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Examiners' Report
June 2017

GCE Biology 9BN0 02

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Introduction

This is the first examination for the new reformed A-level for this unit.

Due to linear nature of the A-level assessment, approximately half of the available marks in this paper are to be allocated to the assessment of topics from Year 1 of the course. The paper is longer than the A-level papers in the previous specification as well – 100 marks instead of 90, and 2 hours in length instead of 1 hour and 45 minutes (6BI05).

In the previous specification, knowledge and understanding topics 7 and 8 was assessed in the first part of the 6BI05 paper, whilst 30/90 marks in that paper would be on questions based on the scientific article. This represents a major change as the scientific article questions are in a different question paper now (9BN0/03). Not only are there more questions on the last two topics from the specification, but there are also more questions testing knowledge of any of the first four topics.

The types of question are different in that there is a greater requirement to apply knowledge and understanding in the context of qualitative and quantitative data provided. There are also two 6-mark questions that require candidates to write at length to convey their ability to produce sustained arguments or linkages between data and biological knowledge.

There were some very good entries, with candidates showing a depth and breadth of knowledge of the learning objectives tested in this paper, particularly concerning transmission of nerve impulses, habituation, muscle contraction, respiration and gas exchange. However, there were some aspects of the Year 1 topics that were not well understood – especially sex-linkage, which may be new to the reformed specification, is a topic that was part of GCSE courses and should therefore have been better grasped than it appeared to have been.

Successful candidates:

- had revised all of the Year 1 topics as well as topics 7 and 8;
- answered questions in the context set;
- had learnt how to interpret the newly introduced command words – such as 'deduce' and provided quantitative evidence to support answers given;
- read through the introductory material for each question – as shown by underlining and highlighting;
- provided specific, relevant details to their answers;
- attempted every question;
- worked through calculations in a logical sequence, showing their working;
- demonstrated the ability to convert units and orders of magnitude.

Less successful candidates:

- had gaps in revision;
- did not answer questions in context, apparently viewing questions through tunnel vision, missing both the command word and the context;
- did not understand how to interpret the command words and therefore misinterpreted questions;

- recited learnt responses from previous mark schemes, irrespective of the context of the questions;
- left out vital details or wrote vague answers lacking relevant facts;
- did not attempt some questions – many questions were left blank, even near the start of the paper;
- made errors in calculations by not checking figures or the numbers in the data already provided.

Implications for future teaching, learning and exam preparation – revisiting the key concepts covered in the Year 1 topics as the Year 2 topics are taught, will emphasise how these provide the foundation for a thorough understanding of the more applied topics. In a linear system, it is easy for students to forget what they were taught in the previous year unless links are constantly being made. Exam preparation should involve reinforcement of the new command words – maybe using a printout of the pages from the specification to be used alongside tests to increase familiarity with their use. It should also be remembered that the sample and specimen materials produced contain mark schemes that have not been reviewed in light of actual student responses, therefore teachers should exercise professional judgement when using this material, perhaps with reference to the mark schemes produced for this first set of live exams

Question 1 (a)

This question asked how low serotonin levels affect transmission of impulses.

However, a significant proportion of candidates described how impulses are normally transmitted across synapses. The fact that the very first question on the paper was misread by candidates does emphasise the need to instil in students preparing for exams that they should pay careful attention to the context of the question.

Many candidates correctly identified serotonin as a neurotransmitter and gained that marking point. Many also identified that low levels of serotonin would lead to fewer depolarisations and less chance of an action potential, but this was often not communicated very clearly, with confusion between depolarisation and action potential.

1 Serotonin is found in the brain and is important in health and wellbeing.

An imbalance of serotonin can lead to problems such as depression. An individual with symptoms of depression may have low serotonin levels in the brain.

(a) Describe how low serotonin levels in an individual can affect the transmission of impulses in their brain.

(2)

Serotonin is a neurotransmitter that diffuses across the synaptic cleft and binds to receptors on the post synaptic membrane. Low levels means that less serotonin binds to post synaptic receptors so less sodium channels open. Less depolarisation and the threshold not reached and action potential is not fired.

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Examiner Comments

A clear answer that gained full marks for correct reference to serotonin as a neurotransmitter and the fact that low levels mean that less binds to the post synaptic membrane, so that the threshold is not reached. This response gained 2/2 marks.

1 Serotonin is found in the brain and is important in health and wellbeing.

An imbalance of serotonin can lead to problems such as depression. An individual with symptoms of depression may have low serotonin levels in the brain.

(a) Describe how low serotonin levels in an individual can affect the transmission of impulses in their brain.

(2)

Seretonen is a neurotransmitter, Low seretonin levels mean that there is less depolarisation of the post synaptic membrane which may mean the threshold level of depolarisation is not met. This means no ~~action~~ nerve impulse will be sent ~~also~~ along this neurone in the brain so their is lower transmission of impulses.

ResultsPlus
Examiner Comments

This response gained 2 marks – clearly showing a sound understanding of the topic and the question.

1 Serotonin is found in the brain and is important in health and wellbeing.

An imbalance of serotonin can lead to problems such as depression. An individual with symptoms of depression may have low serotonin levels in the brain.

(a) Describe how low serotonin levels in an individual can affect the transmission of impulses in their brain.

(2)

If there are less serotonin than there is less serotonin binding to the receptors therefore there are less impulses.

ResultsPlus
Examiner Comments

This response gained 0 marks – it fails to state that serotonin is a neurotransmitter and does not specify where the receptors are or where there will be fewer impulses.

ResultsPlus
Examiner Tip

Make sure that answers are clear – add specific details to make sure the examiner knows exactly what is being referred to. Vague answers will not score marks.

Question 1 (b) (i)

This question asked for a description of how MDMA could affect transmission of impulses, a subject covered within the specification and therefore a context that should have been studied.

Most candidates did understand that MDMA would prevent the re-uptake of serotonin – and the mark scheme did allow for dopamine as this could also have been encountered in the teaching of the course. Others described an increased concentration of serotonin – but not all specified where this would be. Some then went on to describe the effect this would have and to make the link that this would result in more action potentials, although not all were clear that this would take place in the post synaptic neurone. There were some very good answers that described how MDMA could block receptors on the pre-synaptic or post-synaptic membranes.

Marks were lost where answers lacked precision – although it may be obvious to the candidate what they are stating, it must be absolutely clear to the examiner that the candidate understands not just **what** is happening in the synapse, but **where**.

(b) The use of drugs such as MDMA (ecstasy) can cause an imbalance of chemicals in the brain.

(i) Describe how the use of MDMA could affect the transmission of impulses in the brain.

(2)

MDMA is an inhibitor which prevents the re-uptake of Serotonin by the re-uptake channel protein in the presynaptic membrane.

This results in the build up of sedonin in the cleft resulting in more action potential being generated in the post synaptic membrane.

ResultsPlus

Examiner Comments

This is a good response that gained 2/2 marks.

It refers to the prevention of the re-uptake of serotonin and specifies where this happens. It also refers to increased frequency of action potentials – although it would have been better to refer to the post synaptic 'neurone' instead of 'membrane', the context was clear enough to award the marking point.

(b) The use of drugs such as MDMA (ecstasy) can cause an imbalance of chemicals in the brain.

(i) Describe how the use of MDMA could affect the transmission of impulses in the brain.

(2)

MDMA prevents the uptake of serotonin, by the from the synapse between neurones, back into the neurones of the cells. This ensures a high concentration remains between synapses and therefore the transmission of impulses will happen as normal.

ResultsPlus

Examiner Comments

This answer gained 1/2 marks. It got the mark for stating that MDMA prevents the uptake of serotonin – although it is not clear which neurone it is not taken back into. No mark can be given for 'transmission of impulses will happen as normal', because there are likely to be more nerve impulses generated.

Question 1 (b) (ii)

Building on from the previous two parts to Q1, this part asked candidates to explain why use of MDMA could lead to the development of symptoms of depression. The effects of an imbalance in serotonin on depression is covered in the specification, so this was something that should have been studied.

Many candidates identified that consistent MDMA use would lead to lower serotonin levels and this was credited for one mark. However, not many responses described how it could cause a depletion in serotonin, with few identifying a lowered sensitivity of the post-synaptic membrane.

Many answers referred to there being a new 'normal' level of serotonin that was higher than that prior to taking MDMA, as opposed to depletion caused by MDMA use.

(ii) Individuals who use MDMA may develop the symptoms of depression.

Explain how the use of MDMA could result in the development of these symptoms.

(2)

After being stimulated too much during the use of MDMA, the post synaptic membrane can become desensitised to serotonin. This could reduce the effectivity of the synapse at carrying impulses, leading to depression.

ResultsPlus

Examiner Comments

This answer gained 1/2 marks – gaining the least commonly awarded mark for describing the reduced sensitivity of the post synaptic membrane to serotonin.

(ii) Individuals who use MDMA may develop the symptoms of depression.

Explain how the use of MDMA could result in the development of these symptoms.

(2)

The use of MDMA means that more serotonin is used as it is not reuptaken. This could mean that overall individuals who use MDMA could have lower serotonin levels than usual, as more is used per use of MDMA. Low serotonin levels have been linked to depression because serotonin is a neurotransmitter that is used in nerves associated with mood (particularly) happiness, so low serotonin levels = less impulses sent. Which can make people sad & depressed.

(Total for Question 1 = 6 marks)

ResultsPlus

Examiner Comments

This gained 2/2 – one for MDMA use leading to reduced serotonin levels and one mark for linking serotonin to nerves associated with mood and depression.

Question 2 (b)

The context of this question was how the SAN brings about a change in heart rate in response to increased activity levels. This context was not considered in a large number of responses seen, with many describing the role of the SAN with no reference to the context.

Good answers did correctly refer to **more** stimulation of the SAN, with reference to the sympathetic nervous system, leading to **more** waves of depolarisation across the atria and therefore causing **more** frequent contraction of the atria. However, many lost marks as a consequence of not grasping that the heart rate would be increased and how this would be brought about by the SAN.

Many lost marks because they referred to impulses in the heart muscle instead of depolarisation or to faster heart rate rather than more frequent contractions of the atria in particular. There were also vague references to 'messages' and 'impulses'.

Candidates need to make sure they are clear on the differences between nerve impulses that travel along neurones and waves of depolarisation that cause muscle contraction in the heart.

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

The SAN is the pacemaker of the heart, as the initial impulse that determines when the heart beats originates from here. The SAN would increase it's rate of impulse to increase heart rate as the level of activity increases.

ResultsPlus
Examiner Comments

This response gained 0 marks. Although this candidate has recognised the need to describe how the SAN increases heart rate, there are not enough specific, accurate details to award any marks.

ResultsPlus
Examiner Tip

It is important to add details that make it clear what is happening – e.g. the SAN causes there to be more contractions of the atria instead of just an increase in heart rate.

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

SAN is the pacemaker of the heart and initiates an impulse to make the right atrium contract and send and impulse to the AVN which contracts the left atrium creates an excitatory impulse.

ResultsPlus
Examiner Comments

This answer gained 0 marks. It has not answered the question, all it has done is state what the SAN is and what it normally does, although not entirely accurately – it has not described how the SAN brings about an increase in heart rate.

ResultsPlus
Examiner Tip

Read the question carefully – check the context – underline the last words of the question when you get to them, make sure you read the question all the way through.

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

Sympathetic nerve sends more impulses to SAN as level of activity increases SAN then propagates impulses at a faster rate & Impulses from SAN depolarise atria and cause them to contract, so contractions happen at a faster rate - heart rate increases.

ResultsPlus
Examiner Comments

This gained 2/2 – one mark for 'more impulses to SAN' from the sympathetic nerve and one mark for referring to increased rate of contraction of atria.

ResultsPlus
Examiner Tip

Remember: the SAN sends out waves of depolarisation – not impulses – to the atria.

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

The SAN will recieve more frequent stimulation from the medulla telling it to beat the heart. In turn the SAN will more frequently release waves of depolerisation causing the heart to beat.

ResultsPlus
Examiner Comments

This response gained 2/2 marks – one for 'more frequent stimulation' of the SAN and one for more frequent waves of depolarisation from the SAN.

ResultsPlus
Examiner Tip

Always make it clear if there is an increase in any response – words like 'more', 'increased' etc can make the difference between getting the mark and not.

Question 2 (c)

It does appear to examiners that there are occasions where candidates read the first few words of a question and then launch straight into their answers, without bothering to read the whole question. As a result, marks are lost unnecessarily. This question was an example of this trend – with many just seeing the words 'pressure differences in the heart' and then describing all the different pressure changes that occur during the whole cardiac cycle, starting with diastole. The actual question asked for an explanation (not a description) of how pressure changes ensure blood is pumped into the arteries – a very different question to the one that the majority of responses would have fit.

A simple statement that 'increased pressure in the ventricles closes the atrioventricular valves and opens the semilunar valves' would have been enough to gain full marks. Indeed, there were some excellent answers that did just that and also referred to the higher pressure in the ventricles than the arteries causing blood to be forced into the arteries as the ventricles contracted.

However, most candidates discussed the pressure changes in the atria at length before moving onto the ventricles, often for more than half of their response. Some referred generically to valves without naming them. Others described reasons for differences between the right and left sides of the heart or just described the pressure in the ventricles as being 'high' rather than 'higher' than in the atria and arteries.

(c) During the cardiac cycle there are pressure changes in the chambers of the heart.

Explain how pressure differences in the heart ensure efficient pumping of the blood into the arteries.

(3)

The heart has valves that open or close depending on the pressure on either side of it. The valves between the ventricles and arteries are semi-lunar valves. High pressure on the ventricular side and low pressure on the arterial side cause the valves to open so blood can be forced out into them. At the same time, high pressure on the A-V valve's ventricular side causes ~~that~~ the AV values to remain shut to prevent backflow of blood.

ResultsPlus

Examiner Comments

This is a good response, that clearly answers the question to gain 3/3. It tackles the pressure differences in the heart that bring about the forcing of blood into the arteries.

(c) During the cardiac cycle there are pressure changes in the chambers of the heart.

Explain how pressure differences in the heart ensure efficient pumping of the blood into the arteries.

(3)

Differences in pressure determine which valves are open and closed. For instance during atrial systole, the pressure in the artia increases as the atria contracts and there is a decrease in volume leading to the atrioventricular valves opening. The pressure is lower in the ventrial. During ventricular systole, the volume of the ventricles decreases and Pressure increases as it contracts. The pressure is greater than in the atria so the AV valve closed preventing backflow. Similarly, when the pressure is greater in the ventricle than in the aorta, the semilunar valve opens and during diastole, as the ventrical relaxes, pressure decreases and so to prevent backflow from the higher pressure blood in the aorta, the semilunar valves close.

(Total for Question 2 = 6 marks)

ResultsPlus
Examiner Comments

This response did gain 3/3. However, this has been as a consequence of writing everything the candidate recalled about pressure changes in the cardiac cycle and not answering the specific question asked. This did result on all 4 possible marking points being covered:

- increased pressure in the ventricles
- pressure greater in ventricles than atria and in the aorta
- causing the AV valves to close
- opening the semi-lunar valve

ResultsPlus
Examiner Tip

This candidate has run out of space on the lines because they have written much that is irrelevant to the question.

(c) During the cardiac cycle there are pressure changes in the chambers of the heart.

Explain how pressure differences in the heart ensure efficient pumping of the blood into the arteries.

(3)

Right ~~side~~ chambers of the heart need to be under low pressure as blood is being pumped to the lungs which are delicate.
Left hand chambers should be under high pressure to pump blood into the aorta that needs to get blood around the whole body.

ResultsPlus
Examiner Comments

This response gained 0 marks. The candidate has misread the question as 'explain the differences in pressure in the heart' and has explained why pressure is lower in the right side than in the left side. This does not explain how blood is efficiently pumped into the arteries.

ResultsPlus
Examiner Tip

Make sure that questions are read thoroughly, taking into account the context.

Question 3 (a)

The context of Q3 was the effects of cystic fibrosis (CF) on breathing. This part of the question required an explanation for the effect of CF on **rate of oxygen uptake** in the lungs.

Most candidates correctly referred to the thickening of mucus in CF. However, although most could also go on to describe that there was a reduction in air flow or decrease in surface area, they did not always link those aspects to the bronchioles or alveoli respectively. At this level, candidates should refer to bronchioles and not 'airways', which is too imprecise.

Of those who referred to an increased diffusion distance, many failed to identify that this was in the alveoli or that reduced surface area affected gas exchange.

Many candidates did correctly describe poor function of cilia resulting in accumulation of mucus, although some did suggest that the mucus blocked the bronchi.

3 Cystic fibrosis is a condition that affects breathing.

(a) Explain why cystic fibrosis affects the rate of oxygen uptake in the lungs. **(3)**

Because, the lungs produce a mucus in order to trap pathogens that are breathed in. If you have cystic fibrosis this mucus is too dry and sticky, meaning the cilia can't waft it out. This means the mucus blocks bronchioles in the lungs, meaning oxygen can reach less alveoli so there is less surface area for the oxygen to pass into the blood ~~stream~~ supply, so oxygen uptake is slower.

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Examiner Comments

This response was given 3/3 marks. One mark for mucus being too sticky, one for 'cilia can't waft it out' and one for the bronchioles being blocked – although it would have been better to state that air flow through the bronchioles was reduced due to the extra mucus rather than blocked.

3 Cystic fibrosis is a condition that affects breathing.

(a) Explain why cystic fibrosis affects the rate of oxygen uptake in the lungs.

(3)

Due to the mutation in the CFTR gene the mucus surrounding the lungs is highly viscous, as the ions are not being pumped out ~~so~~ so neither does water - as osmosis doesn't occur. This makes the uptake of oxygen more difficult, as the distance of the uptake is longer and thicker - due to the viscous mucus lining areas of the lungs.

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Examiner Comments

This answer gained just 1/3 marks for the description of the viscous mucus. Although it is explained that the distance for oxygen uptake is increased – there is no mention of alveoli, just 'areas of the lungs'.

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Examiner Tip

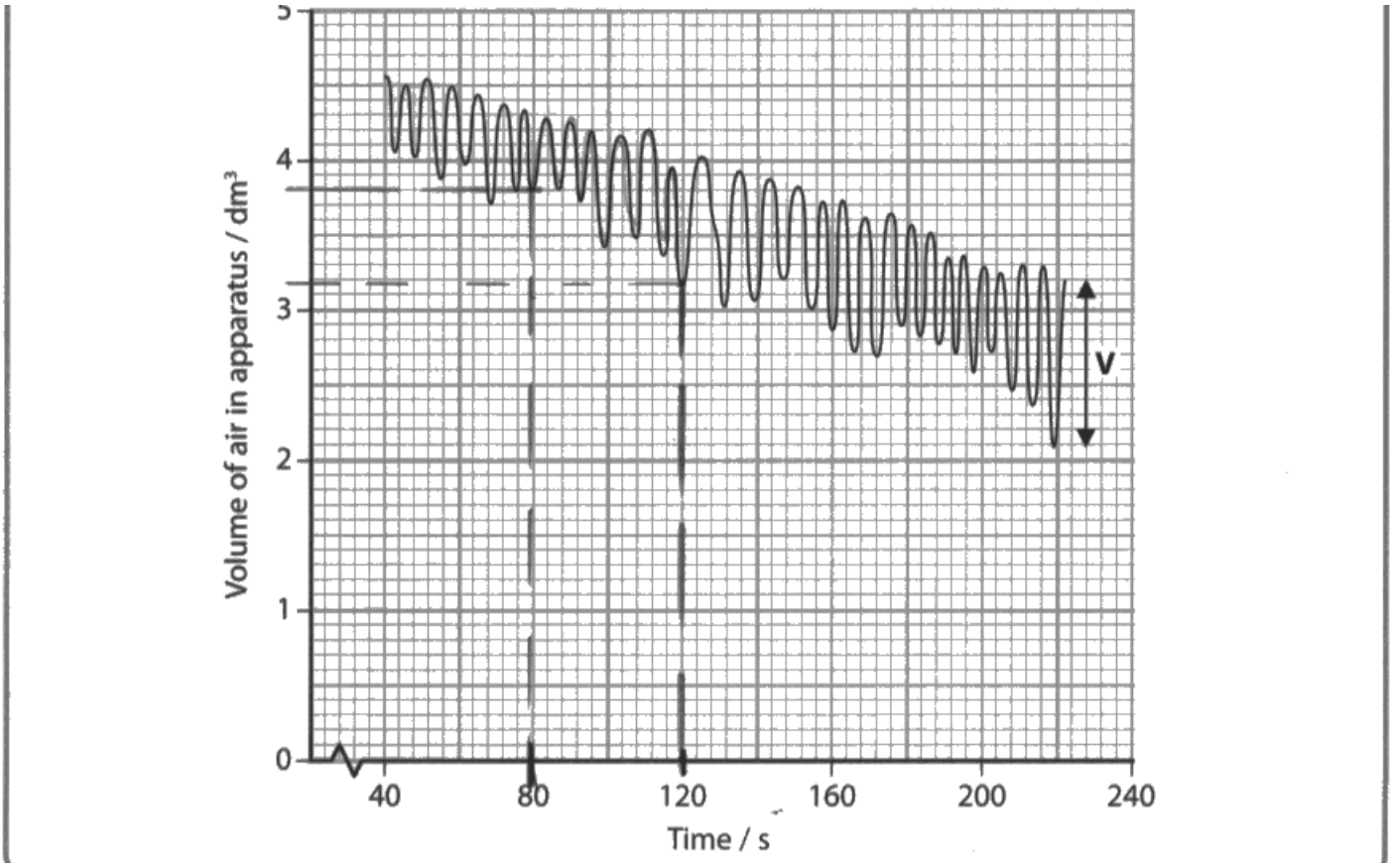
Be specific – state where something is happening – or not happening.

Question 3 (b) (iv)

This calculation question asked for rate of oxygen uptake to be calculated for the time interval 80 – 120 seconds. The units provided in the answer line were $cm^3\ min^{-1}$. The information provided above the relevant graph indicated that the carbon dioxide was removed – therefore any change in volume of air would be due to the uptake of oxygen. Once that volume was deduced it had to be converted from dm^3 to cm^3 and then divided by the time to find the rate, this would also require a conversion from seconds to minutes.

Errors encountered – some candidates tried to use tidal volume instead of oxygen uptake, a number could not convert dm^3 to cm^3 and a number could not read the graph. Many also forgot to convert the unit of time from seconds to minutes.

This proved very difficult for the majority of candidates with almost two thirds gaining no marks at all for this question. There is an increased level of demand with regard to the nature of calculations in the reformed A-level exam papers and candidates need to practise these.



(iv) Calculate the rate of oxygen uptake between 80 and 120 seconds.

(3)

$3.8 - 3.15 = 0.65\ dm^3$

$\times 1000 = 650\ cm^3$

$dm^3 \rightarrow cm^3$

40s → ~~0.67~~

$\frac{650}{40} = 16.25$

~~0.67~~

Answer 16.25 $cm^3\ min^{-1}$

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Examiner Comments

This response gained 2/3 marks for dividing volume over time and then multiplying by 1000 to convert dm^3 to cm^3.

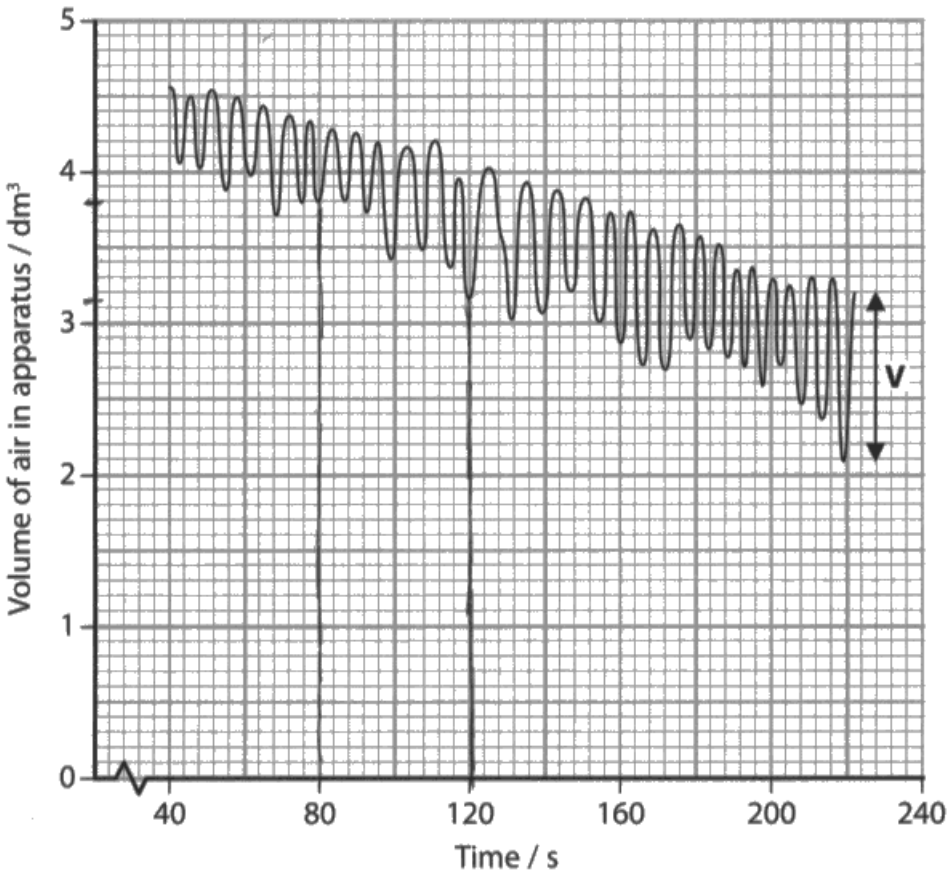
However, this gives a rate of cm^3 per second and not per minute.

ResultsPlus
Examiner Tip

Check the units provided in the answer line. These indicate the type of answer required in calculations.

Setting out the calculation at each stage allowed this candidate to gain 2/3 marks – a wrong answer alone with no working may gain 0 if it is not clear where the answer came from.

Marks are awarded for each step of a multi-step calculation so make sure they are set out clearly.



(iv) Calculate the rate of oxygen uptake between 80 and 120 seconds.

(3)

$$\frac{(3.8 - 3.15)\ dm^3}{40\ s}$$

$$= \frac{0.65 \times 1000\ cm^3}{40/60\ min}$$

Answer 975 $cm^3\ min^{-1}$

ResultsPlus
Examiner Comments

An excellent answer gaining 3/3 – not only the correct answer, but well laid out calculations with units to make it clear how that answer was derived.

ResultsPlus
Examiner Tip

Steps for calculations are very helpful when awarding marks – this candidate has also added the units which make it very clear what they were doing.

Writing out calculations step by step helps candidates when checking their answers. It should be something regularly done so that it is second nature in exam situations.

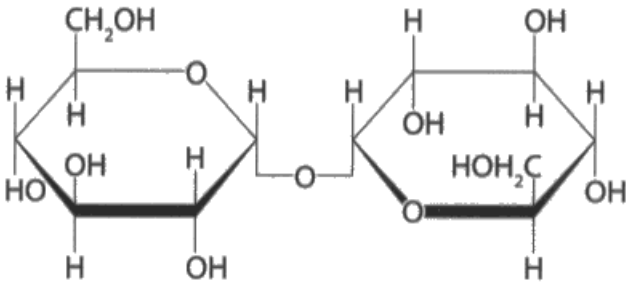
Question 4 (a) (i)

A good description of the condensation reaction was produced in the majority of responses and most achieved full marks.

Most gained marks for stating 'condensation' and 'removal of water'. Many responses discussed reactions between an – H group from one molecule and an – OH from another as opposed to involving two – OH groups. Some also, incorrectly, wrote that it was a hydrolysis reaction.

4 Maltose and trehalose are disaccharides. Trehalose is formed from two molecules of α-glucose.

The diagram shows a molecule of trehalose.



(a) (i) Describe the reaction that joins two α-glucose molecules to form a disaccharide.

(2)

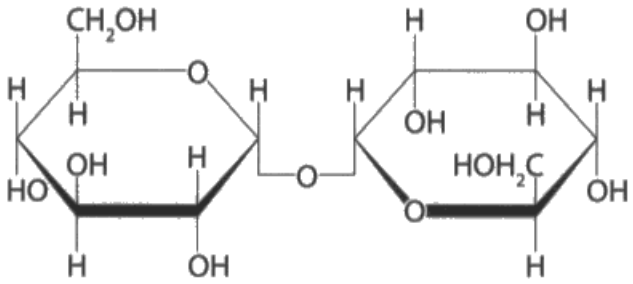
The reaction that joins two α glucose molecules is a condensation reaction between the 1,4 and 1,6 carbons of the two molecules.

ResultsPlus
Examiner Comments

This answer gained just one mark (1/2) for reference to condensation reaction.

4 Maltose and trehalose are disaccharides. Trehalose is formed from two molecules of α-glucose.

The diagram shows a molecule of trehalose.



(a) (i) Describe the reaction that joins two α-glucose molecules to form a disaccharide.

(2)

A condensation reaction joins two a-glucose molecules. The HO of one molecule and the OH of the other react to release a molecule of water (H_2O) and a bond is formed with the remaining oxygen to join the two molecules

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Examiner Comments

This response gained 2/2 marks – one for condensation reaction and the other mark could have been given for either stating that this reaction involved an – HO group from one molecule and an – OH from the other OR that a molecule of water was released.

Question 4 (a) (ii)

Many candidates stated that trehalose contains β-glucose, even though the introduction to the question clearly stated that 'trehalose is formed from two molecules of α – glucose'. Candidates are expected to know the structure of maltose and should therefore have been able to 'compare and contrast' the two disaccharides – which requires similarities and differences to be described.

While the majority scored a mark for both consisting of two glucose molecules, and many also gained a mark for the second glucose being inverted, a number referred to one or other as polysaccharides, or stated incorrect monomers making up one or other of the disaccharides referred to in the question.

Some used unhelpfully vague terms such as one glucose molecule being 'flipped' or 'upside-down', and some candidates got confused with the bonds in trehalose and described 1,4 and 1,6 links either by not looking at or not understanding the diagram provided.

However, most candidates did apply their knowledge of carbohydrate structure well and gained both marks.

(ii) Compare and contrast the structures of trehalose and maltose. ~ 9+9(a)

(2)

Both structures have 2 α-glucose molecules joined by a glycosidic bond. In trehalose one molecules is rotated through 180° whereas in maltose both monosaccharides have identical the same orientation. Maltose contains 2 n monosaccharides of glucose, whereas trehalose contain 2 slightly different monomers.

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Examiner Comments

An excellent answer, gaining 2/2. One mark could have been awarded for describing the two molecules as both containing two α – glucose molecules or the idea that both contained a glycosidic bond for the first marking point. The second mark was given for a clear, well worded description of trehalose having one of the glucose molecules inverted.

ResultsPlus
Examiner Tip

Remember that for 'compare and contrast' there must be reference to both similarities and differences to gain full marks.

(ii) Compare and contrast the structures of trehalose and maltose.

(2)

Maltose is made from 2 molecules of β glucose while trehalose is made from 2 molecules of α glucose. β glucose has an oH group inverted to make bonding slightly different.

ResultsPlus
Examiner Comments

This response gained 0 marks. Instead of realising that both molecules were composed of α – glucose for a similarity, this candidate has stated, incorrectly, that maltose is made of β-glucose as a difference.

ResultsPlus
Examiner Tip

Learn the structures of the biological molecules on the specification.
It will be assumed that this has been learnt and candidates will be expected to know that maltose is composed of α-glucose.

Question 4 (b) (ii)

This final part of the question proved quite challenging with candidates asked to describe the advantages of storing both trehalose and glycogen. Less than 10% of candidates achieved 3 or 4 marks for this question.

The context was provided in the sentence 'insect flight uses a lot of energy'. Despite the unfamiliar context, candidates should have been able to achieve 3 out of 4 marks by focusing on the role of glycogen as a storage molecule even if they could not clearly explain the advantage of trehalose. Marks were lost however, by referring to the molecules as stores of energy rather than of glucose.

Good answers did refer to glycogen being a polymer of glucose and that glucose provides energy through respiration – fairly straightforward points, but not seen very often.

Many described the properties of glycogen that suited its function as a storage molecule – possibly from having learnt the mark scheme for a different type of question. These comments – concerning it being insoluble and having no osmotic effect on the cells were not relevant to this question.

When it comes to the branched nature of glycogen – many described glucose being released 'easily' or branches allowing 'easy' breakdown of the molecule – this is not the key point here: it is the fact that the branched nature of glycogen allows rapid hydrolysis and release of glucose that is relevant. 'Easy' does not equate to 'rapid'.

A few candidates became distracted by the context and made an attempt to describe insect muscles. Others gave detailed accounts of respiration or confused glycogen hydrolysis with respiration, suggesting that the breaking of bonds in glycogen released energy for flight.

In some good responses, candidates interpreted the role of trehalose very well, recognising that it would only take the breaking of one bond to provide two molecules of glucose for respiration.

(ii) Insect flight uses a lot of energy. Explain the advantage of insects storing both trehalose and glycogen.

(4)

* Both a polymer of α-glucose ∴ hydrolised to release lot's of glucose molecules which are a reactant in respiration in order to release energy.
* Trehalose is a disaccheride ∴ can be used for immediate source of energy as it breaks down to only give 2 glucose molecules whereas glycogen is a polymer so can be used as long term store of energy and it forms 1,4 and 1,6-glycosidic bonds ∴ is branched and easily hydrolysed to release glucose monomers
* Glycogen is insoluble so has no osmotic effect & compact so stores large quantity of glucose per unit volume.

ResultsPlus
Examiner Comments

This answer was given 3/4 marks. One mark for stating that both contain glucose that is used in respiration to release energy, one mark for describing glycogen as a polymer of glucose, and one mark for understanding that the disaccharide nature of trehalose allowed it to provide two molecules of glucose as an immediate source of energy.

No mark can be given for the idea of glycogen being branched and therefore 'easily hydrolysed'.

ResultsPlus
Examiner Tip

The branched nature of polysaccharides glycogen and amylopectin allow for **rapid** hydrolysis. The ease of hydrolysis is not relevant – unbranched amylose is easily hydrolysed, but the multiple terminal ends of the branched molecules allows **faster** hydrolysis and **more rapid** release of glucose to be used for respiration.

(ii) Insect flight uses a lot of energy. Explain the advantage of insects storing both trehalose and glycogen.

(4)

Glycogen is a branched polysaccaride made up of many a-glucose molecules joined with glycosidic bonds with 1'4 and 1'6 bonds. Due to it's branched nature, it can be rapidly hydrolysed to release glucose molecules to be used in respiration for energy, even though glycogen is compact, it is still a largeish molecule so it may be useful to use a small disaccharide such a Trehalose as a filler while the glycogen is being moved and hydrolysed a trehalose is a small molecule so can move faster and more easily than glycogen and can be very quickly fully hydrolysed to released energy as one hydrolysis reaction in trehalose will release 2 glucose molecules while 1 in glycogen will normally only release 1 glucose molecule.

(Total for Question 4 = 9 marks)

ResultsPlus
Examiner Comments

An excellent answer that gained 4/4 marks.
Marks were awarded as follows:

- glycogen made of many glucose molecules
- branches allow it to be 'rapidly hydrolysed'
- glucose used in respiration for energy
- trehalose releasing 2 molecules of glucose for each hydrolysis reaction.

Question 5 (a) (ii)

In the reformed specification, sex linkage is a required learning objective in Topic 3; however, it seems to have been poorly understood, with the vast majority of candidates struggling to express their understanding of how it works.

The question asked why genes carried on sex chromosomes have a different pattern of inheritance than genes on other chromosome pairs.

It did appear that many candidates confused sex chromosomes with sex cells or gametes. Many also wrote at length about sex chromosomes not undergoing crossing over or about the inheritance of gender.

Many candidates referred to the Y chromosome being small and having less genes without explaining the effects that would have on patterns of inheritance. Few referred correctly to alleles and loci.

Only a small minority explained that there are genes on the X chromosome missing from the Y chromosome, and fewer still went on to say that the male only inherits one allele.

(ii) Explain why genes found on the sex chromosome pair have a pattern of inheritance that is different from genes found on other chromosome pairs.

(2)

Because the Y chromosome is shorter than the X chromosome. This means that some genes that are present in the X chromosome are not present in the Y chromosome. Therefore this caused sex linkage, where men are more likely to inherit certain diseases due to there not being a dominant allele present in the Y chromosome to counteract a recessive allele in the X chromosome.

ResultsPlus

Examiner Comments

A good effort – this was given 1/2 marks – but came close to gaining full marks. One mark was given for there being genes on the X chromosome that are not on the Y chromosome. However, the point that there would not be a dominant allele on the Y chromosome to counter a recessive allele on the X chromosome did not make it clear that there would be no allele at all for that gene on the Y chromosome.

(ii) Explain why genes found on the sex chromosome pair have a pattern of inheritance that is different from genes found on other chromosome pairs.

(2)

Sex linkage exsits because in males the Y chromosome is shorter and therefore may not contain a second allele of a gene found on the X chromosome. This means that if the allele on the X chromosome is recessive and codes for a disorder then the individual will be a sufferer. Males are therefore more likely to inherit certain recessive disorders than females.

ResultsPlus

Examiner Comments

This answer gained full marks – 2/2. One mark for there not being an allele for some genes found on the X chromosome and one mark for the idea that if the allele on the X chromosome in males is recessive and linked to a disorder, then it will be expressed.

Question 5 (b) (i)

This question provided much information, that – **if read** – would have guided the candidates on how to approach the question. This information gave the alleles for feather colour and stated which was dominant, and stated that the gene was present on the sex chromosomes. The phenotypes were then described for the male and female pigeons that were crossed.

Candidates were then asked to produce a genetic diagram to show expected outcomes if birds inherited sex in the same way as mammals.

However, the vast majority of candidates failed to produce a correct genetic diagram, either failing to account for X and Y at all or labelling the Y with a colour allele Most candidates still correctly identified that all offspring would have blue feathers – partly as a result of incorrectly carrying out a monohybrid cross between homozygous BB and bb. Many others drew a cross between two individuals with the genotype Bb, despite being told the female only had alleles for blue feathers.

There were some good answers from candidates who produced an accurate Punnett square and statement about all the offspring having blue feathers. However, quite a few missed out on marks as they used Y^b instead of Y in their diagrams.

(b) Inheritance of sex in birds is also determined by a pair of sex chromosomes.

A breeding experiment was carried out to investigate the inheritance of sex in birds.

A gene found on the sex chromosomes in pigeons determines the colour of their feathers. The dominant allele, B, produces blue feathers and the recessive allele, b, produces red feathers.

Male pigeons with red feathers were crossed with females that had alleles for blue feathers only. bb BB.

(i) Use a genetic diagram to explain the expected results of this cross if birds inherit sex in the same way as mammals.

(3)

Male = bb red feathes recessive
Female = BB blue feathes dominant

	B	B
b	Bb	Bb
b	Bb	Bb

Their offspring would have blue feathes as it is dominant at a 100% chance.

ResultsPlus
Examiner Comments

This response gained just one mark for stating that all the birds would have blue feathers. However, there were no marks given for using a standard monohybrid cross to demonstrate how all the offspring could inherit one dominant allele for blue feathers.

ResultsPlus
Examiner Tip

Sex linkage crosses are not the same as regular monohybrid crosses that may have been studied at GCSE level. Check the context of the question and read all the information provided.

(b) Inheritance of sex in birds is also determined by a pair of sex chromosomes.

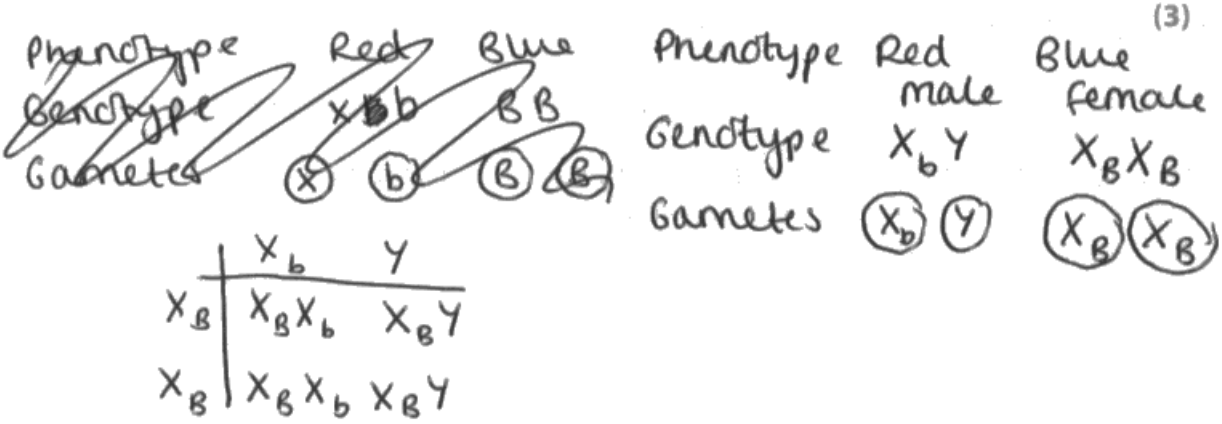
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Male pigeons with red feathers were crossed with females that had alleles for blue feathers only.

(i) Use a genetic diagram to explain the expected results of this cross if birds inherit sex in the same way as mammals.

(3)



All the offspring have blue feathers, 50% are male and 50% are female.

X_bY X_BX_B

ResultsPlus

Examiner Comments

This answer achieved full marks – 3/3 – for using a correctly drawn Punnett square diagram to demonstrate sex linkage, the genotypes of the parents and the inheritance of the alleles for blue feathers by all the offspring.

(b) Inheritance of sex in birds is also determined by a pair of sex chromosomes.

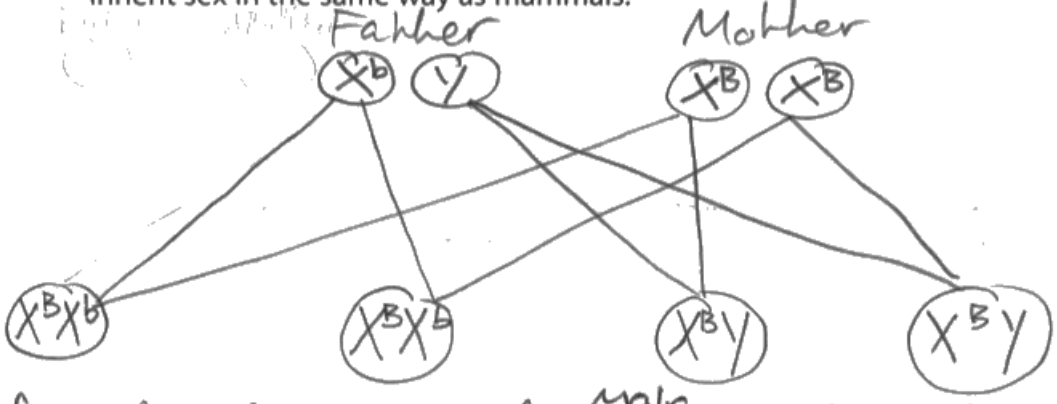
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A gene found on the sex chromosomes in pigeons determines the colour of their feathers. The dominant allele, B, produces blue feathers and the recessive allele, b, produces red feathers.

Male pigeons with red feathers were crossed with females that had alleles for blue feathers only.

(i) Use a genetic diagram to explain the expected results of this cross if birds inherit sex in the same way as mammals.

(3)



When breeding a red ~~blue~~ male and a homozygous blue female, the resulting offspring would have 50% chance being heterozygous female blue or 50% chance being a blue male.
As there are not two recessive genes, there is 0% chance of there being any red birds born.

ResultsPlus
Examiner Comments

This gained full marks for a correctly drawn genetic diagram that explained why all the offspring would have blue feathers.

ResultsPlus
Examiner Tip

Genetic diagrams can be drawn like this or as Punnett squares – either is acceptable.

Question 5 (b) (ii)

The command word for this question was 'deduce', which is defined in the specification as 'draw/reach conclusion(s) from the information provided'. If sex linkage had been understood it should have been possible for candidates to deduce that birds have the opposite sex determination to mammals.

Only a few candidates suspected that birds had a different set of chromosomes that determined gender compared to mammals. These tended to use genetic diagrams to show how the pattern of inheritance described would work if the females were XY and males XX.

However, this deduction was rarely made: almost 90% of candidates failed to achieve any marks for this question.

Many referred to birds having a system where each sex inherits alleles from the opposite sex parent. Many candidates suggested that dominance of an allele switched from blue to red depending on gender, or that male genes were more dominant than female genes in birds, revealing an incomplete understanding of 'dominance' in genetics.

Some candidates concluded that feather colour was not sex-linked: this suggested that they had not read the question properly. Others concluded that sex was not genetically determined in birds.

Of those who did come to the correct conclusion, very few laid out sufficiently clear reasoning to gain more than one mark.

(ii) The cross between male pigeons with red feathers and female pigeons with alleles for blue feathers only was carried out.

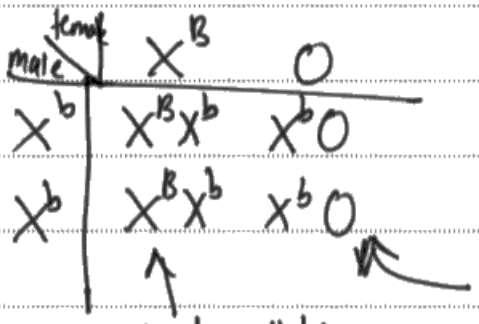
The offspring produced suggested that sex chromosomes in birds have a different effect on sex compared with the sex chromosomes in mammals.

All the male offspring had blue feathers and all the female offspring had red feathers.

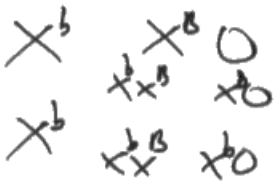
Deduce how the inheritance of sex in birds differs from that in mammals.

(3)

In birds the male posesses two Large sex chromosome (X) and the female posesses one of the Larger chromosomes and 1 smaller chromosome. The gene for feather colour is present on the Large (X) chromosome only So males must posses 2 of the recessive allele to show the phenotype whereas female only need 1.



(Total for Question 5 = 9 marks)



ResultsPlus
Examiner Comments

An excellent answer that gained 3/3 marks. The correct deduction is made that the females must inherit one large and one small sex chromosome. The diagram shows how the female offspring (labelled) inherited just one allele, a b, from their father.

ResultsPlus
Examiner Tip

A well labelled genetic diagram like this one makes it easy for examiners to see where marks can be awarded.

(ii) The cross between male pigeons with red feathers and female pigeons with alleles for blue feathers only was carried out.

The offspring produced suggested that sex chromosomes in birds have a different effect on sex compared with the sex chromosomes in mammals.

All the male offspring had blue feathers and all the female offspring had red feathers.

Deduce how the inheritance of sex in birds differs from that in mammals.

(3)

This suggests that, in birds, females have differing chromosomes (X,Y) and males have the same chromosomes (X,X). This means that the male parents would have been homozygous recessive (b,b) and the females had only one allele (B). This means the male offspring would have inherited B,b so the dominant blue allele is expressed. The female offspring had only b alles, so the red allele is expressed.

ResultsPlus

Examiner Comments

This answer gained full marks for a clearly written response clearly explaining why it has been deduced that the females have different chromosomes and males have the same. The genotypes of the parents and the offspring are indicated, demonstrating how the outcome of the genetic cross could have arisen.

Question 6 (a)

The context of this question was to explain the increase in lactate from 0 to 5 minutes as shown on the graph. During this time, the blood lactate concentration increased.

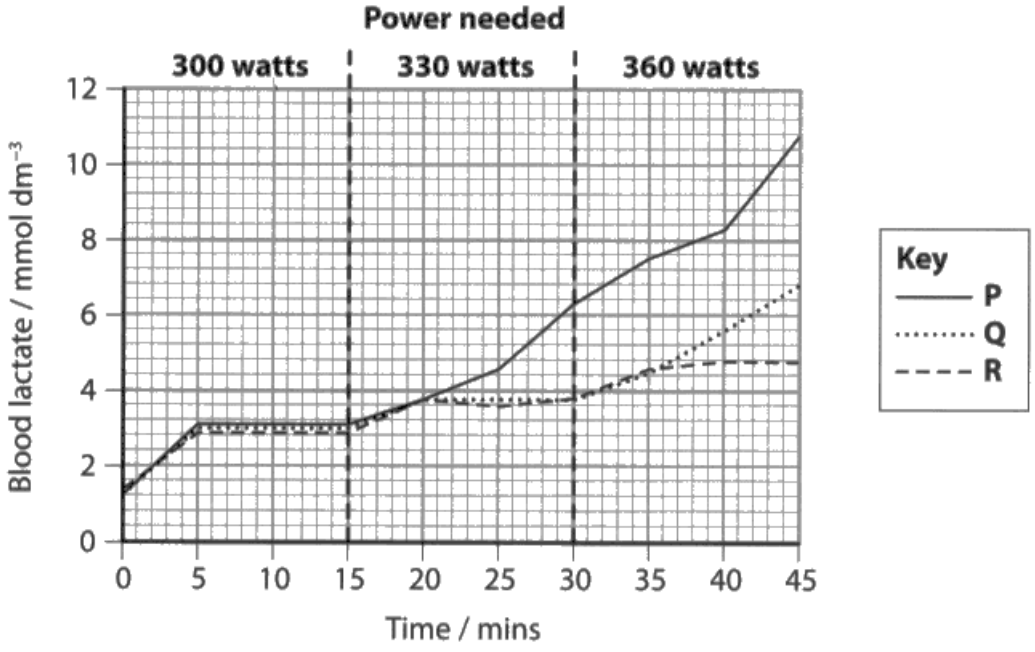
Most candidates recognised lactate as the product of anaerobic respiration, but many failed to give a reason for its increase, such as there being insufficient oxygen for aerobic respiration. Many just stated that there was 'no oxygen' and assumed there was no aerobic respiration occurring at all during that time.

This question differentiated between those who knew the source of the lactate and those who understood why it was present.

6 Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes. The power needed to maintain a constant speed was increased every 15 minutes. Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



(a) Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

(2)

Start of exercise and this indicates that as e; you start exercise, more lactate is produced in blood.

Exercise increases metabolic rate and Lactate in blood

ResultsPlus
Examiner Comments

This response did not gain any marks – 0/2. There is no mention of anaerobic respiration or lack of oxygen.

(a) Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

(2)

As the athletes started to excercise they start to respire anaerobically. This produces ~~increase~~ lactate and causes an increase of 1.8 mmoldm^{-3}

ResultsPlus
Examiner Comments

This gained 1/2 – one mark for linking production of lactate to anaerobic respiration.

(a) Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

(2)

They are respiring anaerobically and therefore producing lactate from reduction of pyruvate. This is causing the increase between 0 and 5 minutes. They are ~~respirat~~ respiring anaerobically originally because they don't have enough oxygen for aerobic respiration yet as there ventilation and heart is still low as they just started exercising.

ResultsPlus
Examiner Comments

This gained 2/2 – one for anaerobic respiration and one for not enough oxygen for aerobic respiration.

Question 6 (b)

As a development of the first part of the question, candidates were asked to give reasons why the blood lactate concentration remained constant from 5 to 15 minutes on the graph. The command phrase 'give reasons' does not require details in the same way that 'explain' does.

On the whole, this question was answered well, although some candidates did go into detail about the different stages of respiration and the conversion of pyruvate to lactate.

The majority of candidates correctly identified aerobic respiration occurring and often linked this to sufficient oxygen supply. Many also referred to increased breathing rate increasing the supply of oxygen – although there were some that provided unnecessary details of the mechanism by which heart rate and breathing rate were increased. There were quite a few responses that also stated that rates of production and breakdown of lactate were equal, although fewer mentioned that lactate was broken down in the liver.

(b) Give reasons why blood lactate concentration remains constant between 5 and 15 minutes.

(3)

Blood lactate could be being converted back to pyruvate at the same rate it's being produced. As their breathing rate and heart rate increases due to low pH of lactate, more O_2 in blood to repay oxygen debt in muscles. Their breathing depth increases to increase tidal volume and ventilation rate.

ResultsPlus

Examiner Comments

Full marks for this answer – 3/3. One mark for increased oxygen in the blood and one mark for linking that to increased breathing rate. One mark for the lactate being converted back to pyruvate at the same rate as it is being produced.

(b) Give reasons why blood lactate concentration remains constant between 5 and 15 minutes.

(3)

The supplies of Oxygen needed ~~not~~ is equal to the the oxygen supply. this will maintain the lactate concentration as ~~lactate~~ oxygen is needed to break down lactate. As lactate is broken down, more lactate is produced. The broken down lactate is equal to the lactate produced, therefore the blood lactate concentration remains constant.

ResultsPlus
Examiner Comments

This response gained 1/3 – one mark for rate of breakdown of lactate balancing production of lactate. No reference to increased oxygen supply.

Question 6 (c)

Although the question starts with the phrase 'analyse the data', this is not the command word, but an instruction to guide candidates to the information from which they should make their deductions.

The question was generally answered well, although a few candidates failed to quote relevant figures from the graph.

Some candidates answered by just giving descriptions and not suggesting suitable training levels, or made vague references such as 'higher level of exercise'. Others concentrated their attention on the time to be spent training and failed to score any marks.

Many responses did refer to the different power ratings of training required, and many gave a relevant reason concerning lactate build up. There were many that answered the question in a systematic manner, making a statement about each of the three athletes.

Many candidates were distracted by the context and referred to other aspects of training, including fast and slow twitch muscles, sprint training versus endurance training, and the specific blood lactate levels of the different athletes, generally gaining no marks. The key here was that opening phrase 'analyse the data' – in other words, use the data provided to answer the question.

(c) The most effective training involves the greatest power requirement over longer periods of time. Therefore, it is important to avoid high concentrations of blood lactate, which causes muscle fatigue, for as long as possible.

Analyse the data to deduce how each of these three athletes should plan their training.

(4)

Athelete P should focus on training between 0 to 30 minutes at a time, to avoid their blood lactate levels becoming too high, ~~Athelete~~ as between 30 and 45 minutes their blood lactate concentration increased by approximately 4.4mmoldm^{-3}, which was greater than the increase between 15 and 30 minutes (3.2 mmoldm^{-3}). Athelete R could remain with doing 45 minute intervals of exercise, as their blood lactate level increased the least after the 45 minutes, out of the 3 atheletes. ~~Athelete's~~ Athelete P's blood lactate level increased the most after 45 minutes. Between 0 and 15 minutes, the blood lactate levels of all 3 atheletes is approximately the same value.

(Total for Question 6 = 9 marks)

ResultsPlus
Examiner Comments

This candidate scored 1/4 for describing an increased lactate with the next level of exercise – however, no other marks could be given as the emphasis was on times of training, rather than intensity of exercise.

(c) The most effective training involves the greatest power requirement over longer periods of time. Therefore, it is important to avoid high concentrations of blood lactate, which causes muscle fatigue, for as long as possible.

Analyse the data to deduce how each of these three athletes should plan their training.

(4)

Person P should use 300 watts, this is because there will be enough energy produced by aerobic ~~respirat~~ respiration as more power will increase the amount of lactic acid. Person Q should ~~yes~~ use 330 watts, this is because ~~there will be~~ once stabilised there is enough energy produced by ~~aest~~ aerobic respiration, so more lactic acid isn't produced. Person R should use 300 watts as ~~there~~ he will release enough energy so that anaerobic respiration doesn't occur.

ResultsPlus
Examiner Comments

This response gained 4/4 – three of those marks for correctly identifying the exercise intensities suitable for athletes P, Q and R. The fourth mark was awarded for reference to the intensity level providing enough energy without increasing the amount of lactic acid.

Question 7 (b) (i)

This was a relatively straightforward question asking for a description of the changes caused when calcium ions bind to the molecules shown in the diagram. It did require candidates to correctly identify the molecules in the diagram – which was described as part of a myofibril.

Many candidates correctly described the movement of the tropomyosin exposing the myosin binding sites – the minimum required to gain both marks. There were some very good answers that went on to correctly state that the troponin moved the tropomyosin, revealing the location of the myosin binding site on the actin filament.

However, there was a range of muddled answers; some described tropomyosin changing shape but not moving and some only mentioned troponin. There was also a tendency to refer to the myosin binding site as the 'actin binding site' or to suggest that it was located on the tropomyosin.

(b) (i) Describe the changes caused when calcium ions bind to the molecules shown in the diagram.

(2)

when Ca^{2+} bind to troponin, this causes a change in shape of troponin, which moves the tropomyosin so that the actin is exposed.

ResultsPlus
Examiner Comments

This response gained 1/2 marks – for reference to the movement of the tropomyosin. No mark for this exposing the actin – must refer to the myosin binding site on the actin.

(b) (i) Describe the changes caused when calcium ions bind to the molecules shown in the diagram.

(2)

When the calcium ions are present, the filamen ts move out of the way of the the myosin binding sites, meaning the muscle is now able to contract.

ResultsPlus
Examiner Comments

This response gained 1/2 marks for a description of the exposure of the myosin binding site.

(b) (i) Describe the changes caused when calcium ions bind to the molecules shown in the diagram.

(2)

Calcium ion binds to troponin, which changes the shape of troponin. The tropomyosin moves, exposing the actin-myosin binding site.

ResultsPlus
Examiner Comments

This gained 2/2 marks – one for movement of tropomyosin and one for exposure of the actin-myosin binding site.

Question 7 (b) (ii)

This built on from part (b)(i) and asked candidates to explain how these changes cause muscles to contract.

On the whole, this was answered well, with many responses suggesting that the sequence of events had been well learnt. Where candidates did lose marks, the language used to describe the process was vague or imprecise, such as confusing myosin and actin.

There was a tendency to refer to the myosin heads moving rather than changing shape, although many used the phrase 'nodding' successfully, while others described a 'rowing motion' or stated that the myosin head 'performs a power stroke' without being clear the myosin changed shape to bring about that action.

Most correctly identified the release of ADP and Pi although a surprising number appeared to believe that ATP was formed by this process. A number of candidates referred to 'P' instead of the conventional 'Pi', which is the accepted biological notation for inorganic phosphate. P is the chemical symbol for phosphorus and is not the same as Pi and should not be given credit.

Another point that cost marks was stating that the myofibril or sarcomere contracts instead of shortens. Although this may seem unfair, the word 'contract' was in the question – therefore the point that was to be given credit was recognition that the movement of the actin filament results in the **shortening** of the sarcomere or myofibril.

(ii) Explain how these changes cause muscles to contract.

(4)

Once the active myosin binding site is released, myosin heads can then bind, forming cross-bridges. The ADP and phosphate in the myosin head then go through phosphorylation to produce ATP. The myosin head then changes shape, causing the head to nod forward on the actin, moving across it. The myosin head then causes ADP and the phosphate to detach, causing the head to detach and change back to the original shape, so the head nods backwards. This happening repeatedly causes muscles to contract.

ResultsPlus

Examiner Comments

This answer was given 2/4 marks. One mark for myosin heads binding to the myosin binding sites and one mark for the myosin head changing shape and nodding forward.

No mark for ATP being formed at this stage and no mark for suggesting that the myosin move across the actin and not the other way around.

(ii) Explain how these changes cause muscles to contract.

(4)

- When myosin head binding sites revealed
- myosin can bind to them
- Causes myosin to nod forward
- Sliding filament (— Cross links between
- over actin
- ATP attaches to ~~myosin~~ ATPase synthase on myosin head
- ADP + Pi formed - energy released.
- Cause myosin heads to move back into upright position

ResultsPlus
Examiner Comments

This response gained 3/4 marks.

One mark was given for myosin binding to the binding site and one for formation of ADP and Pi. One mark was also given for the myosin nodding forward – although this should be in the context of the myosin head, the mark was given as there was reference later on to the movement of the myosin head.

Reference to 'sliding filament' and 'over actin' were too brief and lacking in relevant details to be worth any marks.

ResultsPlus
Examiner Tip

Although answers set out as a series of bullet points are acceptable, the points made must contain enough valid details to gain marks.

(ii) Explain how these changes cause muscles to contract.

(4)

When the myosin binding site are exposed, the myosin head attaches forming an actin-myosin cross-bridge. This leads to the release of ADP and P_i from the myosin head. The myosin head nods forward, contracting and ~~pulling~~ shortening the sarcomere by moving actin filament closer together and reducing the H-zone length. The ATP returns and binds to the myosin head which leads to the myosin head detaching from the binding site. ATPase on the myosin head hydrolyses the ATP into ADP and P_i and this cycle repeats as long as the myosin binding sites are exposed.

ResultsPlus

Examiner Comments

This answer gained full marks – 4/4. Marks were given as follows:

- formation of actin-myosin cross bridge
- release of ADP and Pi
- myosin head nods forward
- shortening of sarcomere

(ii) Explain how these changes cause muscles to contract.

(4)

As the myosin heads are attached to the actin, ~~they~~ they nod forwards, pulling the actin over the myosin. The actin and myosin do not shorten, but the sarcomere does shorten as the filaments are pulled on top of one another. This causes the muscle to contract and pull the ~~limb~~ ~~bones~~ limb. When the myosin head is bound to actin it releases ADP and an inorganic phosphate (P_i). Calcium ions stimulate the head to nod forward. ATP binds to the myosin head, causing it to detach and revert to the original ~~pose~~ position.

ResultsPlus
Examiner Comments

This response gained 4/4 even though the sequence of events was rather jumbled.

Marks were given as follows:

- actin pulled over the myosin
- sarcomere shortens
- ADP and Pi released
- myosin head nods forward

Question 7 (c)

As is the pattern, the final part of most questions is the most challenging – and this question asked candidates to describe how the calcium ion concentration around the myofibrils is controlled.

There was a wide variety of answers, but most candidates seemed to understand the general principles involved, even if their answers failed to outline them in sufficient detail.

Most candidates recalled that calcium ions were released from the sarcoplasmic reticulum, although fewer referred to the role of calcium ion channels or the reason for the release of calcium ions. The most commonly seen responses referred to the release of calcium ions from the sarcoplasmic reticulum following a nerve impulse.

Some candidates also gained marks for describing the movement of the calcium ions back into the sarcoplasmic reticulum by active transport.

A significant minority got things the wrong way around, stating that the calcium ions diffuse into the sarcoplasmic reticulum. However, this question was tackled well by many candidates, with two thirds of responses gaining at least one mark.

(c) Describe how the concentration of calcium ions around the myofibrils is controlled.
neurones

(3)

If a movement needs to take place an impulse will be sent down the motor neurone. This causes a neurotransmitter to be released and to fuse with the post synaptic membrane in the muscle cell. Therefore more Ca^{2+} is released around the myofibrils, causing the muscle contraction process.

ResultsPlus
Examiner Comments

This response gained 0 marks – the only relevant information is the fact that more calcium ions are released around the myofibrils – this does not add much to what has already been provided in the question itself.

(c) Describe how the concentration of calcium ions around the myofibrils is controlled.

(3)

Ca^{2+} is released from the sarcoplasmic reticulum into the sarcoplasm.

ResultsPlus
Examiner Comments

This answer is brief – but enough to gain 1/3 marks, for calcium ions being released from the sarcoplasmic reticulum.

ResultsPlus
Examiner Tip

It is always better to write something rather than nothing.

(c) Describe how the concentration of calcium ions around the myofibrils is controlled.

(3)

The sarcoplasmic reticulum stores and releases calcium ions. When ~~the~~ a nerve impulse reaches the neuromuscular junction and spreads through transverse tubules it causes the sarcoplasmic reticulum to release Ca^{+} ions. A bigger stimulus causes more frequent impulses and more Ca^{+} ions to be released in a short period of time.

ResultsPlus
Examiner Comments

This response gained 2/3 marks for calcium ions being released from the sarcoplasmic reticulum in response to an impulse reaching the neuromuscular junction.

(c) Describe how the concentration of calcium ions around the myofibrils is controlled.

(3)

- Calcium ions are released from the sarcoplasmic reticulum when an impulse arrives at the neuromuscular junction.
- Through active transport, the calcium ions are pumped back into the sarcoplasmic reticulum after contract of the muscle has taken place.

ResultsPlus

Examiner Comments

This response gained full marks – 3/3. One mark for release of calcium ions from the sarcoplasmic reticulum, one for stating that this was in response to impulses arriving at the neuromuscular junction and one mark for calcium ions then being pumped back into the sarcoplasmic reticulum by active transport.

Question 8 (b)

This question asked candidates to explain the electrical changes that occur in an axon that allow an impulse to be detected – therefore the context did not require discussion of hyperpolarisation, which was often added to the responses seen, but was not relevant to the question.

Overall this question was comprehensively answered, with many clear, well-structured answers and many candidates mentioning all possible marking points – which was very pleasing. It appears to be one of the sequences that candidates learn well.

Many candidates correctly stated both the resting and depolarised potential difference. Although there was some confusion between calcium and sodium ions and some referred to sodium and potassium ions moving in the wrong direction, most correctly referred to the roles of both sodium and potassium ions and their movements through the relevant channels in the axon membrane.

Please note that, when marking, examiners will accept Na^+ or K^+ for the ions, but not just Na or K.

(b) Contraction of the muscle in the withdrawal response is stimulated by nerve impulses. These nerve impulses can be detected using electrodes.

Explain the electrical changes in an axon that allow these nerve impulses to be detected.

(4)

The resting potential of the axon is −70 mV. When an action potential arrives, some Na^+ voltage gated channels open and Na^+ diffuses in. Once the threshold is reached, all Na^+ voltage gated channels open and Na^+ rushes in. This causes the inside of the axon to become more positive, and the axon is said to be depolarised at +40mV. K^+ channels open and K^+ diffuses out of the axon down the electrochemical gradient. This is repolarisation and the membrane becomes more negative again, however the K^+ channels close too slowly and too much K^+ exits the axon membrane. This is hyperpolarisation. To reset the resting potential, K^+ diffuses back in so the membrane is at −70mV again. This is the refractory period.

ResultsPlus
Examiner Comments

An excellent answer – well constructed, gaining 4/4 marks. Marks could have been given to the following points made in this response:

- Na^+ voltage gated channels open
- Na^+ rush in causing axon to be depolarised
- description of depolarisation from – 7 0 (m)V to 4 0 (m)V
- K^+ channels open
- K^+ diffuses out of the axon

ResultsPlus
Examiner Tip

Be specific – e.g. this response refers to sodium ions rushing in – but does not say where. To gain that mark it would have been necessary to state – 'sodium ions rush into the axon'.

(b) Contraction of the muscle in the withdrawal response is stimulated by nerve impulses. These nerve impulses can be detected using electrodes.

Explain the electrical changes in an axon that allow these nerve impulses to be detected.

(4)

Electrical changes in an axon allow nerve impulses to be detected. This is due to the change when an axon reaches -55 mv. This will open up more sodium ion channels to move more sodium out of the axon. This will reach around 30 mv which causes sodium ion channels to close and potassium ion channels to open. The sodium - potassium pump maintains a sodium electrochemical gradient as it pumps out 3 sodium molecules for every 2 molecules of potassium that comes in. Myelination allows action potential to jump from node to node in an axon therefore nerve impulses are faster. Schwann cells insulate the axon therefore, action potential is faster.

ResultsPlus
Examiner Comments

This response gained 3/4 marks. Marks were given for:

- opening of sodium ion channels
- depolarisation of the axon described - from -55mV to 30mV (lower case 'v' ignored)
- opening of potassium ion channels

Reference to the sodium/potassium pump is in the wrong context, and was not relevant to this question, as was reference to myelination.

ResultsPlus
Examiner Tip

Make sure that the **direction** of movement of ions is correct – this response lost a mark by saying that the sodium ions moved **'out of the axon'** when it was becoming more positively charged.

(b) Contraction of the muscle in the withdrawal response is stimulated by nerve impulses. These nerve impulses can be detected using electrodes.

Explain the electrical changes in an axon that allow these nerve impulses to be detected.

(4)

Axon changes from resting potential state to an active potential state. Sodium channels open and sodium is pumped in as well as potassium ions. The ~~plate~~ polarity of the membrane changes inside and outside of the membrane

ResultsPlus
Examiner Comments

Only 1/4 for this response – for the idea of sodium channels opening. A few more details could have increased the score to 3/4 – e.g. stating that the sodium **ions** move into the **axon** and that the depolarisation of the axon involved the potential difference changing, or changed from – 70mV to 40mV.

ResultsPlus
Examiner Tip

Add as many details as can be recalled – lack of details will lose potential marks.

Question 8 (c) (i)

This was the first of the longer, extended writing questions in this paper. These style questions are new to the reformed A-level assessment and as such we recognise that candidates will have little experience of these. It is vital that all the information provided is read carefully and the phrase 'analyse the data' reinforces the need to do this before starting to answer the question. The command word here was '**evaluate'**. The definition provided in the specification is as follows:

"Review information then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context."

This was attempted well by the majority of candidates, with more achieving full marks than 0 or 1 mark out of 6. The full range of marks was seen, indicating that this question discriminated well.

Most candidates referred to the results of both investigations, which was necessary to raise the response from Level 1 to Level 2. Some candidates provided a description of the data without any explanations relating to neurotransmitters and thresholds being met or not met in order to initiate a reaction.

Common responses that did not gain many marks included descriptions of the behavioural adaptations linked to habituation, rather than focusing on succinct descriptions of the evidence provided and discussions of the likely causes.

Good answers did make links between the two studies, correctly identifying that the alternating stimuli in study 1 were stimulating different neurones. When applying their knowledge, many candidates described the effect of synapses, neurotransmitters and calcium ions on transmission of impulses.

Descriptions of both experiments were frequently seen accompanied by excellent descriptions of the mechanism of habituation.

Weaknesses were often in unclear descriptions of the studies rather than the theory.

A number of candidates referred to an inhibitory neurotransmitter at the synapse rather than the depletion of neurotransmitter.

A large number of candidates seemed to anthropomorphise the earthworms and described them 'ignoring' stimuli or 'realising they weren't important'. Others changed species and discussed snails instead, their learning of the core practical having pushed to one side the actual context of the question.

*(i) Analyse the data from these two studies to evaluate the most likely cause of the loss of the withdrawal response.

(6)

Hyperpolarisation stops more than one impulse travelling down a neurone at one time, and therefore may cause the loss of the withdrawal response. Touching the same stimulus more than once will not have any response because of this. The second study shows that after the first 3 times, the impulse no longer passes over the synapse. The worm must habituate itself to the stimulus.

ResultsPlus

Examiner Comments

This response was graded as a Level 1 response, 1/6 total.

Reference was made to the second study – but without evaluating the evidence of that study. A conclusion was made, based on knowledge and understanding of habituation and this is what allowed this response to gain the mark – the candidate describes how, after repeated stimuli, the 'impulse no longer passes over the synapse'.

*(i) Analyse the data from these two studies to evaluate the most likely cause of the loss of the withdrawal response.

(6)

After ~~the~~ 20 stimuli ~~on~~ at both points V and W (independently), the worm showed no change in body length. However, after 20 stimuli alternating between V and W, change in body length was 17mm. This suggests that when V and W were stimulated independently, the worm became habituated, but did not habituate ~~when~~ during the alternating stimuli.
The stimulus by the stimulating electrode is the same each time. X also remains the same as position X is on the same neurone that is being stimulated (before synapse). There is no longer an impulse recorded at Y, after the third stimulus. This suggests habituation has occurred at the synapse between the sensory neurone and the main nerve. Therefore, the loss of withdrawal response is a result of the habituation of the synapse between the sensory neurones from V and W, and the main nerve.

ResultsPlus
Examiner Comments

This response was given Level 2, 4 marks.
This answer evaluates the evidence from both studies, but only goes into detail for the second study, concluding that habituation occurred at the synapse between the two neurones involved in the response. Links are made to biological knowledge to some extent, but there are no details of how the mechanism of habituation occurs.

*(i) Analyse the data from these two studies to evaluate the most likely cause of the loss of the withdrawal response.

(6)

Habituation occurs in the earthworm. This is shown because after 20 stimuli at point V, there is no change in body length, which shows there is no withdrawal response. This is the same at point W, after 20 stimuli the response is lost. In the stimulation of the sensory neurone, at first an action potential occurs in X and Y because an impulse is sent along neurones, over the synapse. With repeated stimulation the impulse in Y decreases as less Ca^{2+} is diffused into the presynaptic membrane of X as it becomes less permeable to Ca^{2+}. This prevents the stimulation of the release of neurotransmitters from synaptic vesicle into synaptic cleft and prevents an action potential in the postsynaptic membrane in Y and so no impulse is seen in ~~the~~ neurone where Y is. This is all caused by habituation as the earthworm stops sending impulses to neurone and so the motor neurone is not stimulated to give a withdrawal response, shown in V and W. When stimuli is alternating this still creates impulse and withdrawal response because no longer repeated in one area so ∴ ~~not~~ takes longer to habituate changes in stimuli.

ResultsPlus

Examiner Comments

This excellent answer was judged to be Level 3 and gained 5/6 marks.

There was evaluation of both studies, with the main focus on the second study. Conclusions were made about habituation and this was linked to biological knowledge, with descriptions of the calcium ion channels becoming less responsive and less neurotransmitter being released across the synapse after repeated stimulation.

The reason it was not given full marks was due to gaps in the analysis of the first study – if there had been reference to V and W stimulating different neurones, which explains why habituation occurred when it did, this response could have gained full marks.

Question 8 (c) (ii)

This 'devise an investigation' question was set in the context of the data provided in the first study described in part (c) and asked candidates to devise an experiment to determine that the frequency of stimulation should be 20 stimuli per minute.

The context was therefore the investigations described previously – using earthworms, not snails. However, this did not stop candidates defaulting to the snail scenario, some even venturing into the use of slugs. To allow for marks to be awarded to correct procedures using the wrong species, marks were given for correct descriptions of the independent variable and the standardisation of the procedure.

This question was very poorly answered, with a third of candidates scoring 0, and less than 10% gaining 3 or 4 marks.

Approaching the question logically, some candidates did identify the independent variable – stimuli per minute – and realised that they would have to test a range of frequencies above and below 20 per minute. Those who had carried out the investigation with snails were also able to suggest some method for standardising the procedure, such as touching the earthworm on the same place each time. Marks were also gained for the idea of repeating with other earthworms of the same size or species.

The marking point seen least frequently was the one for a description of how the dependent variable would be measured – with very few correctly checking for habituation. This suggested that candidates did not understand the point of the experiment. An understanding of the core practicals is essential when it comes to applying those techniques to unfamiliar contexts.

(ii) Devise an experiment to show that the frequency of the stimulation used in the first study should be 20 stimuli per minute.

(4)

Prepare several worms in test tubes with electrodes set to stimulate the worm from 10 - 30 stimuli per minute in intervals of 5 stimuli per minute. Plot a graph of ~~number of time stimulated~~ against magnitude of impulse and give each number of stimuli per minute its own line. (Repeat this experiment 3 times and take averages prior to plotting the graph.) The line with 20 stimuli per minute should show the most detailed decrease and anything above that the worm won't have time to return to its prior length.

ResultsPlus
Examiner Comments

This answer gained 1/4 marks.

The only mark achieved was for describing the range of stimuli to provide – with reference to a range from 10-30 stimuli per minute at intervals of 5 stimuli/minute. No other valid details were provided for this investigation.

ResultsPlus
Examiner Tip

If in doubt when designing an investigation, always try to describe the independent variable and how it will be applied, the dependent variable and how it will be measured. Then try to describe valid variables that will need to be controlled.

Repeats on its own is not worthy of a mark – however, reference to repeats using earthworms of the same size would have gained another mark.

(ii) Devise an experiment to show that the frequency of the stimulation used in the first study should be 20 stimuli per minute.

(4)

set up a sample of 10 earthworms with the same width and length. control variables including temperature, pressure of stimulus and size of worm. for each of the earth worms have a different frequency of the stimulus so 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 touches per minute. measure the change in body length after. Repeat using smaller ranges of frequency after first results are obtained. the lowest frequency where the worm becomes habituated should be used as this shows frequency needed for habituation

ResultsPlus

Examiner Comments

This answer was given 3/4 marks, nearly gaining full marks for a good design of a valid experiment. Marks were given for:

- controlled variable – size of worm
- range of stimuli frequencies from 5 – 50 per minute, with intervals of 5
- method for measuring habituation described – measuring change in body length.

Although this candidate also referred to keeping the pressure of the stimuli the same – it was not stated that the location of the stimuli should also be kept the same.

(ii) Devise an experiment to show that the frequency of the stimulation used in the first study should be 20 stimuli per minute.

(4)

Use 5 worms all of similar length and age. They must be from the same species and from the same habitat. Stimulate ~~one~~ them at different rates. ~~Dog~~; 10 per minute, 15 per minute, 20 per minute, 25 per minute and 30 per ~~p~~ minute. ~~Then~~ All the stimuli must be at the same point on the worm and be ~~a~~ the same strength. Measure the change in body length in the worms after 1 minute. The worms that reaches 0mm change closest to one minute will be the worm with 20 stimuli per minute.

ResultsPlus

Examiner Comments

This is an excellent answer, gaining full marks – 4/4. Marks were given for the following reasons:

- same species of worm used
- range of stimuli from 10 to 30 per minute in intervals of 5
- stimuli at the same point of the worm and of the same strength
- body length measured to ascertain the number of stimuli that gave 0mm change

Question 9 (a) (i)

This question called for conversion of m^2 to cm^2 and then the correct calculation of a ratio. Other ratios had been presented in the table of data, providing a guide as to the type of figure required. i.e. 155.6:1.

Generally, candidates either scored full marks or none, with an even split between the two.

Mistakes made included the following: getting the division in the calculation the wrong way around, inputting the wrong calculation into the calculator after having correct working shown on the page, not presenting the final answer as a ratio, not converting m^2 to cm^2 correctly.

9 Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

(a) (i) * Calculate the mean surface area for gas exchange : volume ratio for individuals with mild emphysema.

(2)

97 : 6232.

1 : 64.25

Answer .....

ResultsPlus
Examiner Comments

This response gained 0/2.

The area has not been converted from m^2 to cm^2 and then the ratio has been calculated the wrong way around, with volume divided by area instead of area by volume.

ResultsPlus
Examiner Tip

Be guided by other data provided – the table clearly shows the other ratios as 247.3:1 and 44.6:1.

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Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

(a) (i) Calculate the mean surface area for gas exchange : volume ratio for individuals with mild emphysema.

(2)

Gas exchange : Volume ratio

97 : 6232

0·0156 : 1 = 155.7

155·6

Answer 155.7

ResultsPlus
Examiner Comments

This response gained 1/2 marks.

Although the correct ratio has been worked out for area in m^2, when this was then converted to cm^2 and given as an answer, it was no longer given as a ratio

ResultsPlus
Examiner Tip

Be guided by other data provided – the table clearly shows the other ratios as 247.3:1 and 44.6:1. If the ratio had been given as 156:1, two marks could have been awarded.

Where it is not clear what the answer is that the candidate intends to provide to a calculation, the answer given on the answer line is the one that will be marked.

9 Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1	155.6 : 1	44.6 : 1

(a) (i) Calculate the mean surface area for gas exchange : volume ratio for individuals with mild emphysema.

(2)

$97 \div \frac{6232}{10000} = 155.6$

Answer 155.6:1

ResultsPlus
Examiner Comments

This answer gained full marks, 2/2, for the correct answer of 155.6:1. However, this candidate approached the calculation by dividing the lung volume by 10000 to make the units comparable – another acceptable approach to working out the ratio.

ResultsPlus
Examiner Tip

In the mark scheme, the examples of calculations are not exhaustive, as it is understood that there may be many ways to approach particular calculations.

Question 9 (a) (iii)

This question asked for reasons that lung volume would vary amongst **healthy** individuals – therefore references to ill health, such as cystic fibrosis were irrelevant.

Many answers referred to genetics without mentioning specifics such as gender. Many environmental reasons were mentioned, including playing a woodwind instrument or being an athlete, which may affect vital capacity but not necessarily the actual volume of the lungs. Many candidates gave 'size' as being a cause for variation without any specifics on how this may have differed such as height or weight.

Despite this being a straightforward question, where 'age and gender' would have gained marks, almost a half of candidates scored 0, frequently because they had not read the question carefully, where there was a clear reference to **healthy** individuals.

(iii) Give reasons for the variation in the lung volumes of healthy individuals.

(2)

This may be due to differences in age, lifestyle (smoking) and height. These can all effect the lung volume of an individual.

ResultsPlus
Examiner Comments

This answer gained 2/2 for describing **differences** in **age** and **height**. Reference to smoking was ignored.

Healthy individuals could have another form of lung problem. They could also smoke which would assect lung volume. Lung volume is also genetically influenced based on size.

ResultsPlus
Examiner Comments

This answer gained 0 marks. Suggesting that the **healthy** individuals could have other lung problems or may smoke means that the word **healthy** has not been understood. Reference to 'size' without details such as height or mass, is too vague and not creditworthy.

Question 9 (a) (iv)

Although this question asked for a reason for calculating ratios in the investigation, many missed the point that it allowed comparisons to be made and only a third of candidates gained the mark for this.

Many responses mentioned correlation instead of comparison and it was very common for candidates to discuss how the calculation was required to work out the efficiency of gas exchange, with quite a few mentioning Fick's Law.

(iv) Give a reason for calculating the surface area for gas exchange to volume ratio in this investigation.

(1)

Because it allows the three categories to easily be compaired wihout confusion from the error bars; Comparing both results in one number.

ResultsPlus
Examiner Comments

This gained 1/1 for clearly stating that this allows for comparisons to be made between the three categories.

Gas exchang is proportional to surface area x ~~(~~concentration gradient ~~over~~ diffusion distance. Surface area is an importante variable in ~~the~~ Fick's law.

ResultsPlus
Examiner Comments

This answer was scored 0/1. The description of Fick's Law is not relevant as there is no mention of lung volume in the answer provided.

Question 9 (b)

Most candidates carried out the calculation for part (i) correctly.

However, some did make a mistake with part (ii) dividing the difference by the value for those with severe emphysema instead of that for the healthy individuals – 1584/540.

(b) Fick's law of diffusion can be used to calculate a value for the effectiveness of the uptake of oxygen by the lungs.

This value can be calculated using the equation

$$\text{value} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diffusion distance in alveoli is 0.5 μm.

The mean oxygen concentration in alveoli is 14 kPa and in the capillaries is 5 kPa.

The calculated value for healthy individuals is 2124.

(i) Calculate the value for individuals with severe emphysema.

(2)

$\frac{30 \times 14-5}{0.5} = 540$

Answer 540

(ii) Calculate the percentage difference between the value for individuals with severe emphysema and the value for individuals without emphysema.

(2)

Individuals with severe = 540
Individuals without = 2124

$\frac{540}{2124} \times 100 = 25.4$

Answer 25.4 ✗

ResultsPlus
Examiner Comments

The answer above gained 2/2 for (b)(i) and 0/2 for (b)(ii).

The correct value of 540 was calculated, but the **percentage difference** was incorrectly calculated.

ResultsPlus
Examiner Tip

Work out the difference and then divide by the original value – the one being compared against – to work out percentage difference.

(b) Fick's law of diffusion can be used to calculate a value for the effectiveness of the uptake of oxygen by the lungs.

This value can be calculated using the equation

$$\text{value} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diffusion distance in alveoli is 0.5 μm.

The mean oxygen concentration in alveoli is 14 kPa and in the capillaries is 5 kPa.

The calculated value for healthy individuals is 2124.

(i) Calculate the value for individuals with severe emphysema.

(2)

$\frac{14 \times 5}{0.5} = 140$

Answer 140

(ii) Calculate the percentage difference between the value for individuals with severe emphysema and the value for individuals without emphysema.

(2)

2124 - 140 = 1984

~~1984 ÷ 140 =~~

1984 ÷ 2124 x 100 = 93.41

Answer 93.41

ResultsPlus
Examiner Comments

The answer above gained 0/2 for (b)(i), but was then still able to get 2/2 for (b)(ii) by carrying out the necessary calculation correctly, even though the figure was wrong.

ResultsPlus
Examiner Tip

Show working out. This allowed this candidate to gain 2 marks, even though the figure used and the answer were not correct. It is clear to examiners that the candidate has taken 140 from the first part, and then correctly calculated the percentage difference using that figure – therefore they were given 2 marks.

(b) Fick's law of diffusion can be used to calculate a value for the effectiveness of the uptake of oxygen by the lungs.

This value can be calculated using the equation

$$\text{value} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diffusion distance in alveoli is 0.5 μm.

The mean oxygen concentration in alveoli is 14 kPa and in the capillaries is 5 kPa.

The calculated value for healthy individuals is 2124.

(i) Calculate the value for individuals with severe emphysema.

(2)

c. diff. = 14 - 5 = 9 kPa

$$\frac{30 \times 9}{0.5} = 540$$

Answer 540 $m^2 kPa \mu m^{-1}$

(ii) Calculate the percentage difference between the value for individuals with severe emphysema and the value for individuals without emphysema.

(2)

$$\frac{2124 - 540}{2124} = 0.7457\ldots$$

$$= 74.6\%$$

Answer 74.6 %

ResultsPlus
Examiner Comments

The answer above scored 2/2 for (b)(i) and 2/2 for (b)(ii).

The calculations are clearly laid out and easy to follow with answers written on the answer lines.

ResultsPlus
Examiner Tip

Setting out calculations clearly is important so that if mistakes have been made, it may still be possible to gain marks from the steps carried out correctly.

Question 9 (c)

This question asked candidates to explain why individuals with severe emphysema would tire more easily than healthy individuals.

Good answers used the information provided concerning SA:V for both groups. However, many simply referred to 'reduced surface area' without mentioning lungs or gas exchange. There were also many that described respiration without specifying that it would be aerobic respiration affected by reduced gas exchange surface area, or that reduced oxygen availability would result in an increase in anaerobic respiration.

Carelessly leaving out the word 'respiration' in conjunction with 'aerobic' or 'anaerobic' did cost a number of candidates marks in this question. Others lost marks by not describing a **reduced** surface area or **decreased** oxygen for aerobic respiration. Comparative statements are often required to fully answer a question like this one.

However, many gained marks for demonstrating their understanding that the reduced surface area for gas exchange would lead to lower oxygen uptake and its consequences.

(c) Explain why individuals with severe emphysema will tire more easily than healthy individuals.
(3)

This is due to there being less oxygen being taken in. slower gas exchange. Respiration will occur but not as fast meaning less ATP will be generated. This means they will has less energy for movement and growth and repair. This will result in the become more tired and also weak.

ResultsPlus
Examiner Comments

This answer only gained 1/3 marks – the mark was given for there being 'less oxygen taken in'.

No marks for stating that respiration will occur more slowly – the relevant point is that there will be less aerobic and more anaerobic respiration.

ResultsPlus
Examiner Tip

Remember to relate oxygen uptake with aerobic respiration and not just respiration.

(c) Explain why individuals with severe emphysema will tire more easily than healthy individuals.

(3)

individuals with severe emphysema have a lower mean surface area for gas exchange to volume ratio so rate of diffusion is slower so gas exchange is slower (less efficient) harder less oxygen is diffusing from alveoli to capillaries and to cells, so less oxygen for aerobic respiration, and cells could respire anaerobically producing lactic acid causing fatigue.

ResultsPlus

Examiner Comments

This answer gained 3/3 marks for the following points:

- less oxygen diffusing from alveoli to capillaries (reduced uptake of oxygen)
- less oxygen for aerobic respiration
- therefore cells respire anaerobically – producing lactic acid that causes fatigue.

An excellent answer clearly explaining why emphysema would result in a person tiring easily.

Question 10 (a)

This question was one that candidates understood yet they failed to express their answers clearly enough to gain credit. Two thirds scored zero and the remainder full marks.

Good answers were produced by those who stated clearly that the hybrid plant gained 7 chromosomes from the goatgrass (*Aegilops tauschii*) and 14 from the durum wheat (*Triticum turgidum*).

Marks were lost by those who failed to mention the species from which the chromosomes were gained: a large proportion got to 21 chromosomes by taking the average of 14 and 28. Some understood where the chromosomes originated from by mentioning the species, however not the number of chromosomes from each. Many candidates referred to just 'wheat' which was not specific enough to get the mark as there were two species of wheat to consider.

(a) Explain why each cell of the hybrid plant has 21 chromosomes in its nucleus.

(2)

Because it has 7 chromosomes from goatgrass and 14 chromosomes from durum wheat. This is because the cells divide by mitosis

ResultsPlus

Examiner Comments

This response gained 2/2 for stating how many chromosomes came from each parent plant to explain why the hybrid had 21 chromosomes.

(a) Explain why each cell of the hybrid plant has 21 chromosomes in its nucleus.

(2)

$\frac{14}{2} = 7$ ← chromosomes in goat grass sex cell.

$\frac{28}{2} = 14$ chromosomes in durum wheat sex cell.

14 + 7 = 21 chromosomes in the hybrid.

ResultsPlus
Examiner Comments

This excellent answer scored 2/2. The candidate has clearly explained how the sex cells of the goatgrass and durum wheat will have 7 and 14 chromosomes respectively and how the sum of these gives the 21 chromosomes found in the hybrid plant.

(a) Explain why each cell of the hybrid plant has 21 chromosomes in its nucleus.

(2)

only half the chromosones from each original plant are passed on meaning 7 and 14 are inherited by the hybrid.

ResultsPlus
Examiner Comments

This response gained 0 marks, because there is no indication where the 7 and 14 chromosomes came from.

ResultsPlus
Examiner Tip

With a few more details this answer could have gained full marks – do not leave out important points. Candidates cannot make the assumption that the examiner will 'know what they're thinking' – examiners cannot make this assumption, all they can do is mark what has been written.

Question 10 (c)

This question asked why the hybrid plant could not form haploid gametes and it proved quite hard for many candidates to answer with almost two thirds of them scoring 0.

Many candidates referred to the odd number of chromosomes in the hybrid; however, most responses lacked a clear further explanation of why this would prevent production of haploid gametes, with some trying to explain that the chromosomes could not be broken in half.

Few responses made a reference to lack of homologous pairs or that meiosis would not be able to take place.

(c) Explain why the hybrid plant cannot produce haploid gametes.

(2)

Because it has an odd number of chromosomes, a haploid gamete is one where there is half the number of the somatic cells chromosomes, you cant have half a chromosome.

ResultsPlus

Examiner Comments

This response gained 1/2 for stating that there was an odd number of chromosomes.

(c) Explain why the hybrid plant cannot produce haploid gametes.

(2)

Gamete formation only occurs due to meiosis; ~~of~~ hybrid's cells cannot divide in this way as chromosomes inherited from different species parents are non-homologous so cannot pair up during first mitotic division during meiosis.

ResultsPlus
Examiner Comments

This answer gained 2/2 for explaining that the hybrid cells could not divide by meiosis as they contained non-homologous chromosomes.

ResultsPlus
Examiner Tip

'Explain' questions require a reason to be provided for the answer given – this is an excellent example of a response to this type of question.

Question 10 (d)

Following on from part (c), this question introduced the idea that colchicine breaks down spindle fibres and could result in fertile *Triticum aestivum* plants.

Most candidates struggled to answer this question clearly and many did not attempt it at all. Of those who understood the function of spindle fibres, many found it hard to grasp the significance of this. Many resorted to describing what would normally happen during cell division and just described the different parts of the cell cycle.

Although many seemed to realise that the colchicine treatment would have to result in a cell with 42 chromosomes being produced, they failed to clearly articulate how that would happen. Some correctly deduced that there would be double the number of chromosomes and gained a mark for this statement. However, many were unclear as to how the number doubled in the first place or even if they had.

Some did realise that the breakdown of spindle fibres would prevent the separation of chromatids, although there was confusion between the events of mitosis and meiosis.

(d) Treatment **X** in the diagram uses the chemical colchicine.

Colchicine breaks down spindle fibres in dividing cells.

Explain how treatment of cells of the hybrid plant with colchicine could result in the development of fertile *Triticum aestivum* plants.

(3)

In Mitosis, spindle fibres bind to the chromosomes after they have doubled, condensed and aligned. They pull apart the chromosomes into chromatid. If spindle fibre was broken down ~~as~~ by colchicine, the spindle would not pull apart the chromosomes and so cells would start to be produced with double the number of chromosomes, ~~although~~ ~~but~~ 42, instead of 21, so when it comes to meiosis, haploid gametes can be produced as there are now an even number of chromosomes to be divided.

ResultsPlus
Examiner Comments

This response gained 3/3 marks. Marks were awarded as follows:

- doubling of chromosomes before mitosis
- cells produced with double the number of chromosomes
- haploid gametes can then be produced in meiosis

Question 10 (e)

This was the second of the two extended writing questions set in this paper: another one where the command word was 'evaluate', although in this case it was to consider the risks and benefits of three methods described for producing new varieties of plants. Information was provided in the table to provide context to the question.

Most candidates achieved 2-4 marks for this question, with fewer at the extremes, demonstrating a normal distribution of marks – which is to be expected for this type of question, which discriminates well.

There were some good answers, although others were vague or contained incorrect facts. While many candidates made a reasonable attempt to describe the benefits and risks of the three methods, they were not always very clear on either which risk and benefit related to which approach or what the actual risks and benefits were.

Many mentioned infertility or expense, which are drawbacks rather than risks, indicating that they had not read the question carefully or did not understand what is meant by 'risk'.

Many candidates described 'disadvantages' as opposed to risks.

Many seemed to be under the impression that GM held risks of 'unknown side-effects' or some kind of ethical conundrum.

In general, there seemed to be a very poor understanding of genetic modification, with many of the opinion that GM as a process was unpredictable, potentially spreading various resistances to random other plants, bacteria, insects and even humans. Few drew solid conclusions. Many candidates wasted time repeating information on the benefits that they had been given in the table without revealing anything new at all.

A lack of precise details and accurate biology prevented candidates achieving more than Level 2; this included vague references to risks such as 'super weeds' – often in the context of all three methods – without describing gene transfer or interbreeding. The better responses did refer to the risks of antibiotic resistance and had a clear idea of what could be achieved with each method, they also often referred to the risks of inbreeding and loss of alleles with selective breeding.

Statements made were frequently vague, plain wrong, irrelevant or out of context: for example attributing risks to the wrong method. Answers did repeat a host of scare stories about GM which even A-Level biologists seem to have absorbed, with references to 'natural' and 'unnatural'.

*(e) New varieties of plants with desirable combinations of characteristics can be produced using the methods shown in the table.

Method	Example
Formation of hybrids	In wheat, genome D includes genes for a tolerance of harsh conditions and genome A promotes large starch stores in seeds.
Genetic modification	Production of specific molecules in plant cells.
Selective breeding	Plants with desired characteristics can be used for breeding to produce plants with combinations of desired characteristics.

Evaluate the risks and benefits of producing varieties of plants using these methods.

(6)

The benefits of ~~[illegible]~~ formation ~~[illegible]~~ of hybrids is that the genome contains genes for a tolerance of harm conditions, which will give a higher yield all year round. A risk is that some plant species will not be able to form hybrids. Genetic modification is good because you can select certain molecules such as proteins and produce them in plants which can make them more nutritious for humans. A risk is that people don't know the full implications / long term effects on using genetically modified crops. Selective breeding is good as you can select the advantageous characteristics of the plant and breed them with other plants that also have desired characteristics to make the best plant possible. A risk of this is that the plants may not be fertile or it could be more expensive for farmers.

ResultsPlus
Examiner Comments

This is a Level 1 response to this question. Only one side of the argument – the benefits – has been covered. The risks have not been discussed, instead there has been a description of either disadvantages or vague statements including: cost, some plants cannot form hybrids, the long term implications of GM are unknown, selective breeding may result in infertile plants (valid for hybrids, but not for selective breeding).

The benefits for hybridisation were discussed sufficiently to gain the highest mark available at Level 1.

ResultsPlus
Examiner Tip

If the question asks for risks and benefits to be evaluated, make sure that the risks are not just disadvantages – there is a difference.

e.g. selective breeding takes a long time = disadvantage, but selective breeding may lead to loss of genetic diversity = risk.

*(e) New varieties of plants with desirable combinations of characteristics can be produced using the methods shown in the table.

Method	Example
Formation of hybrids	In wheat, genome D includes genes for a tolerance of harsh conditions and genome A promotes large starch stores in seeds.
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Evaluate the risks and benefits of producing varieties of plants using these methods.

(6)

If a hybrid cross breeds with weeds the favourable genome could be passed on to the weeds making them 'super-weeds' and harder to get rid of. Selective breeding allows more desirable crops to be produced naturally but risks decreasing the gene pool of a species so may make it more difficult for the species to adapt if a new selection pressure arises. Drugs may be produced using plants with is cheaper and more ethical than using animals but if a GM plant cross breeds with food crops people could unknowingly be consuming drugs they don't need but be experiencing side effects of the drug.

ResultsPlus
Examiner Comments

This is a Level 3 response that gained 5/6 marks.

The risks of each method are described well, with relevant details, including hybrids interbreeding with weeds, making them difficult to control, selective breeding reducing the gene pool and GM risking the introduction of unwanted characteristics to food crops. However, the benefits were not discussed as fully, limiting this response to 5 marks instead of 6.

Paper summary

Based on their performance on this paper, candidates are offered the following advice:

- make sure that topics 1-4 are revised as well as topics 7 and 8 for this exam;
- read all the information provided – it is there because it is needed to answer the question;
- learn the command words and the types of answers expected;
- read the whole question, identify the command word and the context;
- set out calculations carefully – show each stage of your working, in case a mistake is made at the final step;
- attempt every question – do not leave gaps, a blank space will always score 0;
- add details – do not expect the examiners to fill in the gaps for you!

Grade Boundaries

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