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June 2025

GCE Biology B 2506 9BI0 01

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June 2025

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Introduction

This paper was typical of previous 9BI0/01 papers with a range of questions from the frequently tested specification points and some of the less commonly tested areas. Some of the questions that were similar to last year, for example the replication of viruses, were answered to a similar level as last year but more candidates were able to apply their knowledge of photosynthesis and respiration than in the previous year. Many questions made use of similar command words but there was still a significant number of candidates who failed to use the data appropriately to explain their answers.

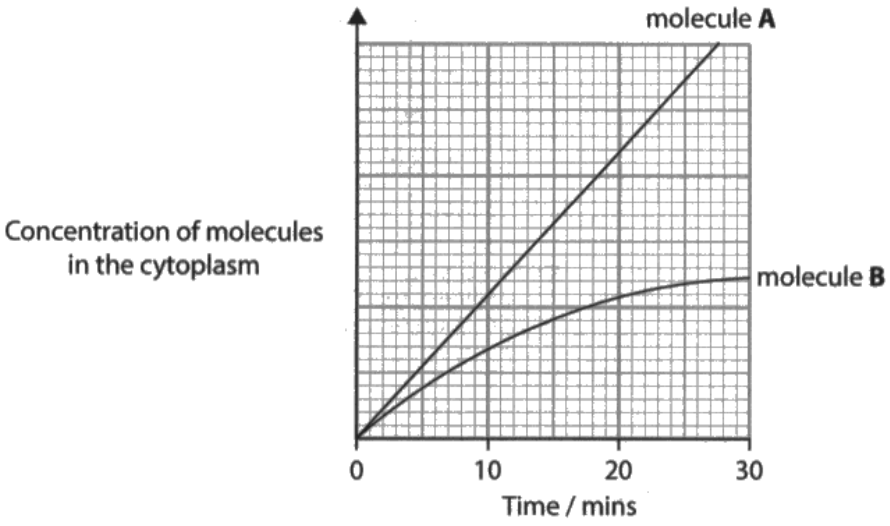
There were a range of responses in the level-based questions with the photosynthesis based question outperforming the final question of the paper. Candidates need to remember that if they are supplied with data, they are expected to make reference to it in their answer. The multiple choice questions were generally answered better than in previous years, although surprisingly some candidates struggled to identify the type of substance carried by active transport.

The statutory number of maths questions were included in this paper. Many candidates demonstrated their ability to manipulate the figures provided in the question and as there were fewer questions that were individually worth more marks, there was the opportunity to gain more marks from showing some correct steps in their working. Where questions are worth multiple marks, candidates need to read the question carefully to use the correct data to carry out their calculations.

Question 1(c)

In this question, candidates were asked to use their knowledge of the transport of molecules across a membrane into the cytoplasm of the cell. They were expected to identify the differences in concentrations of the molecules both inside and outside the cell and explain the reasons for the differences. Many candidates could identify that A was being transported by active transport and B by diffusion but some could not explain the reason for the levelling off of B with time.

(c) The graph shows the change in concentration of molecule **A** and molecule **B**, as they are transported into the cytoplasm of a cell.



Explain the differences in the changes in concentration of molecule **A** and molecule **B** between 0 and 10 minutes and between 20 and 30 minutes.

(2)

A+

0-10 minutes, concentration of molecule A increases faster than B and has a higher concentration in cytoplasm after 10 minutes as A is brought in by active transport which is faster than diffusion which molecule B is brought in by. Between 20-30 minutes, Concentration of molecule A continues increasing at same rate with a higher concentration than molecule B at 27 minutes as active transport moves ~~again~~ molecules against concentration gradient until all ~~lost~~ of molecules are on the other side / in cytoplasm but diffusion reaches an equilibrium where there is an equal concentration of molecules on both sides of the gradient / in cytoplasm and outside cytoplasm which is why concentration of B is lower than that of A at the end.

(Total for Question 1 = 4 marks)

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Examiner Comments

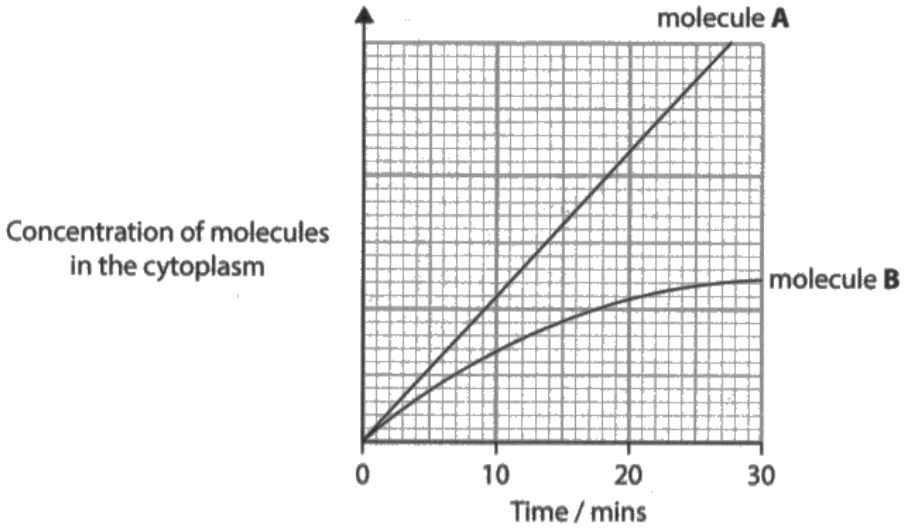
This clip shows a clear and detailed response by a candidate.

The question asks about the transport of two different molecules and candidates are expected to identify the methods as well as explain the reasons for the differences in the rate at which the molecules are transported. In this response, the candidate clearly identifies the methods of transport of each molecule and the reason for the difference between A and B. Therefore they scored both marks.

ResultsPlus
Examiner Tip

When asked to explain a graph candidates need to ensure that they give a reason for the trend or trends that they are describing.

(c) The graph shows the change in concentration of molecule **A** and molecule **B**, as they are transported into the cytoplasm of a cell.



Explain the differences in the changes in concentration of molecule A and molecule B between 0 and 10 minutes and between 20 and 30 minutes.

(2)

Between 0 and 10 minutes, concentration of molecule A increase rapidly while concentration of molecule B increase slowly. Between 20 and 30 minutes, concentration of molecule A continue to increase at a constant rate while concentration of molecule B started leveling off. Concentration of molecule A by a linear relationship

ResultsPlus
Examiner Comments

This response demonstrates an example of a candidate who has simply described the data and not identified the methods of transport being used to carry the molecules into the cell and therefore they scored zero marks.

ResultsPlus
Examiner Tip

Candidates should take care not to just describe data when the command word is explain.

Question 2(c)(i)

This question assessed the candidates' ability to use the data provided to calculate the efficiency of energy transfer when given values relating to one molecule of glucose and one molecule of ATP. Although the values are not the same as the actual values in these molecules, the point of the question was to assess the manipulation of data and to record an answer to two decimal places. Although this last part of the instruction was in bold, some candidates lost a mark because their answer was only recorded to one decimal place.

(c) Cellular respiration yields 36 molecules of ATP per molecule of glucose.

(i) The oxidation of one glucose molecule yields 2 870 224 kJ.

The free energy stored in one ATP molecule is 30 566 kJ.

Calculate the efficiency of energy transfer in the formation of ATP.

Give your answer to **two decimal places**.

(2)

$\frac{36 \times 30\ 566}{2\ 870\ 224} \times 100 = 38.34\%$

Answer 38.34 %

ResultsPlus
Examiner Comments

This response was clearly laid out and the answer was recorded to two decimal places and therefore the candidate scored two marks.

ResultsPlus
Examiner Tip

Always read the question carefully to see if you have to record your answer to a certain degree of precision.

(c) Cellular respiration yields 36 molecules of ATP per molecule of glucose.

(i) The oxidation of one glucose molecule yields 2 870 224 kJ.

The free energy stored in one ATP molecule is 30 566 kJ.

Calculate the efficiency of energy transfer in the formation of ATP.

Give your answer to **two decimal places**.

(2)

$30\,566 \times 36 = 1\,100\,376$

$$\frac{2\,870\,224 - 1\,100\,376}{2\,870\,224} \times 100 = 61.662\ldots\%$$

Answer 61.66 %

ResultsPlus
Examiner Comments

This candidate correctly calculated the energy in 36 molecules of ATP but made an error with the next stage of the calculation and therefore only gained one mark.

ResultsPlus
Examiner Tip

Always include all working as there may be marks awarded even if the final answer is not correct.

Question 2(c)(ii)

This question had a tariff of one mark and many candidates correctly identified that the energy was lost as heat. Some listed more than one reason for there being less than 100% efficiency but this was not necessary.

(ii) State why this process is not 100 % efficient.

(1)

Energy is lost due to other by products such as heat.

ResultsPlus
Examiner Comments

Many candidates correctly identified that the energy was lost as heat, as demonstrated in this response so this candidate gained one mark.

ResultsPlus
Examiner Tip

A question worth one mark does not need more than one reason in the response.

(ii) State why this process is not 100 % efficient.

(1)

Energy is lost ~~while~~ in other forms ~~while~~ during the process.

ResultsPlus
Examiner Comments

Unfortunately this was not quite enough to gain the mark as the candidate needed to suggest that the energy would be lost as heat energy and therefore they did not get any credit.

Question 3(a)

In this question, candidates were expected to identify the role of the host cells being used in viral replication. Many gave coherent answers to the question, demonstrating a clear understanding of the need for specific host cells.

(a) State why specifically-selected cell types have to be grown in **Step 1**.

(1)

As viruses have are specific to a cell type, as they can only bind to their specific cell types surface membrane receptors.

ResultsPlus
Examiner Comments

This is an example of a typical candidate response.

The candidate here gains one mark for identifying that the virus needs a specific cell with complementary receptors to attach (in this case they use the word bind) to, in order to carry out replication.

ResultsPlus
Examiner Tip

Use clear scientific terms when answering the question.

(a) State why specifically-selected cell types have to be grown in **Step 1**.

(1)

They have to be cell types that the virus will invade and replicate from.

ResultsPlus
Examiner Comments

There is not enough detail here and the use of the terminology is a little muddled so no marks were awarded.

ResultsPlus
Examiner Tip

Candidates should be clear on the role of the host cell in replication.

Question 3(b)

This question was worth two marks but many candidates simply focused on the temperature and linked this to enzymes. It needed to be clear that the temperature was important for the enzymes in the host cell. Many overlooked the part of the question that referred to "a few days".

(b) **Explain why the flask has to be incubated at an appropriate temperature for a few days in Step 3.**

(2)

cells contain enzymes and proteins that viruses use to synthesise their viral proteins and DNA (eg in translation). If the temperature is too high, it will surpass the proteins optimum temperature and cause them to denature. This would prevent viral replication. Also, it takes time for viruses to assemble and cause lysis so they must be incubated for a few days.

ResultsPlus
Examiner Comments

In this response the candidate has clearly identified the two aspects of the question; that the temperature needs to be suitable for the cell enzymes and that a time delay is needed for the viruses to assemble and so they gain full marks.

ResultsPlus
Examiner Tip

Take care to read the question through thoroughly and identify all aspects of the question.

(b) Explain why the flask has to be incubated at an appropriate temperature for a few days in **Step 3**.

(2)

To allow the viruses to work at their optimum temperate to allow them to invade the cells. But it can't be the temperature can't be too high or the cells will die.

ResultsPlus
Examiner Comments

In this example the candidate has not made the link to enzymes or the time delay. The candidate has realised that temperature should not be too high or low but there is no scientific explanation as to why and no reference to time, and so scored zero marks.

(b) Explain why the flask has to be incubated at an appropriate temperature for a few days in **Step 3**.

(2)

If the temperature is not appropriate (too ~~high~~ nor / too cold) the cells may die. The virus can not be able to grow within the cells.

ResultsPlus
Examiner Comments

This candidate has realised that the temperature is important for the host cells but not mentioned enzymes and also talked about the virus growing in the host cells. They do not gain any of the mark points.

ResultsPlus
Examiner Tip

Make sure that candidates understand how viruses use the host cell to replicate.

Question 3(c)

This question related to the flow chart of the process of viral replication and extraction. The mark tariff was three and assessed the candidates' ability to apply their knowledge to a process that they were unfamiliar with by using familiar knowledge from the specification. The question asks candidates to identify why cells would not be present and why viruses would. Many only referred to one or the other which limited the number of marks they gained.

(c) Explain why the viruses and not the cells will be present in the filtrate in **Step 5**.

(3)

Cells were grown on the flask's surface and may not ~~be~~ be poured out with the fluid. Many cells would've lysed from new assembles of the virus when the virus replicates.*
Any remaining cells may be too big to pass through the filtration unit, since viruses are smaller.
* and died.

ResultsPlus
Examiner Comments

This was a rare response that related to all three mark points and therefore gained three marks.

ResultsPlus
Examiner Tip

When a question relates to a diagram, ensure that you use this to answer the question.

(c) Explain why the viruses and not the cells will be present in the filtrate in **Step 5**.

(3)

After ~~incubation~~ incubating for a ~~few~~ few days, virus uses host cell machinery ~~to~~ to produce new viral components through protein synthesis. Viral components include capsid ~~protein coat~~ and viral genetic material. ~~The~~ A chemical trigger will then cause viral components to assemble and cell lysis ~~often~~ occurs to host cell. When filtered during step 5 only viruses will be present since cells would have lysed.

ResultsPlus
Examiner Comments

This response was typical of many candidates who had realised that the cells would have been used in the replication of the virus and therefore have lysed and not be in the filtrate. This response gained one mark.

ResultsPlus
Examiner Tip

If there are multiple marks for a question, candidates should aim to make more than one distinct point.

viruses are small partiles than can pass through a filtration unit, other cells are too big to pass through.

ResultsPlus
Examiner Comments

In this response the candidate has identified the purpose of the filtration unit and why viruses would be present but not why cells would not be present.

ResultsPlus
Examiner Tip

Read the whole question carefully to identify the detail that is required in the answer.

Question 4(a)(ii)

In this question candidates were supplied with examples of molecules and asked to draw part of a membrane. Some candidates did not read how many phospholipids they should include and did not understand how the cholesterol should be embedded within the membrane. Many gained the first mark point but fewer placed the cholesterol correctly.

(ii) Draw part of a cell surface membrane that has twelve phospholipids, one channel protein and one cholesterol molecule.

Use the components shown in the diagram.

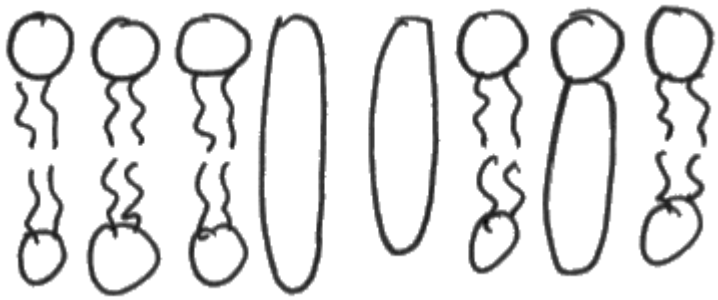
(2)

ResultsPlus
Examiner Comments

This response includes the required 12 phospholipids, the protein channel spanning the membrane and a cholesterol molecule with the correct orientation and therefore gained two marks.

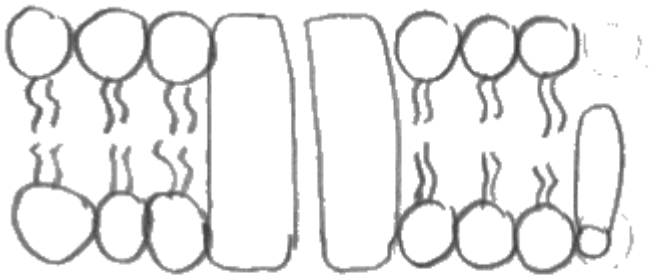
ResultsPlus
Examiner Tip

When candidates are asked to draw structures, they should read instructions carefully and use the key that is provided on the question paper.



ResultsPlus
Examiner Comments

This example demonstrates how important it is to include the correct number of items in a drawing. The candidate only included 10 phospholipids so could not access mark point 1 and also drew the cholesterol molecule spanning the membrane. They therefore gained zero marks.



ResultsPlus
Examiner Comments

This response also gained two marks - it did not matter that the cholesterol was drawn at the end. The candidate had followed all instructions and used the key correctly.

ResultsPlus
Examiner Tip

Take care to draw diagrams clearly and neatly.

Question 4(a)(iii)

This question was a simple recall of the knowledge of the use of channel proteins within a membrane. Many could identify that facilitated diffusion was the process being used and could give an example of a molecule but there was some confusion with polar and non polar molecules.

(iii) Describe the role of channel proteins in cell transport.

(2)

Channel proteins transport ~~a~~ particular molecules across the membrane through facilitated diffusion. Transport molecules that are too large too simply diffuse through the membrane or charged molecules if they're voltage gated channel proteins.

ResultsPlus
Examiner Comments

Candidates needed to identify a type of molecule that would be transported through a channel protein. This response identified both large and charged molecules and the correct process of facilitated diffusion and therefore gained both marks.

ResultsPlus
Examiner Tip

Candidates should take care to not confuse channel proteins with carrier proteins.

(iii) Describe the role of channel proteins in cell transport.

(2)

providing path for polar molecules that can't diffuse through phospholipid bilayers to travel (diffusion) down concentration gradient

ResultsPlus
Examiner Comments

This response identified the corrrect type of molecule but failed to identify facilitated diffusion and therefore only gained one mark.

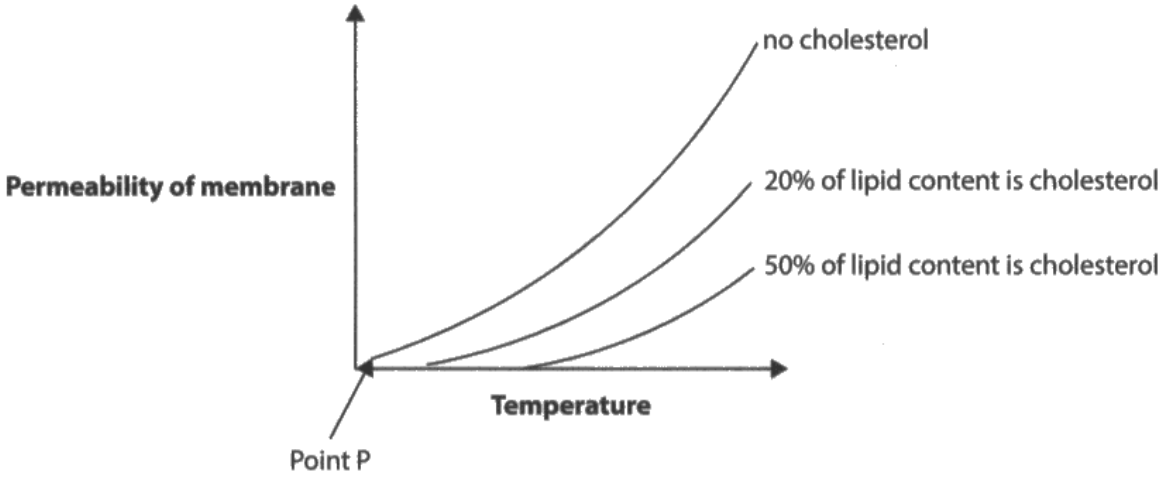
ResultsPlus
Examiner Tip

Candidates should be able to distinguish between facilitated diffusion and diffusion.

Question 4(b)(i)

This question assessed candidates' ability to form conclusions when given several sets of data on a graph. Many could see the link with permeability and temperature but some got confused with the link to the presence or absence of cholesterol and the permeability.

(b) The graph shows the effect on the permeability of membranes of temperature and the proportion of cholesterol in the membrane.



(i) Analyse the data to give **two** conclusions that can be made from this graph.

(2)

As temperature increases the permeability of membrane increases.

As cholesterol (lipid) content increases permeability of membrane decreases.

ResultsPlus
Examiner Comments

This response clearly identified 2 conclusions and therefore gained both marks available.

ResultsPlus
Examiner Tip

Candidates should not feel that they have to fill all available space when they answer a question.

(i) Analyse the data to give **two** conclusions that can be made from this graph.

(2)

~~no cholesterol in a membrane the higher percentage of~~
The higher proportion of cholesterol in a membrane causes ~~increase~~ higher levels of permeability.
As temperature increases ~~(also)~~ this increases the permeability of a membrane.

ResultsPlus
Examiner Comments

This candidate correctly identified that the permeability of the membrane increased with increased temperature but did not read carefully from the graph what trend was being shown with regards to cholesterol and therefore gained only one mark.

ResultsPlus
Examiner Tip

Candidates should not make incorrect assumptions from looking at the pattern of the lines on the graph.

Question 4(b)(ii)

In this question, the candidates were expected to refer to a specific point on the graph and explain why the permeability would be lower. Some read the word temperature and gave a generic answer about the effect of temperature on permeability but did not relate this to what was occuring at point P only.

(ii) Explain the effect of temperature on membrane permeability at point P.

(2)

At point P, the temperature is very low. This means that the molecules in the membrane such as the phospholipids have low K.E., so they do not move/vibrate as much. This reduces the ability of molecules to move through the membrane, as there are less gaps, so the permeability at point P is very low.

ResultsPlus
Examiner Comments

This clearly identifies the link to low kinetic energy of phospholipids and the reduced ability of molecules to pass through the membrane and therefore they gained both marks.

(ii) Explain the effect of temperature on membrane permeability at point P.

(2)

Temperature is low, so membrane permeability is very low (close to 0). The molecules have very little kinetic energy so don't move around a lot, so there are low rates of diffusion, so very few molecules can pass through the membrane. Also, the phospholipids are more tightly packed together.

ResultsPlus
Examiner Comments

This response has clearly referred to the specific point on the graph and correctly identified the link to low kinetic energy and the fact that this would lead to phospholipids moving less and that rates of diffusion would be slower. The response is not as clearly written as the previous one but still gained two marks.

ResultsPlus
Examiner Tip

Candidate should know the details of the components of membranes and the factors that affect their ability to allow substances to pass through them.

Question 5(b)

This question assessed candidates' ability to use ratios and select the correct data to calculate the minimum number of girls born with Turner syndrome. As it was number of people, it was expected that the answer would be as a whole number. Many did this well whilst others calculated the first step correctly but then did not use the second piece of data in the appropriate way.

This response shows one of the correct answers of 120. If they rounded down their final value and gave 119, this was also credited with full marks.

(b) There were 613 936 babies born in the UK in 2020.

The ratio of baby boys to baby girls is 1.05 : 1.

The incidence of TS is between 1 in 2 000 and 1 in 2 500 in baby girls.

Calculate the **minimum** number of baby girls born with TS in the UK in 2020.

(2)

b : g
1:05 : 1 = 2.05
~~299480~~. = 613936
314455 : 299481

Answer 120

girls = 299481

$\frac{299481}{2500} = 119.8 = 120$

ResultsPlus
Examiner Comments

This response used the ratio correctly and also calculated the minimum number of girls born with TS and so gained two marks.

ResultsPlus
Examiner Tip

Always set out working clearly in a multi step calculation.

(b) There were 613 936 babies born in the UK in 2020.

The ratio of baby boys to baby girls is 1.05 : 1.

The incidence of TS is between 1 in 2 000 and 1 in 2 500 in baby girls.

Calculate the **minimum** number of baby girls born with TS in the UK in 2020.

(2)

$1.05+1=2.05$

$\frac{613936}{2.05} = 299480.9756 \times \frac{1}{2000} = 149.74$

Answer 149

ResultsPlus
Examiner Comments

This candidate carried out the first part of the calculation correctly but used the wrong value for the second part and calculated the maximum number of girls born with TS rather than the minimum. They gained one mark for the first part of their calculation.

ResultsPlus
Examiner Tip

Always show working for any calculations worth more than one mark.

Question 5(c)(i)

In this question, candidates needed to make it clear that they understood that a vaccine would trigger an immune response and this would lead to higher numbers of antibodies and therefore those girls would need to be excluded from the investigation. Many understood there was an immune response but they needed to explain that the numbers of lymphocytes would be higher, not just present and that this would invalidate the results.

(c) Scientists studied a group of girls with TS and a group of girls without TS.

They recorded physical features and immunological markers such as antibodies and lymphocytes.

(i) Girls who had recently been vaccinated were excluded from this study.

Explain why these girls were excluded.

(3)

the girls vaccinated would have a greater number of antibodies and lymphocytes due to the specific immune response being triggered. Therefore, B cells differentiate to become plasma cells which produce ~~ant~~ antibodies to fight off the disease. So, would not produce a valid comparison as ~~no~~ vaccinated girls would have more immunological markers than others. There are more lymphocytes to divide into T-killer cells, T-helper cells and memory cells to destroy the antigen.

ResultsPlus
Examiner Comments

This response is clearly explained and was awarded three marks. The candidate has identified the fact that there would be a specific immune response, has stressed several times throughout the response the consequences of this.

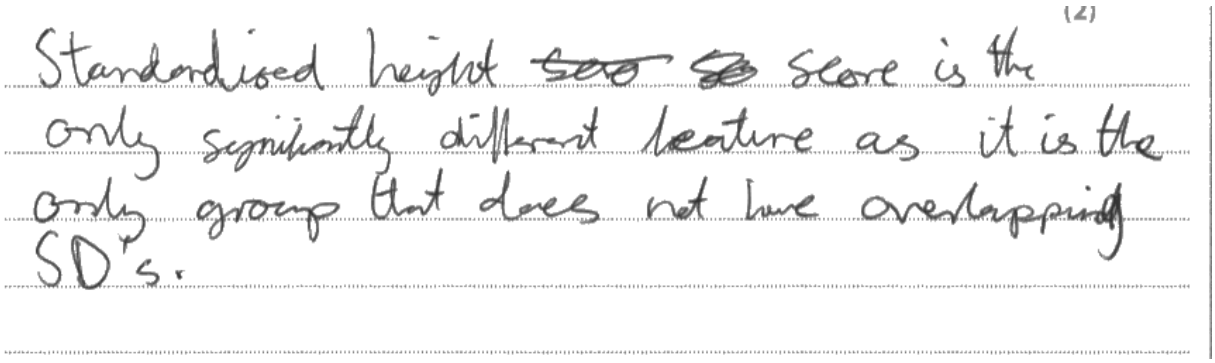
Vaccines are a form of artificial immunity which inject a weakened or dead form of a virus into the body. This results in the body producing lymphocytes ~~which will lead~~ being produced over time, resulting in the formation of memory cells which will remain present for a sustained period of time and would still be present when doing the study. Girls that have not been recently vaccinated may not have memory cells present

ResultsPlus
Examiner Comments

This response gained the alternative mark point for immune response as they identified that memory cells would be present, but there was no indication of more lymphocytes as lymphocytes would be present anyway or impact on the results, and therefore this candidate gained only one mark.

Question 5(c)(ii)

In this response, candidates had to use standard deviation values from a table and understand that where the values did not overlap, this would make the results significantly different. There was quite a lot of data to assimilate but only one set of values had an overlap. This question was assessing AO2 data skills. Unfortunately if the incorrect feature was identified, no marks would be scored.



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Examiner Comments

This candidate correctly identifies standardised height score and that significant difference is because the standard deviations do not overlap.

(2)

The standardised height score was the only significantly different feature.

With turners syndrome the spread of data was from +1.21 to -3.11,

without turners syndrome the spread was between 0.09 and -0.91,

as the standard deviation error bars and values do not overlap, standardised height score is the only significantly different feature.

$-2.16 + 0.95 = -1.21$

$-2.16 - 0.95 = -3.11$

$-0.41 + 0.50 = 0.09$

$-0.41 - 0.50 = -0.91$

ResultsPlus
Examiner Comments

This response is included because it gained two marks. The candidate has clearly shown that they have determined which values do not overlap by including their working. This would have gained the second mark even if they had not stated that the error bars do not overlap.

ResultsPlus
Examiner Tip

When determining whether or not standard deviations overlap, it can be a good idea to show your working.

(ii) The table shows some of the physical features of the two groups of girls.

Physical features	Mean value ± SD for each group of girls	
	With TS	Without TS
Age / years	11.9 ± 4.1	12.5 ± 4.0
Mass / kg	36.7 ± 14.8	45.2 ± 19.3
Height / cm	134.8 ± 20.0	146.3 ± 21.3
Standardised height score	−2.16 ± 0.95	−0.41 ± 0.50
Body mass index (BMI)	19.2 ± 3.3	19.7 ± 4.6

Only one of these features was significantly different between the two groups of girls.

Explain which was the significantly different feature.

(2)

It would be Mass / kg as it has the biggest difference / range in standard deviation between girls with TS and without TS, it also has ~~the greatest percentage~~ a large difference in mean

ResultsPlus
Examiner Comments

There are no marks for this response. The incorrect feature is identified and the candidate does not understand what is meant by significant difference between values.

Question 5(c)(iii)

This question asked candidates to use the data provided to form conclusions that could be made about the two groups of girls. Some candidates only looked at the data for those with Turner syndrome and others only described the results and therefore gained no marks. If candidates looked at the standard deviation values that were provided, they would have noticed that all the values for the two groups overlapped and therefore this was a valid conclusion that could be made. As the question was worth two marks, another suitable statement needed to be made in addition to that to gain all the marks on offer.

Analyse the data to describe the conclusions that can be made about the immunological markers in girls with TS.

(2)

- girls with TS on average have less CD4 ~~and CD~~ lymphocytes than girls without, however there is overlap into the ~~average~~ lower end of the girls without TS.
- Similar levels of IgA antibody in both groups
-

ResultsPlus
Examiner Comments

This response has picked out some of the differences but not made distinct conclusions and therefore gained no marks.

ResultsPlus
Examiner Tip

A conclusion needs to be different to a simple description of some of the results.

Analyse the data to describe the conclusions that can be made about the immunological markers in girls with TS.

(2)

While the mean values for IgA, IgG, and CD4 lymphocytes is ~~greater~~ lower in girls with TS, but the mean value for CD8 lymphocytes is greater, the standard deviations overlap for all of the immunological markers. Therefore, the only conclusion that can be drawn is that there is no significant difference in the levels of each of the immunological markers between girls with TS and girls without.

ResultsPlus
Examiner Comments

This response gained two marks for the first three lines where they compared the levels of the immunological markers in the two groups but they also would have gained a mark for stating that all of the standard deviation values overlap.

ResultsPlus
Examiner Tip

If standard deviation values are supplied, you will be expected to refer to them in your answer.

Question 5(c)(iv)

In this question, candidates were asked to extend the study that had been carried out in the previous question. Ideally they should be using the same groups of girls but this time categorising them so that each of the two groups were subdivided into those with and without an autoimmune disease. However, the key thing here was to look at the link between raised levels of T regulatory cells and girls with TS and an autoimmune disease, and those with TS and no autoimmune disease. Some candidates read the question carefully but others missed the point of the question and did not extend the previous study or state what was being compared and so scored no marks.

(iv) The scientists also determined the number of a type of cell called T regulatory cells in the blood of these two groups of girls.

They found that the numbers of these cells were very similar.

People with autoimmune diseases have been shown to have a decreased number of T regulatory cells.

Explain how this study could be modified to show that a decreased number of T regulatory cells is linked to the risk of autoimmune disease in girls with TS.

(2)

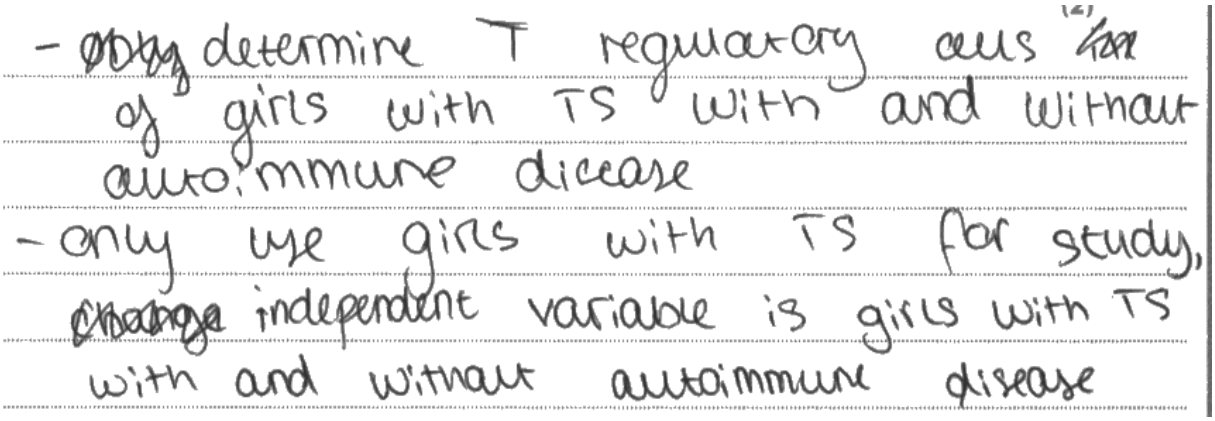
Instead have groups of girls with ts and autoimmune disease and girls ~~without~~ with ts but without autimmune disease. then measure the levels of t regulatory cells in the blood for both groups and compare.

ResultsPlus
Examiner Comments

This answer has clearly used the groups necessary to gain a mark and then stated the levels of T regulatory cells would be compared and so scored two marks.

ResultsPlus
Examiner Tip

When asked to design or extend an experiment, candidates should read the information provided carefully.



ResultsPlus
Examiner Comments

This response is along the right lines but they have failed to say that the levels of cells would be compared and therefore they only scored one mark.

Question 6(a)(ii)

This was a straighforward recall question and the only answer that was acceptable was photolysis.

(ii) Name reaction A.

(1)

photolysis.

ResultsPlus
Examiner Comments

This candidate has clearly named the reaction as photolysis.

ResultsPlus
Examiner Tip

The command word name does not require a description.

(ii) Name reaction A.

(1)

The light dependent reaction

ResultsPlus
Examiner Comments

This response was too broad. The only acceptable answer was photolysis.

ResultsPlus
Examiner Tip

The light dependent reaction was not what we were looking for here. This gained no marks.

Question 6(a)(iv)

Candidates were asked to write the equation for the generation of ATP through phosphorylation. This was done accurately by many candidates but some wrote incomplete equations or used an incorrect arrow.

(iv) Write the equation for reaction C.

(1)

ADP + Pi → ATP

ResultsPlus
Examiner Comments

This response is written correctly and gains the mark.

(iv) Write the equation for reaction C.

(1)

ADP → ATP

ResultsPlus
Examiner Comments

The equation is incomplete therefore no marks awarded.

Question 6(b)(i)

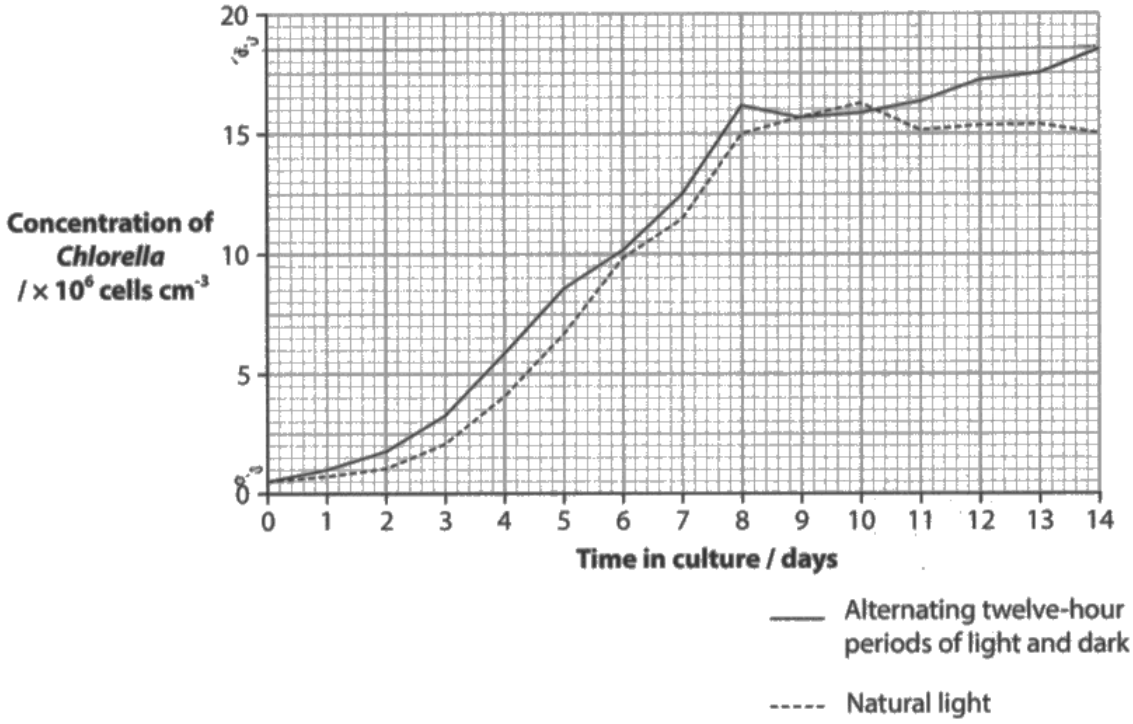
In this question candidates were assessed on their ability to read the correct data from a graph and then work out how many times faster Chlorella grew in alternating periods of light and dark. Many candidates only read the value for day 14 and divided this by 14 and therefore could gain credit for the second part of the question but would not gain full marks. The question also required candidates to give their answer to two significant figures which some failed to do.

(b) Scientists are developing solar cells that contain photosynthetic pigments derived from *Chlorella*.

Solar cells absorb light and generate electricity.

The scientists cultured *Chlorella* under two different lighting conditions.

The graph shows the growth of *Chlorella* exposed to either natural light or to alternating twelve-hour periods of light and dark.



(i) The mean growth rate for *Chlorella* grown in natural light during the fourteen-day period was 1.04×10^6 cells per day.

Calculate how many times faster *Chlorella* grew in alternating periods of light and dark.

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

(2)

rate = $\frac{18}{14} = 1.285714$

ans ÷ 1.04 = 1.236 2637

Answer 1.2

ResultsPlus
Examiner Comments

The candidate has read the two correct figures from the graph and subtracted 0.5 from 18.5. They have then worked out the rate and how many times faster this was than those grown in natural light. They also have given their answer to two significant figures so gain both marks.

ResultsPlus
Examiner Tip

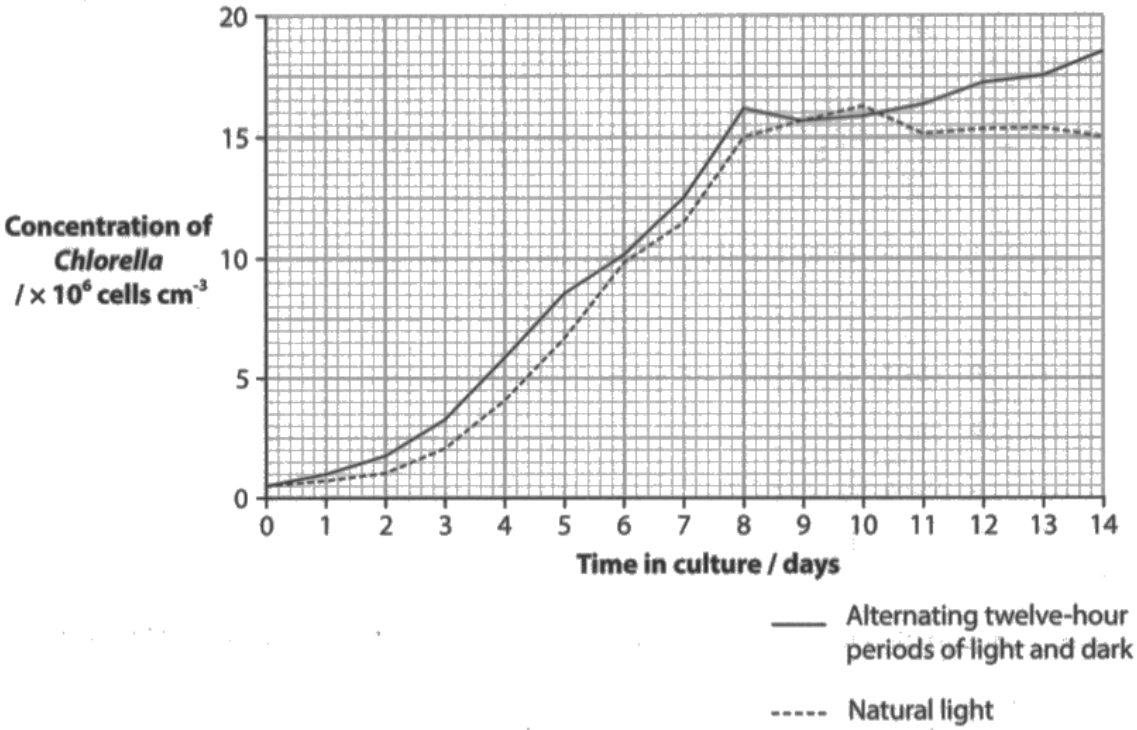
Always show working clearly.

(b) Scientists are developing solar cells that contain photosynthetic pigments derived from *Chlorella*.

Solar cells absorb light and generate electricity.

The scientists cultured *Chlorella* under two different lighting conditions.

The graph shows the growth of *Chlorella* exposed to either natural light or to alternating twelve-hour periods of light and dark.



(i) The mean growth rate for *Chlorella* grown in natural light during the fourteen-day period was 1.04×10^6 cells per day.

Calculate how many times faster *Chlorella* grew in alternating periods of light and dark.

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

(2)

$0.1 \times 10^6 \rightarrow 18.5 \times 10^6$

$\frac{18.4 \times 10^6}{14} = 1.31 \times 10^6$

$\frac{1.31 \times 10^6}{1.04 \times 10^6} = 1.26$

Answer 1.3

ResultsPlus
Examiner Comments

This candidate has only read the highest value from the graph but as they have calculated the second part of the answer correctly, they gain one mark.

Question 6(b)(ii)

Candidates were provided with data on the growth of Chlorella grown in different light conditions. They were asked to explain the observations made, using their subject knowledge of photosynthesis and growth curves. Many candidates were unable to relate the appearance of the cells to the quantities of photosynthetic pigment present and struggled to give reasons for the dark green cells reaching the death phase earlier than the light green cells. Some candidates gave an extensive narrative on the light independent reaction which was not being assessed in this question. There were some good explanations of the stationary and death phases.

This is an example of a very good response by a candidate.

(ii) The cultures were observed for a further four days.

The table shows the observations.

Time in culture / days	Observation	
	Chlorella grown in alternating periods of light and dark	*Chlorella* grown in natural light
17	Dark green cells The number of cells had not increased since the previous day	Light green cells The number of cells had increased since the previous day
18	Cells had entered the death phase	Cells had not entered the death phase

Explain these observations.

(5)

Chlorella in alternating light and dark have darker green cells indicating the cells have adapted to produce more green chlorophyll pigment to maximise light absorption, whereas chlorella in natural light still had light green cells. The number of cells had not increased since previous day in day 17 for alternating light/dark chlorella, suggesting at day 17 this culture is already in stationary (late) stationary phase, whereas chlorella in natural light still in growth (log) phase as numbers still increasing. Moreover, day 18, the culture in alternating light/dark entered death phase, showing that this culture had reached its max carrying capacity much faster due to higher concentration of chlorella at each day compared to natural light sample, so resources are limited and used up, and not enough space / light is limiting factor (hence darker cells = more pigment), so this culture enters death phase first, but not natural light culture yet.

ResultsPlus
Examiner Comments

This candidate has not only explained the dark green cells but also referred to the stationary phase and given reasons for the death phase and therefore scored full marks.

ResultsPlus
Examiner Tip

Candidates should provide explanations for all the observations provided in a table or graph.

* Explain these observations.

(5)

For the Chlorella grown in alternating periods of light and dark, they appear dark green as their photosynthetic pigments have been produced in much higher quantities, as there are more cells.
The alternation of light and dark periods has sped up the replication and binary fission rates so that the competition between each cell has increased, causing the death rate to exceed the rate of reproduction.
At day 17, the Chlorella cells in alternating periods were in the stationary phase.
For the Chlorella grown in natural light, the cells at day 17 are still in the log phase as the rate of binary fission exceeds the ~~rate of~~ death rate.

ResultsPlus
Examiner Comments

This candidate gained three marks for explanation of the pigments, stationary phase and death phase but no reasons were provided for why the dark green culture reached the death phase earlier than the light green culture.

This is a more typical response:

Explain these observations.

(5)

Chorella grown in alternating light periods, in 17 days, cells were dark green and in stationary phase as death rate = growth rate. In 18 days, cells entered death phase as death rate exceeded growth rate.

Chlorella grown in natural light, in 17 days, had light green cells and were in log phase as cells were growing. At 18 days, cells were in stationary phase as had not entered death.

Because in natural light, there is consistent light for photosynthesis. So PS1 can absorb photons. So more photosynthesis so more carbon fixation of RuBP + CO2 to form GP. So more GP converted to TP. But in alternating periods, light is not consistent so less light dependent reaction. As a result less ATP and NADPH for light independent stage so ~~less~~ less electron transport chain. Therefore plants die quicker.

ResultsPlus
Examiner Comments

This response is included to demonstrate how many candidates went into extensive detail on photosynthesis which was not the point of the question. They gained marks for identifying the stationary phase and explaining the death phase only.

ResultsPlus
Examiner Tip

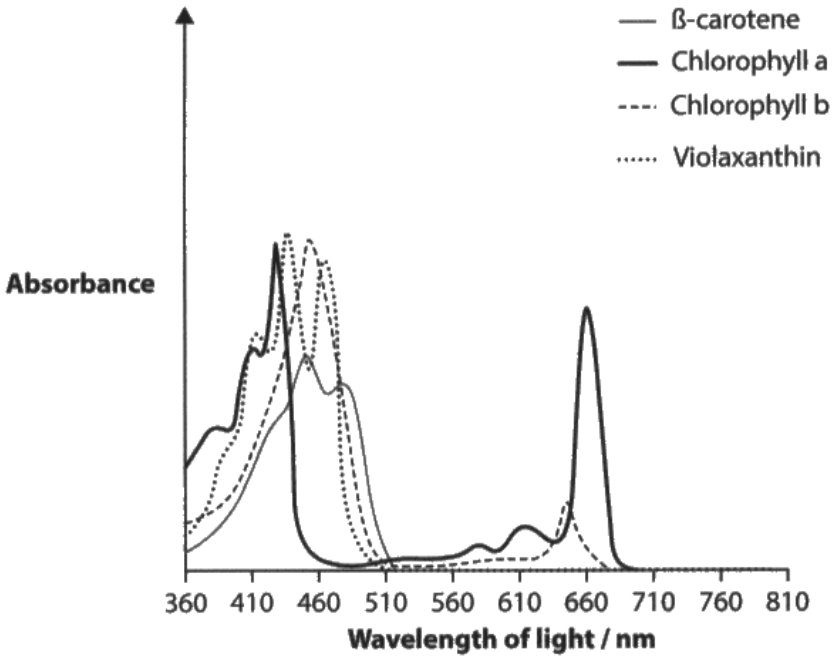
When provided with data, explain the data, do not focus on including everything that might be relevant to the question.

Question 6(b)(iii)

In this question many candidates could identify the fact that *Chlorella* provided a source of several photosynthetic pigments but they did not go on to relate this to why this would be of use to generate electricity in a solar cell. It was important that they explained that several pigments would lead to more light being absorbed than an organism with fewer photosynthetic pigments.

(iii) The scientists chose to use *Chlorella* as a source of photosynthetic pigments for solar cells.

The graph shows the absorption spectra of four photosynthetic pigments found in *Chlorella*.



Explain why *Chlorella* cells are a suitable source of photosynthetic pigments for use in a solar cell.

(3)

Chlorella cells contain a large number of different photosynthetic pigments, ie. this means a large range of different wavelengths of light can be absorbed and since different photosynthetic pigments absorb different amounts of wavelengths of light, it maximises the amount of light that can be absorbed for photosynthesis in the solar cells. Therefore the maximum amount of electricity can be generated using the solar cells.

ResultsPlus
Examiner Comments

This is an example of a good response that related the variety of pigments to the use of *Chlorella* to generate electricity. It gained all three marks.

ResultsPlus
Examiner Tip

Read the whole question carefully to make sure you give a complete answer.

Explain why *Chlorella* cells are a suitable source of photosynthetic pigments for use in a solar cell.

(3)

The chlorella cells contain 4 different pigments that all absorb different wavelengths of light. For example, chlorophyll a absorbs different wavelengths compared to β-carotene. This means more of the visible light is absorbed from the sunlight so more electricity will be generated, making the solar cells more efficient

ResultsPlus
Examiner Comments

This response also gained three marks and was coherently written.

Explain why *Chlorella* cells are a suitable source of photosynthetic pigments for use in a solar cell.

(3)

because chlorella cells contain multiple photosynthetic pigments which absorb ~~at~~ a range of wave lengths of light - using ~~this~~ chlorella is suitable for the use in solar cells as they absorb a large amount of light from different wavelengths meaning that more ~~ene~~ energy can be generated

ResultsPlus
Examiner Comments

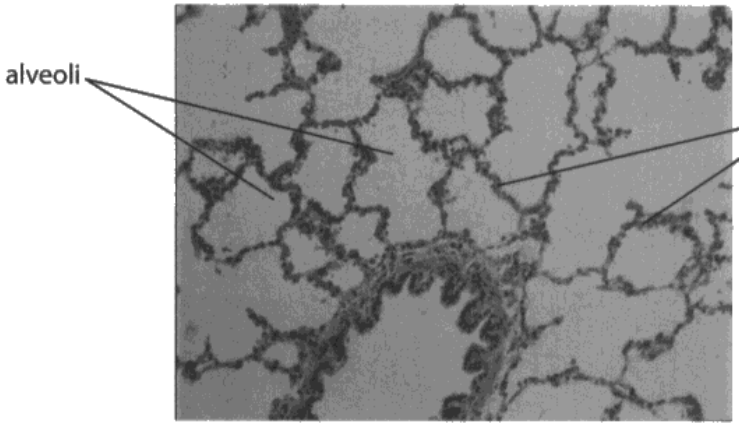
This was a more typical response where the candidate identified that the *Chlorella* was a good source of pigments but they need to relate more clearly the use to a solar cell. We were looking for expressions such as more or maximum light absorbed or electricity generated, ie they needed to be clear that these pigments would be better than an organism with fewer pigments. This response scored one mark.

Question 7(a)(i)

There were many variations of responses for this calculation. Many only did the calculations for alveoli in one lung or presented their answers to the wrong degree of magnification and therefore could not gain full marks. Some candidates could assimilate all the data appropriately and factored in two lungs as well as managing to convert their data into m^2 .

7 Living organisms have a range of gas exchange systems.

(a) The photograph shows human lung tissue, as seen using a light microscope.



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μm = 10^{-6}
mm = 10^{-3}
cm = 10^{-2}
m = 10

(i) The typical diameter of an adult alveolus is 200 μm.

There are 300 million alveoli in each lung.

Calculate the total surface area of a pair of adult lungs, using the formula:

surface area of one alveolus = $4\pi r^2$

Give your answer in m^2.

(3)

diameter = 200μm = 200×10^{-6} m

radius = $(200 \times 10^{-6}) \div 2 = 1 \times 10^{-4}$ m

$4 \times \pi \times (1 \times 10^{-4})^2 = 1.256637 \times 10^{-7}$ = SA 1 alveolus

$1.256637 \times 10^{-7} \times 300 \times 10^{6} \times 2 = 75.39822$

$= 75.4$ (3s.f)

Answer 75.4 m^2

ResultsPlus
Examiner Comments

This response demonstrates what we would expect from candidates. This candidate gains full marks and has set out their workng clearly.

ResultsPlus
Examiner Tip

Always show working clearly.

(i) The typical diameter of an adult alveolus is 200 µm.

There are 300 million alveoli in each lung.

Calculate the total surface area of a pair of adult lungs, using the formula:

surface area of one alveolus = $4\pi r^2$

Give your answer in m^2.

(3)

$200 \div 2 = 100\mu m = 0.1mm = 1 \times 10^{-4} m$

$4\pi \times (1 \times 10^{-4})^2 = 1.25 \times 10^{-7} \times 300000000 = 37.7 m^2$

Answer 37.7 m^2

ResultsPlus
Examiner Comments

This candidate has only calculated the area of one lung but their answer is in the correct order of magnitude and therefore they were awarded two marks.

Question 7(a)(ii)

In this question, candidates were assessed on their knowledge of the importance of surface area. This was an AO1 question, testing knowledge of biological processes. Many could relate increased surface area to increased rates of diffusion but failed to then link this to improving aerobic respiration which was the second available mark point.

(ii) Explain the importance of a large surface area in a gas exchange system.

(2)

A large surface area allows a larger surface for gas exchange, resulting in a faster rate of diffusion in the same amount of time due to Ficks law, meaning more oxygen diffuses into the blood for respiration, producing more ATP for metabolic processes.

ResultsPlus
Examiner Comments

This candidate has explained that a greater surface area would lead to more oxygen diffusion so more respiration can take place. The enhanced respiration is qualified because they state that more ATP would be generated. This response scored two marks.

(ii) Explain the importance of a large surface area in a gas exchange system.

(2)

Increases the rate of gas exchange which allows metabollic reactions to be carried out faster.

This candidate has just got a mark for an increased rate of gas exchange but metabolic processes is too vague.

Question 7(a)(iii)

Many candidates did not understand the purpose of the fluid inside the alveoli even though this was aimed at C and E grade candidates. Most commonly, they were able to state one reason such as the oxygen being able to dissolve, aiding diffusion or to prevent the alveoli from collapsing.

(iii) Fluid passes out of the capillaries into the spaces around the alveoli.

tissue fluid

Some of this fluid passes into the alveoli.

Explain the importance of having fluid inside the alveoli.

(2)

- O_2 and CO_2 can dissolve, which increases the rate of diffusion of CO_2 out and O_2 in
- the fluid prevents the alveolus collapsing and keeps the surface area for diffusion large

ResultsPlus
Examiner Comments

This answer clearly gives two reasons for the presence of the fluid in the alveoli.

(iii) Fluid passes out of the capillaries into the spaces around the alveoli.

Some of this fluid passes into the alveoli.

Explain the importance of having fluid inside the alveoli.

(2)

to prevent alveoli sticking to each other and not fully inflating. The fluid ensures the alveoli inflate and dont stick allowing easy greater diffusion. Fluid inside alveoli makes it easier for gases, oxygen to dissolve in the fluid allowing easier diffusion into blood.

ResultsPlus
Examiner Comments

This answer also clearly gives two reasons for the presence of the fluid in the alveoli.

(iii) Fluid passes out of the capillaries into the spaces around the alveoli.

Some of this fluid passes into the alveoli.

Explain the importance of having fluid inside the alveoli.

(2)

Fluid inside alveoli keeps the surfaces moist which allows for more gas exchange

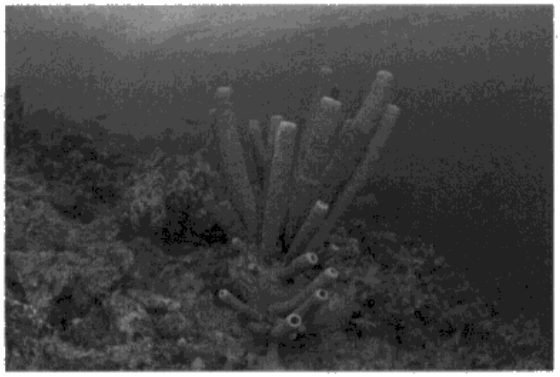
ResultsPlus
Examiner Comments

This response has gained none of the mark points.

Question 7(b)

This question required candidates to use information given in a diagram and apply their knowledge of gas exchange surfaces to an unfamiliar organism. Many were able to recognise that the single layer of cells would mean a shorter diffusion distance but failed to refer to the steeper concentration gradient as indicated by the flow of water through the ostia and that the shape of the organism, not the individual gaps would lead to a large surface area. Flagella were credited in one of two ways; either as increasing surface area or increasing the water flow through the sponge. References to blood were commonly seen, demonstrating that candidates were simply recalling knowledge rather than using the information that they were supplied with.

(b) The photograph shows a marine sponge.



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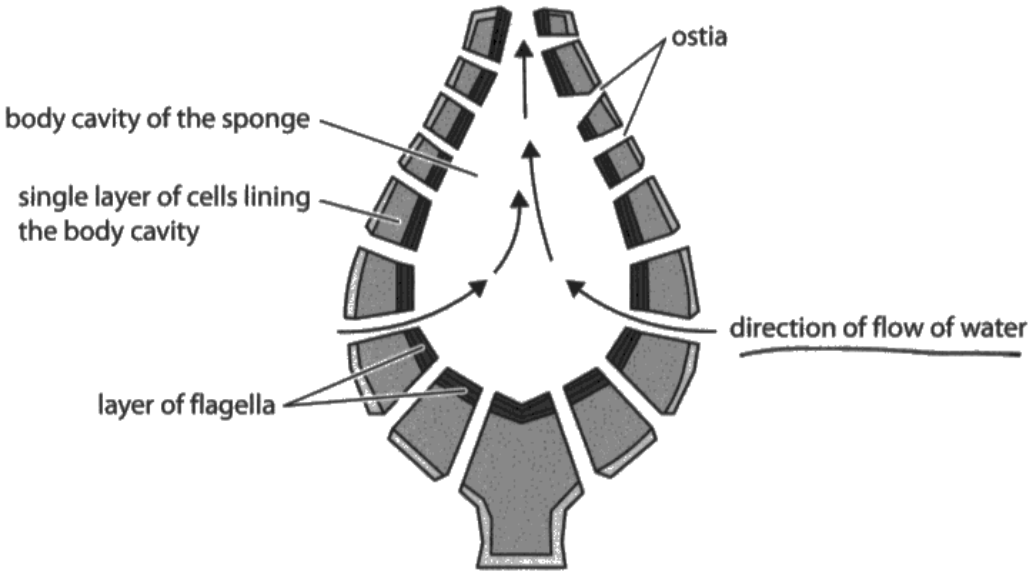
Sponges are aquatic animals that are covered in pores called ostia.

The diagram shows a section through a sponge.



Analyse the information in the diagram to explain how this sponge is adapted for gas exchange.

(3)

→ Single layer of cells lining the body cavity provides shortest possible diffusion distance to cells, thus maximising the rate of gas exchange

→ Lots of ostia allow for water to enter at many places along the sponge, allowing for a strong concentration gradient to be maintained, maximising the rate of diffusion

→ Large body cavity and presence of flagella increases surface area within body cavity, providing maximum possible surface area for gas exchange, maximising rate ~~of~~ and diffusion of gas exchange.

ResultsPlus
Examiner Comments

This canddidate gained three marks for referring to single layer of cells, the concentration gradient through the ostia and the flagella in the body cavity.

ResultsPlus
Examiner Tip

Candidates should try to refer to all of the features shown in the diagram in their answer.

Analyse the information in the diagram to explain how this sponge is adapted for gas exchange.

(3)

Single layer of cells so short diffusion distance. Large surface area for diffusion of gases. Layer of flagella to keep water moving so ~~a~~ concentration gradient is maintained for diffusion of gases. Ostia allow ~~water~~ new water to constantly flow in so a concentration gradient is maintained for diffusion of gases.

ResultsPlus
Examiner Comments

This response also gains full marks for the single layer of cells, flagella and ostia ensuring a high concentration gradient.

Analyse the information in the diagram to explain how this sponge is adapted for gas exchange.

(3)

- has lots of ostia to increase the surface area, increasing rate of diffusion of gases into cells
- has a large body cavity to maintain of steep concentration gradient to increase rate of diffusion
- has a single layer of cells lining the body cavity for a short diffusion distance to increase rate of respiration

ResultsPlus
Examiner Comments

This candidate only got credit for linking the single layer of cells to a shortened diffusion distance.

ResultsPlus
Examiner Tip

Carefully read any information on diagrams that you are provided with.

Question 7(c)

There was a lot of information to assimilate in the two graphs and candidates needed to explain that information, not just simply describe what they could see. They were expected to relate the need for the different gas exchange structures depending on whether the frog was living in water or in air. The best candidates could link the information from the two graphs and see that the skin was important at all stages of the frog life cycle, including being most important for carbon dioxide release.

Analyse the data to explain the role of the gills, lungs and skin in gas exchange as a tadpole develops into a frog.

(4)

The tadpole has [illegible] uses their lungs very little, since they are underwater and using oxygen from the water. The tadpoles skin is used for oxygen uptake and carbon dioxide release, since they have a large surface area : volume ratio. Their gills are also used for gas exchange as they are underwater.

When the tadpole uses oxygen in air, the use of gills decreases since we are not underwater and lungs increase. The skin still increases since still high surface area : volume ratio.

Once it is a young frog, the lungs for oxygen uptake increase a lot, and gills decrease. Gills not required since not underwater. Lungs used for ~ 72% oxygen and skin used to release carbon dioxide. Therefore both oxygen and carbon dioxide diffuses in different places ∴ more area/space for gas exchange. As frog becomes adult, the lungs increase in both O_2 and CO_2, but skin decreases, since as the frog grows, the surface area : volume ratio ~~dem~~ decreases so less gas exchange from ~~skf~~ skin.

ResultsPlus
Examiner Comments

In this response the candidate has explained the use of the skin, gills and lungs at different stages in the life cycle and gained four marks.

ResultsPlus
Examiner Tip

Candidates should ensure that they do not simply repeat the data when asked to explain changes taking place in a graph or graphs.

Analyse the data to explain the role of the gills, lungs and skin in gas exchange as a tadpole develops into a frog.

(4)

When the tadpole is using O_2 in the water the percentage uptake of water is mainly through the skin because it has a large surface area to volume ratio so diffusion is sufficient. ~~When the ta~~ The % of CO_2 released is also greater for the skin and gills. When the tadpole uses O_2 in the air the gas exchange still mainly takes place in the skin ~~this~~ (round 68% O_2 uptake and 44% CO_2 released). When the tadpole develops into a frog the surface area to volume ratio decreases so the ~~lungers~~ lungs play a greater role in gas exchange ~~with more~~ as it provides a large surface area to volume ratio and the importance of the gills decreases ~~bec~~ as it uses O_2 from the air and ~~gills~~ gills are under water. The percentage of CO_2 released from the skin remains high for the frog at all stages and highest for the adult frog compared to the gills and the lungs.

(Total for Question 7 = 14 marks)

ResultsPlus
Examiner Comments

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

Analyse the data to explain the role of the gills, lungs and skin in gas exchange as a tadpole develops into a frog.

(4)

In early life tadpoles use their gills to absorbe oxygen from the water ~~have~~ as a tadpole grows into a frog its gills are no longer used and their role is replaced by lungs as frogs are amphibians and require lungs to breathe on land.

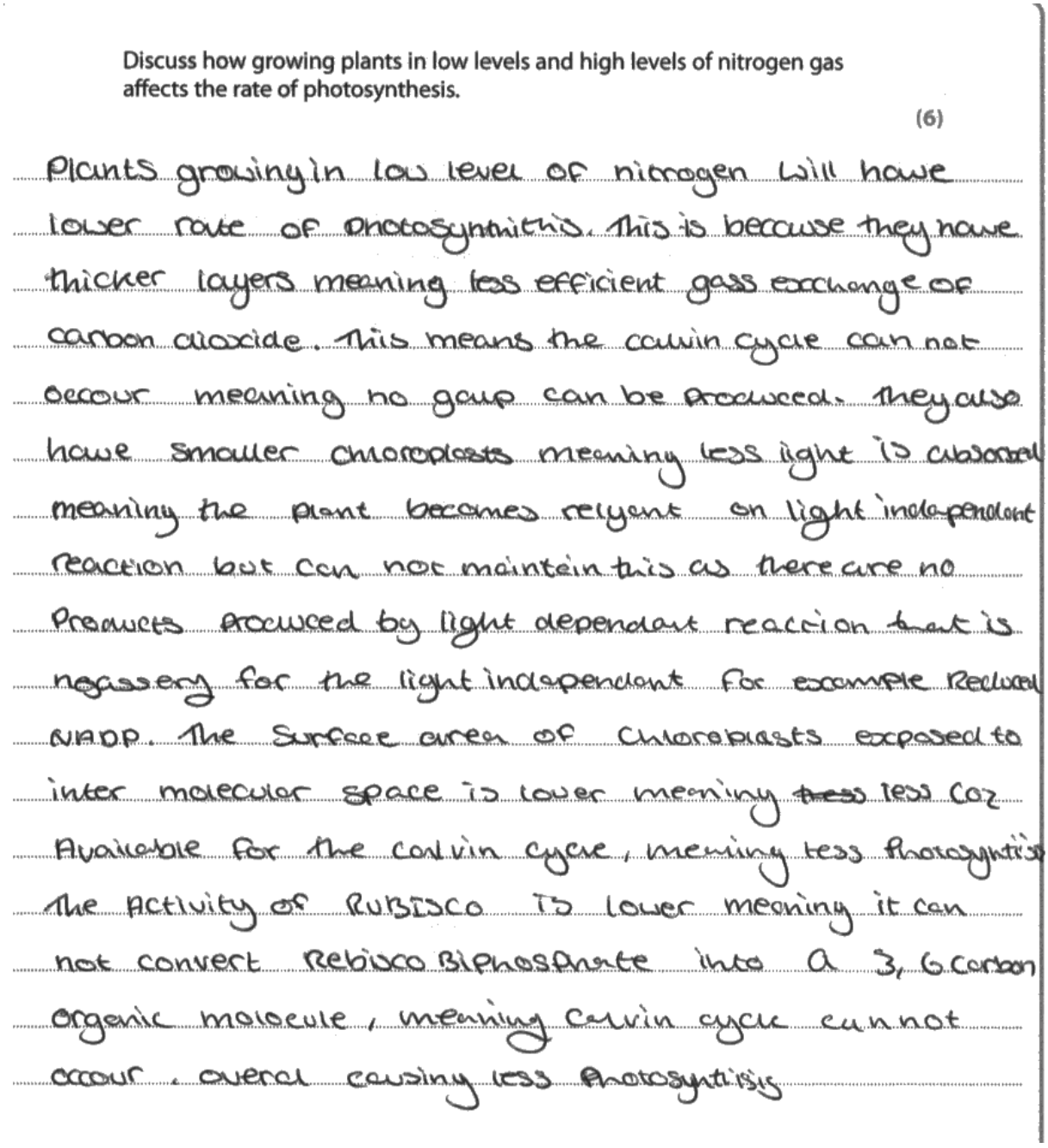
When the tadpole is small oxygen can diffuse through the skin as it has a small surface to volume ratio however when it grows into a frog it cannot primarily rely on this method.

ResultsPlus
Examiner Comments

In this response the candidate gained mark point 1 only. They got confused with surface area to volume ratio and did not relate the lungs to taking in oxygen from the air.

Question 8(b)(ii)

Many candidates were able to describe the patterns that could be seen but did not relate their relevance to the process of photosynthesis. There were some good explanations regarding a drop in the levels of RUBISCO and many could explain the relevance of chloroplast size but often the depth of the layers and area of chloroplasts exposed for gas exchange was not fully explained or was incorrectly related to access to light. A level 3 answer needed to explain these observations in a bit more detail than a simple statement. There was also a significant number of candidates that got distracted by the presence of Nitrogen gas and thought the question was relating to the formation of proteins.



Discuss how growing plants in low levels and high levels of nitrogen gas affects the rate of photosynthesis.

(6)

Plants growing in low level of nitrogen will have lower rate of photosynthiths. This is because they have thicker layers meaning less efficient gass exchange of carbon dioxide. This means the calvin cycle can not occour meaning no gaup can be produced. they also have smaller chloroplasts meaning less light is absorbed meaning the plant becomes relyant on light independent reaction but can not maintain this as there are no Products produced by light dependant reaction that is necessary for the light independant for example Reduced NADP. The Surface area of Chloroplasts exposed to inter molecular space is lower meaning ~~less~~ less Co2 Available for the calvin cycle, meaning less Photosynthis The Activity of RUBISCO IS lower meaning it can not convert Rebisco Biphosphate into a 3, 6 carbon organic molecule, meaning calvin cycle cannot occour, overal causing less Photosynthisis

ResultsPlus
Examiner Comments

This response scored six marks because the candidate has explained each feature in sufficient detail.

ResultsPlus
Examiner Tip

Candidates should aim to describe and explain all the information they are given in a table.

Discuss how growing plants in low levels and high levels of nitrogen gas affects the rate of photosynthesis.

(6)

With a higher level of nitrogen gas, the layers of plants are thicker and the chloroplasts are larger, there is also a greater surface area ~~of~~ of chloroplast exposed. This would imply that with higher N_2 levels, rate of photosynthesis increases as there is larger surface area for reactions to occur, and for CO_2 to diffuse ~~in~~ ~~the~~ into the stroma for the Calvin ~~cycle~~ cycle to ~~be~~ be fixed with RuBP. However, in both low and high levels of N_2 gas, the Rubisco enzyme is less active. This results in lower rate of carbon fixation, ~~and~~ and hence less GP produced at a time and less glucose made in a given time, actually decreasing the rate of photosynthesis. High N_2 increases rate of light dependent reactions, but not the rate of light independent reactions (calvin cycle). Increased rate of LDR because the layers are thicker, so more mesophyll layer, greater area for gas exchange. Thicker leaf surface, more light energy absorbed by photosynthetic pigments.

ResultsPlus
Examiner Comments

This candidate explained 3 aspects in detail but has not explained the relevance of chloroplast size and therefore gained five marks.

Discuss how growing plants in low levels and high levels of nitrogen gas affects the rate of photosynthesis.

(6)

* plants grown in lower levels of nitrogen (N) gas have smaller thickness of layers and size of chloroplast than plants grown in moderate levels. This means that less photosynthesis will occur as the chloroplast will have less ~~chloro~~ photosynthetic pigment to absorb the light
* plants in lower levels of N gas also have a lower surface area of chloroplasts exposed to intercellular air space. therefore they may receive less light
* RUBISCO activity in both plants grown in high and low levels of N gas is lower, which indicates less carbon fixation occuring in light independent reaction therefore less GALP produced and so lower rate of photosynthesis
* Plants grown in high levels of N gas compared to plants in moderate levels have, a larger thickness of layer and size of chloroplast and higher surface area of chloroplasts exposed to intercellular air space which indicates a higher rate of light dependent reaction occuring due to more photosynthetic pigment, which could increase rate of photosynthesis however as light independent reaction is lower rate, the overall rate is likely lower.

ResultsPlus
Examiner Comments

This candidate has explained RUBISCO activity and the size of chloroplasts but got confused trying to explain the other aspects and so gained three marks.

Discuss how growing plants in low levels and high levels of nitrogen gas affects the rate of photosynthesis.

(6)

- The thickness of the layers and size of chloroplasts increase when there is high levels of nitrogen gas because more nitrogen gas is available to be converted into nitrate ions for nucleotides and ~~proteins~~ amino acids for cell growth and division.
- RUBISCO activity decreases in plants grown in high levels of nitrogen gas because there will be lower levels of CO_2, which is one of the substrates for carbon fixing catalysed by RUBISCO.
- RUBISCO activity decreases in low levels of nitrogen gas, because there will be fewer nitrate ions to form RUBISCO. This is also why the thickness of the layers and size of the chloroplasts will be smaller, because there are fewer nitrate ions for amino acids and nucleotides.

ResultsPlus
Examiner Comments

This candidate has got confused by the presence of Nitrogen gas and related this to protein formation but they have successfully described the patterns and given one explanation for RUBISCO. They gained two marks.

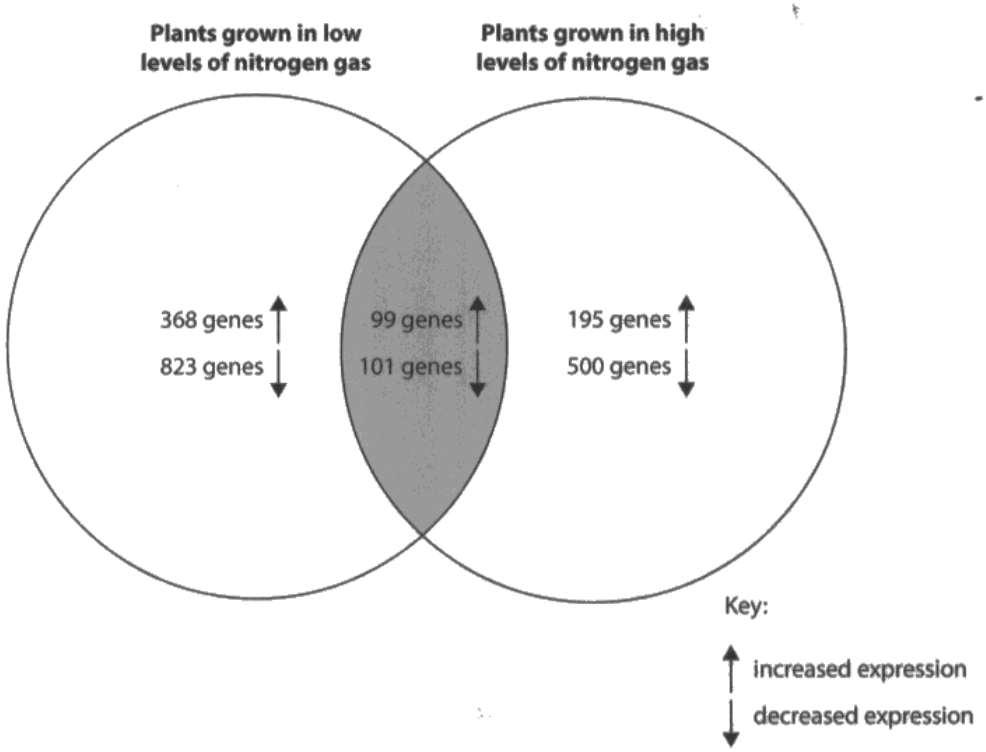
Question 8(c)(i)

This question presented candidates with a Venn diagram displaying the changes in gene expression in plants grown in different levels of Nitrogen gas. As the command word used was determine, one of the marks was allocated to the manipulation of the data supplied. Some candidates struggled to interpret the diagram and thought that the overlap section related to plants grown in medium levels rather than being an indication of the genes that were being expressed or not in the two groups that were tested.

(c) This investigation also studied changes in gene expression in the plants grown in low levels and high levels of nitrogen gas compared with those grown in moderate levels.

The chart shows the results of this part of the investigation.

The shaded area shows the genes that were affected in both groups of plants.



(i) Determine the effect of growing plants in low levels of nitrogen gas and in high levels of nitrogen gas on the changes in gene expression.

(3)

Overall, artificial levels of nitrogen gas impacted 200 genes in both studies. High levels caused 695 unique changes in expression, with ~60% being inhibitory. Low levels of nitrogen led to more unique changes with 1191 unique changes. Overall changes were mostly ~~[illegible]~~ suppressions.

ResultsPlus
Examiner Comments

This is an example of a high scoring response that had clearly manipulated the data to help explain their answer. This candidate explained the overlap in genes expressed between the two groups, that there were more changes in the low level group and that both groups experienced more gene suppression. This response scored three marks.

ResultsPlus
Examiner Tip

The command word determine expects that you will manipulate the data given as part of your answer.

Many candidates scored one mark such as in the example below.

(i) Determine the effect of growing plants in low levels of nitrogen gas and in high levels of nitrogen gas on the changes in gene expression.

(3)

More genes are switch on in plants grown in low levels of N₂ gas

More genes are switched off in plants grown in low levels of N₂ gas.

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Examiner Comments

This candidate described the changes in low levels of Nitrogen gas only.

Question 8(c)(ii)

Many candidates understood which part of the specification this question was referring to and could give several examples of epigenetic modification. However, there was one mark for stating that this was epigenetic modification and one mark for an example of it.

(ii) Describe how gene expression can be changed.

(2)

Gene expression can be changed with epigenetic modification such as ncRNA, histone modification or DNA methylation. This can lead to changes in the proteins made from genes.

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This is an example of a candidate that has gained full marks. The response names epigenetic modification and two examples of it.

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Examiner Tip

Candidates must use the term epigenetic modification, not epigenetics to be awarded marks.

By changing their epigenetics this changes a gene ~~by~~ by switching genes on or off. altering their gene expression

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Examiner Comments

This response gained no marks. This candidate has not quite explained themselves well enough to gain credit for their answer. They need an example of epigenetic modification.

Question 9(a)

This was a compare and contrast question and many gained several marks for this question, despite the context being slightly unfamiliar but as this formed part of the last question of the paper, it was designed to be more demanding. Credit was not given to responses that simply listed the letters of the bases. There was some confusion with the bonds that would hold the individual components together, with some candidates naming hydrogen bonds, instead of phosphodiester bonds.

9 Aptamers are single-stranded DNA or RNA sequences that fold into specific three-dimensional structures.

Aptamers bind tightly to targets such as proteins and viruses.

(a) Compare and contrast the structure of single-stranded DNA with that of single-stranded RNA.

(3)

- DNA has base Thymine but RNA has Uracil instead

- Both have bases cytosine, Guanine, Adenine.

- Both contain phosphodiester bonds.

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Examiner Comments

This response gained full marks and was clearly set out.

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Examiner Tip

Using a linking word such as but or whereas makes the comparison between two molecules very clear.

Single strand of DNA can contains a T base whereas RNA would contains a U base. Both single stranded RNA and DNA contains purine and pyramidine bases. DNA strands and RNA strands and both held together by phosphodiester bonds.

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Examiner Comments

The candidate can identify some differences between the DNA and RNA but the only creditworthy point is the presence of phosphodiester bonds.

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Examiner Tip

A Level candidates are expected to recall the names of bases, not just their letters.

Single stranded DNA is longer than Single stranded RNA. The sugar in Single stranded DNA is deoxyribose and in Single stranded RNA it is Ribose. The bases in Single stranded DNA are Adenine to thymine and Cytosine to guanine whereas in Single stranded RNA, it is Adenine to uracil and thymine to Cytosine. RNA contains uracil, DNA does not.

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Examiner Comments

There was no mark for a comparison of length as we have no indication whether this is relevant in the question. The sugar comparison was correct but the reference to the bases is incorrect and RNA contains Uracil, DNA does not, is not enough to gain a mark. Overall this response gains one mark only.

Question 9(b)

This question assessed candidates on being able to apply their knowledge of PCR in an unfamiliar context. Two of the marks available were targeted at A grade candidates who would be expected to work out that before PCR could be carried out, the single strand of RNA would need to be converted to double stranded DNA using reverse transcriptase and similarly transcription needed to occur after the process. Many could describe at least one key detail of the PCR process, most commonly the temperature change was explained.

(b) Aptamers can be amplified using PCR.

To amplify an RNA aptamer, reverse transcription-PCR (RT-PCR) must be used.

Describe how RT-PCR can be used to amplify RNA aptamers.

(4)

Using reverse transcriptase we reverse the transcription and make DNA from single strand of RNA

Then fragments of this DNA can be cut by endonuclease restriction enzymes

That fragment → put in 90 - 95° (high temperature) → strands unwind

Then add primers at lower temperature of 50°

and then increase the temperature to 65 - 72° add nucleotids and DNA polymerase to be complementary and bind to other parts

→ repeat for multiple times

→ transcribe to get to the RNA again

→ we are going to have a lot of RNA strands.

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Examiner Comments

This is an example of an excellent response. The candidate has included how the strands would be prepared, how RNA strands would be made at the end of the process and given a detailed description of the PCR process. They gained all available mark points.

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Examiner Tip

Questions towards the end of the paper will be harder and will expect candidates to apply their knowledge to unfamiliar situations.

Reverse transcription used in 72°c after breaking Hydrogen bonds at 90-95°c and annealing primers at 50-55°c to join phosphodiester bonds and create more identical DNA.

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Examiner Comments

The candidate has realised that reverse transcription is needed here but have not been clear in what it is needed for. They have described a detail of the PCR process for which they gain one mark.

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Examiner Tip

Learning the details of processes will ensure that some marks are scored.

Question 9(c)

A fair number of candidates did not manage their time well enough to answer this question at all or only gave a very brief and rushed response. This was because it was the last question on the paper. Although the question stated to discuss the advantages and disadvantages of using aptamers, many did not refer to or sufficiently refer to, the data given to gain the higher level marks that were on offer. Four examples of responses have been included to exemplify what low and high scoring responses looked like.

Discuss the advantages and disadvantages of using aptamers to prevent infection with the influenza virus.

(6)

For H_1, H_3, H_5 and H_9 AT3 works the best. For H_7 AT_2 works the best. When the aptamers bind it stops the haemagluttinin from binding to host cells and injecting genetic materials. AT_1 is very weak on all haemaglutinins. However there are no errors bars to see if there is a significant diggerence in the affects of Aptamers on haemaglutinins.

When Investigating the effect of aptamers on the strains of Inglueza virus AT3 was the most effective for Strains W, Y and Z whereas At 2 was the most effective on ~~Se~~ X. Advantage of this is that diggerent Aptamers are effective on diggerent Strains. However there is no errors bars so no significant diggerence. idea if there is a

Also Influenza viruses could mutate to develop diggerent shaped haemagglatinins which are diggerently shaped to Aptamers.

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Examiner Comments

This response scored full marks and demonstrates that you do not have to write volumes in order to access level 3. This response has described 3 patterns from the graph, and explained that viruses will not be able to bind to host cells, that there are no error bars so we cannot tell the significance of the data and that these could be used for different strains of virus but that the virus may mutate and therefore the aptamers may no longer be effective.

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Examiner Tip

Always make use of data provided in level-based questions.

Using aptamers could be advantageous because they bind to the haemagglutinin. AT3 binds the strongest to H1, 3, 5 and 9 while AT2 binds stronger to H7. AT1 does not bind strongly to any. However B binding to these glycoproteins on influenza virus prevent them from binding to the antigens of the host cell. Therefore they cannot invade or infect host cells so the influenza virus cannot replicate its RNA nor replicate itself. Aptamers could also bind to other viruses and prevent their infection. eg. AT3

But overall the aptamers bind less strongly to influenza viruses compared to the haemagglutinins suggesting they're less effective*. This suggests they could bind to other proteins eg protease in the body such as important enzymes which could have dangerous side effects. The influenza virus could also mutate to become resistant to aptamers so it uses a new glycoprotein that aptamers can't bind to.

(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

Furthermore, only 5 haemagglutinins have been tested as well as 4 virus strains.

Also the influenza virus could still infect host cells even if it cannot bind to them via this glycoprotein

* although AT2 seems to bind more strongly to virus X but not Y. So it shows the Aptamers have varying effectiveness to different influenza strains.

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Examiner Comments

This response also gains full marks. There are descriptions of the data, and advantages that the virus will not be able to bind to the host cells so the infection cannot spread. They have stated disadvantages that the aptamers may bind to other molecules and could have unknown side effects and that the virus may mutate so aptamers may not be effective.

(6)

Advantages are that the apatamers will be able to bind to the cell membranes of the host cells and prevent replication of the host cells, thus replication of the virus.

Overall, apatamers bind more strongly to influenza virus than haemagluttinin. - perhaps should get them to bind to viruses.
• AT3 has high strength of binding to H1.

~~Disadvantages of apatamers are~~

Disadvantage is that aptamers act as a selection pressure, which will lead to strains of influenza evolving even further and there be even more strains of influenza from the H investigated.

Should aim to prevent virus from producing viral proteins ~~elsewhere~~ within cell ✓more effective. ~~Don't know~~

(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

Depends on what combination of aptamers are used with what virus and what haemagglutinin - could be effective.

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Examiner Comments

This is a level 1 answer so two marks are scored. The candidate has not described the data in sufficient detail although they have included some relevant detail about mutations and prevention of viral replication.

An advantage is that AT3 is very strong at binding to haemagglutinin, particularly haemagglutinin1. A disadvantage of using aptamers is that AT1 is fairly weak at binding to both haemagglutinin and the influenza virus. A disadvantage of using aptamers to prevent infection of the influenza virus is that the virus can evolve to have properties that don't allow the aptamers to bind, making them useless.

This is a level 1 answer and the candidate gains two marks. There is insufficient reference to the data but some relevant comments are made.

Always give a balanced argument that includes references to the data given.

Paper Summary

Overall, candidates performed slightly better this series in this paper and many were following the instructions given by the command words in the questions. Assimilation of data often proved to be challenging for weaker candidates but many demonstrated a good overall knowledge of the specification points assessed in this paper. It was particularly encouraging to see the process of photosynthesis and the questions requiring application of this knowledge being answered well. Centres are clearly using past paper mark schemes and reports to help candidates to prepare for the final exams, however, candidates still struggle to form conclusions using data and make use of information when supplied in diagram format. The following points have been made in previous reports but are still applicable.

Based on the performance on 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 to answer all multiple choice questions and all questions where they are asked to name a process or molecule.
- 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

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