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Examiners' Report
June 2017

GCE Biology B 9BI0 02

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Introduction

This was the first examination of this unit for the new linear specification. There have been significant changes made to the assessment model from the previous specification. The changes have included:

an increased mathematical content (minimum 10% level 2 mathematics)

- an increased proportion of questions that involve the application of knowledge and data analysis
- a reduction in the number of mark points available for questions. It is now essential for candidates to correctly answer a question in order to gain full credit. Where there may have once been six or seven mark points available for a four mark question, there are now far fewer. This has resulted in the raising of demand of the mark scheme
- the specification is linear so approximately half of the marks for the paper are from topics one to four and half the marks are from topics eight to ten. This has made the examination more synoptic than in previous specifications. Topics one to four, common to AS and A Level include: *Biological Molecules; Cells, Viruses and Reproduction of Living Things; Classification and Biodiversity; and Exchange and Transport*. Topics eight to ten are: *Origins of Genetic Variation; Control Systems; and Ecosystems*.

This paper generated a very broad range of responses across all questions. Some very impressive examples of answers were seen by examiners indicating that many centres and candidates have fully embraced the changes to the specification, and many centres are preparing candidates very well. The majority of candidates were fully conversant with the command words used in questions and appreciated the difference in commands such as *describe* and *explain*. Most have got to grips with new commands such as *comment on* and *compare and contrast*. Many candidates found the increased mathematical demand challenging and candidates and centres should consult the mathematical section of the specification to ensure that they cover all the skills necessary. The examiners commented on the excellent use of vocabulary used by many candidates and strong analysis of the two level based questions.

The increased demand of the papers did, however, make them very challenging for less well-prepared candidates and many did not read data analysis questions carefully enough, gave little depth or detail and often left mathematics questions unanswered. There were a number of minor errors seen, such as not including units in calculations, or mixing up basic terms such as photosynthesis and respiration. Candidates should make sure that answers are very precise - answers that have several errors in them, or have inaccuracies, will not gain credit at this level. Some candidates underestimated the level of depth and detail required at A-level and wrote answers that, although acceptable at GCSE, lacked the depth or accuracy for A-level. It is often frustrating to see answers where candidates show some understanding of a topic but do not express themselves with appropriate vocabulary; for example, candidates should refer to impulses rather than signals or messages when discussing neurones. A small number of candidates ran out of time at the end of the exam: many of these had additional pages of writing for other questions - it is important to work at an appropriate pace and focus on the mark allocation for each question. It is unlikely that a question with an allocation of two marks will require in excess of six lines.

What went well:

- the majority of candidates and centres have fully understood the demands of the new specification and candidates are well prepared
- understanding of the new command words is good
- the use of vocabulary by many candidates is accurate
- most candidates have a good synoptic "feel" for the subject as a whole and can apply different aspects of their knowledge to answer questions
- mathematical skills were good on some aspects.

What went less well:

- some candidates did not read questions carefully enough and misunderstood command words
- some candidates did not have the requisite mathematical skills
- some candidates did not include enough detailed vocabulary in their answers and gave GCSE standard answers
- some candidates needed to pace themselves better in examinations and look carefully at the number of marks allocated to questions.

Question 1 (b)

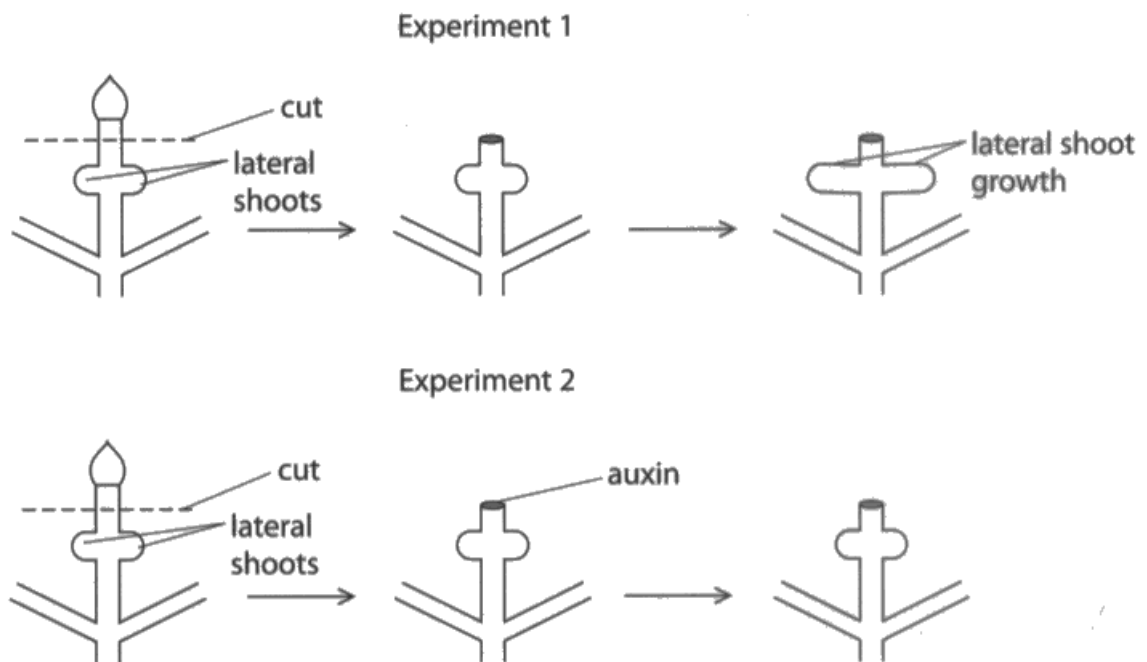
This question was answered well by many candidates showing a full understanding of the roles of auxin and cytokinins in the growth of lateral shoots. Stronger candidates related the evidence from the experiment to the role of auxins in preventing lateral bud outgrowth by suppressing the action of the cytokinins. Some candidates mixed up the roles of the two growth factors and stated that auxin stimulates lateral shoot growth. Many candidates did not refer back to the experiment and so wrote an answer that was not in the full context of the question. A common answer was that auxins and cytokinins are antagonistic, which whilst correct, does not explain what effects the two substances have on lateral shoot growth. A small number of candidates seemed unaware of the phenomena of apical dominance and their only knowledge of auxin was in phototropism.

(b) A scientist investigated apical dominance in plants.

In experiment 1, the shoot tips were cut off and the growth of lateral shoots assessed.

This was repeated in experiment 2, but auxin was placed over the cut end of the tips and the growth of lateral shoots was assessed.

The results are shown in the diagrams.



Explain how the interaction between auxins and cytokinins could have produced the results shown in the diagram.

(3)

Interaction between auxins and cytokinins could have produced measuring the time taken for the auxin to grow the lateral shoots, cytokinins will start to make mRNA is the auxin's

and multiplying mitosis in the stage making the lateral shoots grow.



ResultsPlus Examiner Comments

The candidate has given a confused answer that does not address the question. They are aware that auxins and cytokinins interact but this is just a restating of the question stem. There is some confusion as to whether cytokinins or auxins induce lateral shoot growth. It was awarded zero marks.



ResultsPlus Examiner Tip

Always read questions carefully and think how you will structure your answers before putting pen to paper. Identify how many marks are available and then try to think how each mark point could be awarded.

(b) A scientist investigated apical dominance in plants.

In experiment 1, the shoot tips were cut off and the growth of lateral shoots assessed.

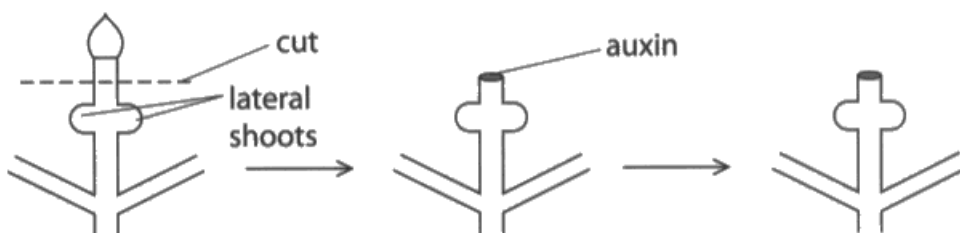
This was repeated in experiment 2, but auxin was placed over the cut end of the tips and the growth of lateral shoots was assessed.

The results are shown in the diagrams.

Experiment 1



Experiment 2



Explain how the interaction between auxins and cytokinins could have produced the results shown in the diagram.

(3)

Auxins and cytokinins have antagonistic effects. Auxins promote apical growth and prevent lateral internode growth, while cytokinins promote lateral internode growth. This can be seen as in experiment 1 where no auxins are present (as they're found in the apical bud) lateral growth occurs however in experiment 2 no lateral growth occurs when auxins are present.



ResultsPlus
Examiner Comments

This answer gained all three marks. Clear references are made to auxins preventing lateral shoot growth and cytokinins promoting it. The role of auxin in the experiment is also discussed for mark point one.

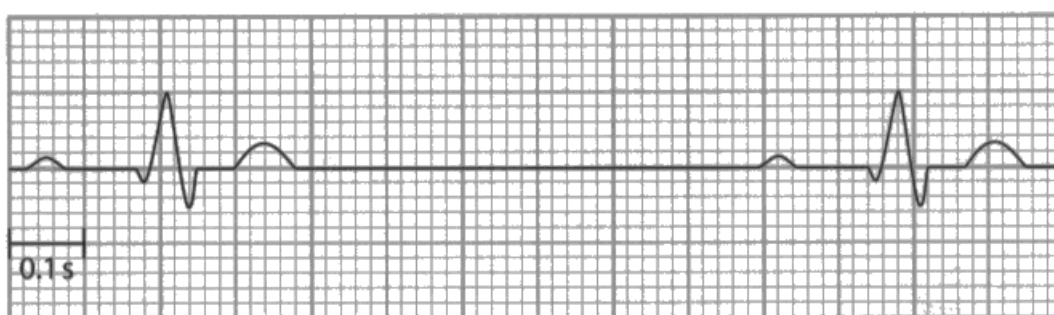
Question 2 (c) (i)

Candidates found this question surprisingly demanding. They were required to determine the time for one heartbeat and then use this to determine the pulse rate. Many did not look carefully at the scale and misread the values of the increments. Some candidates simply gave the length of time for one heartbeat, and others even divided the length of time for one heartbeat by 60 seconds giving a very small number. Candidates should always remember to think whether numerical answers seem appropriate before moving on to the next question.

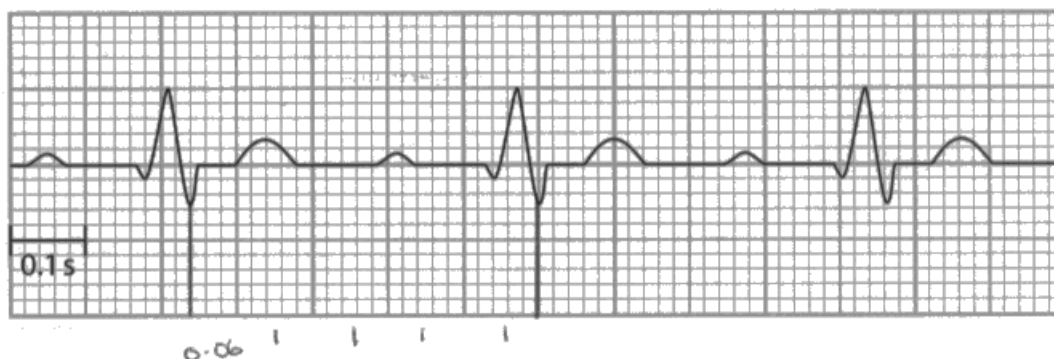
(c) The autonomic nervous system plays a role in regulating heart rate.

The diagram shows an ECG trace from a student before and during exercise.

before exercise



during exercise



(i) Calculate the heart rate of this student during exercise.

(1)

$$4. \quad 0.46 \text{ s}$$

$$60 \div 0.46$$

$$= 130.434$$

Answer 130 bpm



ResultsPlus

Examiner Comments

This is a correct answer with units and so gained the mark. The candidate used the scale correctly to determine the length of time for one beat and then divided 60 seconds by this time.



ResultsPlus

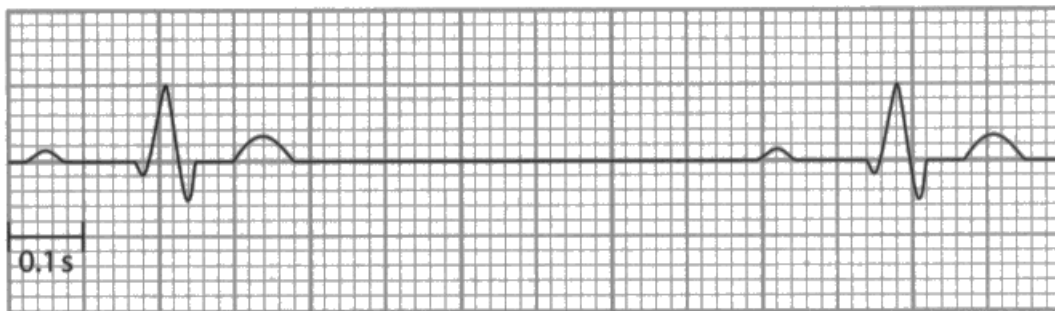
Examiner Tip

For calculations, show all working and ensure that units are given

(c) The autonomic nervous system plays a role in regulating heart rate.

The diagram shows an ECG trace from a student before and during exercise.

before exercise



during exercise



(i) Calculate the heart rate of this student during exercise.

(1)

Answer *0.11s* *0.48s*



ResultsPlus
Examiner Comments

This is an incorrect answer. The candidate had not read the question carefully enough and simply measured the time taken for one heartbeat. They have also misread the scale and given the wrong time.



ResultsPlus
Examiner Tip

Read questions carefully and be careful that you understand the value of each increment when analysing scales.

Question 2 (c) (ii)

This question discriminated well and a very broad range of answers was seen. Some answers were outstanding and gave excellent detail with impressive use of vocabulary. Some candidates misunderstood the question and gave answers that explained why the heart would need to speed up in terms of oxygen demand and respiration. Where answers scored less well, several common mistakes were seen including:

- using imprecise language; at A-level, candidates should refer to impulses travelling through neurones, not signals or messages;
- lack of detail or precision; many were aware that carbon dioxide concentration would increase, but failed to state in the blood. Similarly, many knew that chemoreceptors would respond but did not give a correct location;
- misconceptions: many thought that sympathetic neurones carry impulses up to the cardiac centre in the medulla and many did not appreciate that noradrenaline is released onto the sinoatrial node directly.

Questions that require descriptions at A-level require a high level of accurate detail and vague descriptions should be avoided.

(ii) Describe how exercise results in an increased heart rate.

(4)

Exercise results in increased heart rate due to a detected of a change in pH by chemoreceptors in the carotid artery due to the increase in CO_2 concⁿ, i.e. carboxylic acid. The chemoreceptors then send an electrical impulse to the medulla oblongata which, through cardio acceleratory centre, sends nervous impulses down the sympathetic nerve. This stimulates the release of noradrenaline which in turn increases the frequency of signals travelling to SAN node in the heart via the sympathetic nerve, this increases the frequency at which the heart contracts: increasing heart rate.

Adrenaline may also be secreted due to stress which increases the frequency of signals given off by the SAN node: increasing heart rate.



ResultsPlus

Examiner Comments

This is a very good answer that gained four marks out of four. Mark point one was not awarded for the increase in carbon dioxide because there was no link to the blood. Mark points two, three and four were awarded for stating that the chemoreceptors are in the carotid artery, impulses go to the medulla and impulses then pass down the sympathetic neurones. Mark point five was awarded for the direct effect of adrenaline on the S.A. node; it was not awarded for the effect of noradrenaline, as the candidate did not imply that noradrenaline directly stimulates the S.A. node.



ResultsPlus

Examiner Tip

Ensure that you give full detail in all your answers. It is very easy to just miss mark points by not adding detail. "Low pH is detected by chemoreceptors that send signals to the medulla" would gain zero marks; "low pH in the blood that is detected by chemoreceptors in the carotid artery that sends impulses to the medulla" would gain three marks.

(ii) Describe how exercise results in an increased heart rate.

(4)

adrenaline is released in anticipation of exercise, this causes the blood to thin and blood vessels to expand, decreasing blood pressure, this change is detected by baroreceptors, send an impulse to the cardiac control centre along the sympathetic nerves ~~that~~ in the medulla oblongata to increase heart rate. Also occurs as chemoreceptors detect a change in pH (due to increase CO_2 levels) that send signals to the cardiac control centre along sympathetic nerves.



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Examiner Comments

This answer has a lot of correct terminology but it is often in the wrong context or lacking depth. One mark was awarded for the impulses passing to the cardiac control centre. No marks were awarded for the idea of chemoreceptors, as no location was given, and no mark was awarded for the change of pH as it was not linked to the blood.

Question 3 (b) (i)

This question required candidates to be able to translate a decimal number into standard form correctly, read a value from a graph and then calculate a percentage. Stronger responses usually gained two marks, although many failed to give units. Common errors included not correctly translating the number into standard form, and mis-reading the y-axis on the graph. A surprising number of candidates were able to correctly identify 76%, but were unable to use it to calculate the change in length.

- (i) The mean length of the pollen tubes in the control group was 7.5 mm.

Calculate the mean length of the pollen tubes after adding $0.010 \mu\text{g cm}^{-3}$ of chemical A.

(2)

$$\text{At } 1 \times 10^{-2} \mu\text{g cm}^{-3} : 76\%$$

$$\frac{76}{100} \times 7.5 = 5.7$$

Answer 5.7 mm



ResultsPlus Examiner Comments

This is an example of a correct calculation. The candidate has shown all the stages in the calculation, and has written the answer with the correct units.



ResultsPlus Examiner Tip

Always show working in your calculations. Even if the final answer is incorrect, some credit may be available for correct methods.

(i) The mean length of the pollen tubes in the control group was 7.5 mm.

Calculate the mean length of the pollen tubes after adding $0.010 \mu\text{g cm}^{-3}$ of chemical A.

(2)

$$\begin{aligned} 50\% &= 7.5 \\ 76\% &= ? \\ &= \frac{7.5 \times 76}{50} \end{aligned}$$

Answer 11.4 mm



ResultsPlus
Examiner Comments

This answer gained one mark for the correct identification of 76%. The candidate did not use this value correctly and so did not gain the second mark.

Question 3 (b) (ii)

This question generated a very broad range of responses with many candidates gaining at least one mark, but only the strongest gained all four. Many candidates were able to recognise that preventing translation had a greater effect on the growth of pollen tubes. A common mistake was simply to state that translation has a bigger role in pollen tube growth rather than appreciating that stopping translation reduces the growth of the pollen tube. Fewer candidates gave answers with more detail regarding the data. It is good practice when looking at data sets to carry out some form of manipulation of the data, such as calculating the difference in percentage that different dosages of the chemicals caused. Many candidates simply quoted data points without carrying out any form of manipulation of the figures. Only stronger candidates made valid conclusions which were focused on the idea that since preventing transcription had less effect than preventing translation, it implied that there was already mRNA present and that the synthesis of new proteins is essential for pollen tube growth. Another frequent misconception was that translation was more important, or that translation has a bigger role in pollen tube growth.

(ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth.

(4)

When chemical A is ~~added~~ added the percentage length of pollen grain decreases steadily. At concentration of 1×10^1 and 1×10^2 the percentage length of pollen tube stay about the same. This may be because existing mRNA produce the proteins needed by the pollen tube to grow so little change compared to increasing concentration of B. The percentage length of pollen tube decreases rapidly ^{with comparison to control} for B. At 1×10^1 and 1×10^2 the percentage of is 0 compared to the ~~growing~~ normal growing pollen tubes of control. This suggests that B stops the pollen tubes from growing. This may be because even existing and new mRNA are not translated into proteins so pollen tube can't grow



ResultsPlus

Examiner Comments

This is a good answer that gained three out of the four marks. The candidate has made a clear indication that chemical B reduces pollen tube growth the most, gaining mark point one; they go on to gain two further marks for explaining that mRNA is already present and new proteins need to be synthesised for pollen tube growth. Mark point two is not awarded as there is no clear manipulation of the data to make a comparison.



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Examiner Tip

When given data sets, always carry out numerical manipulations to make comparisons, do not simply give data points. Try to draw valid conclusions about the data, explaining how you reach your conclusions.

- (ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth. (4)

The data

It shows that translation is much more important for pollen tube growth than transcription because at the highest chemical concentration of chemical A the percent growth was 72% which is still quite large whereas it was at 0% for chemical B. This showed that chemical B had a much greater effect because if translation is inhibited then protein synthesis stops and pollen tubes need enzymes to grow so they release hydrolytic enzymes during pollination to go down the style. In both cases the percentage length decreases but it decreased so much more drastically with increasing concentrations of chemical B.



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Examiner Comments

This answer gained two marks for the ideas that chemical B has a bigger effect on pollen tube growth and that translation is essential for enzyme and protein production for pollen tube growth. Although the candidate has referred to data points, there is no manipulation of the data.

(ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth.

(4)

→ chemical A, when present, decreased the length of the pollen tube rapidly at first however the decrease slowed and ~~stopped~~ so some of the pollen tubes were below 70% of the control (4)

→ however chemical B decreased the length of the pollen tube ~~less~~ and more rapidly until no pollen tubes grew (0% at 1×10^{-1} μ g cm⁻³)

→ chemical A, prevented transcription so had less of an effect on the growth of the pollen because DNA that had already been transcribed could be translated into proteins for growth

→ however chemical B stopped translation so no proteins could be produced ~~the~~ ^{meaning} cellular function couldn't be carried out e.g. no enzymes for digesting style so no pollen tubes grew

→ however in A, the ~~error~~ DNA for enzymes had already been transcribed so they could be produced as normal at ribosomes in translation so enzymes would break down the style as normal

→ there is still a decrease in length under chemical A due to less

(Total for Question 3 = 8 marks)



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Examiner Comments

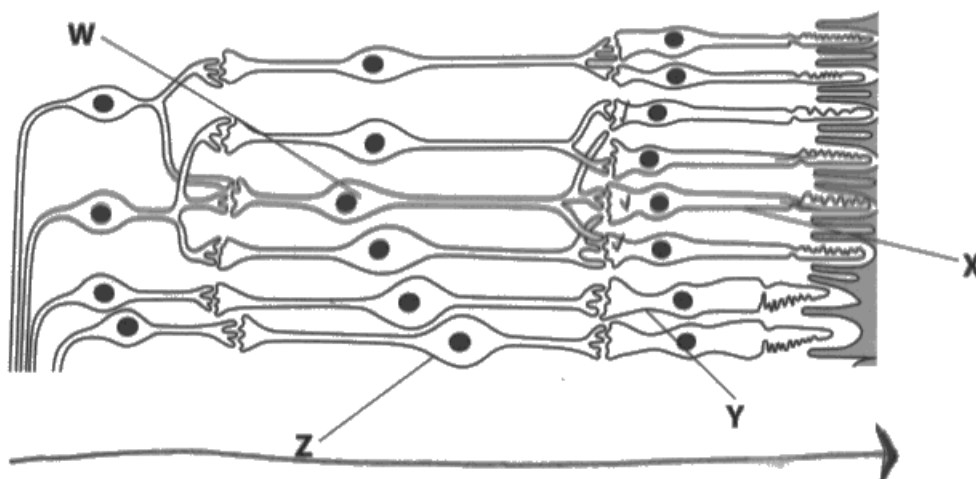
This is a very strong answer that gained all four marks. There is a clear indication that chemical B has a greater effect on pollen tube growth, and more detail is given by referring to the levelling off of the effect of chemical A, whilst chemical B causes a fall to zero. The candidate explains the data by stating that sufficient transcription must have already occurred and that translation ensures that there is synthesis of new proteins for enzymes or tube growth.

Question 4 (a) (ii)

Most candidates were able to correctly recognise that light must pass through the ganglion and bipolar cells before reaching the rods and cones. A significant number of candidates incorrectly drew the arrow in the opposite direction.

4 The retina is the light sensitive structure in the eye.

(a) The diagram shows some of the cells in a human retina.



(i) Which row in the table correctly identifies the cells W, X and Y?

(1)

	Cell W	Cell X	Cell Y
<input checked="" type="checkbox"/> A	bipolar cell ✗	cone cell ✗	rod cell ✗
<input checked="" type="checkbox"/> B	bipolar cell ✗	rod cell ✓	cone cell ✓
<input checked="" type="checkbox"/> C	ganglion cell ✗	cone cell ✗	rod cell ✗
<input checked="" type="checkbox"/> D	ganglion cell ✓	rod cell ✓	cone cell ✓

(ii) Draw an arrow on the diagram to show the direction of the light passing through the retina.

(1)

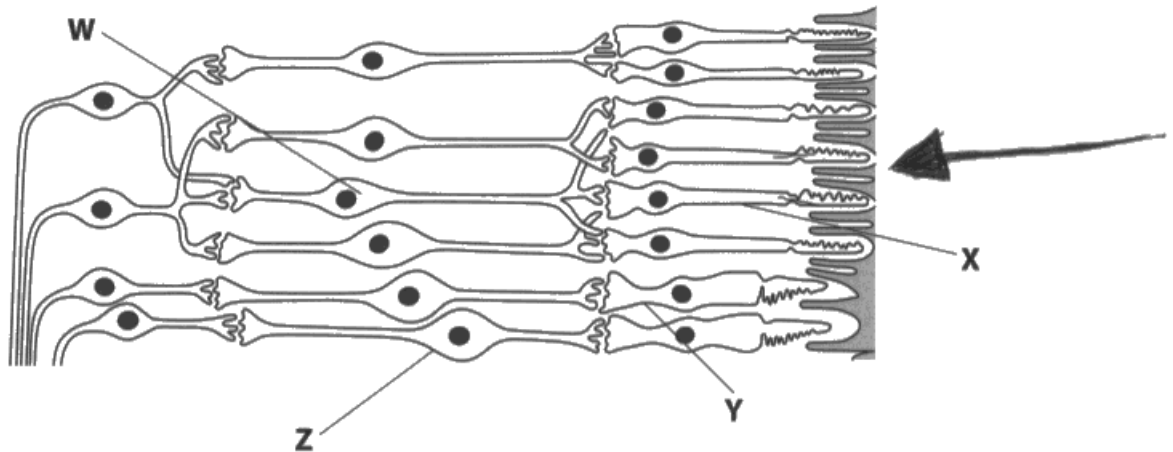


ResultsPlus
Examiner Comments

This example shows the arrow in the correct direction

4 The retina is the light sensitive structure in the eye.

(a) The diagram shows some of the cells in a human retina.



(i) Which row in the table correctly identifies the cells **W**, **X** and **Y**?

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<input checked="" type="checkbox"/> B	bipolar cell	rod cell	cone cell
<input checked="" type="checkbox"/> C	ganglion cell	cone cell	rod cell
<input checked="" type="checkbox"/> D	ganglion cell	rod cell	cone cell

(ii) Draw an arrow on the diagram to show the direction of the light passing through the retina.

(1)



ResultsPlus
Examiner Comments

This example shows a common error with the arrow pointing in the incorrect direction

Question 4 (a) (iii)

This question discriminated well between candidates, with stronger candidates often writing excellent, very accurate answers that gained all three marks. Many candidates clearly have an excellent understanding of the structure of the retina and appreciate how spatial summation occurs between rods and bipolar cells. Many candidates correctly referred to the high sensitivity of rhodopsin and the large quantity that is found in rod cells; the examiners also noted that there is significant evidence for candidates extending their knowledge beyond the bounds of the specification by correctly describing the properties of iodopsin. Weaker candidates often gained one mark for describing how several rods connect to a bipolar neurone (or one cone attaches to a bipolar neurone) but then did not extend their explanation any further. Some had a tendency to restate the questions by simply stating that rods are more sensitive. A few thought that a single rod attached to a bipolar neurone.

(iii) Explain why a higher light intensity is required to produce an action potential in cell Z than in cell W.

(3)

cell Z is attached to a cone cell which is insensitive to light, due to the pigment Iodopsin. ~~The~~ Cell W is attached to a rod cell, ~~that~~ ~~also~~ which cause to form action potentials and ~~depolarise~~ polarise bipolar cell, W. Also rod cells pigment rhodopsin ~~is~~ is very sensitive to light, making it easier to form an action potential at lower light intensities. This is due to the change between ~~rhodo~~ rhodopsin ^{isomers of} when light is present.



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Examiner Comments

This answer gained one mark for the idea of the high sensitivity of rhodopsin. The candidate almost gains mark point one for the idea of one cone attaching to a bipolar neurone but unfortunately negates this by stating that a single rod cell also connects to a bipolar neurone.



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Examiner Tip

Think carefully about what you write. Rushed comments that are incorrect can sometimes lose credit that would have been gained elsewhere.

(iii) Explain why a higher light intensity is required to produce an action potential in cell Z than in cell W.

(3)

Cell Z is synapsed with 1 cone cell whereas cell W is synapsed with 3 different rod cells. Cell W can be depolarised in low light intensities due to convergence of the smaller generator potentials from each of the rod cells which summate to form a large enough generator potential to cause an action potential in W. However, cell Z can only be depolarised when there is a large enough generator potential from the one cone cell which can only occur in high light intensities which the iodopsin absorbs.



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Examiner Comments

This is a very good answer that gained three marks. The candidate clearly describes how one cone attaches to one bipolar neurone, gaining mark point one, and goes on to state that convergence of generator potentials occurs resulting in a depolarisation and action potential to gain mark points two and three. They also go on to discuss how iodopsin is found in cone cells and requires high light intensity.

(iii) Explain why a higher light intensity is required to produce an action potential in cell Z than in cell W.

(3)

The cone cells synapse only one sensory neurone which means that it can only respond as a result of large generator potentials. The sensory neurone is stimulated if the action potential of the generator potential of the cone cell reaches the threshold of the sensory neurone. However, in cell W, many of them synapse with one sensory neurone so convergence can happen whereby many generator potentials small generator potentials act together to reach the threshold of the action potential of the sensory neurone.



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Examiner Comments

This is a very good answer that gained three marks. The candidate has correctly described the connections and gone on to explain how convergence occurs to overcome a threshold and generate an action potential.

(iii) Explain why a higher light intensity is required to produce an action potential in cell Z than in cell W.

(3)

Because cell W is connected to several different rod cells so the action light intensity from both rod cells are put into one W cell. Whereas cell Z receives ~~low~~ is connected to only one cone cell so the cone cell ~~needs to absorb more~~ requires a higher intensity to induce an action potential in cell Z.



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Examiner Comments

This answer gains only one mark. The candidate correctly describes the connections between rod and bipolar neurone but does not go on to explain how this improves sensitivity.

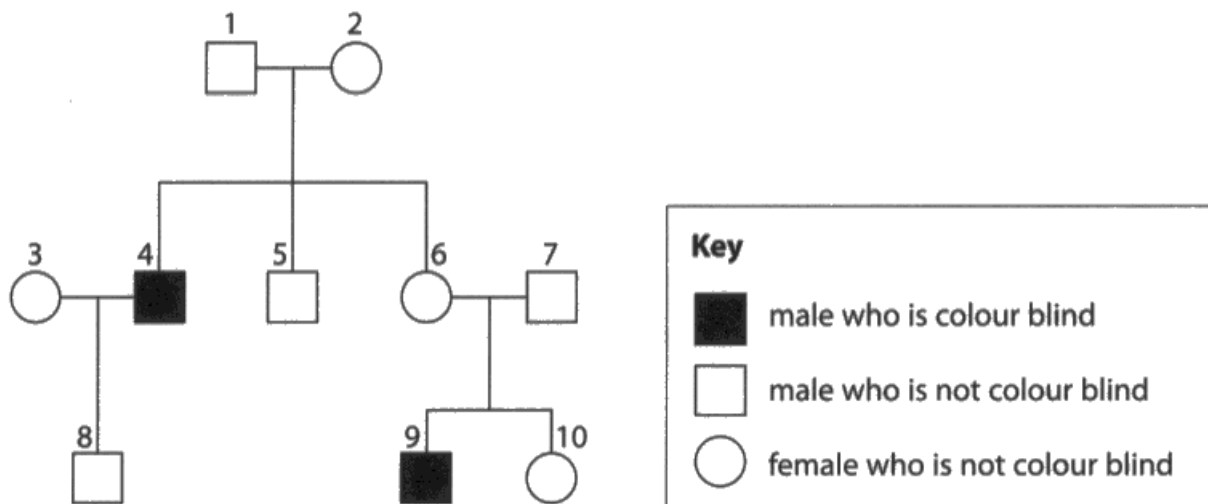
Question 4 (b) (i)

This question was found to be very challenging by many candidates with only the strongest gaining both marks. A large number did not read the question carefully enough, thus not appreciating that colour blindness is a sex-linked condition, with many suggesting that both parents of a colour-blind child would have to be heterozygous. This is incorrect as it would imply that males would be heterozygous when they only have one X chromosome. Candidates often failed to give reference to any particular crosses - it is worth noting for future reference that it is good practice, when asked to state the evidence from pedigree diagrams, to identify the parts of the diagram that show the evidence. Some candidates thought that a recessive condition would have fewer individuals with that phenotype and others thought that the fact only males suffered from it was firm evidence for colour blindness being a recessive condition. When candidates did gain both marks, it was typically for correctly identifying two parents without colour blindness that have a son with colour blindness, and then adding that the mother would have to be a carrier as she passes on her X chromosome to the son.

(b) Red-green colour vision is controlled by a single gene located on the X chromosome.

Colour blindness is caused by a recessive allele for the red-green colour vision gene.

The diagram shows the inheritance pattern of colour blindness for a family.



(i) Explain how the diagram shows that red-green colour blindness is caused by a recessive allele.

(2)
~~→ male 4, who was colour blind, reproduced with a female non-sufferer to produce a male non-sufferer~~
 → male 7 + female 6 reproduced to form 1 male non-sufferer and one male sufferer
 → That means the female 6 must have carried the

allele for colour blindness (because males can't be carriers) but she didn't suffer so it must be caused by a recessive allele



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Examiner Comments

This is a very good answer that gains both marks. The candidate has identified that parents 6 & 7 have a colour-blind son, individual 4, and that the mother (6) is not colour blind. They then explain that the mother (6) must be heterozygous.

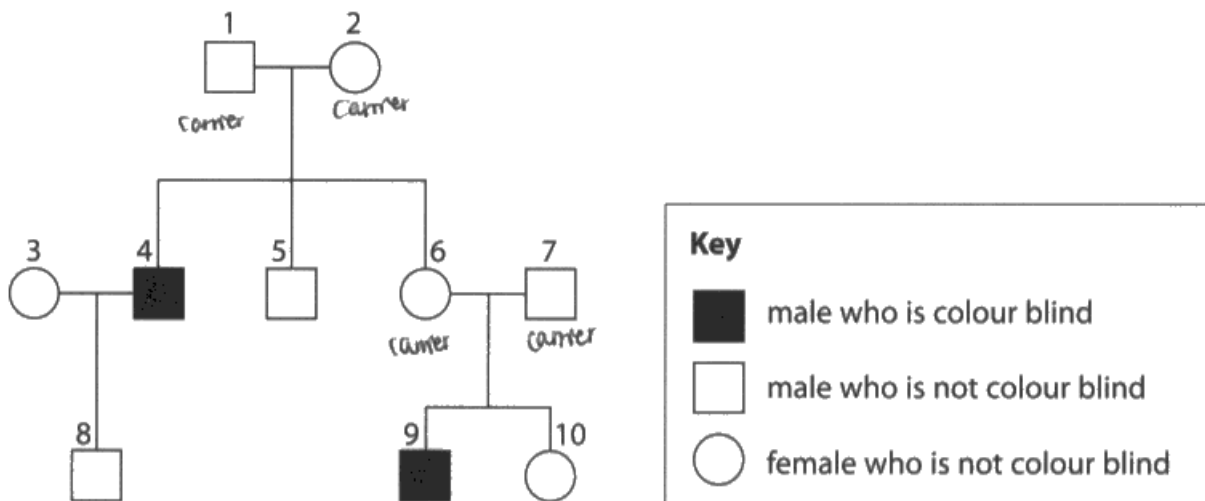


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Examiner Tip

Always indicate the individuals in a genetic cross that provide the evidence for a conclusion.

- (b) Red-green colour vision is controlled by a single gene located on the X chromosome. Colour blindness is caused by a recessive allele for the red-green colour vision gene. The diagram shows the inheritance pattern of colour blindness for a family.



- (i) Explain how the diagram shows that red-green colour blindness is caused by a recessive allele.

Two recessive alleles are required to pass on a colour blindness in an individual. 1 and 2 are carriers of the allele, /produce (2)

the produced 4, a male with colour blindness and 5 and 6 who are not colourblind. 4 is a male who has it, he produces a ~~child~~^{male} with 3 and the ~~child~~^{male} doesn't have colour blindness. red-green colour vision only requires one dominant allele to be present. ~~the mother~~



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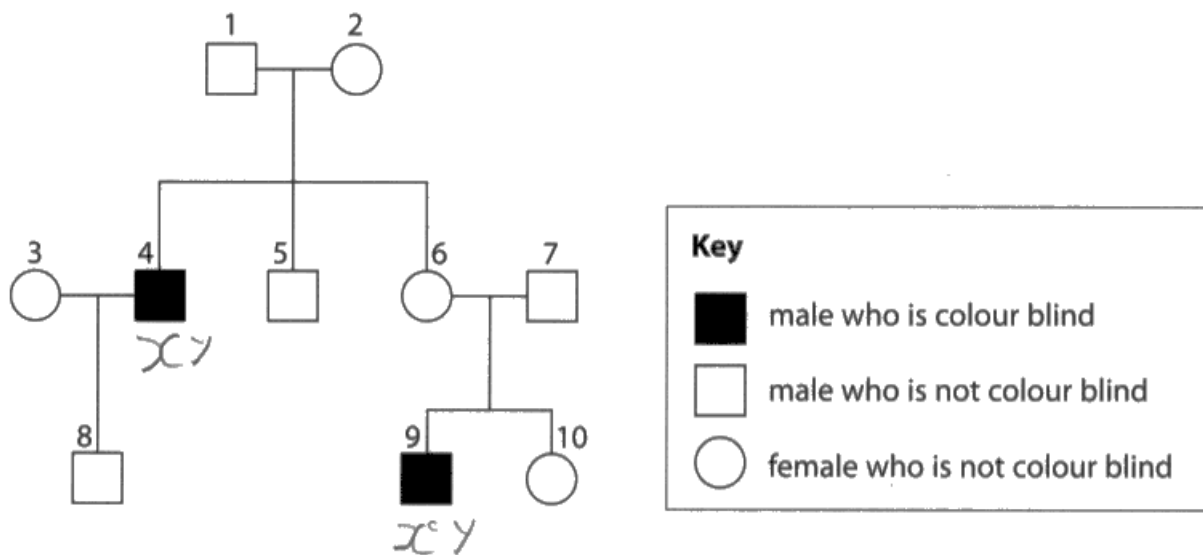
Examiner Comments

This answer does not gain any marks. A correct cross is identified but there is no indication why this provides evidence. The son is recognised as colour-blind but the candidate has not stated that the mother is not. They have also erroneously stated that both parents would have to be carriers.

(b) Red-green colour vision is controlled by a single gene located on the X chromosome.

Colour blindness is caused by a recessive allele for the red-green colour vision gene.

The diagram shows the inheritance pattern of colour blindness for a family.



(i) Explain how the diagram shows that red-green colour blindness is caused by a recessive allele.

(2)

Only males are affected by it but females must also be carriers. This shows that a recessive allele causes the colour blindness.

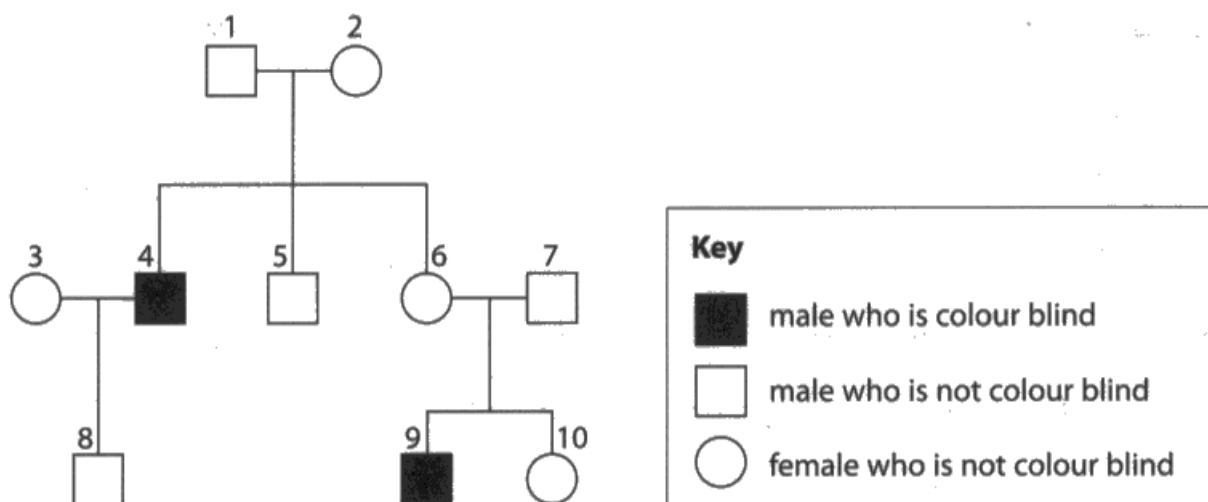
because males only have one copy of the X chromosome so if the recessive allele is present they will be colour blind but female carriers are unaffected meaning they must have a dominant allele too (as women have 2X chromosomes).



ResultsPlus
Examiner Comments

This answer gained one mark. It is an example of how a candidate could have gained credit without referring to a specific cross. The candidate correctly recognises that the mother must be a carrier but is unaffected (mark point four) but does not quite gain mark point three as there is no indication that the son has gained her affected X chromosome.

- (b) Red-green colour vision is controlled by a single gene located on the X chromosome. Colour blindness is caused by a recessive allele for the red-green colour vision gene. The diagram shows the inheritance pattern of colour blindness for a family.



- (i) Explain how the diagram shows that red-green colour blindness is caused by a recessive allele.

(2)

• The parents did not have colour blindness but one of their offspring does, this means that ~~the~~ ~~be~~ ~~at~~ ~~least~~ ~~one~~ ~~of~~ both parents ~~must~~ must have been carriers of the allele, and since ^{colour blindness} it was not expressed in the parents this must mean the allele was recessive and that the parents were heterozygous ~~for~~ (dominant) for the allele.



ResultsPlus
Examiner Comments

This was a common answer that gained one mark for recognising that unaffected parents have had an affected son. The candidate then incorrectly states that both parents would be carriers and so does not gain mark point two.

Question 4 (b) (ii)

This question discriminated well, with many candidates gaining all three marks. Many candidates drew very accurate, well set out genetic diagrams, and the examiners commented on how good some of these were. The commonest error was not recognising that colour blindness is a sex-linked condition and so some simply drew out crosses between two heterozygous parents. This would gain them one mark if they correctly stated the probability as 0.25. Some candidates gave ratios (3:1), rather than probabilities. Many chose unusual symbols for their crosses, and for future reference, sex-linked crosses are best illustrated by a capital X with a superscript allele attached (X^C). Some weaker responses said that the Y chromosome of the males would also have an allele attached to it.

(ii) Use a genetic diagram to determine the probability that the next child of individuals 6 and 7 is a male who is colour blind.

(3)

(7) X^H
 Y

(6) $X^H X^h$
 $X^h X^H$ — 50% chance of heterozygous female

$X^H Y$ | $X^h Y$ — 25% chance that the next child will be male and be colour blind given that the mother is heterozygous (carrier).

25% chance of a male who is not colour blind.

Answer 25%



ResultsPlus Examiner Comments

This is an almost a fully correct answer. The candidate gained mark point three for correctly calculating 25%, and mark point one for stating the parental genotypes. They have unfortunately not carried out the cross correctly and one of the genotypes of the offspring is wrong.



ResultsPlus Examiner Tip

Set genetic diagrams out neatly using keys and clearly identify all genotypes, alleles and phenotypes. Check the cross to make sure that there are no errors.

- (ii) Use a genetic diagram to determine the probability that the next child of individuals 6 and 7 is a male who is colour blind.

(3)

B = not colour blind
b = Colour blind

$$\frac{1}{4} = 25\%$$

	X^B	X^b
X^B	$X^B X^B$	$X^B X^b$
X^B	$X^B X^B$	$X^B X^b$
X^b	$X^B X^b$	$X^b X^b$
Y	$X^B Y$	$X^b Y$

50% 50%
 ↓ ↓
 chance chance
 of male of colour
 blind

Answer 25%



ResultsPlus
Examiner Comments

This is a very good answer that gained all three marks. The diagram is clearly laid out and all aspects of it are correct.

- (ii) Use a genetic diagram to determine the probability that the next child of individuals 6 and 7 is a male who is colour blind.

(3)

	R	r
R	RR	Rr
r	Rr	rr

1/4

Answer $\frac{1}{4}$.

(Total for Question 4 = 10 marks)

	R	r
R	RR	Rr
r	Rr	rr



ResultsPlus
Examiner Comments

This is an example of a common error where the candidate has not appreciated that the cross is sex-linked. Only one mark was gained for the correct probability.

Question 5 (a) (i)

This question required candidates to give a full detailed description of the events leading up to the formation of an EPSP in the postsynaptic neurone. Stronger responses often gained all four marks, giving very detailed descriptions that used correct nomenclature. Many candidates had a rudimentary understanding of the process but often did not use precise language. Common errors included:

- not referring to the presynaptic terminal
- referring to calcium rather than calcium ions or Ca^+ rather than Ca^{2+}
- not stating that vesicles fuse with the presynaptic membrane
- stating that the acetylcholine binds to the postsynaptic membrane rather than receptors.

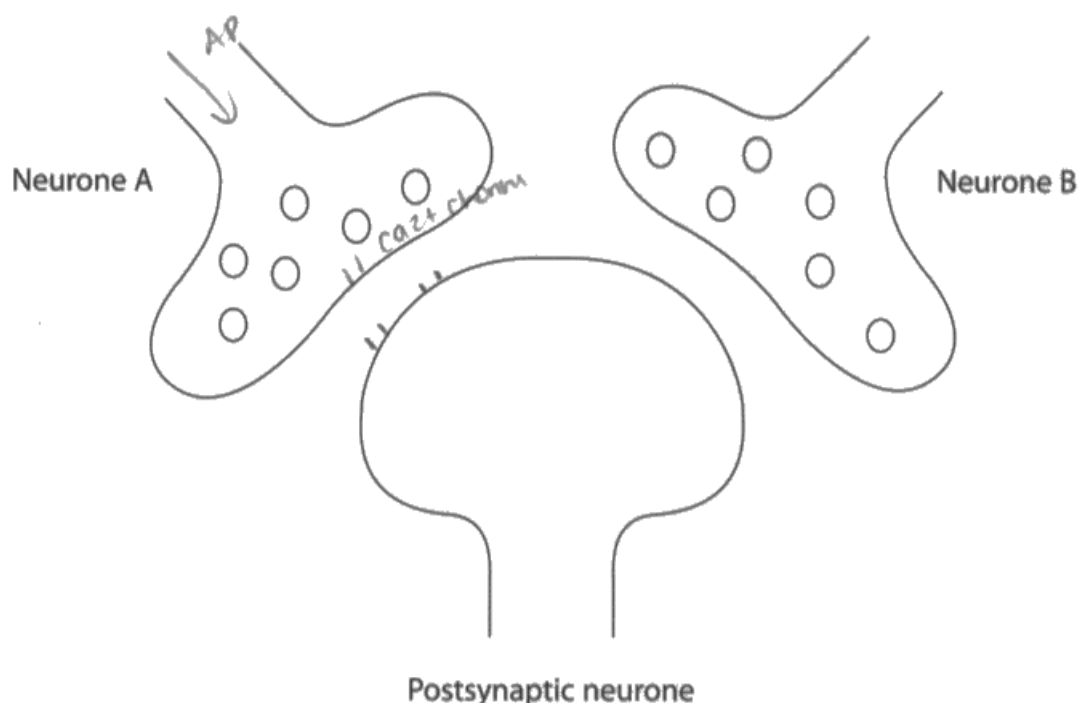
Some candidates misread the question and described the postsynaptic events that lead to the production of an action potential. It is essential to use very accurate, precise language at A-level in order to gain maximum credit.

5 The diagram shows the structure of a synaptic junction between three neurones.

Neurone A releases the excitatory neurotransmitter acetylcholine.

Neurone B releases the inhibitory neurotransmitter glutamate.

Glutamate causes chloride ions to move into the postsynaptic neurone.



(a) (i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

When an action potential arrives at the pre-synaptic knob, it causes Ca^{2+} channels in the pre-synaptic membrane to open. As a result, Ca^{2+} ions enter the pre-synaptic membrane by diffusion down a concentration gradient. This influx causes vesicles containing neurotransmitters to fuse with the pre-synaptic membrane and release their neurotransmitters into the synaptic cleft by diffusion. Neurotransmitters bind to receptors on the post-synaptic membrane causing Na^{+} ion channels to open. Na^{+} ions move in by diffusion creating an EPSP as the inside ^{becomes more} positive.



ResultsPlus Examiner Comments

This is an excellent, very accurate and detailed answer that gained all the mark points. The candidate clearly refers to the action potential arriving at the presynaptic knob, the opening of calcium channels, the fusion of the vesicles with the presynaptic membrane, the diffusion of the acetylcholine across the cleft and the binding to receptors and influx of sodium ions in the postsynaptic neurone. A very strong answer.



ResultsPlus Examiner Tip

Clear use of detailed terminology is essential to gain maximum credit. This answer gained all four marks but missing a few words would have a big effect: an impulse arrives, calcium moves into the membrane causing the release of acetylcholine which binds to receptors on the postsynaptic neurone would gain zero marks.

(a) (i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

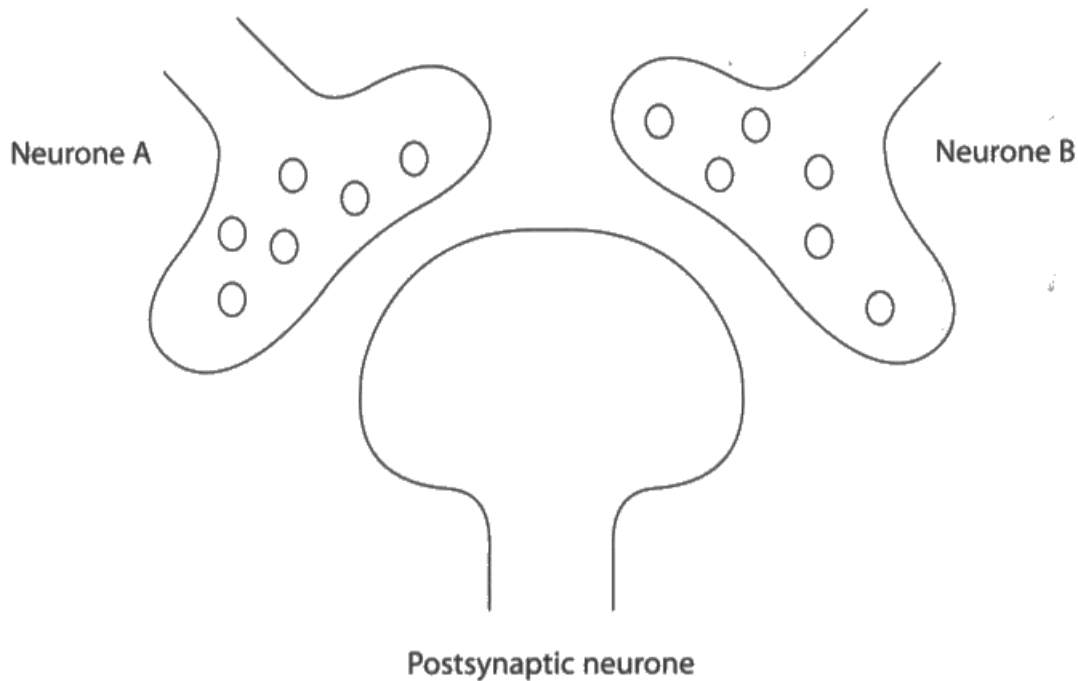
Neurone A is the ~~pre~~^{pre-} synaptic neurone, when an impulse reaches it, its permeability to calcium ions increases so calcium ion channels are opened which diffuse down their concentration gradient in the synaptic knob and cause synaptic vesicles which contain neurotransmitters to bind to ~~pre~~ synaptic membrane and release neurotransmitters in the synaptic cleft which bind to specific receptor sites on neurone B (post synaptic ~~membrane~~ membrane) membrane. In neurone B, sodium ion channels open and this causes an influx of Na^+ which diffuses into the axon causing an action potential (wave of depolarisation). This produces the EPSP.



ResultsPlus
Examiner Comments

This is another good example that gained four marks. The first mark point is not awarded as the impulse does not arrive at the pre-synaptic terminal but all other mark points are clearly evident.

- 5 The diagram shows the structure of a synaptic junction between three neurones.
- Neurone A releases the excitatory neurotransmitter acetylcholine.
- Neurone B releases the inhibitory neurotransmitter glutamate.
- Glutamate causes chloride ions to move into the postsynaptic neurone.



- (a) (i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

A Vesicles containing Acetylcholine (ACh) to fuse with the presynaptic membrane, and are released. ACh to ACh Acetylcholine travels across the synaptic cleft and binds to receptors on the ~~post~~ post-synaptic membrane. This binding ~~causes~~ ^{causes} the A⁺ sodium channels (voltage-gated) on the post-synaptic membrane and the axonal membrane to become more permeable to sodium ions. Hence therefore ~~the~~ sodium ions move into the axonal membrane causing depolarisation.

• Ca²⁺

• ACh vesicles fuse with presynaptic membrane

• ACh is released

• Ca²⁺ channels + Na⁺ channels



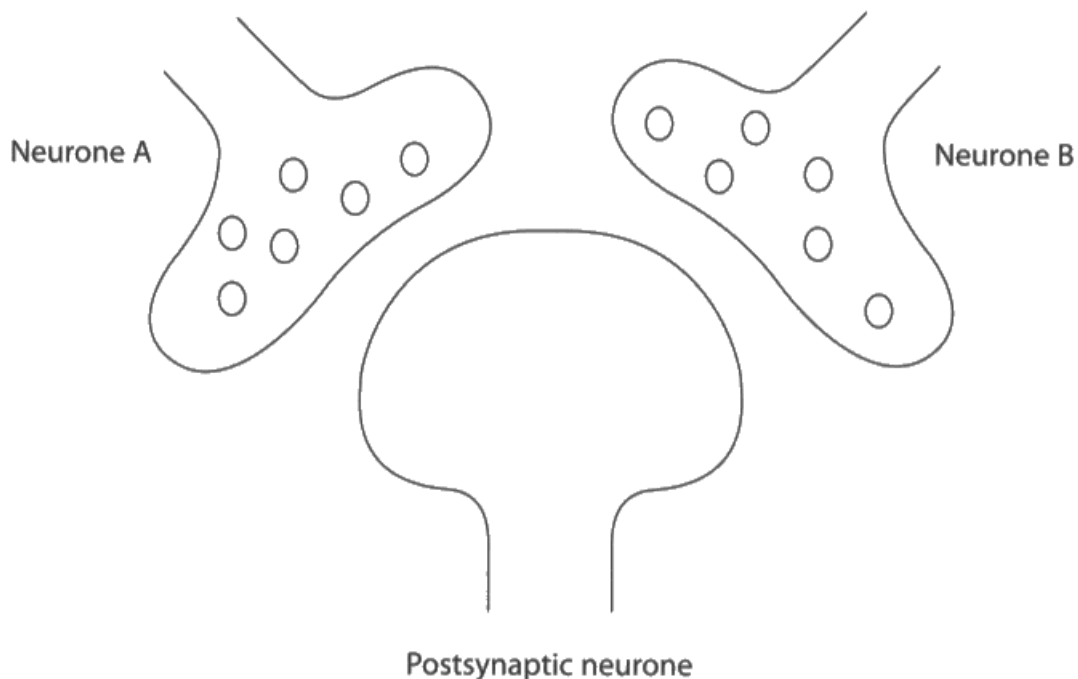
This is a good answer but misses the first two mark points. There is no mention of the impulse arriving at the pre-synaptic terminal and no reference to calcium channels opening so mark points one and two are not awarded. All other mark points are awarded. The candidate clearly understands from their notes at the end of the answer that calcium ions are involved but has not made any proper explanation of this.

5 The diagram shows the structure of a synaptic junction between three neurones.

Neurone A releases the excitatory neurotransmitter acetylcholine.

Neurone B releases the inhibitory neurotransmitter glutamate.

Glutamate causes chloride ions to move into the postsynaptic neurone.



(a) (i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

an action potential in neurone A causes calcium to come into the neurone and moves all the neurotransmitters to the membrane where they move across the synaptic cleft before binding to neuroreceptors

on the postsynaptic neurone and as it's excitatory neurotransmitter's calcium is then moved into the neurone and initiates an action potential in the postsynaptic neurone.



ResultsPlus

Examiner Comments

This is a good example of where a lack of detail loses an answer credit. This answer only gained one mark but is very close on others. Mark point one is just missed as there is no reference to the synaptic terminal. Mark point two is missed as the candidate refers to calcium rather than calcium ions. Mark point three is missed as the neurotransmitter is not within vesicles. Mark point four is awarded for the passing of neurotransmitters across the cleft. Mark point five is not awarded as there is no mention of sodium ion movement.



ResultsPlus

Examiner Tip

Use accurate language. If you are referring to ions, make this clear in your answer. If you use symbols make sure that they are correct, e.g. Ca^{2+} is correct, Ca^+ is not correct.

Question 5 (b)

This question was found to be challenging by many candidates with only stronger responses gaining more than one mark. Many candidates correctly recognised that an action potential only forms after a threshold has been achieved or when stimulation of A was high and B was low. Fewer went on to explain that this was a consequence of the higher levels of acetylcholine compared to glutamate or the higher EPSP compared to the IPSP. Some candidates correctly recognised that if levels of glutamate were high, no action potential occurred due to the inflow of chloride ions making the membrane hyperpolarised or further away from the threshold. Several misconceptions were evident: some thought that acetylcholine and glutamate bound the same receptor and so glutamate blocked the acetylcholine; a significant number of candidates appreciated that glutamate caused chloride ions to move but thought that they would move out (this would cause a depolarisation of the membrane) and others thought that chloride ions were positively charged. Unfortunately, a significant number of candidates did not appreciate that the question was looking for an explanation and just gave a description of the results. Candidates should be clear of the difference between describe and explain.

- (b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	no

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

The intensity of stimulation on neurone A only and B will result on different production of action potential in postsynaptic neurone. If neurone B have a high intensity of stimulation, then there will be nothing but if neurone B have a low intensity of stimulation and neurone A has a high intensity

of stimulation, then there will be a production of action potential in postsynaptic neurone.



ResultsPlus
Examiner Comments

This answer gained one mark for stating that an action potential only occurs when stimulation of A is high and B is low. The candidate does not go on to give any explanation as to why this occurs and so does not gain further credit.



ResultsPlus
Examiner Tip

If a question asks for an explanation, do not just give a description.

(b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

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low	high	no
high	low	yes
high	high	no

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)
~~When~~ low intensity of stimulation doesn't cause an action potential for neurone A, as the intensity of stimulation is ^{not enough} because not enough ~~the~~ Ach binds and so, not enough Na⁺ ions flow in to reach the threshold, hence, no action potential. Neurone B inhibits action potential by causing ~~depolarisation~~ ^{hyperpolarisation} So even if, ^{stimulation of} neurone B is high / low, there'll still not be an action potential as long as neurone A remains low. Neurone A ^{is} ~~not~~ ^{controls} the production of action potential because it opens Na⁺ channels causing ~~and~~

Neuronisation, so when intensity of neurone A is high ^{and} neurone B is low, ^{lots of} Na⁺ ions are still flowing in to reach threshold causing action potential because ^{acetylcholine} more ~~Na⁺ ions~~ than glutamate. When both A and B are high, the ^{amount of acetylcholine} ~~Na⁺ ions~~ and glutamate released are the same so ~~glutamate~~ they cancel each other out causing no action potential.

(Total for Question 5 = 8 marks)



ResultsPlus

Examiner Comments

This is an excellent answer that both describes and explains the results and so gained all three marks. The candidate clearly states that an action potential only occurs when A is high and B is low and then goes on to explain this in terms of acetylcholine and glutamate. The candidate also explains that stimulation of neurone B and the release of glutamate causes hyperpolarisation in the neurone.

- (b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	no

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

A high intensity of ~~action~~ ^{stimulation} on neurone A causes an action potential as it releases excitatory neurotransmitters which increase the positive charge on the post-synaptic neuron making an action potential more likely whereas a high stimulation on neurone B releases an inhibitory neurotransmitter causing chloride ions (negative charge) to move into the post synaptic neuron, increasing the negative charge so there is less likely

to be an action potential, therefore high intensity of stimulation needed on neurone A and low intensity for neurone B for an action potential to occur on post synaptic neurone.

(Total for Question 5 = 8 marks)



ResultsPlus

Examiner Comments

This is a good answer that gained two marks. Mark point one is awarded for stating that an action potential occurs with high stimulation of A and low stimulation of B. This answer also gained mark point four for explaining how the increase in negative chloride ions in the neurone makes the inside more negative.

(b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	no

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

As stimulation of neurone A increases, there is production of an action potential in the post synaptic neurone. This is because the acetylcholine trigger binds to specific receptors? results in Na^+ channels opening in the postsynaptic neurone, triggering an action potential as Na^+ ions flood in & increase the r.p. potential difference of the neurone to $+35\text{mV}$. With neurone B stimulated however, Cl^- move into the postsynaptic neurone & reduce the electrochemical gradient between the

inhibitory neurone of Na^+ , resulting in less Na^+ moving into the neurone so no action potential.

(Total for Question 5 = 8 marks)



ResultsPlus

Examiner Comments

This is a confused answer that gained no marks. Mark point one was not awarded as there is no recognition that stimulation of neurone B must be low for an action potential to occur. Mark point four was not awarded as the candidate has stated that the inflow of chloride ions will reduce the electrochemical gradient which implies a depolarisation rather than a hyperpolarisation.

- (b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	no

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

As action potentials follow the all or nothing law the intensity of stimulation must be enough to get over the threshold potential.
So firstly neurone A must release enough acetylcholine from the presynaptic membrane to stimulate a response. Secondly neurone B must not release enough inhibitory substance to counteract the excitatory response.



ResultsPlus
Examiner Comments

This is a good answer that gained two marks. The candidate has stated that an action potential occurs if a threshold is overcome (mark point one) and then explains that acetylcholine must exceed glutamate (mark point two).

Question 6 (a)

The majority of candidates were able to correctly identify the organelle as the nucleus. The most frequent wrong answers were: nucleolus, lysosome and cytoplasm.

Question 6 (b)

This question required candidates to measure a scale bar and use it with the equation for magnification to determine the magnification of the diagram. They were then expected to measure the nucleus and use their calculated value of magnification and the formula to calculate the real length of the nucleus. A surprising number of candidates found this question very challenging. Very few showed any working and most seemed to prefer to try to work out how many scale bars would fit into the nucleus rather than first calculating the magnification - this approach is correct but is often more prone to error. Many candidates gave incorrect units and it is useful if an estimate of the length is made before starting on any calculation - a nucleus that seems to measure 5.3 m in diameter would imply a mistake has been made in the calculation. Several candidates appeared to have no access to a ruler and others mistook maximum diameter for mean diameter.

(b) Calculate the maximum diameter of organelle Q.

(2)

$$\text{Magnification} = \frac{\text{Actual Size}}{\text{Image size}}$$

$$1 \mu\text{m} = 1 \text{cm}$$

$$\text{Diameter} = 5 \text{cm}$$

$$5 \text{cm} = 5 \mu\text{m}$$

Answer 5 μm



ResultsPlus Examiner Comments

This answer gained no marks. The diameter is out of tolerance. The candidate has correctly stated the equation for magnification but has not shown their working. It should also be noted that the units given are very ambiguous and it is not clear whether they are millimetres or micrometres.



ResultsPlus

Examiner Tip

Show all working and ensure that units are correct. Always consider whether your answer is in the correct magnitude.

(b) Calculate the maximum diameter of organelle Q.

$$\text{maximum ^{image} diameter} = 55 \text{ mm} = 55,000 \mu\text{m} \quad (2)$$

$$\text{scale bar} = 10,000 \mu\text{m} \therefore \text{mag} = \times 10,000$$

$$\therefore \text{actual max diameter} = \frac{55,000}{10,000} = 5.5 \mu\text{m}$$

Answer 5.5 μm



ResultsPlus

Examiner Comments

This answer gained two marks. The final answer is correct (which was awarded two marks) and the candidate has given all their working to make it clear how the final answer has been calculated.

(b) Calculate the maximum diameter of organelle Q.

(2)

$$\text{Maximum diameter} = \cancel{5.3 \times 10^2} \times (\cancel{1 \times 10^{-6}})$$

$$\begin{aligned} & \Rightarrow \cancel{5.3 \times 10^8} \\ 5.3 \times \mu\text{m} &= 5.3 \mu\text{m} \end{aligned}$$

Answer 5.3 μm



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has no working - if the final answer had been incorrect due to an error in the calculation, no marks would have been awarded.

Question 6 (c)

This question was answered well with the majority of candidates gaining at least one mark. Most were able to state that the Golgi is responsible for the modification of proteins and many wrote excellent, detailed descriptions of the addition of lipids and carbohydrates. Many good descriptions of the transfer of vesicles containing protein from the rough endoplasmic reticulum to the Golgi and subsequent packaging of the modified protein into vesicles were seen. Candidates should be careful about the use of the terms exocytosis and endocytosis, as they are often using in the wrong context.

(c) Describe the role of the Golgi apparatus in producing secreted enzymes.

(3)

The golgi apparatus converts proteins into lipoproteins, meaning they can be used as well as packaging enzymes for use outside of the cell by surrounding the protein/glycolipo protein with a vesicle. The vesicle made by the Golgi apparatus can fuse with the cell membrane, ^{the contents} & be secreted by the cell.



ResultsPlus Examiner Comments

This is a very good answer that gained all three marks. The candidate states that the Golgi modifies the protein into lipoproteins, packages it in vesicles and then releases it by vesicle fusion with the cell membrane.



ResultsPlus Examiner Tip

When referring to vesicles and membranes, always refer to the fusion of the membranes.

(c) Describe the role of the Golgi apparatus in producing secreted enzymes.

(3)

When proteins are made in the RER (ribosomes), they pinch off into vesicles, the Golgi apparatus fuses with these vesicles and the protein enters the stacks. The apparatus then modifies and transports these proteins. They can be modified by conjugated groups being added for example. Then it produces enzymes as it modifies the protein into one. It then goes to the end of the stacks in a vesicle and fuses with the membrane to be excreted by ~~exocytosis~~ exocytosis.



ResultsPlus
Examiner Comments

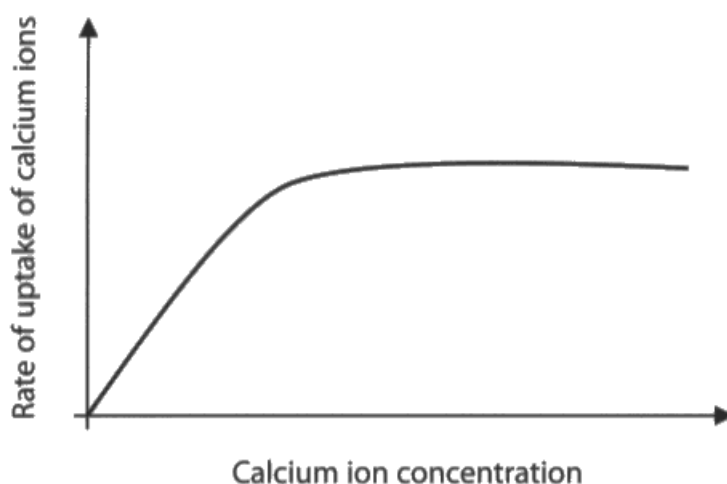
This is an excellent example that gained three marks. Mark point one was awarded for the movement of vesicle with protein from the rough endoplasmic reticulum, mark point two for the modification of the proteins and mark point three for the enzyme leaving the Golgi in a vesicle.

Question 6 (d)

Many candidates found this question demanding, with a significant number misinterpreting the graph. The graph showed that calcium ions were entering the cell by facilitated diffusion. As the concentration of calcium ions increased, the rate of diffusion increased due to an increasing concentration gradient. When the graph levelled off, it was due to the number of calcium ion channels becoming a limiting factor. It was common for candidates to incorrectly assume that the horizontal axis represented time, and that the graph was showing the uptake of calcium ions by diffusion increasing over time until there was no concentration gradient, at which point the graph levelled off. It is important to read questions carefully and not jump to conclusions.

(d) Calcium ions are needed for the secretion of enzymes from pancreatic cells.

The graph shows the effect of increasing calcium ion concentration on the uptake of calcium ions by pancreatic cells.



Explain the effects of calcium ion concentration on the rate of uptake of calcium ions through the pancreatic cell membrane.

(3)

The calcium ion concentration and the rate of uptake of calcium ions are positively correlating for a ~~while~~ ~~point~~ while. There it reaches a certain point, and after that point, the graph levels off. This shows how the pancreatic cell membranes can only uptake a certain amount of calcium ion and above that concentration the cell membrane is no longer accepting an calcium ion due to the high concentration in the cell.

(Total for Question 6 = 9 marks)



ResultsPlus
Examiner Comments

This example gained no marks. There is no recognition that the calcium ions enter by facilitated diffusion and the candidate has assumed that the horizontal axis is time and that ions are entering until an equilibrium is reached.

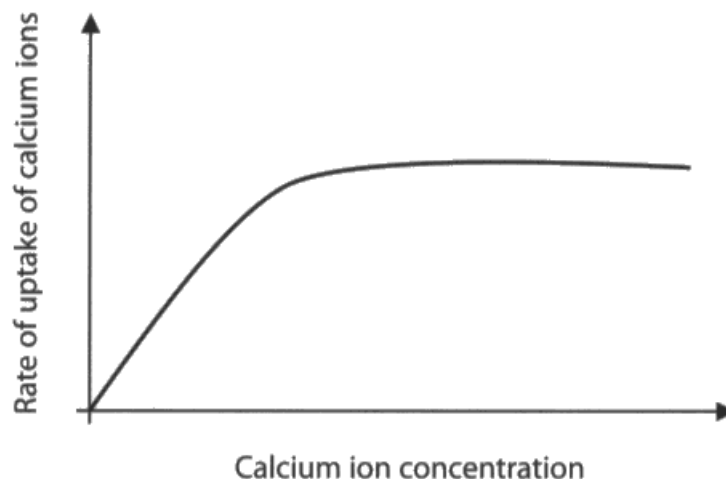


ResultsPlus
Examiner Tip

Be careful to read the labels on graph axes carefully before jumping to conclusions.

(d) Calcium ions are needed for the secretion of enzymes from pancreatic cells.

The graph shows the effect of increasing calcium ion concentration on the uptake of calcium ions by pancreatic cells.



Explain the effects of calcium ion concentration on the rate of uptake of calcium ions through the pancreatic cell membrane.

passive diffusion ^{involving cell surface membrane transport proteins}, initially as an increase in Ca^{2+} in conc on outside increases intake due to an increase in concentration gradient, may that diffusion occurs faster, however at a certain calcium concentration, ~~more~~ ^{max} amount of diffusion & hence uptake has been reached due to limited number of cell surface membrane transport proteins as all are working (3)

at their max capacity so any further $[Ca^{2+} \text{ ions}]$ increase, produces no additional uptake & it diffuses (Total for Question 6 = 9 marks)



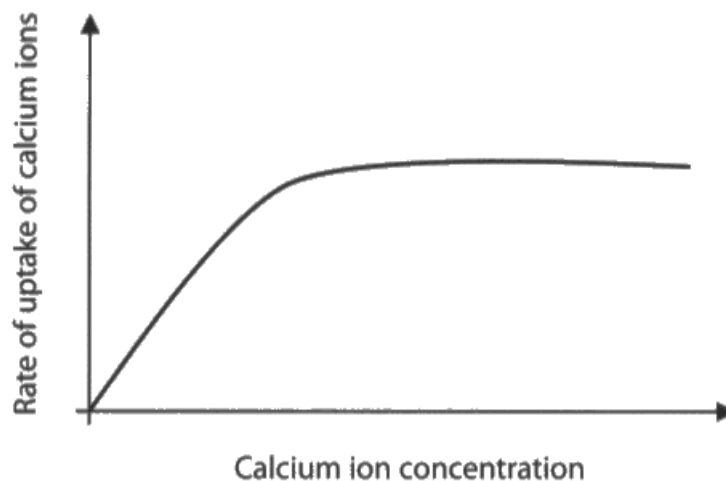
ResultsPlus

Examiner Comments

This is a good answer and it is clear that the candidate has understood the question. Mark point one was awarded for the appreciation of the increasing concentration gradient and mark point two for understanding that the rate has levelled off due to the ion channels becoming limiting. No mention is made of facilitated diffusion so mark point three is not awarded.

(d) Calcium ions are needed for the secretion of enzymes from pancreatic cells.

The graph shows the effect of increasing calcium ion concentration on the uptake of calcium ions by pancreatic cells.



Explain the effects of calcium ion concentration on the rate of uptake of calcium ions through the pancreatic cell membrane.

(3)

As the calcium ion conc. is increased the rate of uptake increases since there is a greater concentration gradient between inside and outside cell so faster rate of facilitated diffusion as conc. increases.

The graph levels off so another factor must be limiting the rate of Ca^{2+} uptake, other than conc. e.g. the number of Ca^{2+} channels in the membrane of the cell.



ResultsPlus

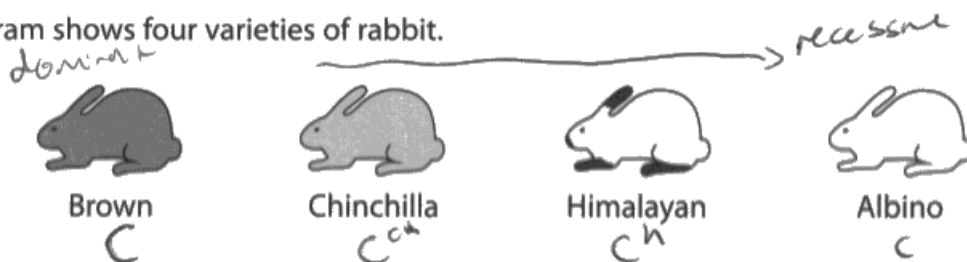
Examiner Comments

This is an excellent answer that gained all three mark points. Mark point one was awarded for the increased concentration gradient increasing the rate of uptake, mark point two for the idea that the ion channels eventually limit the rate of diffusion and mark point three for the correct reference to facilitated diffusion.

Question 7 (a) (i)

This question required candidates to give a description of the processes of crossing over between the chromatids of homologous chromosomes and independent assortment. There was a great deal of confusion regarding the process of crossing over with many candidates not referring to homologous chromosomes and many others describing the crossing over as taking place between sister chromatids. Around half the candidates gained at least one mark with only stronger responses gaining both. Some candidates thought that random fertilisation occurred during meiosis.

7 The diagram shows four varieties of rabbit.



Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C, is dominant to all other alleles
- the allele for chinchilla fur, c^{ch}, is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^h, is dominant to the allele for albino
- the allele for albino fur, c, is recessive to all other alleles

(a) (i) Describe how new combinations of alleles are produced in meiosis.

(2)

This occurs due to recombination, in which during the prophase I, the maternal/paternal chromosomes swap genes at some loci (alleles) during the formation of the chiasmata, leading to homologous chromosomes with new combinations of alleles.

This allows for further genetic variation, as each offspring can inherit a random combination of alleles within their chromosomes.



ResultsPlus
Examiner Comments

This answer gained two marks for correctly describing the processes of crossing over and independent assortment. A clear reference is given to the homologous chromosomes.



ResultsPlus

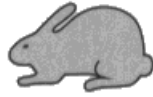
Examiner Tip

Make sure that you know the differences between meiosis and mitosis.

7 The diagram shows four varieties of rabbit.



Brown



Chinchilla



Himalayan



Albino

Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C , is dominant to all other alleles
- the allele for chinchilla fur, c^{ch} , is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^h , is dominant to the allele for albino
- the allele for albino fur, c , is recessive to all other alleles

(a) (i) Describe how new combinations of alleles are produced in meiosis.

~~During~~ Random fertilisation, ^{produces new (2) combinations} and random genetic mutations can produce new alleles. Independent assortment also produces new combinations.

Random fertilisation means that any of the male gametes can fertilise the female gamete.



ResultsPlus

Examiner Comments

This answer gained no credit and is a good example of common errors that were seen. The candidate has discussed random fertilisation and mutation neither of which would produce combinations of new alleles in gametes.

7 The diagram shows four varieties of rabbit.



Brown



Chinchilla



Himalayan



Albino

Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C , is dominant to all other alleles
- the allele for chinchilla fur, c^{ch} , is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^h , is dominant to the allele for albino
- the allele for albino fur, c , is recessive to all other alleles

(a) (i) Describe how new combinations of alleles are produced in meiosis.

(2)

In meiosis new combinations of alleles are produced due to recombination / crossing over occurring during the end of prophase 1. The homologous chromosomes exchange genetic information at the chiasmata hence allowing new allele combinations to be formed, which would code for different characteristics to the parental genotype. Also independent assortment allow ^{random} 2 gametes to fuse together and increasing variation. In crossing over enzymes 'cut and join' parts of ^{homologous} chromosome to each other and produce new alleles.



ResultsPlus
Examiner Comments

This answer gained one mark for the correct description of crossing over. The candidate mentions independent assortment but then gives an incorrect description of it as allowing random gametes to fuse together.

Question 7 (a) (ii)

Many candidates were correctly able to state all the possible genotypes. The most common error was not making a clear distinction between a capital and lower case letter C. Candidates should be careful to use the correct letters in genetic crosses.

Question 7 (a) (iii)

This question discriminated well. It required candidates to look at the final genotypes and phenotypes of the rabbits and effectively work backwards to determine the parental genotypes. Stronger responses correctly derived the parental genotypes and drew clear, labelled genetic diagrams to gain all three marks. Some candidates left the question blank or gave random parental genotypes. Despite the instruction to show working, some candidates only wrote down the final answer and could only gain one mark. Similarly to question 7(a)(ii), a significant number of candidates did not exercise enough care when writing capital and lower case letters.

- (iii) Two parent rabbits with brown fur were mated. Two of the F₁ offspring had chinchilla fur.

The F₁ rabbit offspring with chinchilla fur were mated.

The F₂ generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.

Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur. (3)

~~Cc~~
~~CC~~

$Cc \times Cc$
 $C \quad c$
 $C \quad Cc$
 $c \quad Cc$
 $c \quad cc$
 $c \quad c \quad Cc$

$c^h c^h \quad c^h c^h$ $c^h c^h$

$c^h c^h \quad c^h c^h$

$c^h c^h \quad c^h c^h$

$c^{ch} c^{ch}$
1

$c^{ch} c^h$
2

$c^h c^h$
1

Answer Cc^{ch} and Cc^h



ResultsPlus Examiner Comments

This answer gained all three marks. Despite not being set out neatly, the parental genotypes are clearly stated and the working shows the F_1 generation genotypes being crossed and the F_2 offspring.



ResultsPlus Examiner Tip

Set out genetic diagrams clearly, give a key and label the phenotypes.

(iii) Two parent rabbits with brown fur were mated. Two of the F_1 offspring had chinchilla fur.

The F_1 rabbit offspring with chinchilla fur were mated.

The F_2 generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.

Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur. (3)

F_1 Genotypes $c^{ch} c^{ch}$ $c^{ch} c^h$ $c^{ch} c$

	C^{ch}	C ^{ch}	c ^h
C ^{ch}	C ^{ch} C ^{ch}	C ^{ch} c ^h	
c ^h	C ^{ch} c ^h	c ^h c ^h	



ResultsPlus

Examiner Comments

This answer gained two marks for correctly stating the F₁ genotypes and the resultant F₂ genotypes. Unfortunately, the candidate has not worked back to give the parental genotypes.

- (iii) Two parent rabbits with brown fur were mated. Two of the F₁ offspring had chinchilla fur.

The F₁ rabbit offspring with chinchilla fur were mated.

The F₂ generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.

Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur.

F₀ = Brown x Brown

F₁ = Chinchilla x Chinchilla

F₂ = Himalayan + Chinchilla

F₁: C^{ch}
C^{ch} C^{ch} C^{ch}

C^h C^{ch} C^h

c^h
C^{ch} C^h

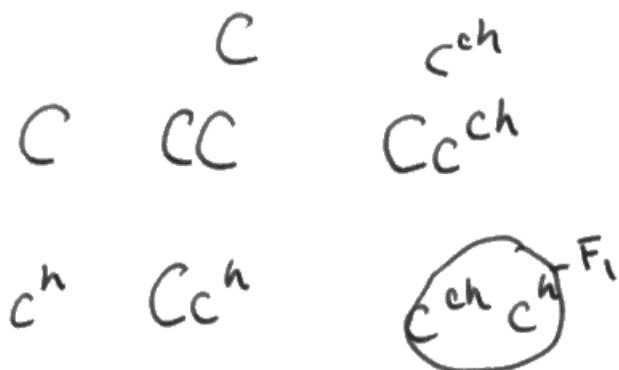
C^h C^h

→ ∴ only chinchilla + Himalayan produced

F₁ genotypes = C^{ch} C^h

(3)
chin = C^{ch}C^{ch}, C^{ch}C^h
Him = C^hC^h

∴ must be c^{ch} + c^h present in F_0
 → brown $\therefore F_0 = \underline{C c^{ch}} \times C c^h$



Answer $F_0 = C c^{ch} + C c^h$



ResultsPlus
 Examiner Comments

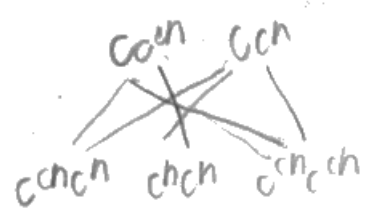
This is a very good answer that gains all three marks for stating the parental, F_1 , and F_2 genotypes.

(iii) Two parent rabbits with brown fur were mated. Two of the F_1 offspring had chinchilla fur.

The F_1 rabbit offspring with chinchilla fur were mated.

The F_2 generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.

Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur. (3)



Answer Cc^{ch} , Cc^{ch}



ResultsPlus

Examiner Comments

This answer gained one mark for correctly stating the parental genotypes. No reference is made, however, to the F_1 or F_2 genotypes.

Question 7 (b)

This question was found to be very demanding by a large number of candidates and the answers seen showed a large number of misconceptions. Very few candidates gained all three marks, with many gaining zero or one mark. Some candidates did not understand that the command "compare and contrast" requires both similarities and differences, and full credit will not be awarded for only describing one aspect. For the similarities, it had to be clear that the candidate was pointing out what was similar, and for differences references had to be made to both forms of selection. Key misconceptions included:

- the term gene being confused with the term allele. Phrases such as "large number of genes" and "large number of alleles" mean different things;
- stating that disruptive selection occurs in a changing environment whilst stabilising occurs in a stable one;
- stating that disruptive selection increases genetic diversity whilst stabilising reduces it. Both will, in fact, reduce genetic diversity;
- stating that disruptive selection developed two new species. It is true that it may lead to the production of new species but this does not occur automatically (it actually leads to the production of two distinct phenotypes or populations);
- confusing disruptive selection with directional selection;

Many candidates drew diagrams - this is a very good way of helping an explanation: however, diagrams should be annotated and labelled. Many diagrams were, however, inaccurate.

(b) The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

- Stabilisation is where ^{both} an extreme is ^{in a population} selected against causing ^{one population where extremes are removed} a shift in gene pool and genes selected. Disruptive selection is where the median is selected against in a population. Disruptive selection can lead to two different population forming and where as stabilisation only does not form two different population.



ResultsPlus

Examiner Comments

This is a good answer that gained two marks for the ideas of selected for or against extremes and the production of two or more population. The candidate has given no similarities.



ResultsPlus

Examiner Tip

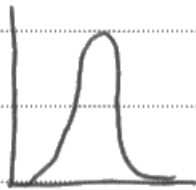
If a question is "compare and contrast", you will need both similarities and differences.

(b) The fur colour of animals can be affected by natural selection.

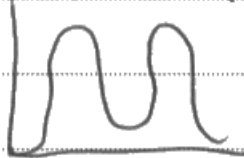
Compare and contrast stabilising selection with disruptive selection.

(3)

Stabilising selection is when there is one ~~phenotype~~ ~~phenotype~~ phenotype that is outcompeting the rest, so it has one high peak on the graph and goes down like a curve either side.



Whereas, disruptive have 2 or more peaks meaning there are more than just one phenotype that is competing / in higher demand than the other. Also, it has at least one dip that the phenotype is almost non-existent / extinct.



ResultsPlus

Examiner Comments

This example gained no marks. The diagram has no annotations or explanation. If the candidate had clearly shown "before and after" diagrams for both forms of selection, and labelled the axes, marks may have been awarded. The answer is also too confused to gain any credit.

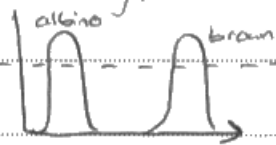
(b) The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

(3)

Stabilising selection is when the environment of the species remains unchanged whereas within disruptive selection there is a change.

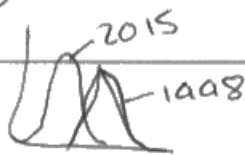
Disruptive selection involves the favouring of two extreme phenotypes leading to a split.



This is evident in rabbit fur colour as two

extreme phenotypes are favourable for survival so these get passed on.

Stabilising selection leads to a gradual change in the optimum type. e.g.:



(Total for Question 7 = 9 marks)



ResultsPlus
Examiner Comments

This answer gained no marks. The candidate describes how extreme phenotypes are selected for in disruptive selection but does not go on to give an accurate explanation of what occurs in stabilising selection. The diagram for stabilising selection shows directional selection.

(b) The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

(3)

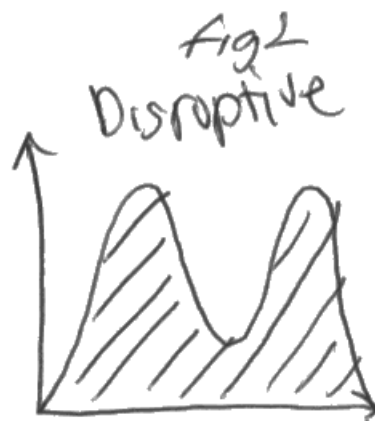
Stabilising selection occurs when a favourable characteristic becomes more popular and increases in value. It does not change, it just becomes more important and stronger as figure 1 shows.

Disruptive selection causes a separation in species as a characteristic can change and can become favourable in multiple ways. There is a dip in the graph and two new peaks are formed as two new characteristics in a species separate from.

Stabilising selection does not separate the species, instead makes

(Total for Question 7 = 9 marks)

them stronger as a population and characteristics are passed on to their offspring, whereas disruptive selection splits a species so that so organisms are more suitable to the environment. This could be caused by a geographical incident/change such as mountains forming which separated the species.



ResultsPlus
Examiner Comments

This answer gained no marks. The answer has correct elements in it but there is also a great deal of confusion. The diagram showing stabilising selection is also incorrect.

(b) The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

(3)

→ stabilising selection selects and reinforces the intermediate phenotype whereas disruptive selection selects against the intermediate phenotype

→ however both types of selection will change allele frequency in a population due to selection pressures being introduced

→ stabilising is where there is free gene flow between a population making the population phenotypically more similar however in disruptive there isn't gene flow so a population ~~is~~ is split in two, this may be a physical barrier or reproductive barrier, so the populations become phenotypically more different leading to speciation

Total for Question 7 = 9 marks



ResultsPlus
Examiner Comments

This is a good answer that gained two marks for the idea of selecting for and against the intermediate phenotype and the fact that both change allele frequency. The last paragraph is describing the process of speciation rather than disruptive selection.

Question 8 (a) (i)

This question required candidates to give a description of net primary productivity (NPP) which they could do in several ways. The most common correct answer seen was a statement that it is the gross primary productivity minus respiratory losses. Other candidates correctly described NPP as the energy available to the primary consumers. There was some confusion however, and some candidates mixed up NPP with GPP and thought it was the total energy fixed in photosynthesis. Another common mistake was to give vague references to light energy being stored in plants or used to grow. Candidates should try to write precise, accurate definitions.

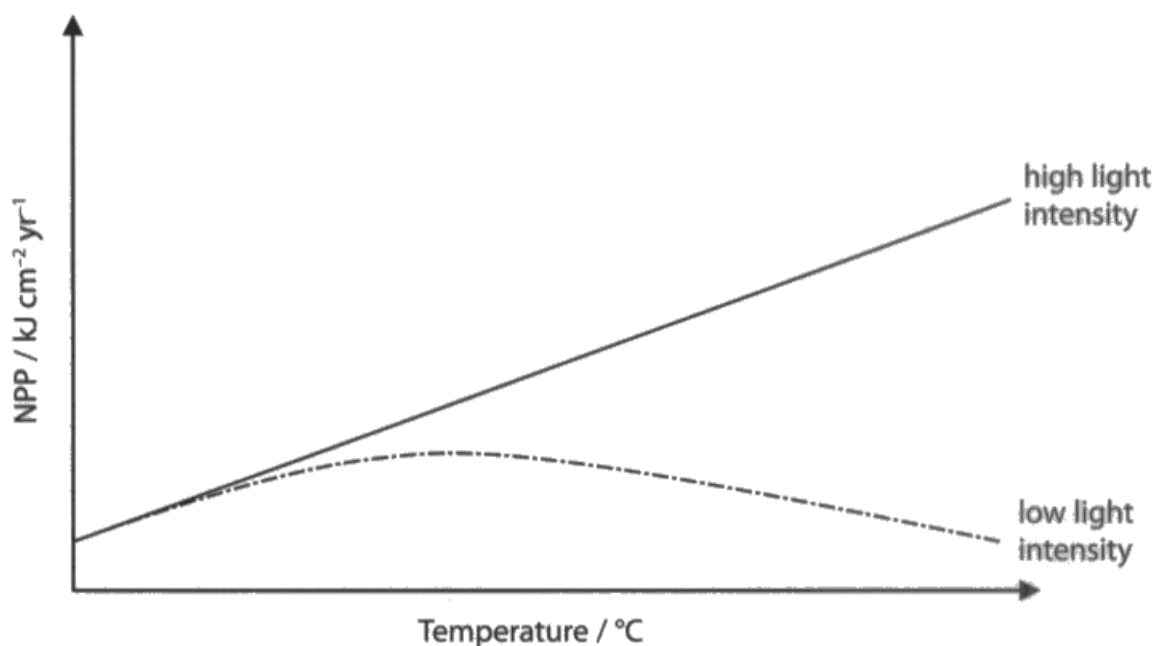
- 8 The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.

$$GPP = NPP - R$$



- (a) (i) State what is meant by the term net primary productivity.

This is amount of light taken in by producers (through photosynthesis) to produce energy.

Let's fixed by consumers (1)



ResultsPlus
Examiner Comments

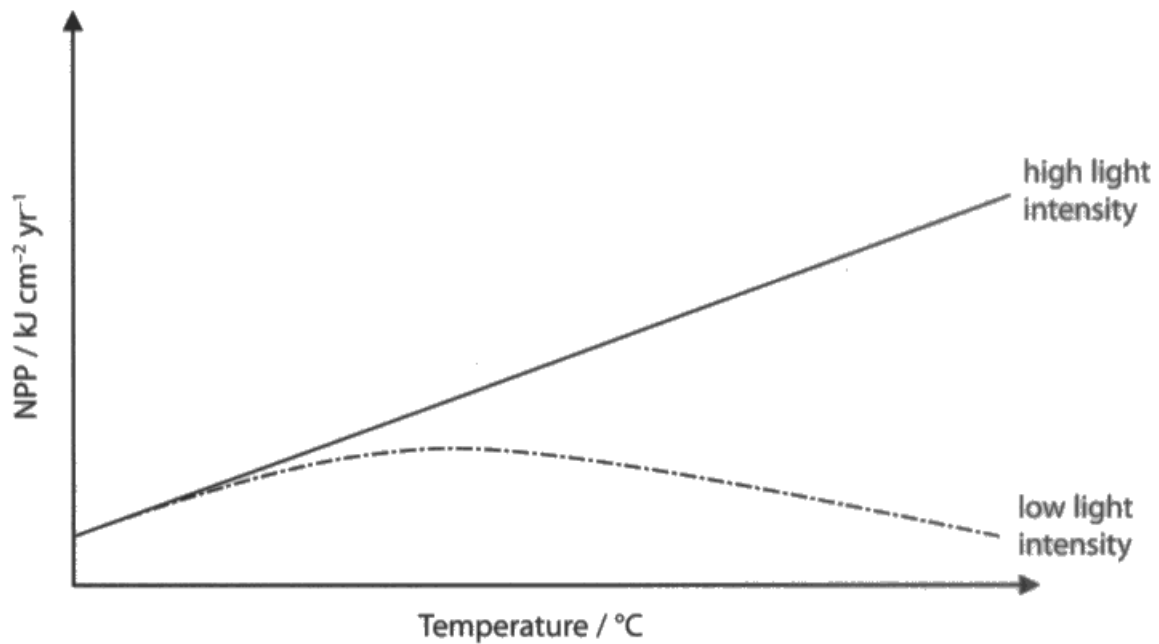
This answer gained no marks. The candidate has confused NPP with GPP and has made no reference to respiration. The annotation on the diagram is also incorrect.

- 8 The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.



- (a) (i) State what is meant by the term net primary productivity.

(1)

Net primary productivity = gross primary productivity - respiration.

The net total of organic material made.



ResultsPlus
Examiner Comments

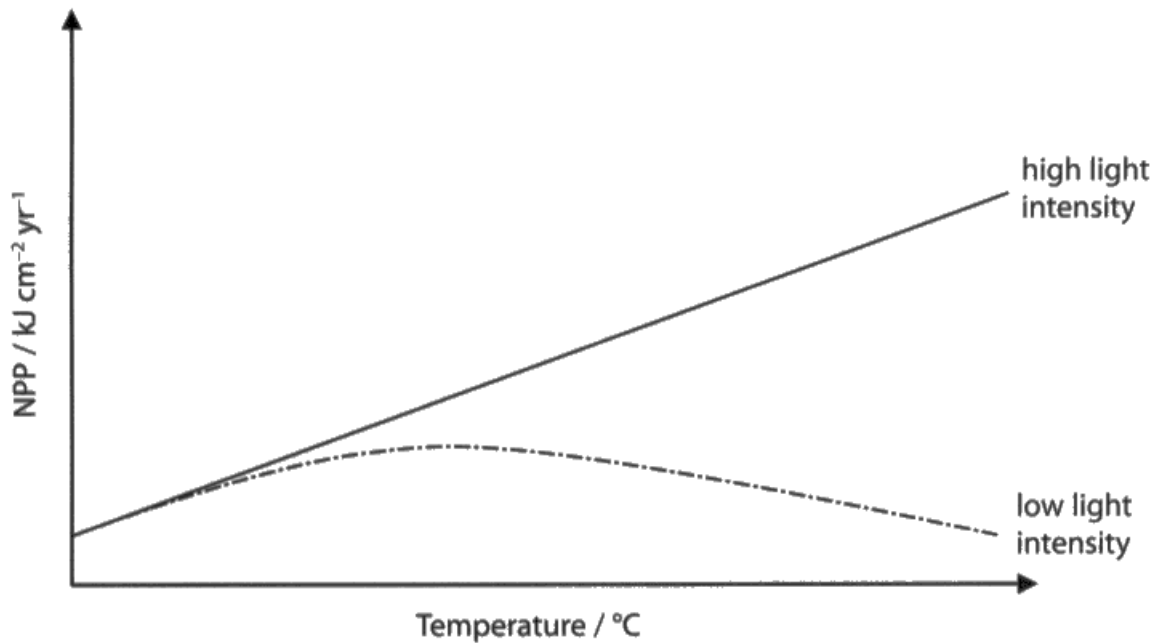
This is a good example of a correct answer. One mark was awarded.

- 8 The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.



- (a) (i) State what is meant by the term net primary productivity.

(1)

The chemical energy obtained by plants during photosynthesis using sunlight
- the energy used by plant for respiration



ResultsPlus
Examiner Comments

This is an excellent answer that clearly states that $\text{NPP} = \text{GPP} - \text{R}$.
GPP is correctly described as the energy from photosynthesis.

Question 8 (a) (ii)

Many candidates found this question very challenging with only a few gaining both marks. The question required candidates to appreciate that NPP is the result of the energy fixed by photosynthesis minus the respiratory losses. If temperature increases, both respiration rate and photosynthesis rate increase provided that light intensity is not limiting. If light is limiting, the rate of respiration increases with temperature but photosynthesis does not so that NPP falls. Many candidates just referred to photosynthesis getting faster. Common incorrect answers included:

- stating that respiration rate exceeded photosynthesis rate. This would cause NPP to become negative which is not true.
- suggesting that the enzymes in the plants denatured at higher temperatures.

(ii) Explain why temperature has different effects on NPP at these two light intensities.

(2)

More photosynthesis in higher light intensity so therefore more materials produces for the energy stores which is excess and can be passed along. Whereas, low light intensity respiration rate becomes faster than photosynthesis rate so plant starts using energy store.



ResultsPlus

Examiner Comments

This answer gained no marks. The candidate is aware that photosynthesis and respiration rates are involved; it is not true, however, that respiration rate exceeded photosynthesis rate.



ResultsPlus

Examiner Tip

Be careful with the language you use in your answers. You need to explain the points accurately.

At low light intensity, as the temperature increases the rate of enzyme controlled reactions increases until respiration ^{rate increases} ~~is greater~~ ~~than the NPP~~ so NPP ^{falls}. In high light intensity, higher temperature increases the rate of photosynthesis and the GPP is large enough for the increased rate of respiration not to cause a decrease in NPP.



ResultsPlus

Examiner Comments

This is a very good answer that gained both mark points. It is clear that the candidate understands how the relative rates of respiration and photosynthesis affect NPP in both light intensities.

Question 8 (b)

This question was the first extended, levels-based question on the paper. These questions are not marked on a point based mark scheme but using level descriptors. Indicative content is given in the mark scheme but it is not necessary for a candidate to mention all the points and additional creditworthy material can be included. This question required candidates to explain the process of succession in an abandoned field and link their theoretical knowledge to the graph. A purely descriptive account would only gain a level one mark (one or two marks). If a candidate gave a detailed description of succession in the field together with some explanation of succession and either the changes in minerals or NPP, a level two mark was awarded (three or four marks). To gain a level three mark (five or six marks), candidates had to give a detailed description and explanation of succession, explain the changes to both minerals and NPP and this had to be for the whole time period; it was also important that there were no major errors evident.

A very good range of answers were seen, some of which were of very high quality. Answers that gained six marks often explained the process of succession in detail, explained how niches changed, explained how mineral ions are formed from decay but reduced in quantity due to conifers not losing leaves and explained how a reduced proportion of photosynthetic tissue in trees lowers NPP. Weaker answers tended to give a basic description of succession with little reference to the graphs. Many candidates did not give answers that explained the full time period - the dip in NPP and mineral ions was important here. Some candidates included basic errors, such as mixing up photosynthesis with respiration, and as such could not gain a level three mark. Candidates should try to take a positive view of the six-mark questions as the level based mark scheme enables them to gain full credit in different ways rather than looking for key points.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

Over the 50 years there is a increase in plant biomass due to the large number of coniferous trees. This is link to Succession because as the trees do not shed their leaves it means they are not decomposed into soil which explains the decrease of mineral ions in the soil as show on the graph, less minerals ions in the soil means fewer plants can grow therefore less habitates for

animals, which explains the small index of diversity of animals. ~~where decrease~~ from the lack of variants in the plants species means that there is a decrease in NPP at 50 years because ~~the~~ less energy is produced from light.



ResultsPlus Examiner Comments

This is a weak answer that gained one mark. There is no real explanation so it was classed as a level one answer. There is very little detail and the description is only weakly linked to the data so one mark was awarded.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

Succession directly involves 4 key steps. The abandoned field symbolised the beginning of succession when nothing was there, as there were ^{colonisation of bacteria etc would build up from the} groups growing there before the mineral content was higher this means pioneer species were able to develop and grow using mineral ions from the soil, pioneer species being mosses and lichens etc.

Following on from pioneer species would be herbaceous plants, such as bushes and small trees, this is where we begin to see in the graph the increase in plant biomass as herbaceous plants are beginning to grow and these continue to grow, the NPP will continue to increase as plants are respiring more as they are growing, however ~~the~~ this begins to decrease as the plants get older and their net NPP decreases as their GPP will also be decreasing as their growth rate is slowing down decreasing the energy required,

As these plants also age the mineral ion content of the soil also decreases as plants are taking this in for personal growth leaving the soil with lower levels. // Following on from herbaceous plants during succession comes a climax community where secondary consumers begin to arrive on this, this is shown by the increase in index of diversity of animals, however it is still early days and succession is continuous.



ResultsPlus Examiner Comments

This answer gained two marks. The answer is almost purely descriptive with little explanation. Where explanation is made of NPP, a major error is evident - photosynthesis and respiration are mixed up.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

The graph and change of plant biomass, NPP, mineral ion content and index of diversity in the abandoned field is a example of secondary succession. This is because in secondary succession the minerals, and pioneer species of plant are present as shown at 0 years on the graph. Over several years as the pioneer species die out their nutrients provide soil high enough in mineral ions to allow secondary plant species with a greater biomass than the pioneer species to grow and allow smaller organisms including insects to live. Finally, after the secondary species of plant die the climax community can develop where trees

and ~~small~~ small mammals can live. At this point the soil has enough mineral ion content to have plants with large biomasses to grow on it with increasing rate of NPP in larger plants and index of diversity increases because more plants inhabit the area.



ResultsPlus

Examiner Comments

This answer was awarded three marks. There is a description of succession and some attempt is made at an explanation which makes the answer better than level one. There is no real description of the full time period and the description is not detailed, so it is not a level three answer. It is a level two answer but the limited explanation means that it gained three marks.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

Succession caused the biomass of plant to produce as the coniferous trees grow and they have a very large biomass. Overall succession means growth of new species and coniferous forest, along with many other plants have more biomass than crops. The NPP increased until 40 years where it starts to decline. This may be because ~~they are~~ respiring the older coniferous trees were higher but the new ones are shorter so they are respiring with the new higher numbers of leaves a lot more than the older trees but not photosynthesising as much. This means the NPP has decreased. The mineral ion content of the soil has also decreased after 40 but reached its peak at 30 years. This

may be because the leaves do not shed on coniferous trees that much meaning less mineral ions go back into the soil. After 40 years, the number of plant biomass was too high and more mineral ions are taken out by the new plants than are given to the soil, causing a decrease. The Index of biodiversity has, over the 50 years increased. At the moment it is slowly declining. The plant biomass increasing over the years led to more habitats being made, therefore diversity of animals have increased.



ResultsPlus Examiner Comments

This answer was awarded four marks. It has a description of succession but not in enough detail for level three. There is a good attempt at an explanation so it was classed as a level two answer and the good explanations means that it gained four marks rather than three.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

At the start of recording, at '0' years, there ~~are~~ is a not a variety in mineral ion content of the soil, and farming was previously done in the field, so the same mineral were removed from the soil and not replaced. In addition, the ~~biodiversity~~ biodiversity index was very low, ~~since~~ because of the farming which is usually ~~done~~ done for only a few crops. ~~The~~ ~~After~~ At about 10 years, we can see that some organisms ^(pioneer species) have managed to colonise the area, and make use of the limited amounts of mineral ions there, are, and so we see ~~the~~ the secondary succession begins.

and the plant biomass increases by about 2 times that at 0 years. The NPP therefore increases, as the plant biomass has increased. As these organisms die and decomposers cause their decay, humus and mineral ions are returned to the soil. This increases the mineral ion content further, as well as the soil depth, which means that after 20 years, the diversity index increases ~~to~~ by about 80 times. ~~Now~~ These new species are able to colonise because of an increase in soil depth and mineral ions, which there are now enough of to be able to support them, and deep enough soil for the plants to survive, and so more animals are present which can feed on these new plants, according to their diets. The plant biomass increases by almost 3 times as much too, ~~so~~ and so the NPP does as well, but not by as much as plant biomass (due to respiration etc). The diversity of animals levels off at this maximum at 20 years, but the plant biomass keeps increasing up past 50 years, and will continue to do so until climatic climax is obtained. Animal diversity levels off because of competition for ~~resources~~ ~~or~~ ~~resources~~.

(Total for Question 8 = 9 marks)



ResultsPlus Examiner Comments

This is a very strong answer that was awarded five marks. A detailed description of succession is given along with explanations of the changes in diversity, NPP and minerals. The answer considers the full time period and gives a detailed explanation of mineral ion changes. A little more explanation of the changes in NPP would have given this answer six marks.



ResultsPlus Examiner Tip

Make sure that you explore all aspects of data that are given to you to analyse.

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

This is an example of secondary succession as soil was already present when the process began. A pioneer species, for example a grass, will have colonised the bare and rather nutrient poor soil, as seen with the low factor of mineral ions in the soil to begin with on the graph. This is due to the crops having taken up a large proportion of them. Over a ten year period the grass will have thrived and increased in mass, hence the increase in biomass. As ~~the~~ the grass grew it will also have died and decomposers in the soil will have broken down the plant material making the soil more fertile ~~and~~ and habitable for other species. This can be seen as between 10 and 40 years there is a steady increase in biomass and thus NPP as further ~~species~~ ^{species} in certain trophic levels begin to thrive. The increase in plants also provide a habitat for wildlife such as insects and birds which as seen increases the index of diversity for animals. After 50 years the field had developed into a climax community, however the fact that the coniferous trees, the dominant species, do not ~~lose~~ lose their leaves the mineral ion content of soil drops as the trees are utilising it yet not dying and decomposing in order to restore it. This \therefore decreases ⁱⁿ NPP ^{is due to} the older trees having less leaves \therefore less light is absorbed by the sun \therefore less energy enters the ecosystem via the producers \therefore NPP decreases.



ResultsPlus
Examiner Comments

This was an excellent answer that was awarded six marks. A full detailed description along with explanation of all areas without any errors meant that this was classed as a level three answer and the level of depth enabled it to gain six marks.

Question 9 (a) (i)

This question tested a standard mathematical skill that candidates are expected to know - the calculation of the initial reaction rate of an enzyme from a curve. To gain full credit, a correct tangent had to be drawn and the gradient of the tangent calculated. A surprising number of candidates did not attempt the question and a significant number seemed to be unaware that to calculate the initial rate of reaction, a tangent to the curve must be drawn. Some candidates did gain all three marks and clearly understood how to draw a tangent and calculate the gradient. If candidates drew the tangent incorrectly (which many did), marks were still available for calculating the gradient correctly. Candidates were restricted to one mark if they calculated the gradient of the initial part of the curve without drawing a tangent. Candidates should ensure that they familiarise themselves with all the requisite mathematical skills listed in the specification; there is also a useful student mathematics guide available on the Pearson website. http://qualifications.pearson.com/content/dam/pdf/A%20Level/Biology/2015/teaching-and-learning-materials/Biology_Maths_Student_Guide_-_FINAL.pdf

9 Polyphenol oxidase is an enzyme found in many plant cells.

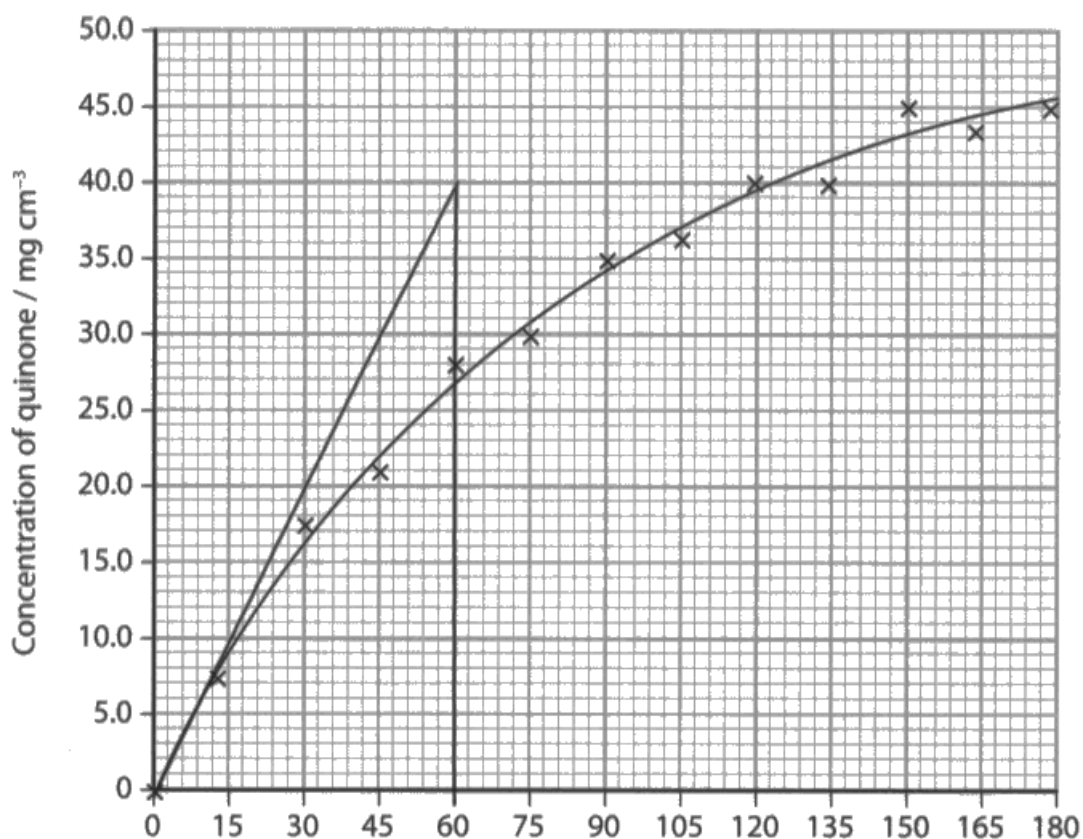
This enzyme catalyses the following reaction



This reaction causes cut fruit to turn brown when exposed to air.

(a) A student carried out an investigation into the rate at which grape juice produced quinone.

The graph shows the results of this investigation.



Time / s

(i) Calculate the initial rate of this reaction.

$$\frac{\text{change } Y}{\text{change } X}$$

$$\frac{0 \rightarrow 40}{0 \rightarrow 60}$$

$$\frac{40}{60} = \frac{2}{3}$$

(3)

Answer $0.67 \text{ mg cm}^{-3} / \text{s}^{-1}$



ResultsPlus

Examiner Comments

This is a very good answer that gains all three marks. The tangent is drawn correctly and the gradient then calculated correctly. Units are also included.



ResultsPlus

Examiner Tip

Don't forget to show all working and include units.

9 Polyphenol oxidase is an enzyme found in many plant cells.

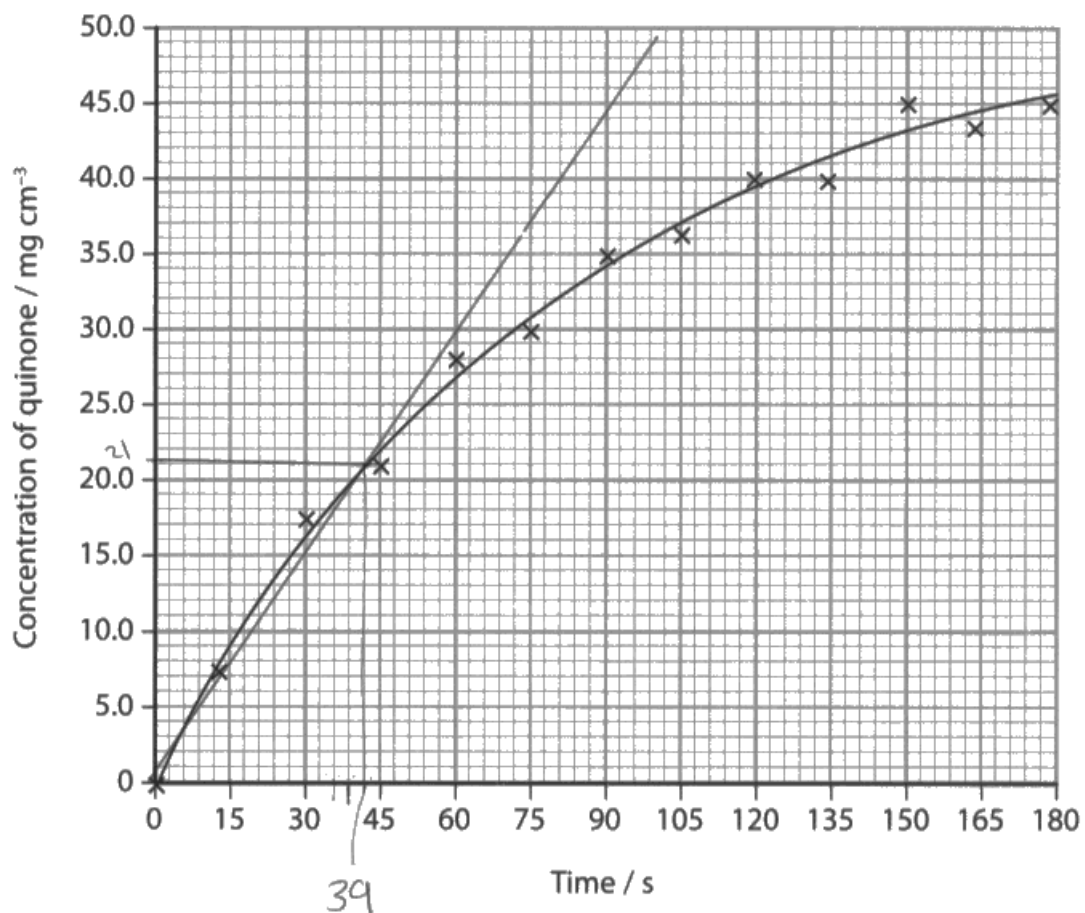
This enzyme catalyses the following reaction



This reaction causes cut fruit to turn brown when exposed to air.

- (a) A student carried out an investigation into the rate at which grape juice produced quinone.

The graph shows the results of this investigation.



- (i) Calculate the initial rate of this reaction.

$$\begin{array}{l} \frac{\text{change in } y}{\text{change in } x} \frac{\text{mgcm}^{-3}}{\text{s}} \quad (3) \\ = \frac{21}{39} = 0.538 \end{array}$$

Answer 0.538 mgcm⁻³s



ResultsPlus

Examiner Comments

This gained one mark. The tangent is wrong so mark point one was not awarded. The x-axis has not been read correctly so mark point two was not awarded. Mark point three was awarded as a transfer error, for correctly carrying out a gradient calculation.

Question 9 (a) (ii)

This question required candidates to use their knowledge of how pH affects enzyme activity to explain how adding citric acid alters that activity of the enzyme polyphenol oxidase. Stronger responses gave very detailed descriptions of the effects of H⁺ ions on hydrogen and ionic bonds, the effect on the shape of the active site and how this prevents the substrate from binding. Candidates should be careful to give accurate terminology as many simply stated that the enzyme would be affected rather than referring to the active site. Some listed all the tertiary bonds, including disulfide bonds, as being affected which is incorrect. A few very confused answers were seen that suggested that citric acid is a competitive inhibitor and would fit into the active site, or that it absorbs oxygen to prevent browning. Many candidates just stated that the enzymes denatured; whilst this is correct, a little more detail is required at A-level to explain what the term denature actually means.

(ii) Explain why adding citric acid to cut fruit reduces the rate at which the fruit turns brown.

(2)

This is because adding acid makes the pH of the solution decrease hence the change in pH breaks bonding in active site of enzyme and denaturing the enzyme so it no longer has an active site ^{complementary} to the monophenol. Therefore the rate at which the enzymes convert monophenol to quinone is greatly reduced as enzyme activity decreases as enzymes denatured.



ResultsPlus Examiner Comments

This answer gained one mark for the idea of a change of shape of the active site. The candidate suggested that the acid breaks bonds but did not name the bonds. They also did not clearly state that the substrate will no longer bind in the active site.



ResultsPlus Examiner Tip

Be careful to use the correct terminology when discussing enzymes. Terms such as active site, tertiary structure, hydrogen bonds, and ionic bonds should be used where appropriate. The term denaturation is correct, but at A-level, you should add more detail to explain what denaturation actually is.

(ii) Explain why adding citric acid to cut fruit reduces the rate at which the fruit turns brown.

(2)

citric acid lowers the pH causing the enzymes to denature, as a result polyphenol oxidase denatures and no longer catalyses the oxidation of monophenol. This means quinone is produced over a lot longer time, reducing the rate at which the fruit turns brown. It no longer catalyses because monophenol no longer fits in the active site.



ResultsPlus
Examiner Comments

This answer gained one mark for the idea of substrate no longer fitting into the active site. No mention is made of why the active site shape changes.

(ii) Explain why adding citric acid to cut fruit reduces the rate at which the fruit turns brown.

(2)

⇒ citric acid contains high concentration of H^+ ions which interfere ~~with~~ with hydrogen bonds in the tertiary structure of the enzyme polyphenol oxidase and break them
⇒ so the tertiary structure & active site changes shape so the substrate is no longer complementary therefore the enzyme doesn't catalyse the reactions so the fruit turns brown less quickly



ResultsPlus
Examiner Comments

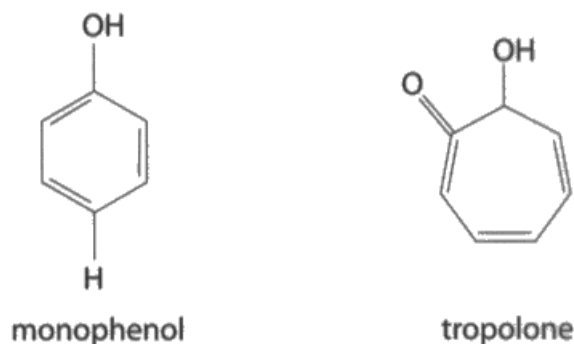
This is a very good answer that gained two marks. The candidate clearly states that the hydrogen ions interfere with hydrogen bonds and goes on to explain how this will alter the shape of the active site so that the substrate no longer fits.

Question 9 (a) (iii)

In this question, candidates were presented with the structures of the substrate of the enzyme, polyphenol oxidase, and an inhibitor, tropolone, and asked to explain why tropolone affects the rate of enzyme activity. Most of the candidates were able to deduce that the structures of the two molecules were similar and so tropolone was a competitive inhibitor. Some candidates incorrectly considered that the structure of tropolone was significantly different to that of monophenol and so was acting as a non-competitive inhibitor. Candidates should remember that whilst the structures, or shapes, of competitive inhibitors may be similar to substrates, they are unlikely to be identical. Some candidates tried to use their knowledge of chemistry to predict how tropolone would react with monophenol - candidates should be aware that the examination is seeking to assess knowledge of the A-level Biology course and whilst A-level Chemistry is a useful subject to study in combination with biology, the biology exams would not seek to directly test it.

(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

monophenol is a similar shape to tropolone
Tropolone ~~could~~ could inhibit polyphenols
active site & which would reduce
the rate the grape juice turns brown
because the reaction cannot be
catalysed if ~~the~~ the enzymes
are inhibited.



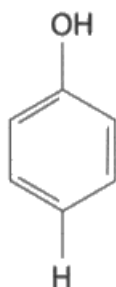
ResultsPlus

Examiner Comments

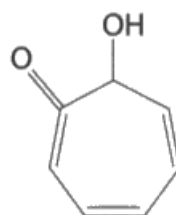
This answer gained one mark. The candidate correctly states that tropolone is similar in shape to monophenol to gain a mark and then goes on to say that it will inhibit the active site - this was not enough to convey the idea of binding in the active site.

(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



monophenol



tropolone

Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

Similar structure so competitive inhibition binds to active site of enzyme, slows rate of reaction.



ResultsPlus

Examiner Comments

This answer almost gained both marks but only gained mark point two for the idea of competitive inhibition. The candidate states that there is a "similar structure" but does not go on to tell us which molecules are similar. They state that the reaction is slowed but do not state that this is due to substrate being able to bind in the active site.



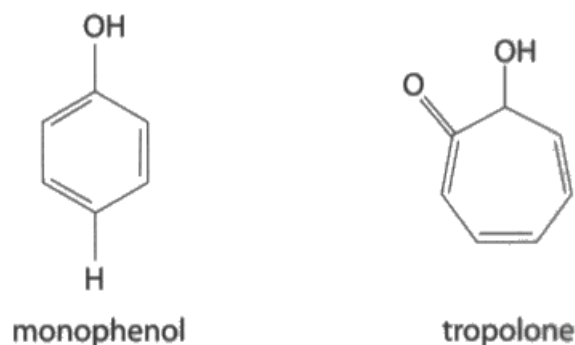
ResultsPlus

Examiner Tip

Be careful to make it very clear what you mean in your answers. Do not use phrases like "similar structure" when you mean to say "tropolone has a similar structure to monophenol". Examiners can only mark what you present to them on the paper.

(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

Changes the active site = substrate can't bind easily and this decreases the rate, as tropolone already has an added oxygen, and further oxidation would oxidize the tropolone.

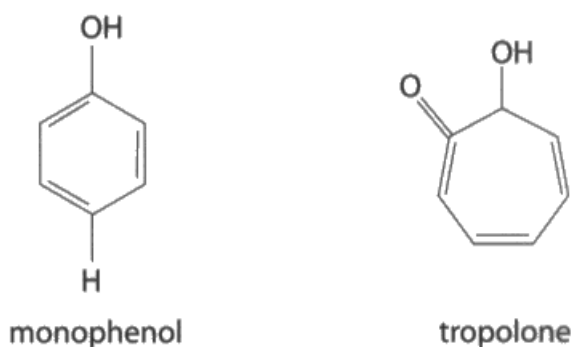


ResultsPlus
Examiner Comments

This answer gained no marks. The candidate has mixed up competitive and non-competitive inhibition.

(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

tropolone acts as a competitive inhibitor with monophenol. Because of their similar structures, tropolone temporarily binds to the polyphenol oxidase active site so monophenol cannot, slowing the rate at which it turns brown.



ResultsPlus
Examiner Comments

This is an excellent answer that gained two marks and actually shows all three mark points. The candidate clearly states that tropolone and monophenol are similar and tropolone is a competitive inhibitor. They go on to explain that tropolone prevents the monophenol binding to the active site.

Question 9 (b) (ii)

This question required candidates to use their knowledge of mutations and protein structure to explain why mutation to the gene of the enzyme would result in a non-functional enzyme. Most candidates understood that the sequence of amino acids would change, but when expressing this on paper, they should be careful to explain that the primary sequence changes and not give a vague term such as "different polypeptide". Fewer candidates referred to the R groups being different or gave named secondary and tertiary bonds. Around half of the candidates were able to use the term tertiary structure - it is important to use correct terminology and not just give vague statements such as "change the structure of the enzyme". Some very strong answers were seen that gave excellent descriptions of altered tertiary bonds and the effects on structures such as the alpha-helix and beta-pleated sheet.

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

Because a change in the base sequence creates a gene/point mutation. This means that either a different or a lack of an amino acid is brought to the chain by the tRNA anticodon as the code is different. A different amino acid or lack of one will change the shape of the polypeptide chain and tertiary structure meaning the active site of the enzyme will be different. The changed shape of an active site means it won't bond to the same substrate and cannot catalyse the reaction. (Total for Question 9 = 11 marks)

~~It is inactive for its original function.~~



ResultsPlus
Examiner Comments

This is a very good answer that gained all three marks. The candidate clearly explains that the amino acid sequence would change and then goes on to state the effect on the tertiary structure, active site and inability of substrate to bind.



ResultsPlus
Examiner Comments

When discussing protein structures, always refer to the specific bond types that are used in each structure.

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

A change in the ~~primary~~ base sequence will change the ^{sequence of} mRNA codons transcribed and therefore the mRNA will ^{cause} ~~lead~~ to a different tRNA adaptor to bind with its anticodon, this changes the amino acid sequence of the gene to be different to the initial sequence if the primary structure is different, the ~~primary~~ bonds and folds of ~~the~~ tertiary structure will be different leading to an inactive enzyme.



ResultsPlus
Examiner Comments

This is a good answer that gained two marks. There is a degree of imprecision in the answer where the candidate states that the amino acid sequence of the gene is different - this could imply that a gene is made of amino acids and not nucleotides. Mark point one is awarded though, as the candidate describes the different primary structure and then goes on to describe the different tertiary structure for mark point three. No mention is made of the R groups, bond types or effect on the active site.

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

If the base sequence is different, different amino acids are brought to the ribosome in translation, these amino acids then

form different bonds between their R groups, making the enzyme form a different shape. If the active site is a different shape, the substrate will not fit and the reaction will not take place, making an inactive enzyme.



ResultsPlus
Examiner Comments

This is a very good answer that gained three marks: mark point one for reference to different amino acid sequence, mark point two for referring to different R groups and mark point three for explaining the effect on the active site.

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

A change in the base sequence ~~code~~ changes what it codes for. This change can produce a different polypeptide chain during protein synthesis. This changes the structure of the proteins that the enzyme is made up of and causes it to be inactive because its active site ^{can no longer} ~~cannot~~ bind with monophenols.



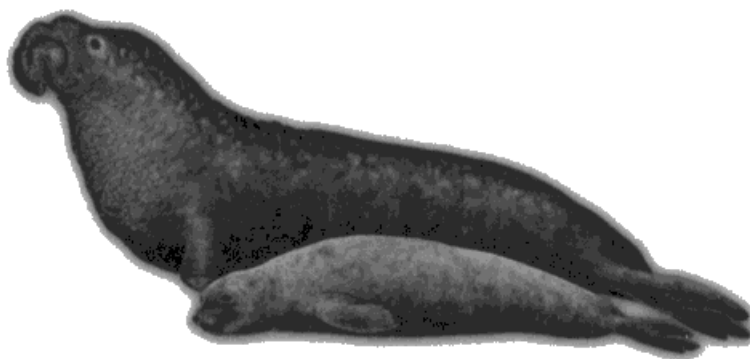
ResultsPlus
Examiner Comments

This answer gained no marks and is a good illustration of how a lack of precision can lose marks. The candidate appreciates that the polypeptide chain is different but does not explain that there is a difference in the amino acid sequence. There is an attempt at explaining the effects on the active site but no reference to the change of shape of the active site, so that mark point four was not awarded.

Question 10 (a) (i)

The majority of candidates showed a very good understanding of the role of CITES and were able to explain that it is a treaty that aims to reduce hunting or trading of endangered species. Fewer referred to the idea that it is a treaty that only affects those countries who sign it. A few candidates gave descriptions of in situ and ex situ conservation rather than explaining that the treaty is primarily about reducing trade of species.

10 The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

(a) (i) Describe the role of treaties such as CITES in maintaining global biodiversity.

(2)

CITES is an international agreement between governments which monitors population sizes and keeps records of numbers of animals ^{& plants}. Helps ~~countries~~ ^{countries} agree to reduce poaching and fish responsibly etc. Helps prevent extinction of animals and plants within countries.



ResultsPlus
Examiner Comments

This is a good answer that explains that the treaty is agreed between different governments and aims to reduce activities such as poaching. It gained two marks.

In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

(a) (i) Describe the role of treaties such as CITES in maintaining global biodiversity.

(2)

CITES regulates the trade of endangered species, therefore if a species is endangered trade will be banned for this species and through doing this less species will face extinction and global biodiversity is more likely to be maintained.



ResultsPlus
Examiner Comments

This is a good answer that gained two marks. The candidate clearly states that CITES controls trade of endangered species.

Question 10 (a) (ii)

This question required candidates to explain why the dramatic fall in population of the Northern elephant seal had led to the increased risk of disease. Many candidates fully appreciated that the seal population had undergone a genetic bottleneck and as a result the gene pool was reduced. Fewer candidates referred to the probability of gaining two recessive alleles. Some candidates misunderstood the context of the question and discussed the transmission of infectious disease or suggested that pollution was affecting the seals. Candidates should also be clear about the distinction between the terms genetic bottleneck and founder effect.

(ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

- This is because due to the fact that because only a small population of them, the seals would have had to have been inbred. This would have caused recessive alleles that cause health problems to be circulated around and increased their probability to be expressed.
- They have a smaller gene pool.
- Population bottleneck



ResultsPlus
Examiner Comments

This is a very good answer that explains the increased risk of being affected by disease due to recessive alleles and also explains the smaller gene pool due to a genetic bottleneck. It gained both marks.

(ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

- There is low genetic diversity of the seal population because of a population founder effect so the gene pool size is very small.
- This causes the inheritance of many ~~recessive~~ recessive alleles which are so many

individually ~~increase~~ the prevalence of ^{homozygous} recessive phenotypes increases, which usually ~~are~~ cause a disease.



ResultsPlus

Examiner Comments

This is a very strong answer that explains the reduction in size of the gene pool and how this would affect the probability of gaining two recessive alleles. It gained two marks.

- (ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

The original population contained about 20 seals which means the gene pool was very small, this may mean that ~~these~~ genes causing health problems become widespread in the gene pool, may also be due to interbreeding of relative seals as only a very small population can cause health problems.



ResultsPlus

Examiner Comments

This answer gained one mark for the idea of a smaller gene pool. If the candidate had made it clear that there was more chance of harmful recessive alleles being passed down, a second mark would have been awarded.

Question 10 (c) (i)

This question tested mathematical skills and required candidates to convert units correctly and carry out calculations of orders of magnitude. Many candidates found this very challenging and only the strongest responses gained all three marks. A common error was to calculate only the total volume of blood in one seal and then not go on to use this to determine the mass of haemoglobin. Many candidates also found converting between cubic decimetres and cubic centimetres very difficult and often multiplied by 1000 when they should have divided by 1000. In the new specification, a minimum of 10 % of the marks must be from level two mathematics questions, and it is important that candidates are fully conversant with all the necessary skills that are laid out in the specification.

- (c) Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

Species	Maximum time holding breath / min	Maximum diving depth / m	Mass of animal / kg
bottlenose dolphin	5	20	200
harbour seal	17	19	24
Weddell seal	82	400	400
Northern elephant seal	119	437	400

Species	Volume of oxygen in body / $\text{cm}^3 \text{kg}^{-1}$	Concentration of haemoglobin in blood / g dm^{-3}	Total blood volume / $\text{cm}^3 \text{kg}^{-1}$	Percentage of stored oxygen in different body tissues		
				lungs	blood	muscle
bottlenose dolphin	36	14	71	34	27	39
harbour seal	57	21	132	13	54	33
Weddell seal	87	210	173	5	66	29
Northern elephant seal	97	216	207	4	71	25

- (i) Calculate the total mass of haemoglobin in a Northern elephant seal.

(3)

$\hat{\text{con}}^{\text{blood}}$
 haem
 216 g dm^{-3}

$\hat{\text{blood}}$ vol
 $207 \text{ cm}^3 \text{ kg}^{-1}$

$207 \times 10^{-3} = 0.207 \text{ dm}^3 \text{ kg}^{-1}$

$$\cancel{0.207 \times 10^3} = 207 \text{ dm}^3$$

$$0.207 \times 216 = 44.7 \text{ g}$$

It's a big camel
4.47 kg

Answer ~~44.7g~~ 4.47kg



ResultsPlus

Examiner Comments

This answer gained two marks. The candidate has correctly divided by 1000, gaining mark point two, and then determined the mass of haemoglobin per cubic decimetre of blood to gain mark point one. They did not then multiply this by 400 kg to determine the total mass of haemoglobin in one seal.



ResultsPlus

Examiner Tip

Look at the mark allocation for calculations. There are often the same number of marks as there are steps in the calculation.

- (c) Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

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				lungs	blood	muscle
bottlenose dolphin	36	14	71	34	27	39
harbour seal	57	21	132	13	54	33
Weddell seal	87	210	173	5	66	29
Northern elephant seal	97	216	207	4	71	25

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

$$\text{Vol of blood} = \frac{207}{100} \times 400 = \frac{82800}{100} \text{ cm}^3 = 828 \text{ dm}^3 \quad (3)$$

$$\begin{aligned} \therefore \text{mass of haemoglobin} &= 216 \times 828 \\ &= 178848 \text{ g} \\ &= 178.848 \text{ kg} \\ &= 179 \text{ kg} \end{aligned}$$

Answer 179 kg



ResultsPlus
Examiner Comments

This is an excellent answer and gains all three marks. The candidate has shown all their working and calculated the correct answer.

Question 10 (c) (ii)

This question was the second six-mark, level-based question on the paper. The mark scheme shows indicative content that candidates may include in their answers and the descriptions of what an answer would be expected to have for it to gain each level. Candidates were presented with several sets of data regarding the maximum diving depths and physiology of different marine mammals and asked to analyse the patterns. The underlying theme is that deeper diving mammals need to spend longer under water and so need to store more oxygen. The deeper diving mammals are able to hold their breath longer but have less oxygen stored in lungs and so store the oxygen in the blood and muscles, having a higher haemoglobin content. Few candidates picked up that deeper diving mammals have less oxygen stored in the lungs as that would increase buoyancy or create problems with gas dissolving into the blood at high pressure.

Answers that only gave a description of the data and picked out a few correlations were restricted to level one. Those answers that went on to give an explanation of the data in terms of aerobic respiration rate, length of time under water were classed as level two answers. Where candidates gave a detailed description and explanation of the diving depths, lung volumes and blood and body oxygen storage together with some quantitative comparison they were awarded five or six marks for a level three answer. The question stem contained the phrase "analyse the data". This means that candidates should (a) quote examples of data from what they are presented with to support their conclusions and (b) attempt some form of manipulation of the data. A few outstanding answers were seen where candidates had actually carried out calculations to determine masses of oxygen found in different tissues or compared the total haemoglobin masses of different mammals.

The question discriminated well with a diverse range of answers seen. Some answers were outstanding and gave accurate descriptions of the data with appropriate explanations supported by manipulated data. Where candidates scored less well, they often simply described a small number of patterns and did not attempt any explanations. A common misconception was that marine mammals have gills and some candidates wrote answers about reduced oxygen concentrations in deeper water necessitating counter current systems and large surface area to volume ratios in gills.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

They have high max depth that allow them to dive for metres under the sea, they have max holding breath time e.g. the elephant sea has a 119 min max time of holding its breath and can dive up to 437 m undersea, it has the highest concentration of haemoglobin which suggests that it can transport and store more oxygen.



ResultsPlus

Examiner Comments

This answer was classed as a level one answer and gained one mark. There is a very basic description but no explanation.



ResultsPlus

Examiner Tip

If a question asks you to "analyse the data" you need to refer to the data in your answer and ideally carry out some manipulations.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

marine ^{mammals} ~~animals~~ are adapted in several ways for diving.

An example of this is the northern elephant seal.

As it has a mass of 900kg which is significantly higher than that of the bottlenose dolphin, it is able to hold its breath longer than the other ~~and~~ mammals. This is also due to its adaptation

that allows it to store vast amounts of oxygen in its blood. For this reason it has a high concentration of haemoglobin (216 g dm^{-3}) in its

blood. Similarly, the bottlenose dolphin is adapted to be able to store oxygen all over its body (lungs, blood, muscle). However, as it has

a smaller blood volume it ~~cannot~~ has a decreased amount of haemoglobin in the blood compared to the northern seal.



ResultsPlus

Examiner Comments

This answer gives a basic description of some aspects of the data. Little explanation is attempted although there are some references to data from the tables. As there is little explanation, it was classed as a level one answer and was awarded two marks.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

The deeper the animal dives → the longer it holds its breath for → the more oxygen it needs

The northern elephant seal dives the deepest and so has the greatest concentration of haemoglobin in blood → which has the highest affinity for oxygen as he has a ratio 97 : 216 volume of oxygen in blood : concentration of haemoglobin

So he requires fewer less haemoglobin to keep more oxygen compared to a bottlenose dolphin (5.5x better)

$$\frac{97}{216} \div \frac{36}{14} = 5.56$$



ResultsPlus

Examiner Comments

This answer was classed as level one and awarded two marks. There is a basic description with some effort to support it with data from the table. There is no real explanation, however, so it does not gain a level two mark.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

Marine animals are able to hold their breath under water for much longer periods of time. For example the maximum diving depth of the weddel seal and Northern elephant seal is above 400m because they can hold their breath for over an hour. This is because

they have myoglobin which has a much higher affinity for oxygen. They also have a much larger volume of ^{oxygen in} ~~blood~~ ^{body} and concentration of haemoglobin. It's because they have a higher concentration of haemoglobin and they contain myoglobin that they have a larger volume of ~~blood~~ oxygen in ~~blood~~ body which allows for them to have a much larger maximum time holding breath.

Most of their oxygen is kept in the blood eg. 71% for northern elephant seal which means not all the oxygen is used up as quick



ResultsPlus Examiner Comments

This answer has a description of some of the patterns and goes on to give a limited explanation in terms of myoglobin content storing oxygen in muscles and the length of time spent under water. The explanation classes this as a level two answer but as the level of description is not very detailed and there is little explanation, it was awarded three marks.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

Marine animals are adapted for diving through multiple means, the more O_2 vol stored in the body, the more time the animal can hold its breath, as seen through the bottlenose dolphin having $36 \text{ cm}^3 \text{ kg}^{-1}$ & 5 min holding breath, compared to the northern elephant seal with $97 \text{ cm}^3 \text{ kg}^{-1}$ & 119 min breath holding. The concentration of Hb in blood also seems to have an effect, as the more Hb the longer the animal can stay underwater, as more

O₂ can be stored in the blood. The greater blood volume is likely also contributing, as the greater the blood volume, the more Hb you can have in blood. Marine mammals adapted for prolonged diving store more O₂ in the blood than the lungs, with roughly $\frac{1}{4}$ of the O₂ stored in muscles for respiration. By storing the O₂ in the blood it allows O₂ to reach where it is needed very quickly, as the blood is saturated with O₂ during the dive.



ResultsPlus Examiner Comments

This answer was classed as a level two answer and was awarded four marks. There is a good, although not detailed description of some of the patterns and some explanation that is supported by data from the table.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

The deeper a marine mammal dives the longer time the mammal can hold their breath for because it takes more time to reach a ~~an~~ greater depth. However this is not shown between bottlenose dolphin and harbor seal. A seal dives to 1m shallower but can hold breath for 12 minutes longer.

This could be due to differences in ~~the~~ swimming speed or other factors.

As maximum time holding breath increases the concentration of haemoglobin in blood increases ~~also~~ by 20 g dm^{-3} as time is increased by 112 minutes.

This means a greater volume of O₂ can be ~~stored~~ carried in blood due to increased haemoglobin. This is shown by data: as volume concentration of haemoglobin is increased the volume of O₂ is increased.

Also as maximum time holding breath is increased volume of blood/kg

is increased, so more Hb, so more O_2 is stored in blood for respiration. Also a greater % of O_2 is stored in blood and less is stored in lungs and muscle as animal holds its breath for longer. This is because this allows for more O_2 to be stored in total stores and this allows O_2 to be transported by blood to the tissues which require O_2 the most, such as the brain.



ResultsPlus

Examiner Comments

This is a very good answer that has a detailed description of several of the patterns. A good explanation is offered and this is supported by references to data from the table. It was classed as a level three answer and awarded five marks; a little more explanation and the use of manipulated data would have given it six marks.

physi- behav. variations.

*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

marine mammals have evolved many adaptations that increase their chances of survival. They have physiological adaptations which allow them to hold their breath for much longer than ~~other~~ ^{other} mammals due to ~~the~~ adaptations in their biochemical pathways and bodily systems. This enables them to continue to respire aerobically even underwater, ~~using the less O_2 stores~~ ^{to generate ATP for their} necessary bodily functions. It can be seen that the Northern elephant seal ~~can~~ has the maximum time holding its breath although it has the same mass as a Weddell seal it can hold its breath for 37 minutes longer.

Another anatomical adaptation is the ~~concentration of haemoglobin~~ ^{amount of stored} in ~~oxygen in different parts of the body tissues~~ ^{the} muscles of the Weddell and Northern elephant seals. As they can be seen to dive further than the dolphin and the harbour seal, they have a correspondingly larger mass, this

could be stored due to stored blubber which keeps them
thermostable at cooler temperatures at the bottom of the ocean.

1
The mammals are able to hold their breath for such long periods due
to their concentration of blood hemoglobin ~~was~~ so large, another
physiological adaptation.



ResultsPlus
Examiner Comments

This answer was classed as level three and awarded five marks. There is a detailed description of several of the patterns and good explanations. An attempt has been made to manipulate the data but only at a basic level.

Paper summary

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

- be fully familiar with all the mathematical skills required by the specification;
- use accurate and precise vocabulary at all times;
- be fully familiar with each of the command words listed in the specification;
- support your answer with data when asked to "analyse the data";
- maintain a steady pace throughout the examination;
- plan answers for the longer questions before putting pen to paper;
- appreciate that for the level-based questions there may be different ways to structure your answer, all of which may be equally creditworthy.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

<http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx>

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Ofqual
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Llywodraeth Cynulliad Cymru
Welsh Assembly Government

