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International GCSE Biology 4BI1 2B

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Introduction

The examiners commented on the impressively high standard of many examination scripts. Candidates have clearly prepared very thoroughly for this examination and should be commended on their hard work and effort. Their achievements are especially impressive since they have clearly coped well with the many disruptions that have occurred to their education over the last two years. Many candidates and centres clearly used the Advance Information carefully and this was evident in the high quality of answer seen to questions such as Q6(b)(ii) (protein synthesis) and Q4(c) (osmoregulation). The mean mark on the paper was higher than in 2019 and this is largely due to the use of the Advance Information. Mathematical skills were very strong with most candidates being able to complete all the required calculations. Practical skills were also very strong with most being able to describe the biuret test for proteins although a number of candidates struggled with the use of the hydrogen-carbonate indicator to investigate gas exchange in plants. The use of technical language was generally very good, although candidates do need to make sure that they use technical terms accurately – a small number appreciated that terms such as 'transcription' and 'translation' are involved with protein synthesis but used them in the wrong contexts. Most centres and candidates have worked hard over the last few years to practise the longer answer questions that tend to use command words such as 'discuss' or 'evaluate' and the examiners commented on the improved standard of answers to this style of question. A few candidates continue to confuse command words such as 'explain' and 'describe' – before sitting the examinations, candidates should make sure that they are fully familiar with the requirements of each command word.

Question 1 (a)(i)

Most candidates were able to correctly name a greenhouse gas. A few candidates gave incorrect examples such as carbon monoxide or sulfur dioxide, and others did not read the question carefully and gave carbon dioxide. Methane was the most frequently seen correct answer.

- (a) (i) Carbon dioxide is a greenhouse gas.

State the name of another greenhouse gas (line 7).

(1)

Sat Methane



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Examiner Comments

This is a correct answer that gained one mark. Methane was the most frequently seen answer.

- (a) (i) Carbon dioxide is a greenhouse gas.

State the name of another greenhouse gas (line 7).

(1)

Sulfur dioxide.



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Examiner Comments

This answer is incorrect and so did not gain any marks. A significant number of candidates stated sulfur dioxide confusing greenhouse gases with acid rain.

- (a) (i) Carbon dioxide is a greenhouse gas.

State the name of another greenhouse gas (line 7).

(1)

carbon monoxide



ResultsPlus
Examiner Comments

This answer gained no credit. A significant number of candidates incorrectly wrote carbon monoxide.

Question 1 (a)(ii)

Many candidates gained at least two marks on this question. Mathematical skills were generally excellent across the whole paper. Most candidates were able to calculate the increase in mass of carbon dioxide and convert the units correctly. A few were unable to convert the final answer into standard form and either did not convert the answer or gave the wrong power of ten. A small number of candidates selected the wrong information from the comprehension. Candidates should be careful to read all the instructions in questions, in this example, several clearly did not read the instruction to convert the final answer into standard form.

- (ii) Calculate the increase in mass, in kg, of atmospheric carbon dioxide in 2020
(lines 2 to 7).

Give your answer in standard form.

[1 gigatonne = 1 000 000 000 000 kg]

$$727 + 37 = 764 \quad (3)$$

$$764 - 746 = 18$$



ResultsPlus
Examiner Comments

This answer gained one mark. The candidate has correctly calculated the increase as 18 but has not converted the units or used standard form.

- (ii) Calculate the increase in mass, in kg, of atmospheric carbon dioxide in 2020 (lines 2 to 7).

Give your answer in standard form.

[1 gigatonne = 1 000 000 000 000 kg]

~~727 + 37 = 764~~

$727 + 37 = 764$ $18 \times 1,000,000,000$
 $= 1.8 \times 10^{10}$

$764 - 746$

$= 18$

Increase in mass = 1.8×10^{10} kg



ResultsPlus
Examiner Comments

This answer gained one mark. The candidate has correctly calculated 18 but has not correctly converted the units.

- (ii) Calculate the increase in mass, in kg, of atmospheric carbon dioxide in 2020 (lines 2 to 7).

Give your answer in standard form.

[1 gigatonne = 1 000 000 000 000 kg]

$$37 + 727 = 764 \text{ gigatonnes released} \quad (3)$$

$$\begin{aligned} 764 - 746 &= 18 \text{ gigatonnes} \\ &= (18 \times 1\ 000\ 000\ 000\ 000) \text{ kg} \\ &= 1.8 \times 10^{13} \text{ kg} \end{aligned}$$

Increase in mass = 1.8×10^{13} kg



ResultsPlus
Examiner Comments

This answer gained all three marks. The candidate has completed all steps in the calculation correctly. The working is set out carefully and clearly – an example of good practise.

Question 1 (a)(iii)

Most candidates were able to correctly give two effects of global warming. Melting of ice, sea level rises and habitat loss were the most commonly seen correct answers. A few candidates simply stated that global warming would cause a temperature rise. Some candidates only gained one mark as they gave the same concept twice, for example flooding and increased sea levels – when asked to give a specific number of reasons, candidates should always try to give distinct reasons.

(iii) State two consequences of global warming for the environment.

(2)

- 1 Increase in global temperature. Higher temperatures in summer and lower temperatures in winter.
- 2 Melting of ice caps due to global warming.



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Examiner Comments

This answer gained one mark for the melting of ice caps. The statement about an increase in global temperature is not a consequence of global warming.

(iii) State two consequences of global warming for the environment.

(2)

- 1 The melting of Polar ice caps

- 2 The harming/destruction of the O-zone layer



ResultsPlus
Examiner Comments

This answer gained one mark for melting of ice. The loss of the ozone layer is not an effect of global warming.

(iii) State two consequences of global warming for the environment.

(2)

1. Destruction of habitats / ecosystems.

2. Rising Sea levels.



ResultsPlus

Examiner Comments

This answer gained two marks for habitat destruction and rising sea levels.



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Examiner Tip

When asked to give a set number of reasons, always give clearly distinct reasons rather than similar ones.

Question 1 (b)

This question required candidates to identify why growing the genetically modified plants with additional suberin could reduce atmospheric carbon dioxide. Many excellent answers were seen that explained that the plants would take in carbon dioxide and use it to make suberin, a substance that does not decay rapidly so does not release carbon dioxide rapidly. Many candidates also correctly recognised that the plants are perennials so do not decompose each year. Most candidates were able to gain at least two marks with many going on to get three or four. Some candidates did not refer to the removal of carbon dioxide by photosynthesis and others gave vague answers that simply restated phrases from the comprehension.

- (b) Explain why producing genetically engineered plants with additional suberin in their roots could reduce atmospheric carbon dioxide (lines 14 to 17 and lines 19 to 24). (4)

suberin can "lock" the carbon dioxide away - so

it reduces CO₂ further by photosynthesis as well as

suberin. The more suberin in a plant, the more

CO₂ is being taken out of the atmosphere - these

plants don't have to constantly pollinate but uses

micro propagation, increasing the number of plants with
suberin in their roots.



This answer gained two marks for correctly stating that plants take in carbon dioxide by photosynthesis.

- (b) Explain why producing genetically engineered plants with additional suberin in their roots could reduce atmospheric carbon dioxide (lines 14 to 17 and lines 19 to 24). (4)

As the modified plants would capture carbon dioxide and assimilate some of that carbon into the suberin in the roots. As the plants are perennials, they would remain alive for a long time and store a high amount of carbon in their roots. As suberin is very slowly decomposed, this carbon would remain as carbon in the soil, and not be decomposed back to CO_2 in the atmosphere.



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Examiner Comments

This is a strong answer that gained four marks. The candidate clearly explains that carbon dioxide is removed by the plants. They also explain that because the plants are perennials and that suberin decomposes slowly, there is a lower rate of carbon dioxide release.

- (b) Explain why producing genetically engineered plants with additional suberin in their roots could reduce atmospheric carbon dioxide (lines 14 to 17 and lines 19 to 24).

(4)

It could reduce it by absorbing more carbon dioxide than other plants, and storing it for many years instead of releasing it, by turning it into suberin. Because suberin is ~~released~~^{decomposed} very slowly, the carbon will stay underground a lot longer than being released into the atmosphere.



ResultsPlus
Examiner Comments

This answer gained three marks for correctly stating that the plants absorb carbon, convert it into suberin and this then decomposes slowly.

Question 1 (d)

Many candidates found this question challenging and did not appreciate that the question was about osmosis. Strong answers that gained two marks explained that the high salt concentration of the soil would reduce the water potential and so waterproof suberin would prevent water loss by osmosis. A significant number of candidates incorrectly stated that the role of the suberin would be to prevent uptake of salt.

- (d) Explain why the additional suberin in the cell walls of the roots will make the transgenic plants tolerant to soil with a high salt concentration (lines 26 to 28).

(2)

Because suberin is waterproof, and extra waterproofing would restrict osmosis of water out of the plant to the salty soil. If this happened, the plant would lose all of its water, and dry out. By having extra suberin waterproof, the transgenic plants will have a reduction in loss of water via osmosis, and therefore would be able to tolerate salty soil.



ResultsPlus
Examiner Comments

This is a strong answer that gained both marks. The candidate explains that the suberin prevents water loss by osmosis.



ResultsPlus
Examiner Tip

If a question is about osmosis, always refer to the movement of water from a higher water potential to a lower water potential (or a dilute solution to a more concentrated solution). Don't write about concentrations of water – refer to the salt or sugar concentrations.

- (d) Explain why the additional suberin in the cell walls of the roots will make the transgenic plants tolerant to soil with a high salt concentration (lines 26 to 28).

(2)

It will make it tolerant to soil with a high salt concentration because the more suberin means the more tolerant and the cell walls have a shorter diffusion distance. Because suberin is high in carbon atoms it means that it can tolerate salts. It also lasts for a long time and is resistant to water.



ResultsPlus
Examiner Comments

This answer gained no marks. The candidate has not referred to the movement of water or osmosis.

- (d) Explain why the additional suberin in the cell walls of the roots will make the transgenic plants tolerant to soil with a high salt concentration (lines 26 to 28).

(2)

Because suberin is waterproof. Therefore water can't move out the cells in the plant to the soil by osmosis, as the walls aren't permeable.



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has correctly stated that the suberin prevents water loss by osmosis.

Question 1 (e)

This question required candidates to suggest three reasons why micropropagation was used to produce the plants rather than pollination. Most candidates were able to gain at least one mark with many going on to gain all three. Common answers included: producing large numbers of plants, producing plants that are genetically identical and rapid propagation. Candidates do need to be careful with how they phrase their answers, high yield was not accepted unless it was linked to the number of plants produced.

- (e) Give three reasons why the scientists use micropropagation to reproduce the transgenic crop plants (lines 24 to 25).

(3)

- 1 It is a quicker process.
- 2 The plants would be genetically identical.
- 3 They can be produced in large amounts.



ResultsPlus
Examiner Comments

This answer gained all three marks. The candidate has correctly stated that micropropagation would be quicker, would produce genetically identical plants and can produce large numbers of plants.

- (e) Give three reasons why the scientists use micropropagation to reproduce the transgenic crop plants (lines 24 to 25).

(3)

- 1 To produce crops with better yields.
- 2 To genetically modify them.
- 3 For mass production of crops



ResultsPlus
Examiner Comments

This answer gained one mark for the mass production of the plants. High yield would not have gained a mark and no credit was given for the ability to genetically modify the plants.

- (e) Give three reasons why the scientists use micropropagation to reproduce the transgenic crop plants (lines 24 to 25).

(3)

- 1 They don't need bees to take their pollen making them grow another crop
- 2 They can micropropagate all year round
- 3 They don't rely on insects to take their pollen and can do it themselves.



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Examiner Comments

This answer gained one mark for the idea that micropropagation can be used all year, unlike pollination.

Question 2 (a)

This question asked candidates to identify the independent variable in a practical. Most were able to correctly state that the sterilisation of the soil was the independent variable. A few candidates incorrectly stated that the presence of nitrate was the independent variable. Candidates should be familiar with the terms independent, dependent and control variables.

The table shows the student's results.

Soil sample	Result of test for nitrates		
	At start of investigation	After water has passed through for five minutes	Three days after adding ammonium salts
unsterilised	present	absent	present
sterilised	present	absent	absent

(a) Give the independent variable in the investigation.

(1)

sterilisation of soil



This answer gained one mark for correctly identifying the independent variable as soil sterilisation.

(a) Give the independent variable in the investigation.

(1)

number of days.



This answer gained no mark as the candidate has incorrectly identified a control variable as the independent variable.

Question 2 (b)(i)

This question assessed candidates' understanding of experimental design. Many candidates found the question challenging and suggested reasons such as the need to provide bacteria with water or gave vague reasons such as washing the soil. Some excellent answers were seen that explained how the nitrate ions would be washed out so that any nitrates present at the end of the experiment must have been produced from the added ammonium ions. Although this is not a core practical, candidates should be prepared to comment on unfamiliar experimental designs.

- (b) (i) Suggest why the student poured water through the soil samples for five minutes before adding the ammonium salts.

(2)

to make sure to leach away all remaining nitrates in the soil so the nitrate present after putting the ammonium salts was due to only the ammonium salts



ResultsPlus
Examiner Comments

This is an excellent answer that gained both marks. The candidate clearly explains that adding water removes the existing nitrates so that any new nitrates must have been made from the ammonium.



ResultsPlus
Examiner Tip

Make sure that you know terms such as independent, dependent and control variables.

- (b) (i) Suggest why the student poured water through the soil samples for five minutes before adding the ammonium salts.

(2)

To remove the remaining mineral ions. To remove nitrate ions specifically for valid comparison after the experiment. To make sure that nitrate ions were formed during the experiment and not before that.



This answer gained both marks.. The candidate correctly states that the water removes the nitrates so that any nitrates formed must have been produced from the ammonium.

- (b) (i) Suggest why the student poured water through the soil samples for five minutes before adding the ammonium salts.

(2)

To remove micro-organism's or pathogen's which cause disease. To remove decomposer like fungi & bacteria.



This answer did not gain any marks. The candidate has mistakenly stated that the water removes microorganisms.

Question 2 (b)(ii)

This was a challenging question that was well answered by many candidates. The examiners were impressed with the level of detail given by many candidates. Most were able to gain at least one mark, often for stating that nitrates were present in the unsterilised sample. Strong answers went on to explain the nitrifying bacteria would have converted the ammonium ions into nitrites and eventually nitrates. Some candidates confused nitrifying bacteria with nitrogen fixing or denitrifying bacteria. Candidates should take care to use scientific language accurately, it is not enough to simply use scientific terminology if the context is incorrect.

- (ii) Comment on the results of the nitrate tests on the two soil samples three days after adding ammonium salts.

(4)

In the unsterilised soil sample there were nitrates present at the beginning of the investigation and at ~~the end of~~ ^{soil sample} three days after adding ammonium salts to the soil sample.

In the sterilised ~~soil sample~~ nitrates were present at the start of the investigation but absent three days after adding ammonium salts to the soil sample.



ResultsPlus Examiner Comments

This answer gained one mark for correctly stating that nitrates were present in the unsterilised soil. No reasons for the presence of nitrates are given.



ResultsPlus Examiner Tip

Make sure that technical language is used accurately. It is not enough to use key words if they are in the wrong context. For example, candidates may refer to nitrifying bacteria but will not gain credit if they are linked to an incorrect role.

- (ii) Comment on the results of the nitrate tests on the two soil samples three days after adding ammonium salts.

(4)

the nitrogen fixing bacteria in the unsterilised soil is still active ~~and~~ within the sterilised soil where it was killed at 60°C. this bacteria works on changing ammonium ions into nitrates in the soil which is why the sterilised soil does not produce nitrates, because the bacteria had been sterilised. they had to be left for three days to show the results definitely so the bacteria had time to work.

(Total for Question 2 = 7 marks)



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has correctly stated that the unsterilised soil contains nitrates and that these have been made from the ammonium ions. The candidate has incorrectly stated that nitrogen fixing bacteria have produced the nitrates.

- (ii) Comment on the results of the nitrate tests on the two soil samples three days after adding ammonium salts.

(4)

- The ~~gf~~ sample with unsterilised soil had nitrates present after three days. When three days before there were no nitrates present.
- This is due to the presence of nitrifying bacteria converting ammonium ions ~~W~~ into nitrates in a process called nitrification.
- The sample with sterilised soil had no nitrates present after three days. Because all bacteria is killed when heated to 100°C for one hour, three days ago.
(Total for Question 2 = 7 marks)



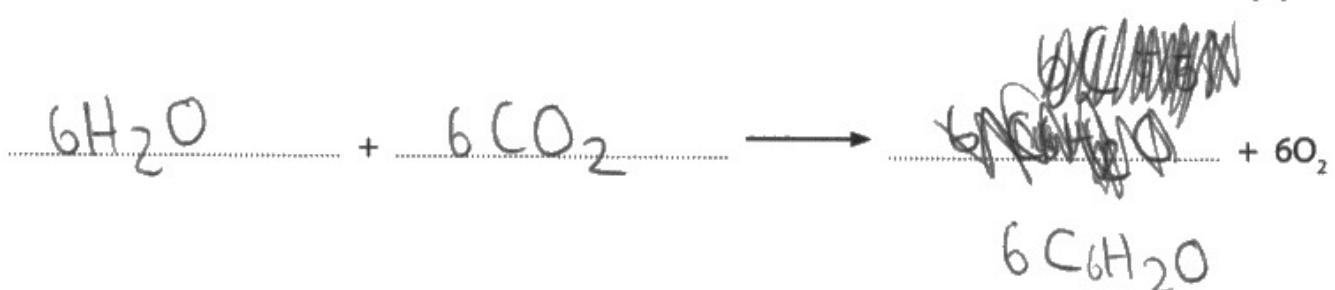
This answer gained all four marks. The candidate has correctly stated that there is nitrate present in the unsterilised soil and that the sterilised soil has no nitrate as the bacteria have been killed. The candidate also correctly states that nitrifying bacteria convert the ammonium ions into nitrate.

Question 3 (b)

Most candidates were able to complete the balanced chemical symbol equation. A few candidates confused the equation for photosynthesis with the equation for respiration. Some candidates were unable to balance the equation and a few were not aware of the chemical formula for glucose.

(b) Complete the balanced chemical symbol equation for photosynthesis.

(2)



ResultsPlus
Examiner Comments

This answer gained one mark for correctly giving the left hand side of the equation. The candidate has given the incorrect formula for glucose.

(b) Complete the balanced chemical symbol equation for photosynthesis.

(2)



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has completed both sides of the equation correctly.

Question 3 (c)(i)

This question assessed candidates' knowledge of gas exchange in plants. Many candidates correctly recognised that at low light intensities the rate of respiration was higher than the rate of photosynthesis resulting in a net intake of oxygen. Some candidates recognised that the photosynthesis rate would be low but did not relate this to the rate of respiration. Candidates should make sure that they explain data fully.

- (i) Explain why *Chlorella* takes in oxygen at light intensities below 10 arbitrary units.

(2)

This is because, during the night, plants cannot photosynthesise due to the lack of light energy. Therefore, they aerobically respire leading to uptake in oxygen and carbon dioxide being released.



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate explains that the light intensity is low and so the rate of photosynthesis is lower than the rate of respiration.

- (i) Explain why *Chlorella* takes in oxygen at light intensities below 10 arbitrary units.

(2)

1)- takes in oxygen due to gas exchange taking place below 10 arbitrary units. this shows that the volume of O₂ at -10 will start the gas exchange process.



ResultsPlus
Examiner Comments

This answer gained no marks. The candidate has not referred to how the low light intensity has affected the rate of photosynthesis.

- (i) Explain why *Chlorella* takes in oxygen at light intensities below 10 arbitrary units.

(2)

Below 10 arbitrary units the rate of photosynthesis producing oxygen is less than the oxygen taken in for respiration as the light level is too low. This means, overall, the *Chlorella* takes in CO_2 .



ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has correctly explained that the rate of photosynthesis is higher than the rate of respiration so that the rate of oxygen consumption is higher than the rate of oxygen production.

Question 3 (c)(ii)

This question required candidates to look at the effect of increasing light intensity on the rate of oxygen production. Candidates had to recognise that increasing the light intensity increased the rate of photosynthesis until other factors limited the rate. Many candidate scored at least one mark but few went on to gain all three. A significant number of candidates recognised that other factors would limit the rate of photosynthesis beyond 55 arbitrary units of light but a few incorrectly stated that light would be limiting at that light intensity. A few candidates correctly stated that at 10 arbitrary units the rates of photosynthesis and respiration were equal. Some candidates did not give explanations but instead gave descriptions of the data.

- (ii) Explain the changes in the volume of oxygen released as the light intensity increases from 10 arbitrary units.

~~It seem~~ It shows that after it reached 10 arbitrary units , the volume of oxygen started to increase rapidly until it reached 40 mm^3 the stayed at that pace . (3)



ResultsPlus
Examiner Comments

This answer did not gain any marks. The candidate has given a description rather than giving an explanation.



ResultsPlus
Examiner Tip

Always read command words carefully. Do not confuse 'describe' with 'explain'.

- (ii) Explain the changes in the volume of oxygen released as the light intensity increases from 10 arbitrary units.

(3)

The volume of oxygen released ^{is 0} increases at 10 units as the photosynthesis ~~take-in~~ ^{release} of oxygen equals the take-in of in respiration. However as light intensity increases, so does photosynthesis - so it goes from 0 mm^3 at 10 units to 40 mm^3 at ~55 units where it plateaus as light intensity is in excess - no longer a limiting factor which is now carbon dioxide. Light intensity is in excess.



ResultsPlus
Examiner Comments

This answer gained all three marks. The candidate has correctly stated that the rate of photosynthesis has increased and related this to the rate of respiration. The candidate also goes on to explain that other factors limit the rate of photosynthesis at 55 a.u.

- (ii) Explain the changes in the volume of oxygen released as the light intensity increases from 10 arbitrary units.

(3)

- The higher the light intensity, the more light is absorbed by chlorophyll, so more photosynthesis can occur if light increases.
- Therefore higher rate of photosynthesis than respiration.
- Increasing photosynthesis means a net increase in O_2 , more O_2 released. Until, at 55 arbitrary units, light intensity is no longer a limiting factor, but factors like temperature or CO_2 conc are.

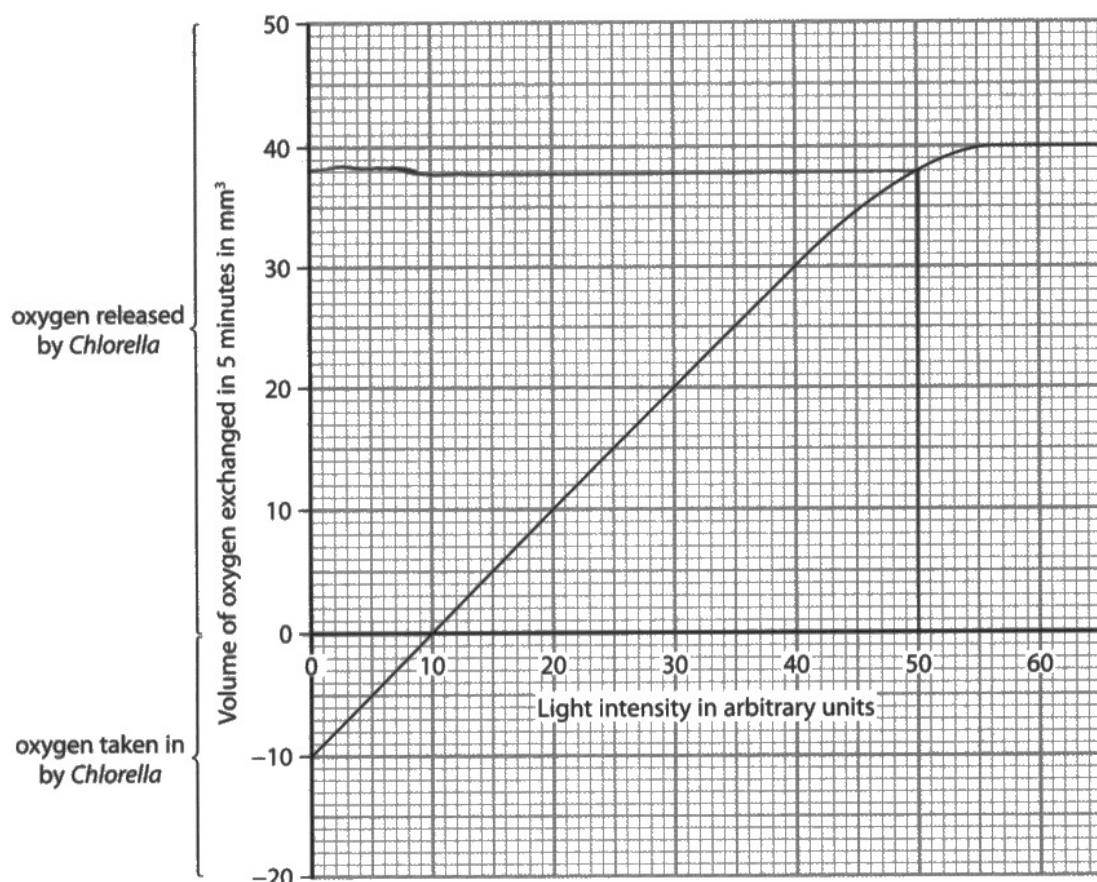


ResultsPlus
Examiner Comments

This excellent answer gained all three marks. The candidate correctly states that the rate of photosynthesis increases and becomes higher than the rate of respiration. The candidate also goes on to explain the changes in oxygen release and the effect of other limiting factors.

Question 3 (c)(iii)

Many candidates found this question challenging. Candidates were asked to use the graph to calculate the volume of oxygen produced by photosynthesis. Candidates were required to use the graph to determine the volume of oxygen used by respiration at zero light intensity and add this to the net volume of oxygen released at 50 a.u. Many candidates were able to determine the volume of oxygen released at 50 a.u. but only a few were able to use this to correctly calculate the total volume of oxygen produced.



(iii) The volume of oxygen released by *Chlorella* is the difference between the oxygen produced by photosynthesis and the oxygen taken in.

Use the graph to calculate the volume of oxygen produced in five minutes by photosynthesis at a light intensity of 50 arbitrary units.

(2)

$$38 \text{ mm}^3 - (-10) \text{ mm}^3$$

$$= 38 + 10$$

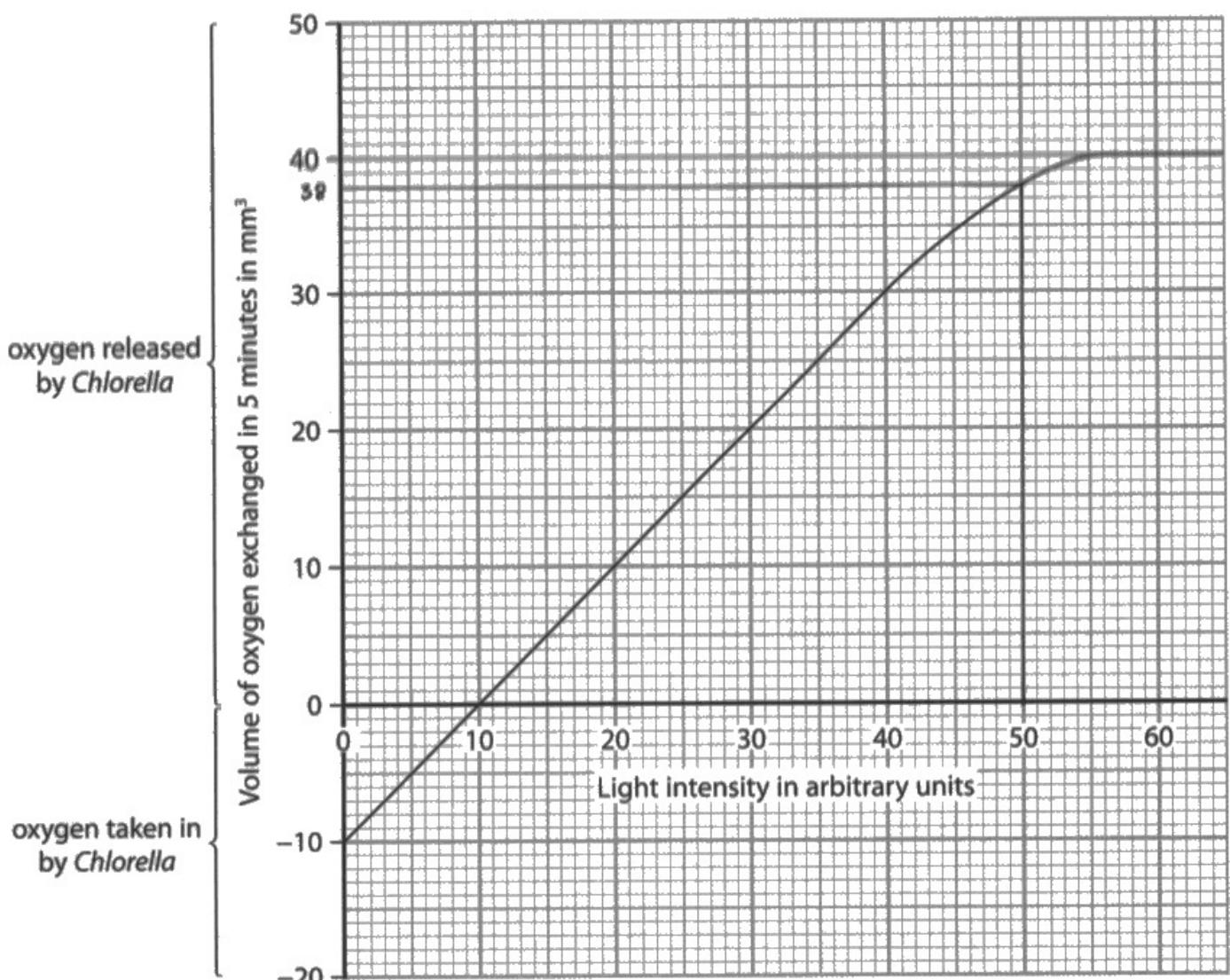
$$= 48$$

volume of oxygen = 48 mm³



ResultsPlus
Examiner Comments

This answer gained both marks for correctly calculating the volume of oxygen produced.



- (iii) The volume of oxygen released by *Chlorella* is the difference between the oxygen produced by photosynthesis and the oxygen taken in.

Use the graph to calculate the volume of oxygen produced in five minutes by photosynthesis at a light intensity of 50 arbitrary units.

(2)

$$\begin{aligned}
 & 38 - 10 \\
 & = 28 \text{ mm}^3
 \end{aligned}$$

volume of oxygen = 28 mm³



ResultsPlus
Examiner Comments

This answer gained one mark for correctly using the graph to determine the volume of oxygen released. The candidate has incorrectly subtracted the volume of oxygen used by respiration.

Question 3 (d)

This question asked candidates to describe how the hydrogen-carbonate indicator could be used to investigate the effect of light intensity on gas exchange. Some excellent answers were seen that explained how light intensity could be changed, often by placing a lamp at different distances. A significant number of candidates did not give a method for changing the light intensity but simply stated that the light intensity would be changed. Many candidates correctly explained the colour changes that occur when carbon dioxide increases and decreases. Some candidates incorrectly referred to oxygen changing the colour of the indicator and some gave incorrect colour changes. Many candidates correctly stated that a control tube with no *Chlorella* would be used and others gave correct control variables. Candidates should be careful to refer to volumes rather than amounts, for example, they should state that the same **volume** of indicator is used.

- (d) Describe how hydrogen-carbonate indicator could be used to investigate the effect of light intensity on carbon dioxide exchange by *Chlorella*.

(3)

Add hydrogen carbonate indicator to sample of the *Chlorella* at different CO_2 levels such as testing by testing it at different light intensities. For example testing *Chlorella* in light intensity of 10 arbitrary units would make the hydrogen carbonate indicator go ~~purple~~ yellow as it is respire more than photosynthesising. At high light intensities such as 60 arbitrary units *Chlorella* would be photosynthesising more and so less CO_2 would be produced, therefore it will go purple.

(Total for Question 3 = 14 marks)



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Examiner Comments

This answer gained one mark for the correct colour changes. No method for changing the light intensity was given.

- (d) Describe how hydrogen-carbonate indicator could be used to investigate the effect of light intensity on carbon dioxide exchange by Chlorella.

(3)

You would had 4 or 3 chlorella in varying light intensity and leave one as a control. Add hydrogen carbonate indicator to all 3 tubes. Add chlorite and hydrogen carbonate indicator to three bigger test tubes. Wrap one test tube in opaque tin foil, one in translucent gauze and leave one open. Also have an extra one for control. Leave for 24 hours. The hydrogen carbonate indicator should go yellow in the tin foil test tube, remain orange in gauze and the other should go purple.



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Examiner Comments

This answer gained all three marks. The candidate has correctly given a method for changing the light intensity, has controlled the time taken and has given correct colour changes.



ResultsPlus
Examiner Tip

Make sure that practical details are given. For example, state **how** the light intensity would be changed rather than just stating that it will be changed.

Question 4 (a)

Most candidates were able to gain at least one mark. A significant number of candidates confused the urethra with the ureter and others gave spellings that were not clearly the ureter. Most candidates had clearly prepared for this topic (excretion) as it was listed on the Advance Information.

- (a) Name the structures labelled A and B.

(2)

A Urethra

B Bladder



This answer gained one mark for correctly naming the bladder.

- (a) Name the structures labelled A and B.

(2)

A Urethra

B (Gall) Bladder



This answer gained no marks. The bladder mark was not awarded as the candidate has referred to the gall bladder.

(a) Name the structures labelled A and B.

(2)

A *ureter*

B *bladder*



ResultsPlus
Examiner Comments

This answer gained both marks – both structures are correctly named.

Question 4 (b)(i)

This question was well answered by many candidates and it was evident that many had used the Advance Information carefully to prepare for this topic. Most candidates understood that proteins are large molecules and many went on to explain that due to the size of proteins they cannot leave the glomerulus or enter Bowman's capsule. Some candidates did not mention the glomerulus or Bowman's capsule but simply referred to Area X and Area Y. Some candidates gave descriptions of the data rather than explaining why there was no protein present in the Bowman's capsule. Many candidates gained at least one mark on this question and a significant number went on to gain two marks.

The table shows the relative concentrations of glucose and protein in the areas labelled X, Y and Z on the diagram.

Substance	Relative concentration of substance in arbitrary units		
	Area X	Area Y	Area Z
protein	100	0	0
glucose	100	50	0

- (i) Explain the difference between the concentration of protein in area X and the concentration of protein in area Y.

(2)

Protein molecules are too large to be forced out of the glomerulus and into the Bowman's capsule during ultrafiltration.



This answer gained both marks as the candidate correctly refers to the large size of protein molecules and why it cannot leave the glomerulus.

- (i) Explain the difference between the concentration of protein in area X and the concentration of protein in area Y.

(2)

The concentration of protein in area X will be greater than the concentration of protein in area Y. This is because ^{protein} molecules are too large to pass to area Y because area X only allow smaller molecules to pass.



ResultsPlus
Examiner Comments

This answer was awarded one mark for stating that protein molecules are large. No second mark was awarded as there is no reference to the Bowman's capsule or glomerulus.

- (i) Explain the difference between the concentration of protein in area X and the concentration of protein in area Y.

(2)

The difference between the concentration of protein from area X to area Y is shown as there is a huge decrease for the relative concentration.



ResultsPlus
Examiner Comments

This answer was not awarded any marks. The candidate has not explained why there is no protein present in Area Y but has simply given a description of the data.

Question 4 (b)(ii)

Similarly to Q4(b)(ii), this question was well answered by many candidates. Most appreciated that glucose is reabsorbed into the blood and many went on to give the location as the proximal convoluted tubule and / or stated that active transport is involved. A few candidates described the data rather than explaining why there is no more glucose present in the filtrate in Area Z. Some candidates confused the proximal convoluted tubule with the distal tubule or loop of Henle.

- (ii) Explain the difference between the concentration of glucose in area Y and the concentration of glucose in area Z.

(2)

In area Y, some glucose is filtrated into the tubules + Bowman's capsule, meaning the concentration will be higher. via selective reabsorption, however the glucose is reabsorbed into the capillaries, and so the concentration in area Z goes down to 0.



This answer gained one mark for correctly stating that the selective reabsorption of glucose into the blood occurs.

- (ii) Explain the difference between the concentration of glucose in area Y and the concentration of glucose in area Z.
- (2)
they are too big

Bowman's capsule

At area Y (the glomerulus), there will be a high concentration of glucose because ultrafiltration will have occurred to remove it from the blood stream. At Z (the proximal tubule), selective reabsorption will have occurred where glucose is re-introduced into the blood stream, so none would still be present in the nephron.



ResultsPlus
Examiner Comments

This answer gained both marks. The candidate correctly states that glucose is reabsorbed in the proximal convoluted tubule.

- (ii) Explain the difference between the concentration of glucose in area Y and the concentration of glucose in area Z.

(2)

Glucose Z is reabsorbed by between Y and Z in the proximal convoluted tube by active transport, using energy from respiration, where glucose molecules move against the concentration gradient. Thus there is no glucose at Z, less and more glucose at Y.



This answer gained two marks. The candidate correctly states that the glucose is reabsorbed in the proximal convoluted tubule and is reabsorbed by the process of active transport.

Question 4 (c)

Many candidates wrote very impressive answers to this question and it was clear that many candidates had used the Advance Information effectively to ensure that they had a good understanding of osmoregulation. Strong answers explained that osmoreceptors in the hypothalamus detect blood concentration and lead to the release of ADH by the pituitary gland. Some candidates referred to the hypothalamus but did not explain that the osmoreceptors detect the blood concentration, instead referring to levels of water in the body. Similarly, a significant number of candidates were aware that ADH levels increase but made no reference to the pituitary gland. Many candidates understood that ADH increases the permeability of the collecting duct leading to the absorption of water. Weaker answers tended to gain one mark, often for recognising that there is an increased absorption of water.

- (c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

- 1- the hypothalamus detects a decrease in water
- 2- this causes the brain to release more ADH in the pituitary gland
- 3- this causes the distal convoluted tubule to increase its permeability allowing more water to be reabsorbed back into the body.
- 4- causing a higher concentration of urine to be present. and less water present.



ResultsPlus
Examiner Comments

This answer was awarded three marks. The candidate states that the hypothalamus detects changes in water but does not refer to the blood. They correctly state that the pituitary gland releases ADH and this increases permeability leading to the reabsorption of more water. The candidate has confused the collecting duct with the distal convoluted tubule.

(c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

When the body is dehydrated, more ADH is released. This makes the membrane more permeable to allow larger molecules of water to pass through. This makes the urine colour more yellow. The concentration has increased.



ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating that the permeability increases. No mark is awarded for the mention of ADH as there is no reference to the pituitary and the candidate does not clearly state that water is absorbed.

(c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

When your body is dehydrated, more water is reabsorbed back into the body via osmosis making the urine more concentrated. Concentrated with urea. This is because ADH is secreted making the nephron walls more permeable so more water can be reabsorbed.



ResultsPlus
Examiner Comments

This answer gained two marks for correctly referring to the absorption of water and increase in permeability of the nephron.

(c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

The brain detects loss of water in the body and releases more ADH from the pituitary gland. The increase in ADH concentration in the body makes the collecting duct more permeable. Therefore more water is absorbed from the kidney's lumen into the blood. This means there is less water in urine creating a more concentrated solution.



ResultsPlus
Examiner Comments

This answer gained four marks. The candidate correctly stated that ADH is released from the pituitary gland and this causes the collecting duct to become more permeable and absorb more water.

Question 5 (a)(i)

This calculation required candidates to recognise that one of the values in the table was an anomaly and so should not be included in the mean. Candidates then had to calculate the mean and give their answer to two decimal places. Most candidates gained at least one mark. Many recognised that one value was anomalous and went on to calculate a correct mean value. Some candidates used all four values to calculate a mean, often gaining two marks. The majority of candidates were able to calculate a mean and if they did not gain all three marks, it was typically for not recognising that one of the values was anomalous or did not give an answer to two decimal places.

- (a) The table shows the student's results for the volumes of gelatine digested at pH 4.

Tube number	Volume of gelatine digested in cm ³
1	0.55
2	1.89
3	0.54
4	0.61

— Anomaly

- (i) Calculate the mean volume of gelatine digested in cm³.

Give your answer to two decimal places.

$$\frac{0.55 + 0.54 + 0.61}{3} = 0.5\cancel{6}6 \quad (3)$$
$$= 0.57 \quad (2 \text{ dp})$$

mean volume = 0.57 cm³



ResultsPlus
Examiner Comments

This answer gained three marks. The calculation is set out clearly with all the working.

(i) Calculate the mean volume of gelatine digested in cm³.

Give your answer to two decimal places.

$$\begin{array}{r} 0.55 + 0.54 + 0.61 + 1.89 \\ \hline 3.59 \\ 4 \\ = 0.8975 \\ = 0.9 \text{ cm}^3 \end{array}$$



This answer was awarded one mark. The candidate has not excluded the anomaly and not given the final value to two decimal places.

(i) Calculate the mean volume of gelatine digested in cm³.

Give your answer to two decimal places.

(3)

$$\begin{array}{r} 0.55 + 1.89 + 0.54 + 0.61 \\ \hline 4 \\ = 0.8975 \\ = 0.90 \end{array}$$

mean volume = 0.90 cm³



This answer was awarded two marks. The candidate has calculated the mean value to two decimal places but did not exclude the anomaly.

Question 5 (a)(ii)

Most candidates correctly stated that the products of protein digestion are amino acids or peptides. A few candidates incorrectly suggested fatty acids or glucose.

- (ii) State what substances are produced when the gelatine protein is digested.

(1)

amino acids



ResultsPlus
Examiner Comments

This is an example of a correct answer that gained one mark.

Question 5 (b)(i)

This question required candidates to suggest two variables that would need to be controlled to allow a valid comparison. Many candidates were able to gain at least one mark with a significant number going on to gain a second. Common correct answers included concentration of gelatine, temperature and time taken. Some candidates gave vague references to amounts of buffer or gelatine – candidates should try to use more precise language such as volume or mass.

(i) Give two variables the student should control.

(2)

- 1 The temperature of the water bath
- 2 The amount of pH buffer and pineapple juice



ResultsPlus
Examiner Comments

This answer was awarded one mark for correctly stating that the temperature would need to be controlled. No mark was awarded for the amount of buffer – if the candidate had referred to volume, a second mark would have been awarded.

(i) Give two variables the student should control.

(2)

- 1 temperature
- 2 volume or pH buffer ~~etc~~



ResultsPlus
Examiner Comments

This answer was awarded two marks for correctly stating that the temperature and the volume of buffer would have to be kept constant.

Question 5 (b)(ii)

Most candidate were familiar with the effect of pH on enzymes and gained at least one mark. Many correctly stated that as pH increases to five, the volume of gelatine digested increased and then when the pH increased further, the volume digested decreased. Many candidates correctly recognised that the optimal pH would be close to 5 and that the enzyme denatures when pH is high or low. Many excellent descriptions of denaturation were seen, with many candidates going on to explain that when the enzyme denatures, the substrate will no longer bind to the active site. Weaker answers tended to describe the data without giving any explanations. Some candidates also incorrectly referred to optimal temperatures.

- (ii) Explain the effect of changing the pH on the mean volume of gelatine digested.

(3)

The enzyme works best at a pH of 5, a weakly acidic^{pH}, and the activity changes significantly as the pH rises or falls. Past this point, this is because protease enzymes are also found in the stomach to digest proteins, which is an acidic environment. Here this is the optimum pH and as the pH changes the enzymes become denatured and no longer work, which is the reason for a lower volume of gelatine being digested.

as the active site has changed shape



This answer was awarded three marks. The candidate describes how pH affects the volume of gelatine digested and goes on to explain that as the pH moves away from the optimum, the enzyme denatures.

- (ii) Explain the effect of changing the pH on the mean volume of gelatine digested.

(3)

The optimum pH is pH 5. The gelatine digests faster when the protease is in a weak acid and does not digest well when it is alkaline.



This answer was awarded one mark. The candidate states that the optimum pH is 5 but gives no more detail.

- (ii) Explain the effect of changing the pH on the mean volume of gelatine digested.

(3)

The most gelatine digested occurs at the pH of a weak acid, such as 4-5 as this is the optimum pH for the action of the digestive enzymes and they begin to denature outside of this range.



This answer was awarded one mark for correctly stating that the optimum pH is near to five and the enzymes denature when the pH changes.

- (ii) Explain the effect of changing the pH on the mean volume of gelatine digested.

(3)

* As ~~the~~ ~~enzymes~~ ~~decrease~~, changing the pH changes the active site of the enzymes, so the enzyme bromelain becomes denatured. Substrate can no longer fit into the active site, so enzyme-substrate complexes decrease, so the mean volume of gelatine digested decreases. The optimum pH for the enzyme bromelain is pH 5 as it has the highest mean volume of ~~the~~ gelatine digested.



ResultsPlus
Examiner Comments

This answer was awarded three marks. The candidate clearly states that a change in pH causes the enzyme to denature so that the substrate will no longer bind. The candidate also correctly refers to the optimal pH.

Question 5 (c)

This answer was well answered by most candidates and it was clear that after studying the Advance Information, many candidates had prepared for this topic carefully. Most correctly referred to the use of biuret reagents to test for protein and went on to give the correct colour change. Some candidates suggested the wrong tests (often Benedict's test) and / or gave the wrong colour change.

(c) Describe how to test for the presence of protein.

(2)

- At - In a test tube add food sample
- To the test tube add 2 cm³ of biuret solution
- Swirl test tube to mix.
- If protein is present, the solution will have turned a mauve colour.
- If protein isn't present, the solution is blue.

(Total for Question 5 = 11 marks)



This answer gained two marks for correctly stating that the biuret solution is added and that the colour changes to mauve.

(c) Describe how to test for the presence of protein.

(2)

Biurets test - add biurets solution to the protein sample if proteins are present it will go a blueish colour



This answer was awarded one mark for correctly stating that the biuret solution would be used but the colour change is incorrect, so no second mark was awarded.

Question 6 (a)

This question was well answered by many candidates. Most appreciated that having less haemoglobin would reduce the oxygen transported and many candidates went on to explain that this would reduce the respiration rate of body tissues. Many also correctly stated that there would be less oxygen transported to the muscles although a significant number simply stated that less oxygen would be transported to the body. Candidates should always try to refer to the affected structures, organs and tissues. Some candidates gave vague references to reduced transport of energy – candidates should always refer to transport of oxygen when discussing haemoglobin.

- 6 Beta thalassaemia is a genetic condition caused by a mutation in a gene for haemoglobin.

People with beta thalassaemia produce less haemoglobin and fewer red blood cells than people without the condition.

- (a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

People with beta thalassaemia may experience tiredness because the red blood cells are less so fewer oxygen is been transported to the cell. This mean the red blood cell can not or don't have the capacity to transport enough oxygen.



ResultsPlus
Examiner Comments

This answer was awarded one mark for correctly stating that less oxygen would be transported. No second mark was awarded as there was no reference to muscles or respiration.

(a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

people with this condition may experience tiredness because their body needs to constantly have a good supply of oxygen and because they have fewer red blood cells they cannot carry as much oxygen so the body needs to work harder which causes fatigue.



ResultsPlus
Examiner Comments

This answer was awarded one mark for stating that less oxygen is transported. There is no mention of respiration or muscles.

(a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

- They have less haemoglobin, therefore less oxygen can be transported around the body for respiration
- Less oxyhaemoglobin as there is not enough oxyhaemoglobin for oxygen to bind to
- Less respiration, therefore less energy and more tired.



ResultsPlus
Examiner Comments

This excellent answer gained two marks. The candidate correctly refers to the reduced transport of oxygen and goes on to explain that there would be less respiration.

Question 6 (b)(i)

This question was well answered with many candidates gaining both marks. Most understood the base pair rule and that RNA contains uracil rather than thymine. A few candidates did not replace thymine with uracil and so gained one mark.

- (i) The strand of RNA used in this treatment is complementary to one strand of the DNA in the haemoglobin gene.

Give the base sequence of RNA that is complementary to this sequence of DNA.

(2)

DNA strand

A A T G G C G G C T C A

RNA strand

U U A C C G C C G A G U



ResultsPlus
Examiner Comments

This correct answer gained two marks. The candidate has shown the correct base pairing and recognised that U replaces T.

- (i) The strand of RNA used in this treatment is complementary to one strand of the DNA in the haemoglobin gene.

Give the base sequence of RNA that is complementary to this sequence of DNA.

(2)

DNA strand

A A T G G C G G C T C A

RNA strand

T T A C C G C C G A G T



ResultsPlus
Examiner Comments

This answer was given one mark. The base pairing is correct but the candidate has not replaced T with U.

Question 6 (b)(ii)

This question generated a wide range of responses. Many outstandingly accurate and detailed answers that gained full marks were seen. A significant number of answers contained detail of an A level standard that went well beyond the requirements of the International GCSE specification. Many candidates wrote well organised descriptions of 'transcription' and 'translation' using technical terms such as 'codons' and 'anticodons'. Some candidates were aware of the terminology involved in protein synthesis but did not use it accurately. For example, transcription and translation were sometimes confused. Some candidates did not state that mRNA and tRNA are involved and just referred to RNA production. Another common error was the suggestion that the RNA is made from amino acids rather than tRNA bringing amino acids to be joined together. A few candidates left the answer blank or gave vague references to ribosomes being involved in protein synthesis. In the specification, this topic is printed in bold and so can only be tested on paper 2 – candidates should ensure that they pay particular attention to emboldened topics before taking paper 2.

(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

DNA strand broken into single sugar protein strand
RNA strand messenger RNA attaches to complimentary
proteins in strand of genetically modified gene.



This answer did not gain any marks. Messenger RNA is mentioned but there is no clear indication that it has been produced from the DNA template.

(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

Transcription:

The mRNA strand. The DNA of the haemoglobin gene unwinds and unzips, allowing the RNA nucleotides to join to their complementary base pairs. Polymerase forms the sugar phosphate backbone and the mRNA strand detaches and leaves the nucleus by the nuclear pore

Translation: The mRNA strand binds a ribosome in the cytoplasm and joins to it. tRNA anti-codons attach to the ribosome if they are complementary, these anti-codons hold an amino acid. The ribosome shifts down to the next codon and repeats the process, holding it in place to allow a peptide bond to form between the amino acids. The ribosome repeats this until the stop codon is reached and detaches, leaving the polypeptide (protein)



This is an excellent answer that gained all four marks. The candidate gives a detailed, logical account of 'transcription' and 'translation' using all technical terms accurately.

(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

RNA → transcription = RNA polymerase unzips DNA

mRNA made by complementary base pairing

mRNA exits nucleus into cytoplasm

Translation = ribosome attaches to mRNA reads
each codon at a time

tRNA anticodon binds with complementary codon

tRNA has specific amino acid

amino acids form ~~protein~~ chain joined by peptide bonds

poly peptide chain folds to form protein



This is an excellent answer that gained all four marks. All mark points are present.

Question 6 (b)(iii)

This question required candidates to read the information about the use of genetic modification to treat thalassaemia and evaluate whether or not it is a better treatment than using blood transfusions. Most candidates scored at least two marks with many going on to gain three or four. Many candidates recognised that the new treatment was permanent, increased the number of red blood cells and reduced the need to keep attending hospitals. Most candidates also recognised that there were downsides to the new treatment such as the side effects, small sample size and time scale of the trial and the need to spend time in isolation. The examiners all commented on how well most candidates had answered the question – most candidates gave both sides of the argument and considered several points. Candidates have worked hard since the last series to improve their answers to these longer style questions.

Evaluate the use of the new treatment compared to weekly blood transfusions.

(4)

Despite there being serious side effects from the new treatment for beta thalassaemia in the short term, in the long term they are more free to live their lives as the treatment has permanently changed their coding. This is different to blood transfusions which are endless and require weekly ~~visits~~ visits to the hospital, this not only takes away the patient's freedom, but uses up valuable blood resources as the blood transfusion requires blood from other donors.



This answer was awarded two marks. The candidate has stated that the new treatment has side effects but reduces the long-time dependence on hospitals.



ResultsPlus
Examiner Tip

If asked to evaluate information, make sure that both sides of the argument are considered.

The new treatment shows results of improvement as an increase in red blood cells with sufficient haemoglobin so enough oxygen. It is permanent and ~~patients~~^{parents} could exercise normally while blood transfusion needs weekly treatment.

There is no chance of rejection or need for immuno suppressants as with blood transfusions. Blood transfusion also takes time, as suitable donor is needed.

However the new treatment has severe side effects which might mean that it is too dangerous and can cause death. Only two ~~patients~~ patients are used so sample size is not large enough, more tests need to be conducted. There is no information on gender, age, health, smoking, diet, etc. (Total for Question 6 = 12 marks)



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Examiner Comments

This excellent answer was awarded four marks. The candidate states that the benefits of the new treatment include the fact that more red blood cells are made, there is no risk of rejection, and there are fewer hospital visits needed. They also give negative aspects of the treatment such as the side effects and the fact that there is only a small sample size.

The new treatment produces large numbers of red blood cells with suppressed haemoglobin meaning that it succeeds to do its job, & will be blood transfusion. However, the new treatment comes with serious side effects ~~so~~ so that kept them in the hospital for 15 months. After recovering, the treatment seems to be successful as both patient successfully recovered and were able to exercise normally without feeling tired. The new treatment is more dangerous as it has some side effects but is very useful in the long run as weekly blood transfusions won't be required, this can satisfy the patient as ~~but~~ the patient can save money, ~~at~~ (not having to go every week).



ResultsPlus
Examiner Comments

This answer gained all four marks. Both benefits and drawbacks of the new treatment are considered.

Paper Summary

The general standard of answer to this paper was excellent.

Based on their performance on this paper, candidates should:

- use technical terms accurately.
- understand all the command words listed in the specification.
- ensure that they have covered all the mathematical skills listed in the specification.

Grade boundaries

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

<https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html>

