Pearson
Edexcel

Examiners' Report
June 2024

GCE Biology B 9BI0 01

ResultsPlus

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus. Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2024

Publications Code 9BI0_01_2406_ER

All the material in this publication is copyright

© Pearson Education Ltd 2024

Introduction

This paper was typical of previous 9BI01 papers with a range of questions from the frequently tested specification points and some of the less commonly tested areas. Some of the more frequently tested topics were in a similar context to the previous year although there were a few questions where candidates had to apply their knowledge to unfamiliar situations. Many questions made use of similar command words but there was a significant number of candidates who still struggled to explain data that was supplied to them.

There were a range of responses in the two levels-based questions and it was evident that some had been well prepared on how to answer these type of questions, ensuring that they made use of the data that was supplied to them. In the ten multiple choice questions, there were also a range of responses with candidates finding the identification of the type of DNA in mitochondria the most challenging.

The statutory number of maths questions were included in this paper. Many candidates demonstrated their ability to manipulate data in the maths based questions although it was noted that a significant number struggled with the calculation of an appropriate ratio when given data.

Question 1 (a)

This question was meant to be a straightforward start to the paper, testing candidates knowledge on the structure of the blood vessels. Many demonstrated that they knew that both veins and capillaries contain endothelial cells and that veins had valves but there were a significant number that got one or both of these elements incorrect.

1 Blood is pumped around the body in blood vessels to supply cells with nutrients and oxygen.

(a) Which box in each row of the table shows where endothelial cells and valves are found?

(2)

Features of blood vessels	Type of blood vessel			
	both capillaries and veins	capillaries only	veins only	neither capillaries nor veins
Endothelial cells	☒	☒	☒	☒
Valves	☒	☒	☒	☒

ResultsPlus
Examiner Comments

This response demonstrates that the candidate identified both parts of the question correctly.

ResultsPlus
Examiner Tip

Remember that all blood vessels contain endothelial cells as part of their structure.

Question 1 (b)

This question proved to be challenging to some candidates. Some who understood what was being asked in the question referred to hydrostatic pressure but did not relate this to the pressure being higher at the arteriole end, and therefore did not gain the mark. Candidates also needed to be clear that this was taking place through the capillary walls.

(b) Nutrients and oxygen pass into cells from tissue fluid.

Explain how tissue fluid is formed.

(2)

Tissue fluid is formed due to hydrostatic pressure generated by the force the heart creates when it pumps blood. Hydrostatic pressure is higher at the arteriole end of the capillary than oncotic pressure so pushes fluid small enough through gaps in the capillary walls. Plasma proteins, also generate higher pressure in capillaries.

(Total for Question 1 = 4 marks)

ResultsPlus
Examiner Comments

This is an example of a good answer. The candidate has described both marking points clearly.

ResultsPlus
Examiner Tip

Do not confuse the formation of tissue fluid which is what is formed to bathe cells with the formation of a tissue.

Question 2 (b)

This question was generally well answered with many candidates demonstrating that they had a clear idea of the differences between amylose and amylopectin. It was evident that many had been prepared well in ensuring that they also include the ways in which the two structures were similar to each other. Several candidates got the two molecules confused and they were not clear on stating the differences between the two, due to the way that their answer was constructed, not due to their lack of knowledge.

(b) Compare and contrast the structure of amylose and amylopectin.

(3)

Amylose and amylopectin both contain ∝ glucose molecule chains joined together by glycosidic bonds. They both contain 1 – 4 glycosidic bonds.
However, amylopectin has 1 – 6 glycosidic bonds as well but amylose only has 1 – 4 glycosidic bonds.
Amylopectin has branched chains but amylose is compact and is not branched.

ResultsPlus
Examiner Comments

This candidate clearly describes the differences at the start of their response, ensures that they are clear on the isomer of glucose and then goes on to make clear comparative statements.

ResultsPlus
Examiner Tip

Take care to not just describe the two molecules you are asked to compare in separated statements. Use a linking word such as 'but' or 'whereas'.

(b) Compare and contrast the structure of amylose and amylopectin. (3)

only 1/6 — STARCH — 1/4 + 1/6

• Amylose is a coiled structure whereas amylopectin is a branched structure

• amylose only contains 1,6-glycosidic bonds whereas amylopectin contains both 1,6 and 1,4-glycosidic bonds

• both amylose and amylopectin form from glucose molecules as their monosaccharide unit

ResultsPlus
Examiner Comments

This response only scored 1 of the available marks.

They got confused with the bonds present and were not specific on the monomer present in the molecules.

Question 3 (a)

This question was intended to be fairly straightforward, but candidates were not specific enough in their answers and often repeated the words "appropriate cells" that were given in the stem of the question. Some also went on to include information that was tested in the following question.

Viruses are specific ~~and at~~ due to antigens on their surface so they only invade specific host cells and therefore can only be cultured with these cells as they take over the biochemistry of the cell and use their organelles ~~eg~~ such as ribosomes to form h viral proteins and new viral particles

ResultsPlus
Examiner Comments

This response was clear enough to gain the third mark point, but did not make it clear that the virus has to bind to the host cell and the location of the antigens was vague.

3 Viruses can replicate using the lytic cycle.

Viruses can be grown in a laboratory by culturing them with appropriate cells.

(a) Explain why viruses have to be cultured with 'appropriate cells'.

(2)

If viruses are cultured with other virus cells then new strains of virus may form via ~~the~~ transmission of ~~DNA~~. Viruses require specific protein receptors on the surface of host cells that they can bind to and inject viral ~~DNA~~ DNA. Therefore appropriate cells are required for replication of viru

ResultsPlus
Examiner Comments

This response clearly demonstrates the first two marking points although the first part of their response is not relevant.

Question 3 (b)(i)

Many answered this question well and demonstrated a good knowledge of the processes that must take place inside the host cell before the number of viruses would be recorded as increasing. Unfortunately, some gave a good answer but did not relate their points to a time delay and therefore lost out on being awarded marks.

(i) Explain why the number of viruses did not start to increase until after 20 minutes.

(3)

As the ~~a~~ virus must insert its viral DNA into the host cell. Synthesise the replication of its viral DNA and viral proteins. Then it must assemble the viruses before infecting other cells. It only started to increase one the ~~a~~ new viruses lysed the host cell to infect other

ResultsPlus Examiner Comments

This response gained all the mark points and made a clear enough reference to the time delay.

ResultsPlus Examiner Tip

Make sure that you read the whole question and relate each part of the answer to the time delay.

Question 3 (b)(ii)

This question tested the ability of candidates to read data from the graph and convert them from log values. Many could read the graph accurately but then struggled with the second part of the question. Those that did both steps correctly generally also paid attention to the need to produce an answer to 3 significant figures in their final answer.

(ii) Calculate how many more viruses are present at 70 minutes than at 50 minutes.

Give your answer to **three significant figures**.

(2)

- 70 mins → 10^7 viruses
- 50 mins → $10^{5.7}$ viruses

so $10^7 - 10^{5.7} = 9498812.766$ viruses

$= 9500000$ viruses to 3 sig. figures

Answer 9500000

(Total for Question 3 = 7 marks)

ResultsPlus
Examiner Comments

In this response, the candidate has clearly laid out all their steps in the calculation.

ResultsPlus
Examiner Tip

Always include your working as, even if the final answer is not correct, you may gain some marks.

Question 4 (a)

This should have been a fairly straightforward question, but it transpires that very few candidates knew the source of the oxygen in the glucose. The command word in this question was to **name** the inorganic molecules and so if candidates wrote the formulae, they did not gain any credit.

4 Photosynthesis results in the production of GALP. This molecule is used by plants to produce glucose and other organic molecules.

(a) Glucose consists of the elements of carbon, hydrogen and oxygen.

Name the inorganic molecules that supply these elements for photosynthesis.

Carbon carbon dioxide

Hydrogen water

Oxygen carbon dioxide ~~and water~~

ResultsPlus
Examiner Comments

This response clearly demonstrates that the candidate knows the origin of the inorganic molecules.

4 Photosynthesis results in the production of GALP. This molecule is used by plants to produce glucose and other organic molecules.

(a) Glucose consists of the elements of carbon, hydrogen and oxygen.

Name the inorganic molecules that supply these elements for photosynthesis.

Carbon from carbon dioxide

Hydrogen from water

Oxygen from water

ResultsPlus
Examiner Comments

This was a typical response that only scored 1 mark.

ResultsPlus
Examiner Tip

Always read the question carefully and if the command word is to name something, then do not use shorthand.

Question 4 (c)(i)

This proved to be very challenging as candidates were expected to demonstrate the purpose of the Calvin Cycle and its contribution to growth, not simply describe it. Many also used up the answer space describing some of the stages of respiration because they recognised the name acetate. Some recognition was given in these cases, but many just gave lengthy descriptions that did not answer the question. Having said this, there were some candidates who did read all the information provided and applied their knowledge in the appropriate context.

During the light independent reaction of photosynthesis the acetate could be reduced to GALP in the Calvin cycle using NADPH and ATP. GALP can then be used to build up organic molecules such as starch for storage and cellulose for cell walls

ResultsPlus
Examiner Comments

In this response, it was clear that the candidate realised that the acetate compound was being used to make the compounds that would usually be made in the Calvin cycle. They then related their answer to the compounds being converted to those that could be used for growth.

They gained 2 marks.

Question 4 (c)(ii)

This was quite straightforward and answered well by many, but some candidates were thrown off by the mention of plant based food and the use of renewable energy, so did not gain the mark available.

(ii) The scientists hope that this technique will be able to produce plant-based food.

State **one** advantage of using this method.

Give a reason for your answer.

(1)

Plants can be grown all year round as won't be dependant on certain light levels (intensity) to grow ∴ plant growth won't be seasonal.

ResultsPlus
Examiner Comments

This response demonstrates the sort of answer required to gain credit.

(ii) The scientists hope that this technique will be able to produce plant-based food.

State **one** advantage of using this method.

Give a reason for your answer.

Better for the environment, less energy used.
Not relying on meat → no deforestation.

ResultsPlus
Examiner Comments

These might be advantages, but they do not relate to the whole question. So in this case, the candidate did not gain credit.

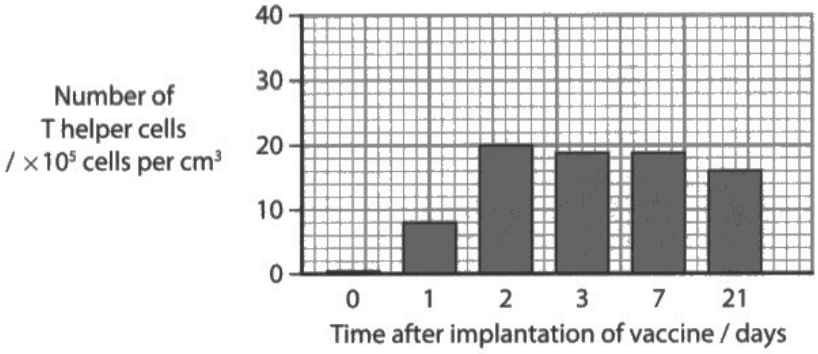
ResultsPlus
Examiner Tip

In this sort of question, think carefully about the information that you have been provided for the whole question.

Question 5 (d)(i)

There was a range of responses seen to this question with many demonstrating that they had a good understanding of the specific immune response, but full marks were only gained if candidates related the points that they made to the data given. In order to do well in this question, it was also necessary to read the information above the graph which some failed to do and therefore their answer was not always given in the correct context.

(i) The graph shows the number of T helper cells in the lymph nodes that drain the part of the body where the vaccine was implanted.



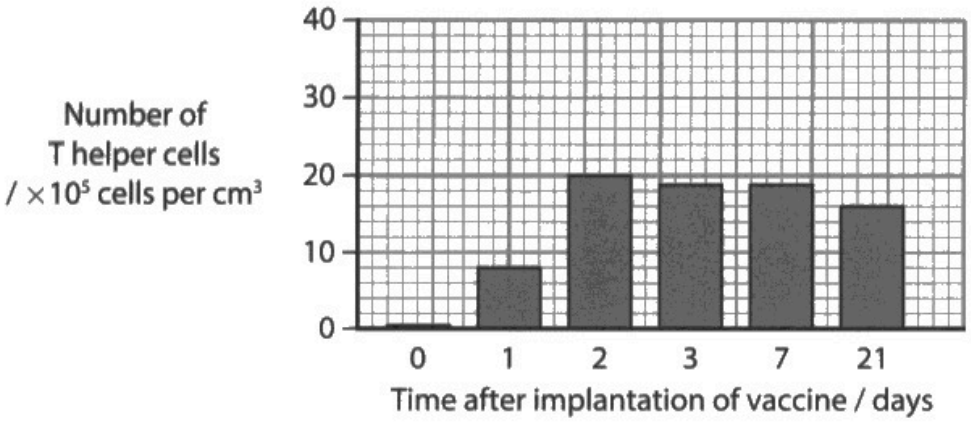
Explain the results shown in the graph.

(3)

- On the day 0, no/barely any T helper cells present as the macrophages haven't detected the bacterial antigen yet meaning they have T-Helper cells haven't been activated.
- Day 1, there is a major increase as the macrophages have engulfed the antigens in phagocytosis and a T-helper cell complementary to the antigen displayed on the surface of the macrophage has binded to it and become activated, hence dividing by mitosis to form more identical T-helper cells
- Day 2, T-helper cell number more than doubled from day 1 as more T helper cells produced from mitosis.
- Day 3 to 21, the number decreases as no more T-helper cells made by division and the lymph fluid is transported into the blood, which reduces the number of T-helper cells in the lymph node.

ResultsPlus
Examiner Comments

This response gained full marks. The candidate clearly relates their answer to the data provided.



Explain the results shown in the graph.

(3)

The number of T-helper cell increase from day 0 to 1 and day 1 to 2, following which it plateau's. This suggests that MRSA does attract Macrophages which become Antigen Presenting Cells so that T-helper cells can bind to activate thus allowing T-memory cells with the antibodies to E. Coli. or S. aureus form.

ResultsPlus
Examiner Comments

This response scored 0 marks. There is a reference to the data at the start, but their explanation has no time reference.

ResultsPlus
Examiner Tip

Look to the number of marks on offer for 'explain' questions and then try to use make the same number of points in your answer, clearly referencing the data.

Question 5 (d)(ii)

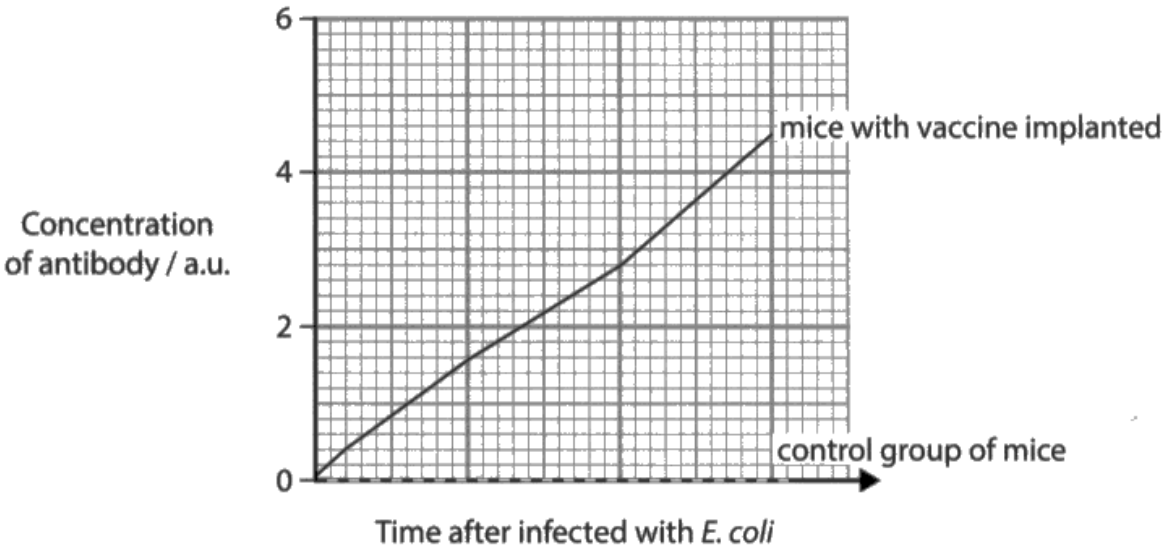
This question was answered better than Question 5(d)(ii) with many candidates demonstrating a clear understanding of the difference between the primary and secondary immune response.

(ii) In part of this investigation, mice had the vaccine implanted 35 days before being infected with *E. coli*.

A control group that had not received the vaccine was also infected with *E. coli*.

The levels of antibody in the blood of both groups of mice were determined.

The graph shows these results.



Explain the results shown in the graph.

(3)

Mice with vaccine has memory B cells and memory ~~which with~~ rai T cells, to with reinfection, rapidly was able ho duvide into an~~te~~ B effector cell, differentiate to a plasma cell and produce the antibodies. It was a secondary immune response so was rapid at releasing antibodies. Control group had to start a primary specific immune response which takes much longer. Control group of mice produced no antibodies, mice with vaccine produced antibodies quickly after infection

(Total for Question 5 = 10 marks)

ResultsPlus
Examiner Comments

This response gained all the possible marks and clearly explained the rapid increase in antibody production.

ResultsPlus
Examiner Tip

There is no specific time period defined on the x axis but when time is mentioned, it is expected that candidates will realise that one response is much quicker than the other.

The graph shows that mice that had the vaccine implanted prior had higher concentration of antibodies present as time increased in comparison to the control group of mice with no antibodies. This is because the mice with the vacline is going through the second infection stage as the vacine initiated the humoural response which produced antibodies and T memory cells. The T memory cells, on second infection, rapidly produced antibodies for the antigen. The control group of mice is going through the first humoural response which takes days to produce plasma/antibodi

(Total for Question 5 = 10 marks)

ResultsPlus
Examiner Comments

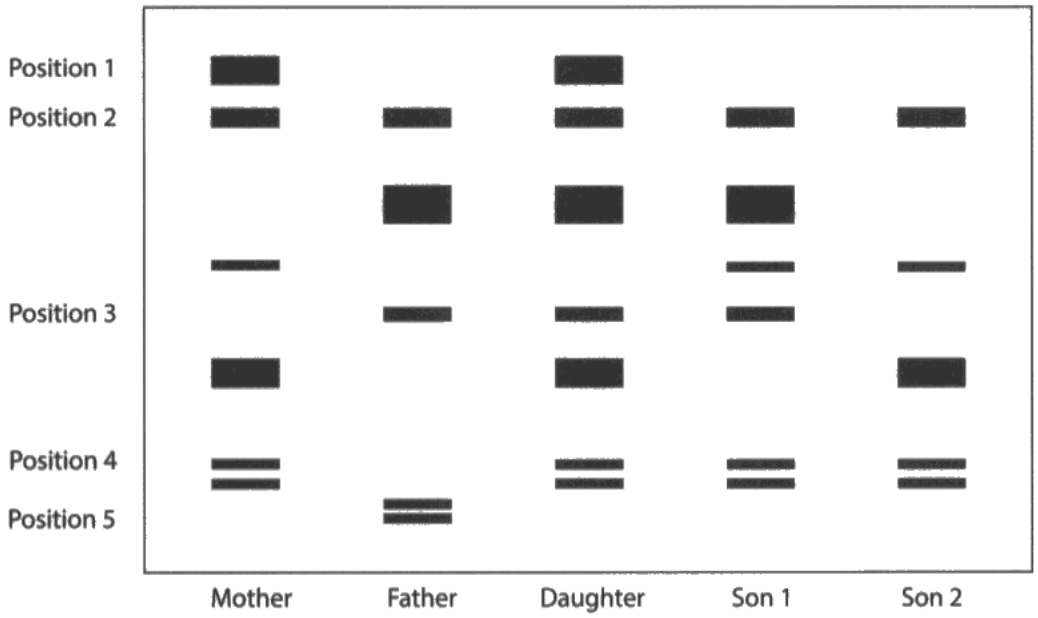
This response gained 1 mark for the presence of memory cells in the vaccinated mice, but did not use appropriate terminology to gain any more marks

Question 6 (c)

A good number of candidates answered this question well enough to score three of the four available marks by explaining positions 1-3. There was only a small number that related the positions of bands 4 and 5 to the mitochondrial DNA. As this question was about analysing the data provided, there was no credit for describing the process of electrophoresis and if their answer did not make it clear that they knew the bands were DNA, then they did not get credit.

(c) Gel electrophoresis can be used to analyse the DNA of a person.

The diagram shows some of the bands produced when the DNA of a family was analysed using gel electrophoresis.



Analyse the information to explain the bands found at positions 1 to 5 in this family.

(4)

- Position 1: Bands at position 1 are only found in mother or daughter, thus DNA may be specific to women
- Position 2: Bands at position 2 found in all members of family, so all have same base length for this section of DNA
- Position 3: Bands at position 3 found in father, daughter and son 1. Son 2 may not share these alleles due to independent assortment (random assortment of maternal and paternal chromosomes)
- Position 4: Bands at position 4 found in all members of family other than father, so children inherit this DNA from their mother (could be mitochondrial DNA)
- Position 5: Band at position 5 only found in father

ResultsPlus
Examiner Comments

In this response, the candidate gained all the marks on offer by clearly explaining the positions of bands 1-4.

(4)

- Each individual has unique DNA sequences, due to differences in the number of repeats in each micro-satellite region, causing different sized
- Bands will accumulate fragments. The DNA fragments move towards the positive electrode when a current is applied, due to S-phosphate groups being present. Smaller fragments have less resistance in the agarose gel, so move further. Position 1 has smallest DNA fragments, 5 has largest.
- Each one of the bands in the children can be matched to a band of the parent, since each child will inherit one micro-satellite region in homologous pairs of chromosomes from each parent.
- Fragments in position 5 show base sequences present only in the father
- Fragments in position 2 shows a base sequencing, and short tandem repeat shared by all individuals.

ResultsPlus
Examiner Comments

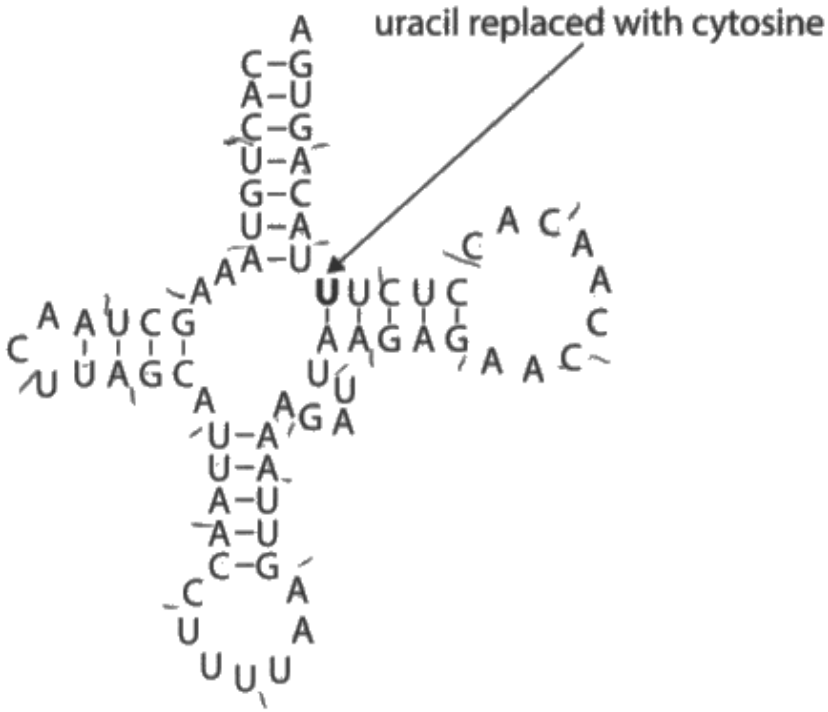
In this response the candidate scored 1 mark at the end of their response. They wrote irrelevant information about the electrophoresis process in the first part of their response.

Question 6 (d)(i)

Many named this type of mutation correctly although there were incorrect answers. An example of a common incorrect answer was the use of the term point mutation, which was not specific enough to get the mark.

(d) A mutation in the $tRNA^{Lys}$ gene in the mitochondria replaces one uracil with a cytosine in the resulting tRNA molecule.

The diagram shows the position of the uracil that is replaced with cytosine in a $tRNA^{Lys}$ molecule.



(i) Name this type of mutation.

Substitution.

ResultsPlus
Examiner Comments

This response demonstrates a clear answer to the question posed.

Question 6 (d)(ii-iii)

Question 6(d)(ii): This question proved challenging for many and some were thrown by the use of the word 'structure' and got confused with protein synthesis. There was a good number that correctly identified the lack of the formation of hydrogen bonds and the impact that this would have on the structure.

Question 6(d)(iii): This part of the question also proved to be challenging because candidates were not specific enough in their answer and often failed to use key words such as anticodon or state where the amino acids were being taken to. The mark scheme expected paired statements and often candidates showed that they had an understanding of the process, but gained one point from a paired statement.

(ii) Explain how this mutation could affect the structure of the $tRNA^{Lys}$ molecule shown in the diagram.

(2)

As uracil has been substituted with cytosine, it cannot form a bond with adenine (A). As it cannot form a bond with A, it cannot create the structure of $tRNA^{Lys}$ as the hydrogen bonds cannot form.

(iii) Explain how this mutation could affect the role of the $tRNA^{Lys}$ molecule.

(2)

As the hydrogen bonds cannot form, the shape of tRNA cannot be made and therefore it's a different shape. As it is a different shape it cannot attatch to the corresponding amino acid and cannot carry out its function of carrying an amino acid to the ribosome to make a polypeptide.

ResultsPlus
Examiner Comments

In this response, the candidate scored full marks for both of the question parts.

(ii) Explain how this mutation could affect the structure of the $tRNA^{Lys}$ molecule shown in the diagram.

(2)

- Changes primary structure so tertiary structure will change and ~~to the active site~~ amino acid binding site will change as protein will fold differently

~~- causes frame shift~~ - Anti codon changes shape

(iii) Explain how this mutation could affect the role of the $tRNA^{Lys}$ molecule.

(2)

- Tertiary structure changes as primary structure affected, so the amino acid binding site will change and will no longer be complimentary to Lys and won't be able to attach to mRNA codon as the anticodon of $tRNA^{Lys}$ will have folded differently and will no longer be ~~compli~~ complimentary.

(Total for Question 6 = 11 marks)

ResultsPlus
Examiner Comments

This candidate got confused with protein structure in the first part, but managed to gain a mark for describing that the anticodon would not bind to the codon on the mRNA.

Question 7 (a)(i)

This was quite well answered with many candidates recognising that they needed to refer to glycolysis. Fewer went into sufficient detail to gain both marks.

These birds all have mitochondria in their red blood cells.

(a) More than 90% of ATP is produced by mitochondrial respiration.

(i) Describe how the remaining ATP is produced.

(2)

In glycolysis in the cytoplasm, glucose is phosphorylated to phosphorylated 6C sugar. ~~This~~ Then into glycerate 3 phosphate to pyruvate, this produces ATP by substrate level phosphorylation. ADP + Pi → ATP

ResultsPlus
Examiner Comments

This response includes all of the available mark points.

Question 7 (a)(ii)

In this question, candidates were expected to apply their knowledge of the role of protons in respiration. A good number demonstrated this, but did not make it clear that the rate at which they moved through the ATP synthase would be slower. Some demonstrated knowledge but could not gain credit as they stated that there would be no concentration gradient and no ATP generation.

(ii) In the mitochondria, ATP is synthesised on the inner mitochondrial membrane.

Leakage of protons (H^+) across the inner mitochondrial membrane reduces ATP synthesis and generates more heat. This is called leaked respiration.

Explain why leakage of protons reduces ATP synthesis.

(3)

The protons cannot accumulate as well in the intermembrane space as they leak. This means the electrochemical gradient is lower and protons move less frequently or move slowly down ATP synthase. This would have the effect of reducing ATP as less ADP + pi can be ~~phosphorylated~~ phosphorylated and turned into ATC. Furthermore less electrons would be moving in the Electron transport chain, overall reducing levels of ATP synthesis

ResultsPlus
Examiner Comments

This response gained full marks.

• leakage of H^+ means less H^+ available for chemiosmosis

of H^+ from mitochondrial matrix to mitochondrial membrane

• so, less H^+ to move through ATP synthase in membrane

• so, less energy for synthesis of ATP from ADP and Pi available

• so, less ATP produced from ETC

ResultsPlus
Examiner Comments

In this response, the candidate said enough for mark point 3 only.

Question 7 (b)(i)

Many calculated the magnification correctly, but some did not measure carefully enough or divided the bird size by the size of the image instead.

(i) Calculate the magnification of the photograph of the blue tit.

Measure from the top of the head to the tip of the tail.

(1)



$\frac{4.1}{12} = 0.34x$

Answer 0.34x

ResultsPlus
Examiner Comments

This candidate has included their working and written the correct answer in the answer space provided.

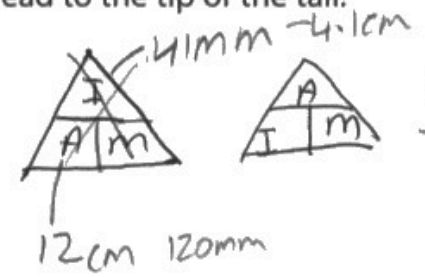
ResultsPlus
Examiner Tip

Take time to measure any images as carefully as you can.

(i) Calculate the magnification of the photograph of the blue tit.

Measure from the top of the head to the tip of the tail.

(1)



120 mm / 41mm = 2.927
2.93

Answer X 2.93

ResultsPlus
Examiner Comments

This candidate measured the image correctly, but did the calculation incorrectly.

Question 7 (b)(ii)

This was poorly answered, suggesting that many candidates need to work on the calculation of ratios when given information. Many used the correct information but did not give the simplest ratio or give the ratio the correct way round.

(ii) Calculate the length from head to tail : mass ratio for the **great tit**.

Give your answer to **one decimal place**.

(1)

14 : 18

0.7777... : 1

: 1

0.8

Answer 0.8 : 1

ResultsPlus
Examiner Comments

This is an example where the candidate has completed the calculation correctly.

(ii) Calculate the length from head to tail : mass ratio for the **great tit**.

Give your answer to **one decimal place**.

(1)

14 : 18

1 : $\frac{9}{7}$

1 : 1.25

Answer 1 : 1.3

ResultsPlus
Examiner Comments

Many candidates gave this as their answer.

ResultsPlus
Examiner Tip

When asked to calculate a ratio, the part that is second in the ratio (in this case, mass) should have 1 as its value.

Question 7 (c)(i)

This was a fairly straightforward question with a range of responses. Many were able to gain one mark, but did not relate their answer clearly to the investigation that was being carried out.

(i) Explain why well-stocked bird feeders containing nuts were available throughout this investigation.

(2)

So the birds were able to obtain enough food. So they would all have enough glucose concentration to use for respiration. The glucose is not a limiting factor in the rate of respiration of mitochondria. Therefore the rate of respiration was a valid way to show if any heated respiration occured and the investigation on the generation of heat was valid.

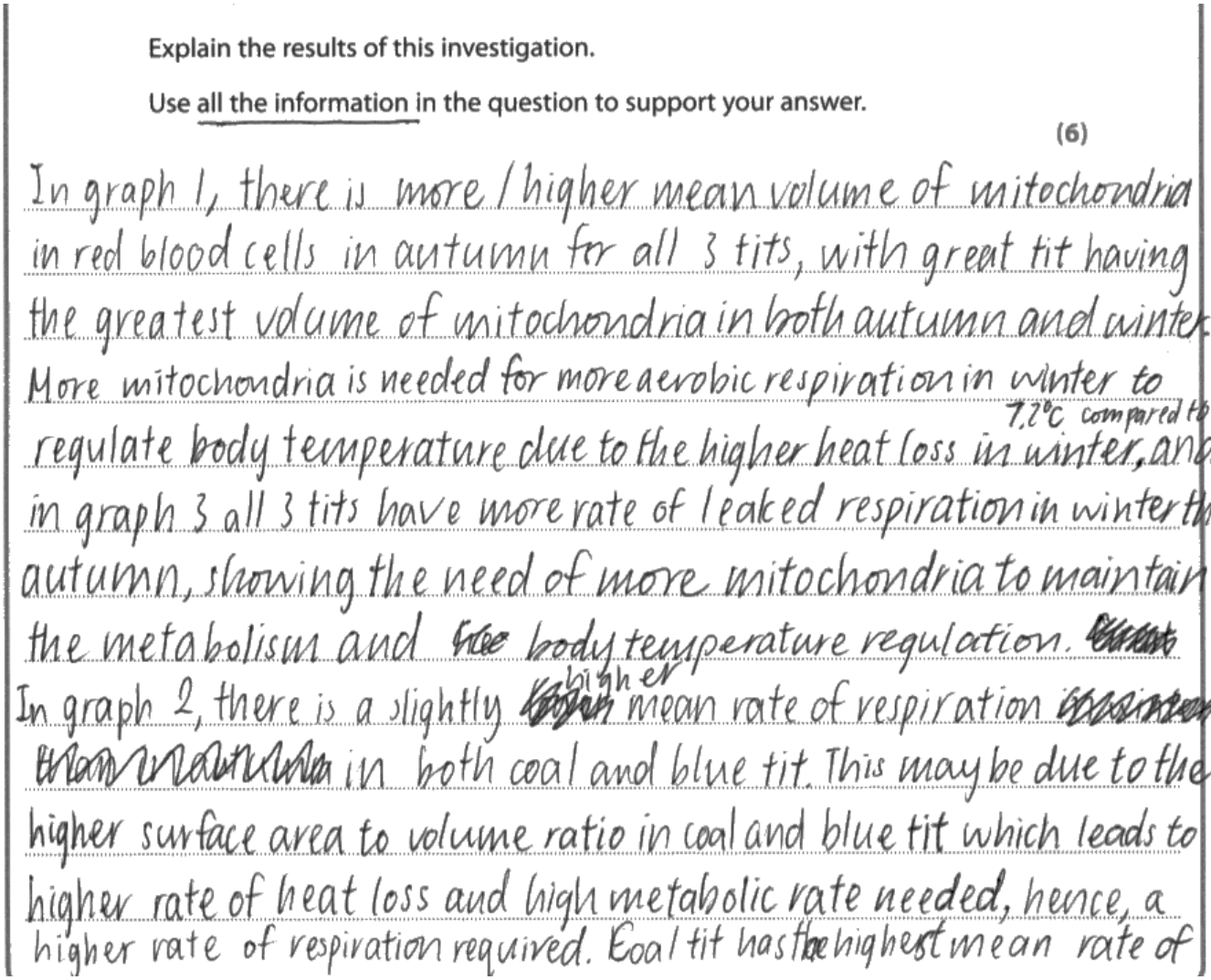
Respiration generats heat, so diffrent amounts of glucose means different rates of respiration so diffrent amounts of heat would be produced.

ResultsPlus
Examiner Comments

This response includes all 3 of the available marks.

Question 7 (c)(ii)

In this question, there were three graphs and many candidates realised that they needed to refer to all of them in their answer. However, some spent two long describing and/or explaining the first graph and therefore restricted their answer to a Level 1 response. To gain access to the highest level, candidates needed to explain at least two of the graphs but also make reference to the error bars or lack of them. They also needed to refer to the significance of the seasons and the size of the birds



Explain the results of this investigation.

Use all the information in the question to support your answer.

(6)

In graph 1, there is more / higher mean volume of mitochondria in red blood cells in autumn for all 3 tits, with great tit having the greatest volume of mitochondria in both autumn and winter. More mitochondria is needed for more aerobic respiration in winter to regulate body temperature due to the higher heat loss in winter, 7.2°C compared to 10.7°C and in graph 3 all 3 tits have more rate of leaked respiration in winter than autumn, showing the need of more mitochondria to maintain the metabolism and ~~the~~ body temperature regulation. ~~Blue~~ In graph 2, there is a slightly ~~higher~~ higher mean rate of respiration ~~in~~ than in both coal and blue tit. This may be due to the higher surface area to volume ratio in coal and blue tit which leads to higher rate of heat loss and high metabolic rate needed, hence, a higher rate of respiration required. Coal tit has the highest mean rate of

respiration out of the 3 birds however the difference is insignificant due to the overlapping error bars between winter coal tit and autumn blue tit. While there is also no significant difference between the rate of respiration in autumn and winter in the 3 birds as error bars overlap, while there is completlely no difference between autumn and winter in coal tit. In graph 3, the higher rate of leated respiration in winter in all 3 birds also explains why there is a lower respiration rate in winter despite with more mitochondria.

(Total for Question 7 = 15 marks)

However, there is no error bar or standard deviation calculated, the data in graph 3 may be invalid. There is also a lack of data to explain the sample size of each species of birds and the health condition of each birds as there may be higher respiration rate due to age, sex difference and caused by other health conditions.

Mitochondria is the site of aerobic respiration with ETC and ATP synthase in the inner-membrane for oxidative phosphorylation to produce ATP as NADH and FADH are reduced to release e^- and H^+, which H^+ accumulates in the intermembrane space to synthesis ATP when passing through ATP synthase.

Despite having a lowest mitochondria volume, coal tit has the highest rate of respiration of ATP produced may be due to anaerobic respiration and production of ATP in glycolysis in the cytoplasm.

ResultsPlus
Examiner Comments

This response gained full marks although there is some irrelevant detail at the end.

Explain the results of this investigation.

Use all the information in the question to support your answer.

(6)

Graph 1:

- Great tit has the most mitochondria in blood cells, especially in winter
- Coalt tit has the lowest mitochondria in blood cells especially in autumn.
- Great tit produces more mitochondria when it' colder. (more division)

Graph 2:

- mean rate of respiration is similar in all 3 tits
- However in Coalt is highest ~~meaning that there is data~~ • Great tit has the same mean in autumn and winter.

Graph 3:

- meant rate of leaked respiration is higher in Coalt tit
- it's lower in Great tit.
- overall the Coalt tit is the healthiest

Graph 1:

in Calt tit only 30%/40%

as ATP is produced by mitochondria.

(Total for Question 7 = 15 marks)

ResultsPlus
Examiner Comments

This candidate has only included a description of each graph and so their answer is limited to 2 marks

Question 8 (a)

The key to this question was the timing of the acrosome reaction. Unfortunately, many candidates demonstrated their knowledge of the enzymes and what they did but did not relate this to timing, and so gained no credit. Few gained the last point regarding what would happen if the acrosome reaction was taking place too late.

8 Changes must occur to mammalian sperm cells as they pass through the female reproductive tract, if successful fertilisation is to take place.

Capacitation results in changes to the sperm cell membrane and increased motility.

The acrosome reaction (AR) must follow capacitation but not too soon nor too late.

(a) Explain why the timing of the AR is important for successful fertilisation.

(3)

The AR must not be before capacitation as the sperm membrane will not be ready to fuse with the cell membrane of the oocyte and the AR would cause a release of hydrolytic enzymes too early before it is needed to digest the zona pellucida so there will be no hydrolytic enzymes left when the oocyte is reached. If the AR happens too late, the sperm will have died before it manages to digest its way through the zona pellucida. The AR is required to reach the nucleus of the ovum to break down the jelly-like zona pellucida using hydrolytic enzymes

ResultsPlus
Examiner Comments

This is an example of a response where the candidate addressed all 3 mark points clearly in their answer.

ResultsPlus
Examiner Tip

Read the question carefully. Don't be tempted to see a key word and then write what you know about it without putting it into the context of the question.

8 Changes must occur to mammalian sperm cells as they pass through the female reproductive tract, if successful fertilisation is to take place.

Capacitation results in changes to the sperm cell membrane and increased motility.

The acrosome reaction (AR) must follow capacitation but not too soon nor too late.

(a) Explain why the timing of the AR is important for successful fertilisation.

(3)

The ~~acroso~~ AR timing is important as when the digestive enzymes are released can determine if the egg gets fertilized. Too early and the AR misses the egg as the sperm has not reached it yet. Too late and the sperm was killed before the AR could take place.

ResultsPlus
Examiner Comments

The candidate has gained the third mark point, but not linked their point on the enzymes to the acrosome reaction taking place too early.

Question 8 (b)

This question challenged candidates in terms of the information that they needed to assimilate and in terms of the instructions as to how they were meant to complete their answer. It is always important to read all the information provided and to try to give a complete answer when filling out grids or multiple choice questions.

(b) A protein is involved in the timings of capacitation and the AR.

This protein exists in two forms: protein G and protein G-P.

Protein G-P results in the stimulation of capacitation and protein G results in the inhibition of the AR.

Protein G-P is located in the midpiece (neck) and flagellum of the sperm.

Protein G is located in the head region of the sperm.

The levels of these two forms of protein change just before capacitation, during capacitation and just before the AR.

Complete the table to show which form of protein is present and which is absent.

If the protein is present put a tick (✓) in the box and if the protein is absent put a cross (✖) in the box.

(4)

Event	Presence of protein G		Presence of protein G-P	
	Head region	Midpiece and flagellum	Head region	Midpiece and flagellum
Just before capacitation	✓	X	X	✓
During capacitation	✓	X	✓	✓
Just before the AR	X	X	X	✓

ResultsPlus
Examiner Comments

This candidate has read the information and the instructions carefully and gained 3 out of the 4 available marks.

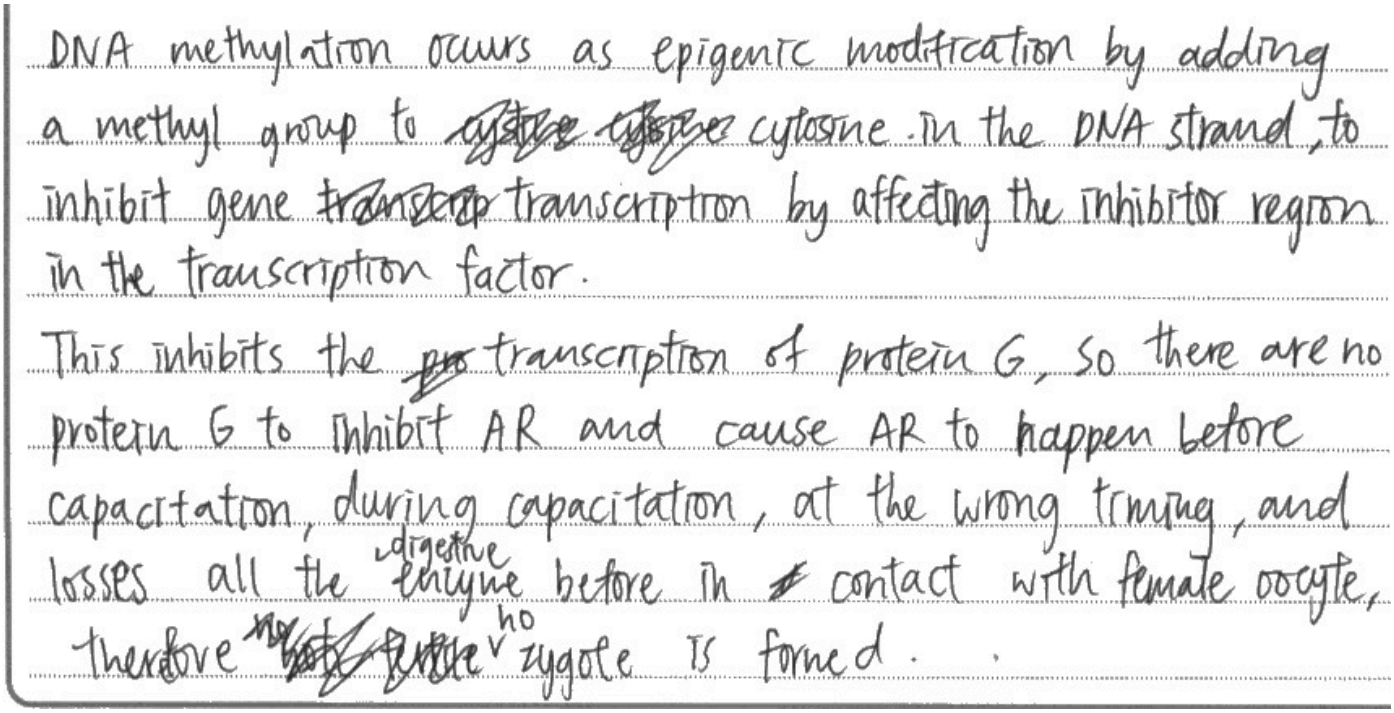
Event	Presence of protein G		Presence of protein G-P	
	Head region	Midpiece and flagellum	Head region	Midpiece and flagellum
Just before capacitation	✓			✓
During capacitation		✓	✓	
Just before the AR		✓	✓	



This candidate has not completed all boxes and so could not gain any marks.

Question 8 (c)

Many candidates were able to pick up at least one of the marking points here, but it was surprising that so few made the link to epigenetic modification in their answer. Again, marks were not obtained if the candidate had not made their answer specific to the question being asked. A number used the whole answer space to include detail on how the gene would be switched off but would usually only gain the first mark point.


DNA methylation occurs as epigenic modification by adding a methyl group to ~~cytose~~ ~~cytose~~ cytosine in the DNA strand, to inhibit gene ~~transcrip~~ transcriptron by affecting the inhibitor region in the transcription factor.

This inhibits the ~~pro~~ transcription of protein G, so there are no protein G to inhibit AR and cause AR to happen before capacitation, during capacitation, at the wrong timing, and losses all the digesthe enzyme before in ≠ contact with female oocyte, therefore ~~no~~ ~~not~~ ~~female~~ no zygote is formed.

ResultsPlus
Examiner Comments

This response was given credit for epigenic modification and therefore also gained full marks. It is included here because they have given a good example of how mark points 3 and 4 could be achieved.

ResultsPlus
Examiner Tip

Always relate the material that you have covered in the course to the context of the question.

(c) In some infertile males, the gene coding for protein G is methylated.

Explain why DNA-methylation of this gene could result in infertility.

(3)

Methylation results in the silencing of this gene. Without protein G being produced, AR is not inhibited, ~~so~~ meaning it can occur at any point before or during capacitation. Its digestive enzymes are therefore all exhausted before reaching the egg. It cannot digest the zona pellucida and fertilise the egg.

ResultsPlus
Examiner Comments

This response clearly relates DNA-methylation to the context of the question and although they did not mention epigenetic modification, they gained the other 3 mark points.

Question 8 (d)(i)

Surprisingly here many reused the work 'knockout' in their answer which meant that a significant number of candidates repeated the stem of the question. As the question also stated, they needed to relate their definition to the context of the question which was what the second mark point was aimed at.

(d) Scientists have used 'knockout' mice to investigate the effect of protein G on fertility.

(i) State the meaning of the term 'knockout' mice, as used in this context.

(2)

mice who have had certain genes silenced in order to investigate the effect of something.

ResultsPlus
Examiner Comments

The candidate has not made their answer specific to the context and therefore would not gain any credit. They have also not defined the term 'knockout' and therefore gained no marks.

(d) Scientists have used 'knockout' mice to investigate the effect of protein G on fertility.

(i) State the meaning of the term 'knockout' mice, as used in this context.

(2)

· Genetically modified mice which have had the gene that codes for protein G methylated, silenced, to investigate the infertility of those G M- mice.

ResultsPlus
Examiner Comments

This answer has demonstrated that they understand the meaning of the term and explained it in the context of the question.

Question 8 (d)(ii)

This question tested candidates skills on what should be considered in an experiment to test the fertility of these mice. They were expected to think about the other factors that could affect fertility such as ensuring that the females were fertile, of breeding age and had an appropriate diet. They also needed to give consideration to how fertility could be measured and there were some interesting answers such as testing fertilised eggs and the number of eggs laid. Candidates that scored highly here had included something such as counting the successful pregnancies or offspring produced and comparing this value with a control group.

Female mice should be all fertile and placed with males in pairs to know who has bred with who. The offspring should then be bred with ~~eachot~~ another group to see if fertility has been effected.

ResultsPlus
Examiner Comments

This response gained a mark for the use of fertile females but got confused as to how the experiment should be conducted.

(ii) In an investigation, female mice and 'knockout' mice were housed together.

Describe how this investigation should be designed to confirm that protein G affects fertility.

(3)

All the female mice must be tested to make sure they are all fertile. Some of the knockout mice should ~~be the~~ produce & have their gene for protein G switched off and some should have the gene switched on. Do the female mice that reproduced with the male mice, which had the gene ~~for~~ coding for protein G switched off, didn't get pregnant, while the others did, then protein G affects fertility

ResultsPlus
Examiner Comments

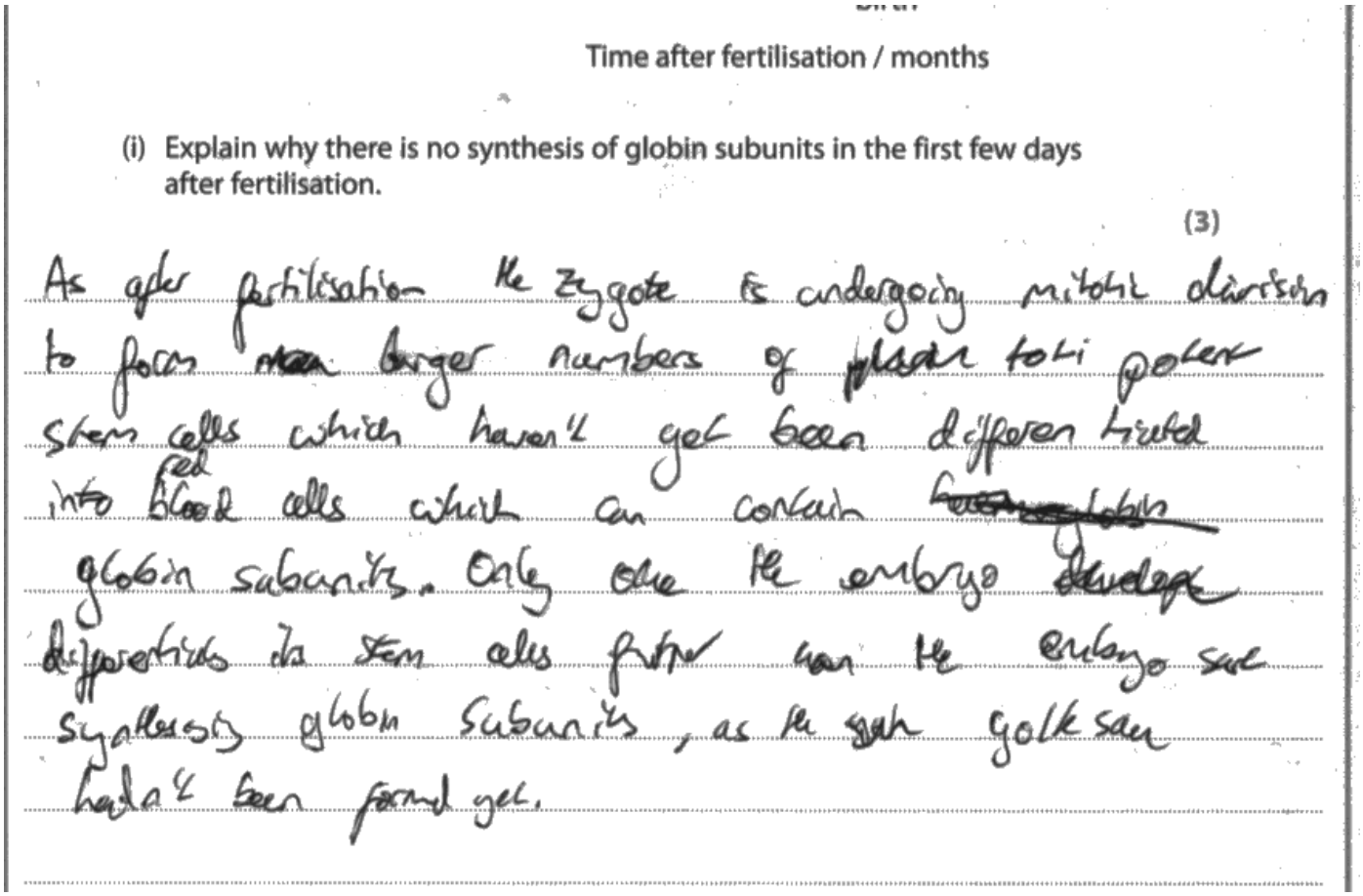
This is a good example of a response that gained full marks.

ResultsPlus
Examiner Tip

Read the question carefully to determine the independent and dependent variables in the design of an experiment and make sure you include them in your answer.

Question 9 (a)(i)

There was a range of responses to this question with many candidates demonstrating that they knew what must be taking place. It was felt that those candidates that only gained some of the available marks, did not study the graph carefully enough before answering the question but those that did would gain the mark relating to the yolk sac.



Time after fertilisation / months

(i) Explain why there is no synthesis of globin subunits in the first few days after fertilisation.

(3)

As after fertilisation the zygote is undergoing mitotic divisions to form larger numbers of pluripotent stem cells which haven't yet been differentiated into red blood cells which can contain globin subunits. Only once the embryo develops differentiates its stem cells further can the embryo start synthesising globin subunits, as the yolk sac hasn't been formed yet.

ResultsPlus
Examiner Comments

This candidate has clearly explained what is taking place following fertilisation and gained full marks.

In an embryo all cells are totipotent and first they must divide and differentiate to the blastocyst stage. Then epigenetics will continue to occur, such as DNA methylation, leading to the formation of somatic cells such as cells for the synthesis of globin subunits. It takes time for the DNA for globin subunits to be epigenetically modified and then transcribed and translated to produce them. After fertilisation Mitosis is occurring to increase the number of cells and allow cleavage to occur and the blastocyst to form.

ResultsPlus
Examiner Comments

This response scored mark point 2 from the mark scheme, but was not clear enough in their response to gain any other marks.

ResultsPlus
Examiner Tip

If there is data given, make sure you study it before answering the question.

Question 9 (a)(ii)

This question proved challenging to candidates with many simply describing the data. The emphasis here was on giving conclusions but good answers were able to conclude which structures were responsible for each type of globin.

(ii) Analyse the data to describe conclusions that can be made about globin subunit synthesis during the 14 months following fertilisation.

(4)

Beta globin is synthesised the most after birth and is required in child haemoglobin. Gamma globin synthesis decreases after birth and is only required in foetal + embryo haemoglobin, not in a child. Epsilon globin synthesis rapidly decreases after an initial high after a few days and is not required in the fetus, only the embryo. Gamma globin is present throughout, embryo, fetus and child. Delta globin is synthesised the least and is present in the fetus and a child slowly increasing in synthesis. beta globin is synthesised in the bone marrow. Gamma globin is mostly synthesised in the liver. Epsilon is synthesised in the yolk sac. Delta globin is synthesised in the bone marrow.

ResultsPlus
Examiner Comments

This response has some description in the middle but there is a clear conclusion at the start of their answer and reference to the different structures and the types of globin they are responsible for at the end.

• epsilon must be synthesised from yolk sac as stops producing globin first. Delta must be produced from spleen as only max. 4% globin subunits synthesised so is smaller structure. gamma must be synthesised from liver as after birth it falls to 4% as foetus starts using own circulatory system instead of relying on placenta to obtain oxygen. Foetal haemoglobin must be made before the child is born. Beta is highest after birth so must be synthesised in bone marrow as in an adult, stem cells are found in bone marrow and haemoglobin is synthesised here in adults and all other subunits (gamma, ~~epsilon~~ delta) fall after birth.

ResultsPlus
Examiner Comments

An example of another response that gained full marks. This may seem a little descriptive but they have used the data and said what they can conclude from it.

Most of the globin subunits were synthesised in the liver or bone marrow, with the yolk sac only synthesising at the beginning and the spleen synthesising whilst the liver and bone marrow are. The delta subunit is very slow to be synthesised and only 4% is synthesised during the 14 month period. Epsilon is very quickly synthesised at 64%. after the first few days, but it drops rapidly to 0 after 2 months. The gamma and beta subunits had a higher % synthesised. The gamma subunit rose after the first few days to almost 100%, before dropping down to 2% over the 14 months. The beta subunits were constantly synthesised, meaning that they started slowly then increased to almost 100%.

ResultsPlus
Examiner Comments

This response gained 0 marks. The candidate was not specific about the type of globin being synthesised and the rest of their response is simply a description of the data.

ResultsPlus
Examiner Tip

In a question that asks for conclusions, do not simply just describe the data. You need to think, "what is the data telling me?".

Question 9 (a)(iii)

Many candidates could read the values off the graph correctly, but some then divided their answer by the incorrect value. There were some who generated the correct answer but did not give it to 2 decimal places or failed to include the correct units and so missed out on the second mark.

(iii) Calculate the rate of decrease in percentage of gamma globin subunit synthesis from 7.6 to 10 months after fertilisation.

Give your answer to **two decimal places** with appropriate units.

(2)

~~B~~

84% to 32%

84 - 32 = 52

10 - 7.6 = 2.4

7.6 months = 84%

10 months = 32%

$\frac{84-32}{10-7.6} = \frac{52}{2.4} = 21.666$

Answer 21.67%/month

ResultsPlus
Examiner Comments

This candidate has clearly shown their working and given their answer to 2 decimal places and included the correct units.

(2)

32
84

$84 - 32 = 52$

$10 - 7.6 = 2.4$

$\frac{52}{2.4} = 21.6\dot{6}$

21.67

Answer 21.67

ResultsPlus
Examiner Comments

This candidate has the correct working but only scored 1 mark because they omitted the units from their answer.

Question 9 (b)(i)

Many candidates were able to calculate the ratio correctly although some did not read the instructions carefully enough and did not calculate the number of people without SCD, so their ratio was incorrect.

(i) There are approximately 67 million people in the UK, 15 000 of these people are affected by SCD.

Calculate the ratio of the number of people **without** SCD to the number of people **with** SCD in the UK.

Express your answer in **whole numbers**.

(2)

66985000 : 15000) ÷15000

4465.67 : 1

4466 : 1

Answer 4466 : 1

ResultsPlus
Examiner Comments

This candidate has shown their working clearly and placed the final ratio in the answer space provided.

$\frac{67000000}{15000} = 4466.6 = 4467:1$

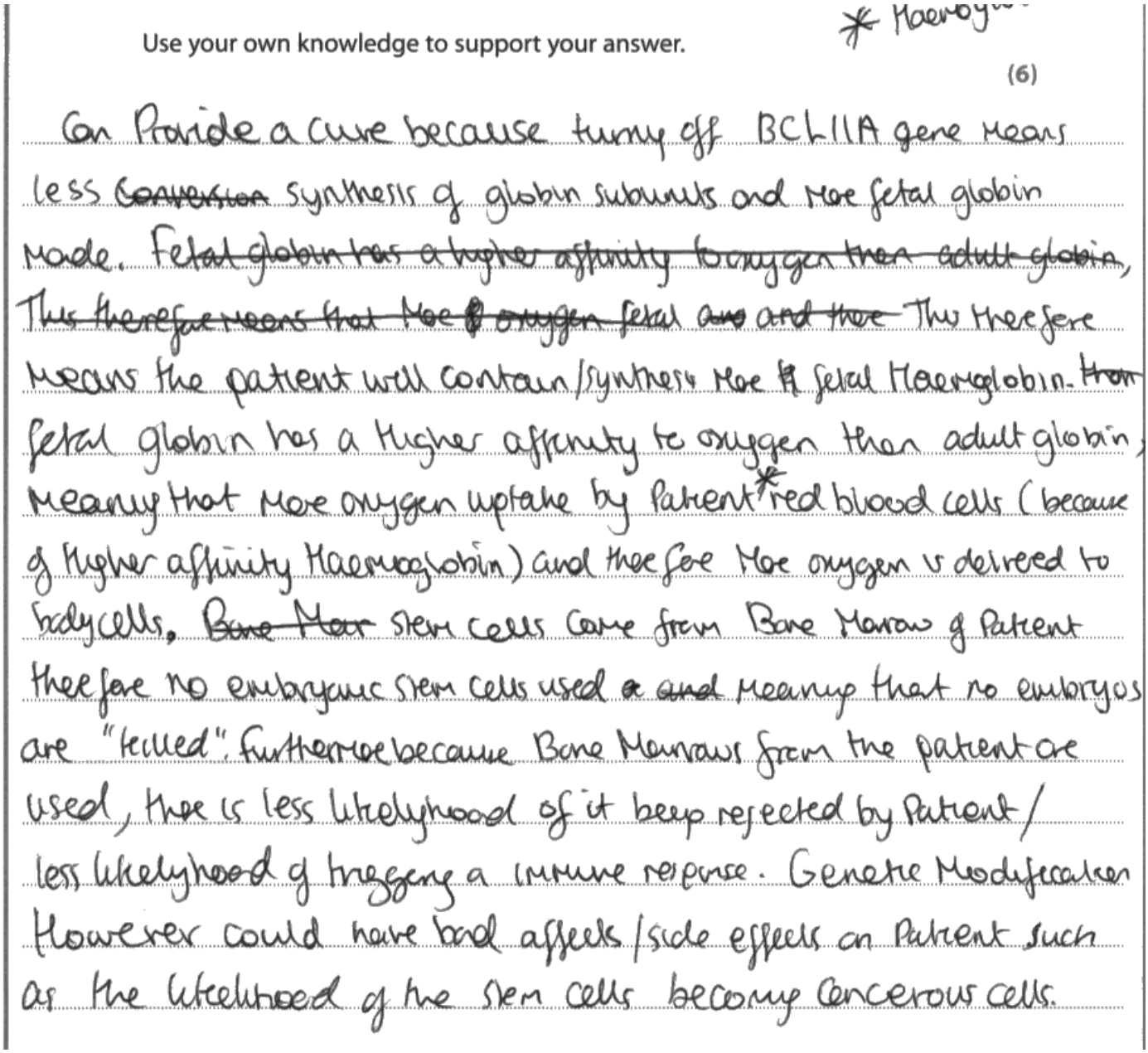
Answer 4467:1

ResultsPlus
Examiner Comments

Unfortunately, the candidate has calculated the incorrect ratio and therefore scores 0 marks.

Question 9 (b)(ii)

This question has a wide range of responses and many candidates demonstrated a good understanding of SCD but were limited in their score because they did not refer to the information that was given to them in the previous part of the question. There was also a fair few that saw the word 'ethics' in the question and then concentrated their answer on this aspect of the question which limited them to Level 1. A good answer needed to demonstrate an understanding of SCD, how the stem cells were being modified and the implications of using stem cells from the patient.



Use your own knowledge to support your answer.

(6)

Can Provide a cure because turning off BCL11A gene means less ~~Conversion~~ synthesis of globin subunits and more fetal globin made. ~~Fetal globin has a higher affinity to oxygen than adult globin,~~ ~~This therefore means that more oxygen fetal and and more~~ This therefore means the patient will contain/synthesis more fetal Haemoglobin. ~~from~~ fetal globin has a higher affinity to oxygen than adult globin, meaning that more oxygen uptake by Patient red blood cells (because of higher affinity Haemoglobin) and therefore more oxygen is delivered to body cells. ~~Bone Marr~~ stem cells come from Bone Marrow of Patient therefore no embryonic stem cells used ~~a and~~ meaning that no embryos are "killed". Furthermore because Bone Marrows from the patient are used, there is less likelyhood of it beep rejected by Patient/ less likelyhood of them getting a immune response. Genetic Modification However could have bad affects/side effects on Patient such as the likelihood of the stem cells becoming Cancerous cells.

ResultsPlus
Examiner Comments

This response covered the manipulation of the gene, the use of the patient's own stem cells and the lack of an immune response and also addresses ethical issues and disadvantages and so gained full marks.

Use your own knowledge to support your answer.

(6)

The approach could provide a cure as the stem cells are borrowed and inserted back into the same patient which is easy and does not involve other people who may not provide content. Also by turning the BCL11A gene off, the SCD will not develop, meaning that person will no longer pass it down genetically, since their genes have been modified.

However some people disagree w/ genetic modification due to the ethics of artificially changing.

ResultsPlus
Examiner Comments

This was a Level 1 response. There are 2 points made at the start of the response.

ResultsPlus
Examiner Tip

In the last question of the paper, it is likely you will need to include information from the previous question part. When questions use the word **discuss**, you are likely to need to include several different parts to your answer.

Paper Summary

Overall, the paper worked as intended with the exception of Question 8(b) and some excellent responses were seen demonstrating not only an excellent knowledge of the syllabus, but also a clear understanding of the command words. Centres are clearly using past paper mark schemes and reports to help candidates to perform to the best of their ability, but candidates still struggle with the application of knowledge in photosynthesis, microbiology and immunology based questions. The following points have been made in previous reports but are still applicable.

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

- Candidates need to ensure that they are competent in the required maths skills for this specification and that they carefully take note of instructions regarding giving their answer to a required number of decimal places, significant figures or the inclusion of correct units.
- Working to calculations should be shown.
- Candidates should attempt an answer at all multiple choice questions and read the instructions carefully to any grid based questions.
- Candidates should identify the command word in the question and ensure that their answers to 'explain' questions are not simply a description of the data.
- Candidates should look at the number of marks allocated to each question and aim to make that number of distinct points.
- Levels-based responses should cover all aspects of the question and not just focus on one piece of data or part of the question being asked.
- All questions should be attempted and candidates should try to pace themselves so that they have sufficient time to complete the more challenging questions towards the end of the paper.

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

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.