerol and glycogen, or assumed they were the same substance.

Q91.

Overall this was very well answered with many candidates attaining maximum marks.

(a) Many candidates correctly identified the contraction of the heart as the cause of the pressure. However, too many gave the type of pressure represented, i.e. hydrostatic pressure, rather than its cause.

(b) Able candidates answered this well with clear explanations of the roles of both hydrostatic pressure and water potential. Weaker answers explained the loss of water only in terms of high hydrostatic pressure or only gave vague references to water potential. A common misconception was that water moves out of the capillary down a water potential gradient when in fact it is being moved against the water potential gradient. Often the term ‘pressure’ was used, rather than ‘hydrostatic pressure’ or ‘blood pressure’.

(c) Most candidates were able to describe the role of the lymphatic system in dealing with the ‘extra fluid’, but did not specify the destination of that fluid. Although it was accepted in the mark scheme that lymph was returned ‘to the blood’ it was disappointing to note that many candidates wrote that lymphatic fluid returned to a range of incorrect vessels. Some candidates incorrectly suggested that lacteals and the digestive system are involved in absorbing and breaking down the tissue fluid.

(d) Only the more able candidates were able to attain two marks by accurately explaining how a shortage of dietary protein affects the water potential gradient between blood plasma and tissue fluid. Weaker answers frequently gave vague references to ‘concentration gradients’ without making it clear whether the concentration was water or protein. Many failed to indicate the direction of the gradient. Some weaker candidates gave answers in terms of lack of protein carriers in the membranes of capillaries or the cells making up the tissue.

Q92.

Many candidates attained good marks for this question, showing an understanding of the oxygen haemoglobin dissociation curves presented. However only the better candidates attained maximum marks by being able to explain clearly how the relationship between the percentage saturation of haemoglobin and oxygen partial pressure gave an advantage to the fetus or to the adult during exercise.

(a) (i) Although most candidates answered this with an appropriate calculation, there

were many examples which fell outside the accepted range due to inaccurate reading of the graph. A few candidates attempted to answer in prose and failed to give a figure.

(ii) Many candidates explained that fetal haemoglobin has a high affinity for oxygen, but only the better candidates went on to explain that this means that fetal haemoglobin takes up oxygen when adult oxygen haemoglobin dissociates.

(b) (i) Many candidates were able to draw correctly the change in the position of the curve as a result of vigorous exercise; however a significant number sketched a shift to the left.

(ii) Whilst most candidates explained the advantage of this change in terms of oxygen haemoglobin releasing more oxygen to the cells, only the most able related this to the fact that this amount of oxygen was released at a higher partial pressure of oxygen. A sizeable proportion of candidates referred incorrectly to the oxyhaemoglobin loading more easily or having a higher affinity for oxygen and so being able to carry more around the body.

Q93.

This question was well answered with many attaining very high marks.

(a) (i) This was well done, with many candidates giving the correct answer.

(ii) It is surprising that many candidates had difficulty applying their understanding of the cardiac cycle to interpret the data provided, as only the more able candidates gave the correct response. Ranges of 0.2 – 0.3 or 0.3 – 0.4 were frequently given rather than the correct maximum range of 0.2 – 0.4.

(b) This question was well answered, although there were many answers referring to blood from the left ventricle going all round the body rather than giving the cause of the difference in pressure as asked. Candidates failed to gain credit here by not specifying more muscle, but writing in rather more general terms of ‘bigger’ or ‘stronger’.

(c) This question was well answered by only the better candidates. Many answers simply gave an explanation of how the structures of the blood vessels are related to their function, without any reference to the information provided in the table. Many candidates gave a good explanation of how the structure of capillaries is related to their function but the structure and function of arteries and veins was less well understood. Some candidates incorrectly thought that veins actively pump blood back to the heart using their muscle layer. Answers frequently referred to the thick wall of arteries, but only the most able candidates gave answers relating the amount of muscle or elastic tissue to the function of these vessels. Although reference was made to elastic tissue smoothing out blood flow or maintaining pressure, it was rarely linked to more or thicker elastic or muscle tissue in the arteries as seen in the table. Many candidates also failed to gain marks because they wrote about thick or thin vessels and compared the diameter of the lumens when the question required a comparison of the walls.

Q94.

Most candidates scored highly on this question, with only the weakest having problems.

(a) Few candidates were unable to identify the blood vessel labelled X and the

substances it carried.

(b) Most correctly identified the small diameter of capillaries as a cause of slow flow rate, but only the more able candidates were able to relate the small diameter to increased friction or resistance.

(c) Again most were able to identify the type of blood vessel in part (i) but part (ii) discriminated well with only the more able candidates being able to explain fully the role of elastic tissue in smoothing out the flow of blood. Many candidates correctly described that elastic tissue expands and recoils but only the better candidates explained that the expansion of arteries accommodates increased blood flow, and recoil when blood flow decreases. Errors such as elastic tissue contracting and relaxing were common.

Q95.

Answers to this question indicate that many candidates have a good knowledge and understanding of the events occurring during the cardiac cycle.

(a) Many answers correctly identified the thinner muscle wall of the atrium as the cause of the lower pressure.

(b) Many candidates scored maximum marks but there were some answers with vague explanations. For example, in part (i) good candidates correctly stated that the evidence from the graph is that the pressure in the left ventricle is *higher* than the pressure in the left atrium but many answers gave vague references to the pressure in the ventricle increasing and the pressure in the atrium decreasing. In part (ii) good answers correctly identified closing of the semi-lunar valves as the second heart sound, which was caused by the pressure in the aorta rising above the pressure in the ventricle.

Q96.

(a) In part (i) most candidates were able to identify the position of the dissociation curve at pH 7. 2. However, in part (ii) only the most able candidates were able to explain how the pH change affects the supply of oxygen to tissues. Many answers correctly explained how the pH change causes more oxygen to be unloaded, but very few answers related this to the oxygen haemoglobin dissociation curve.

(b) There were many very good answers with clear explanations of how an increase in the rate of respiration leads to a decrease in pH.

Q97.

There were many very clear and accurate answers to both parts (a) and (b), showing an excellent understanding and a high standard of communication skills.

(a) This part of the question required candidates to describe and explain the features of a single capillary, which adapt it for exchange. Good answers described a feature, such as a wall, which is only one cell thick, and then explained how it enables efficient exchange, such as the reduction of diffusion distance. Many answers described a feature but then gave an incomplete explanation, such as ‘makes diffusion more efficient’. The narrow lumen of capillaries and red blood cells in contact with the capillary wall were frequently described as features, but with no explanation of how these features affect the exchange of substances.

(b) The explanations of how tissue fluid is formed and how it is returned to the blood

system indicate that this topic is well understood by many candidates. There were many excellent explanations of how hydrostatic pressure causes the loss of fluid from capillaries at the arterial end and how changes in water potential bring about the return of fluid at the venous end of a capillary. Candidates failed to gain marks by using inaccurate language, such as ‘plasma’ being lost from capillaries, or ‘tissue fluid’ being returned to them.