AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.6.1.3 CONTROL OF HEART RATE

SCORE	PERCENTAGE
/130	%

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Q1.

(a) 1. Chemoreceptors detect rise in CO_2 / H_+ / acidity / carbonic acid / fall in pH
OR
Baro / pressure receptors detect rise in blood pressure;
2. Send impulses to cardiac centre / medulla;
3. More impulses to SAN;
4. By sympathetic (nervous system for chemoreceptors / CO_2)
OR
By parasympathetic (nervous system for baro / pressure receptors / blood pressure);

1. Ignore: location of receptors.

1. Ignore: chemoreceptors detect oxygen.

2 and 3. Accept: action potentials.

2. Reject: 'messages', 'signals', 'an impulse' or an 'action potential'.

3. Ignore: messages', 'signals', 'an impulse' or an 'action potential' as emphasis here is on increase in frequency.

4

(b) 1. Less / no malonyl-CoA;
2. (More) fatty acids transported / moved into mitochondria;
3. Respiration / oxidation of fatty acids provides <u>ATP;</u>

1. 'Inhibition of malonyl-CoA' on its own is not enough but accept production of malonyl-CoA is inhibited.

2. Accept: 'transport of fatty acids into mitochondria is not inhibited'.

2. Ignore: method of entry.

3. Accept: for respiration any stage of aerobic respiration e.g. Krebs (cycle), link (reaction) etc.

*3. Reject: production of energy, **but** accept production of energy in the form of <u>ATP</u>.*

3. Accept: acetyl CoA can enter Krebs cycle / mitochondria to provide ATP.

3

[7]

Q2.

(a) 21.59 / 21.6;

19/88 × 100 = 1 mark

Accept for 1 mark - 19/69 × 100 = 27.5%;
(only award if rounding correct)
Max 1 for incorrect rounding
Accept any number of significant figures
as long as the rounding is correct

2

(b) 1. Electrical activity only through Bundle of His / AVN;

2. Wave of electrical activity passes over / through both ventricles at the same time;

For 'electrical activity' accept impulses / depolarisation / action potential

Reject messages/signals/information once only

2. Accept 'wave of electrical activity passes through the Purkinje / Purkyne fibres / tissue'

2

[4]

Q3.

(a) 1. Treat with insulin (injection/infusion);
2. (Control) diet/control sugar intake;

2. Accept '(regular) exercise'

2

(b) 1. Damage to <u>autonomic</u> (nervous) system in diabetic rats;
2. (Could be) pressure receptors/baroreceptors (in arteries/aorta/carotid body) don't work as well;
3. Damage to medulla

OR

Change in (number of) impulses to/from medulla;
4. (When pressure drops damage to) sympathetic system, so doesn't speed up (enough);
5. (When pressure rises damage to) parasympathetic system, so doesn't slow down (enough);

*Accept answers in terms of what happens in healthy rats **only** if then qualified by statement these things don't happen/happen less in rats with diabetes*

1. Accept damage to ANS

2. Ignore reference to chemoreceptors

4 and 5. Appropriate system and effect on heart rate both needed

4 max

[6]

Q4.

(a) 1. (Increased pressure) deforms / changes <u>stretch-mediated</u> sodium (ion) channel;
2. (Sodium channels open and) sodium <u>ions</u> flow in;

Accept Na^+

3. Depolarisation (leading to generator potential).

Accept correct description of depolarisation

3

(b) Value between 2.17:1 and 2.29:1;

Accept rounding up to 2.2 or 2.3

Accept: number without : 1

Correct working showing answer but incorrect rounding in answer line = 1

Values between 117 to 119 and between 52 to 54 found but ratio wrong way round = 1 mark.

Wrong way round gives answer between 0.35:1 and 0.46:1

2

(c) 1. Parasympathetic greater effect than sympathetic;

Ignore: descriptions of graph

2. Parasympathetic keeps heart rate down / lower / decreases heart rate (as blood pressure increases);

3. Sympathetic keeps heart rate up / higher / increases heart rate (as blood pressure increases);

2. and 3. Accept converse for blood pressure decreases

4. Parasympathetic greatest / greater effect at high blood pressure / sympathetic greatest effect at low blood pressure.

3 max

[8]

Q5.

(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]

Q6.

(a) 1. People swimming 100 m / group1 had higher heart rates than people swimming for 30 minutes / group 2;

2. (Trend is) as temperature increases heart rate increases for swimming 100 m / group 1;

3. No trend for swimming for 30 minutes / group 2;

4. (SD values show that) each set of results has little variation;

Four approaches but only 1 mark available

1 max

(b) 1. Assumes that an increased HR is beneficial (whatever the temperature of the water);

2. (But) haven't measured the 'benefits' to health / increased heart rate may not be 'better';

3. No definition of better / flat out / better / flat out is subjective / based on opinion;

4. Only know the highest heart rate / time at highest heart rate not known;

5. Swimmers only tested once / only a short-term effect (on heart rate) / long-term effects are not known;

6. Distance covered in 30 minutes not known / might vary / time to complete 100 m not known / might vary / swimming ability might vary (among volunteers / between groups);

7. Groups may not be representative (of population);

4 max

[5]

Q7.

(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]

Q8.

(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]

Q9.

1. SAN → AVN → bundle of His / Purkyne fibres;
1. Mark for correct sequence

2. Impulses / electrical activity (over atria);

3. Atria contract;

4. Non-conducting tissue (between atria and ventricles);

5. Delay (at AVN) ensures atria empty / ventricles fill before ventricles contract;

6. Ventricles contract from apex upwards;

5 max

[5]

Q10.

(a) 1. (Oxygen / carbon dioxide) detected by chemoreceptors / (pressure) detected by baroreceptors;

2. Medulla / cardiac centre involved;
Accept a valid equivalent e.g. cardioacceleratory centre

3. More impulses to SAN / along sympathetic nerve;
Neutral: signals / messages
Accept: acceleratory nerve
Need idea of 'more impulses' directly, not by implication

3

(b) (i) 1. To ensure results are due to omega-3 / fatty acids (only) / not due

to something else in the oil;
Neutral: Idea of comparing groups / results

2. Placebo linked to mental / psychological effect;
Neutral: reference to a control group / placebo (unqualified)

1 max

(ii) 1. Lower / greater change of heart rate for Group **A**;
Ignore references to methodology

2. (Differences) are real / reliable / significant / not due to chance;

3. As bars do not overlap / values are not shared;

3

[7]

Q11.

(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]

Q12.

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]

Q13.

(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]

Q14.

(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]

Q15.

(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

Q16.

(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]

Q17.

(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]

Q1.

(a) Considering that this question required mainly straightforward recall, it was disappointing to note that over 25% of students did not obtain a mark and that only 10% obtained full marks. One of the main reasons for this was the use of poor terminology, particularly when describing nerve impulses as 'messages' or 'signals'. Most responses did refer to chemoreceptors but there was some confusion concerning their role. A minority of students mentioned baroreceptors, often in addition to chemoreceptors. The role of the sympathetic nervous system in increasing the heart rate was the most frequently credited mark point. However, the increase in frequency of impulses from the medulla was only described in the best answers. Interestingly, this question proved to be one of the best discriminators on the paper.

(b) This question also proved challenging with over a third of students scoring zero. Nevertheless, most students gained credit for describing the action of AMPK in inhibiting the conversion of acetyl-CoA to malonyl-CoA. However, the idea that this would lead to more fatty acids being transported into mitochondria was often misunderstood with many students incorrectly suggesting that transport of fatty acids would be reduced. A common misconception was that glucose would be used as an alternative respiratory substrate to fatty acids. Better answers did refer to increased ATP production from the use of either fatty acids or acetyl-CoA as respiratory substrates.

Q2.

(a) Most students successfully completed this calculation. Some used 19/69 × 100 to achieve 1 mark. Incorrect rounding is seen regularly and is penalised here with the comment "Max 1 for incorrect rounding".

(b) There was much successful use of the correct terminology to refer to the electrical activity in the heart and only a few instances of 'messages' or 'signals'. There was, though, some confusion of the order that the electrical activity passes through the bundle of His and the Purkyne fibres. Mark point 2 could not be awarded for a repetition of the stem (that the ventricles contract at the same time), the response had to refer to what causes the ventricles to contract simultaneously and so to the electrical activity passing over both ventricles simultaneously.

Q3.

(a) Control of type 1 diabetes was well known by students and 78% obtained both marks.

(b) This part discriminated quite well but 40% scored 0. Many students ignored the results and simply wrote an account of the control of heart rate. Some started in this way and then 'saved' themselves by saying that 'this doesn't happen in diabetic rats'. Even amongst those who did try to explain the results, answers were often riddled with errors and incorrect terminology. Instead of writing about changes in frequency of nerve impulses, many wrote about faster or slower signals or messages. Some wrote about single impulses, rather than higher or lower frequencies of impulses. Others referred to the sympathetic and parasympathetic systems but not what they each do in regard to heart rate; some got them the wrong way round. Quite a number wrote about chemoreceptors, rather than pressure receptors and the hypothalamus, rather than the medulla. Only 4% managed to

obtain all four marks.

Q4.

(a) Just over a third of students obtained 3 marks. The examiners were looking for a reference to stretch-mediated sodium channels. This is the term used in the specification and is appropriate for this pressure receptor. Some students wrote about movement of sodium, rather than sodium ions, or did not state that they moved / diffused / flowed in. Others failed to note that this produces depolarization.

(b) About 30 percent of students obtained 2 marks in this part. As has been noted in other examinations, ratios seem to pose problems for many students. Many do not realize that a ratio should be given as something : 1. Other students did not realize that it mattered in which order the numbers were given when they were asked to give the ratio of heart rate in experiment 2 to that in experiment 3. These problems resulted in about 30 percent obtaining one mark. Many students had no idea how to calculate a ratio.

(c) Nearly 50 percent obtained 2 marks for stating that the parasympathetic slows heart rate and the sympathetic speeds it up. Very few noted from the graph that the parasympathetic has a much greater effect / influence on heart rate than the sympathetic; resulting in only 10 percent obtaining all 3 marks.

Q5.

(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.

Q6.

(a) The most common responses were versions of marking points 1 and 2. Students who failed to score on this question did not make clear to which group of swimmers they were referring.

(b) Amongst the cohort, all marking points were seen. Many students scored three or four marks on this question showing a good appreciation of incomplete information provided by the investigation and the subjective nature of the statement.

Q7.

(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.

Q8.

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.

Q9.

Many students showed a good understanding of this part of the specification and went on to gain 4 or 5 marks. There were some who confused the SAN and the AVN and only the best answers showed an understanding that the delay at the AVN was linked with the ventricles filling or the atria emptying before the ventricular systole. Many students also included a description of the route taken by the blood as it passes through the heart and how pressure changes caused the valves to open and close. The weakest answers only described this and, therefore, gained little credit.

Q10.

(a) Many students gained two marks for mentioning chemoreceptors and the medulla

(or equivalent). However, only the best students conveyed the importance of *more* impulses being sent to the sinoatrial node (SAN) in increasing the heart rate. Some weaker students failed to read the stem of the question carefully enough. They explained why, rather than how, the heart rate increases during increased intensity of exercise.

(b) (i) The role of Group **B** in ensuring that the results were only due to omega-3 fatty acids or not due to something else in the oil was only given by a minority of students. Those who failed to score typically gave 'stock' *How Science Works* responses, which could apply to any investigation. These almost always involved the need to compare groups or results, or that Group **B** acted as a control or placebo, without any further qualification. Students should be reminded of the need to relate their answers to the specific investigation outlined.

(ii) This proved to be a good discriminator. Just over one third of students gained full credit. However, over half of students gained two marks for stating that Group **A** showed a greater change in heart rate and that the differences between the two groups are significant. It was usually only better students who referred to the fact that the standard deviations did not overlap. Unfortunately, some students failed to appreciate that the negative values for the change in the mean heart rate compared the heart rate before and after treatment i.e. at low intensities of exercise, the mean change in heart rate after exercise was lower for Group **A** after taking omega-3 fatty acids. Similarly, despite the question asking how information in the graph supported the conclusion, some weaker students criticised the methodology of the investigation. These responses usually referred to the sample size not being known or a control group not being used.

Q11.

(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.

Q12.

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.

Q13.

(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.

Q14.

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.

Q15.

(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.

Q16.

(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.

Q17.

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.