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Examiners' Report
June 2022

GCE Biology A (Salters-Nuffield) 9BN0 01

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Introduction

Many candidates had a good range of knowledge of many of the aspects of Biology in this paper, but not all of them managed to apply that knowledge to answering the questions. Some of the answers were too vague and general.

Candidates were able to answer questions on the role of organelles in protein synthesis and the effect of mutations on protein synthesis particularly well.

Candidates did not always have a good understanding of the requirements of the different command words eg an explain question will always require a level of reasoning and evidence of linkages.

Many candidates appeared to have a good knowledge of the core practicals but did not put them into the context given.

Question 1 (b)

Most candidates understand that movement against a concentration gradient is active transport and requires energy. The better candidates were able to link this to carrier proteins.

(b) Mineral ions enter the plant through the roots.

Mineral ions in the soil are in lower concentrations than in the vacuoles of root hair cells.

Describe how mineral ions are taken up by root hair cells.

(3)

Mineral ions are taken up by the root hair cells by active transport. This uses ATP, which provides energy as it is against the concentration gradient. Active transport is the movement of molecules from an area of high concentration to an area of low concentration. In addition, it involves carrier proteins for the uptake of mineral ions.

ResultsPlus
Examiner Comments

A clear answer that gains all 3 marks.

ResultsPlus
Examiner Tip

If there are 3 marks, make sure you have 3 points.

soil ..
cell ....

(b) Mineral ions enter the plant through the roots.

Mineral ions in the soil are in lower concentrations than in the vacuoles of root hair cells.

Describe how mineral ions are taken up by root hair cells.

(3)

Mineral ions are taken up by root hair cells by active transport. Mineral ions are charged molecules so they cannot pass through the phospholipid bilayer directly as they will be repelled. Instead, they go through carrier / channel proteins in the membrane from an area of low concentration to an area of high concentration. ATP (energy) is needed

ResultsPlus
Examiner Comments

A well-expressed answer that gains all 3 marks.

Question 2 (b)(i)

Many candidates knew that animals produce methane, although fewer stated that plants remove carbon dioxide from the atmosphere.

It is important to read the command word in a question-explain requires a reason to be given. Candidates will not achieve credit for simply repeating data from the table.

(i) Explain why a diet based on plant protein produces lower greenhouse gas emissions than a diet based on animal protein.

(3)

· Plants produce lower greenhouse gas than animals because they sequester (absorb) carbon dioxide, a greenhouse gas, for photosynthesis. *
· Therefore, when nuts are produced they are carbon neutral whereas animals do not use carbon dioxide for photosynthesis. Animals release methane in belches etc, which is a greenhouse gas contributing to ~~rising~~ global warming

* carbon dioxide is used in the light independent reaction, becoming fixed by RUBISCO to produce GP.

ResultsPlus
Examiner Comments

This response gains 2 marks for stating that plants remove carbon dioxide from the atmosphere and animals produce methane.

Although there is a statement that carbon dioxide is fixed to produce GP, it does not go on to name an organic compound used in growth, so this mark is not awarded.

(i) Explain why a diet based on plant protein produces lower greenhouse gas emissions than a diet based on animal protein.

★, up to 6.5 kg less than some meat products. (3)

The two sources of plant proteins (tofu and nuts) are the two lowest in terms of the mass of greenhouse gases released in production★. This is largely a result of photosynthesis, as plants take in carbon for carbon fixation, and reducing atmospheric carbon levels. The remaining greenhouse gas release is likely to result from transport. Animals, however, release carbon dioxide from respiration and do not photosynthesise. Animals such as cows also release high levels of methane, another greenhouse gas. Therefore, the production of greenhouse gas is significantly higher per animal protein production, suggesting a plant protein diet will result in lower greenhouse gas emissions

ResultsPlus
Examiner Comments

This is a good response that explains the link between photosynthesis and carbon fixation, the release of carbon dioxide in respiration and the production of methane by animals.

It gains 3 marks.

There is no credit for the release of carbon dioxide by transport or machinery because this also applies to the production of plant protein.

Question 2 (b)(ii)

Many candidates gave answers that were too generalised to score highly. This question compared deforested land with natural pastures, so answers related to cattle farming in general were not relevant. Some candidates referred to the use of farm machinery to clear the land, but this is not relevant to the question.

(ii) Beef cattle are traditionally reared by grazing on natural pastures (grassland).

In recent years, large areas of rainforest have been cleared to produce beef.

Explain why the farming of beef cattle on deforested land produces more greenhouse gas emissions than from those reared on natural pastures.

(3)

Deforested land = reduced number of trees which is a big carbon sink. Therefore CO_2 is ~~taken~~ level of take up through photosynthesis is reduced, leaving a greater amount of CO_2 in the atmosphere. Cattle release methane gas as waste → as more farming increases, production of methane via cattle increases.

ResultsPlus
Examiner Comments

This response gains 2 marks for correctly identifying trees as carbon sinks and linking the reduction in photosynthesis and carbon dioxide uptake with the loss of trees.

ResultsPlus
Examiner Tip

Make sure all of your response answers the question.

Cattle release methane regardless of the pasture they are on.

(ii) Beef cattle are traditionally reared by grazing on natural pastures (grassland).

In recent years, large areas of rainforest have been cleared to produce beef.

Explain why the farming of beef cattle on deforested land produces more greenhouse gas emissions than from those reared on natural pastures.

(3)

This is because large areas of rainforest are cleared. This results in deforestation. deforestation involves combustion, which releases CO_2. CO_2 (carbon dioxide) is a greenhouse gas. ~~Using natural pastures does not involve deforestation. Therefore lower greenhouse emissions.~~ In addition, deforestation means that there are less trees to absorb CO_2 in the atmosphere for photosynthesis. This increases the carbon dioxide in the atmosphere.

ResultsPlus
Examiner Comments

This answer gains 1 mark for the release of carbon dioxide by combustion and 1 mark for stating that the removal of trees reduces photosynthesis.

Question 3 (a)(i)

Most marks gained on this question were for linking the depth of the layer with age rather than carbon dating.

Some candidates confused the question with the analysis of pollen in peat bogs as evidence for climate change.

(a) (i) State how the age of the layers in a peat bog can be determined.

(1)

The deeper the peat the older the ~~sa~~layer is.

ResultsPlus
Examiner Comments

One mark for linking the depth in the peat bog to the age of the layer.

(a) (i) State how the age of the layers in a peat bog can be determined.

(1)

Using carbon dahng of pollen

ResultsPlus
Examiner Comments

The mark was given here for carbon dating.

Question 3 (a)(ii)

Many candidates recognised that conditions in the peat bog are anaerobic or that acidic conditions denature enzymes.

Only the better candidates identified both conditions and linked this to respiration and the inability to digest organic material.

(ii) Explain why the conditions in peat bogs prevent decomposition.

(3)

The pH is too low and too acidic for decomposers enzymes to survive. The decomposers' enzymes such as bacteria, would become denatured. waterlogging means that there is not enough oxygen present for decomposers' respiration. so they will die. less enzyme activity means there is less hydrolysis of dead plant and animal matter.

ResultsPlus
Examiner Comments

This candidate has linked the acidic conditions to denaturing of the enzymes and the waterlogging to lack of oxygen. Therefore, decomposers are unable to respire.

It gains 3 marks.

(ii) Explain why the conditions in peat bogs prevent decomposition.

(3)

This is because peat bogs are highly acidic. This preserves the pollen grains in the peat bog as decomposers such as ~~fungi~~ or bacteria are not able to survive and breakdown the pollen grain by secreting extracellular enzymes. The acidic conditions also denature the active sites of the enzymes, so that the organic matter of the pollen grains cannot be broken down

ResultsPlus
Examiner Comments

This response gains 2 marks for linking acidic conditions to denaturing the enzyme, preventing breakdown of the organic material.

ResultsPlus
Examiner Tip

An explain question needs you to make linkages and give a reason.

Question 3 (b)

Most candidates were able to score some marks on this question. A few candidates described the wrong experiment, but successfully described sampling at regular intervals. Some candidates gave a correct account of the use of a quadrat to carry out random sampling but described an investigation they had carried out rather than relating it to the situation they were given.

Devise a procedure to measure the rate of recovery of the peat bog.

(4)

Use a random number generator and use two tape measures to create a $10 \times 10\ m^2$ of the peat bog. Place a $1 \times 1\ m^2$ Quadrat at each coordinate generated and ~~COUNT~~ calculate the percentage cover of Sphagnum moss of the quadrat. This can help work out the rate of recovery. The area of the sphagnum moss covering the quadrat ÷ total area of the field (measured) ×100. Do this for 15 coordinates and record results in a table. Repeat several times and calculate a mean.

ResultsPlus
Examiner Comments

A clear answer that describes the steps needed to obtain the data required.

A practical that the candidate has carried out is modified correctly.

It gains 4 marks.

ResultsPlus
Examiner Tip

When answering a question based on a practical, decide first which procedure it applies to then consider the changes that are required to answer the question.

Devise a procedure to measure the rate of recovery of the peat bog.

(4)

Visit the area of a peat bog. Use two tape measures (10m tape measures) and place them like a ~~grid~~ graph. one line as the x-axis and the other as a y-axis. Use a random number generator from ~~1-20~~ 1-10. make 5 different co-ordinates. walk to the co-ordinate and place a 10 by 10 quadrat. (Each square counting 1% (if small)). count how many sphagnum moss have grown. After 15 years, do the same (repeat) and count the moss. Work out the difference and divide by your initial, amount of moss. ~~plot the rate~~ plot a graph.

same co-ordinates

ResultsPlus
Examiner Comments

This candidate has correctly described the procedure but has not included regular sampling. Although there are 5 quadrats, the mean is not calculated.

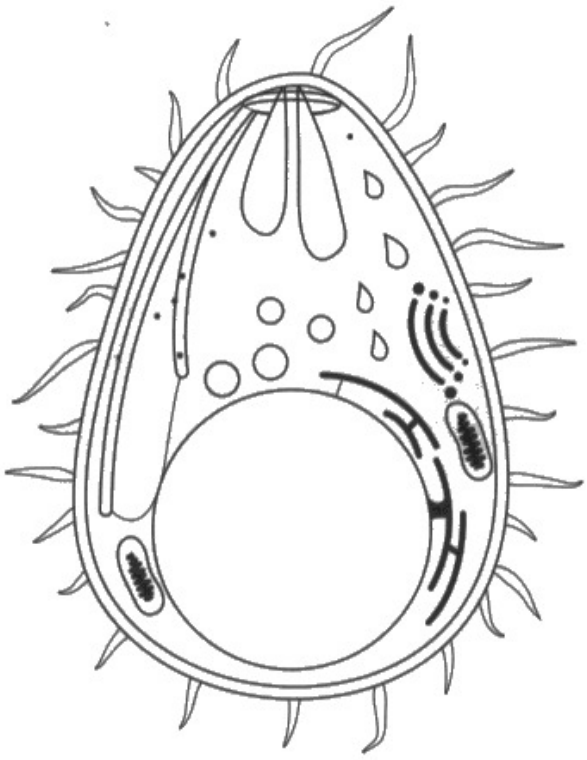
It gains 3 marks.

Question 4 (a)

The command words for this question were 'state' and 'justify'. There was 1 mark for naming 2 organelles and 1 for the justification that they are membrane-bound organelles.

Many candidates correctly identified at least 2 organelles; the better candidates gave a correct justification.

Most candidates understood the difference between Eukaryote and Prokaryote.



(a) State and justify two structures shown in the diagram that indicate that *Plasmodium* is a eukaryotic organism.

(2)

Contains a nucleus which stores genetic material which is membrane bound, whereas prokaryotes have ~~plasmids~~ plasmids.

It also contains a Golgi Apparatus which is used for modifying protein.

It has 80s ribosomes, whereas prokaryotes have 70s ribosomes.

ResultsPlus
Examiner Comments

This response correctly identifies the nucleus and Golgi apparatus and states that they are bound by membranes.

2 marks awarded.

A mark would not have been awarded for the 80s and 70s ribosomes as it is not possible to see this from the diagram.

(a) State and justify two structures shown in the diagram that indicate that *Plasmodium* is a eukaryotic organism.

(2)

Plasmodium is ~~an~~ eukaryotic organism because it contains mitochondria which is a membrane-bound organelle. Plasmodium also contains the ~~goe~~ golgi apparatus used for packaging and organising lipids + proteins.

nucleus ✓
ribosomes ✓
mito ✓
~~nucleoos~~

ResultsPlus
Examiner Comments

This response gains 1 mark for correctly naming the mitochondria and the Golgi apparatus, and 1 mark for stating that they are membrane bound organelles.

2 marks awarded.

Question 4 (b)(i)

Most candidates were able to correctly describe the primary structure of a protein.

A few candidates lost a mark because they said a chain of amino acids, which doesn't give the significance of the order.

(b) Malaria can be controlled by killing the mosquitoes that transmit the disease.

Scientists are genetically modifying *Metarhizium pingshaense*, a fungus that infects mosquitoes.

The genetically modified (GM) fungus contains a gene from a species of spider. This gene codes for a protein that kills mosquitoes.

(i) The GM fungus transcribes and translates the gene for this protein.

Describe the primary structure of a protein.

(2)

A sequence of amino acids held together by peptide bonds.

ResultsPlus
Examiner Comments

Both points are given, gaining 2 marks.

(i) The GM fungus transcribes and translates the gene for this protein.

Describe the primary structure of a protein.

(2)

sequence of amino acids (R groups) in a polypeptide chain. Amino acids joined in condensation reaction to form peptide bonds between amino acids.

ResultsPlus
Examiner Comments

A clear description of the primary structure of a protein gaining 2 marks.

Question 4 (b)(ii)

Most candidates were able to correctly describe the role of organelles in the cell in forming the tertiary structure of the protein. Many went on to describe events after this. This did not lose any marks but did take up time.

(ii) The primary structure of this protein is then converted into a tertiary structure and modified by organelles in the cell.

Describe the role of the organelles involved in these processes.

(5)

The ribosome synthesises the polypeptide, then the polypeptide moves into the RER to get folded into its tertiary structure after which is taken to the Golgi Apparatus by transport vesicles to get chemically modified by adding carbonydrates and lipids. Then the Golgi Apparatus packages the protein into secretory vesicles which take the protein and fuse with the plasma membrane releasing the protein through exocytosis.

ResultsPlus
Examiner Comments

A very good response that gained 4 marks.

ResultsPlus
Examiner Tip

Try not to waste exam time by including information that is not relevant to the question.

(ii) The primary structure of this protein is then converted into a tertiary structure and modified by organelles in the cell.

Describe the role of the organelles involved in these processes.

(5)

In rough endoplasmic reticulum, the protein is folded further into its tertiary structure, e.g. becomes an enzyme as its gets further folded into a globular protein. The protein is then transported by vesicles to the golgi apparatus where the membrane of the vesicle fuses with the membrane of golgi and the protein is released into the golgi by exocytosis. Here, it is adding a lipid to make a glycolipid the protein is further modified and is then packaged into a secretary vesicle. This secretary vesicle then travels to the cell surface membrane and fuses with the cell membrane to release the modified protein by exocytosis.

ResultsPlus
Examiner Comments

A detailed description that gains 4 marks.

Question 5 (a)

Many candidates have a good understanding of the effect of a mutation on enzyme activity.

Only the better candidates were able to link the different R groups to the change in tertiary structure.

5 Porphyria is a life-threatening genetic disease. It is caused by a mutation in the gene coding for an enzyme involved in the production of haem.

In people with porphyria, haem cannot be produced.

(a) Explain why this mutation may prevent the enzyme involved in the production of haem from functioning correctly.

(4)

The mutation results in a change in the base sequence of DNA and (if it results in a frameshift or substitution) a change in the sequence of amino acids. This means there is a change in the triplet code, leading to a change in the primary structure of the protein. This protein may not, therefore, have the correct tertiary structure, Meaning that the active site of this protein / enzyme will be the wrong shape due to the difference in tertiary structure. A change in the active site will mean that the substrate will no longer be able to bind to the enzyme as it will no longer fit. This means the enzyme cannot catalyse the reaction.

→ The mutation may have resulted from an insertion, deletion or substitution of a base in the base sequence of the DNA.

ResultsPlus
Examiner Comments

A detailed account that gains 4 marks.

(a) Explain why this mutation may prevent the enzyme involved in the production of haem from functioning correctly.

(4)

a mutation causes a change in a base on the base sequence, alterons a triplet code, resulting on the production of a different amino acid, which may result in a shorter amino acid sequence being produced if the mutation is a deletion of in a base, due to a stop codon being introduced earlier, The resulting in a change in the primary structure change of an amino acid on the amino acid sequence will result in it having a different R group, resulting in different bondons between amino acids, for example a hydrogen bond rather than disulfide bridges, resulting in a different secondary and tertiary structure, as this is determined by the bondons between amino acids, meaning the protein will not fold correctly into its unique 3D globular shape, meaning the ~~oxygen bondons~~ active site will be the wrong shape, so ~~will be the incorrect shape, so oxygen will be unable to bind~~ will be unable to bind to the substrate, meaning the enzyme will be unable to catalyse the reaction in order to produce the haem group, meaning haemoglobin will not be produced, so oxygen cannot bind to haemoglobin so cannot be transported in the blood around the body to cells, resulting in death.

ResultsPlus
Examiner Comments

This response gives all 5 marking points, including the link between the R groups and the tertiary structure.

It gains maximum 4 marks.

Question 5 (b)(i)

The answer to this question requires both the genotype and phenotype.

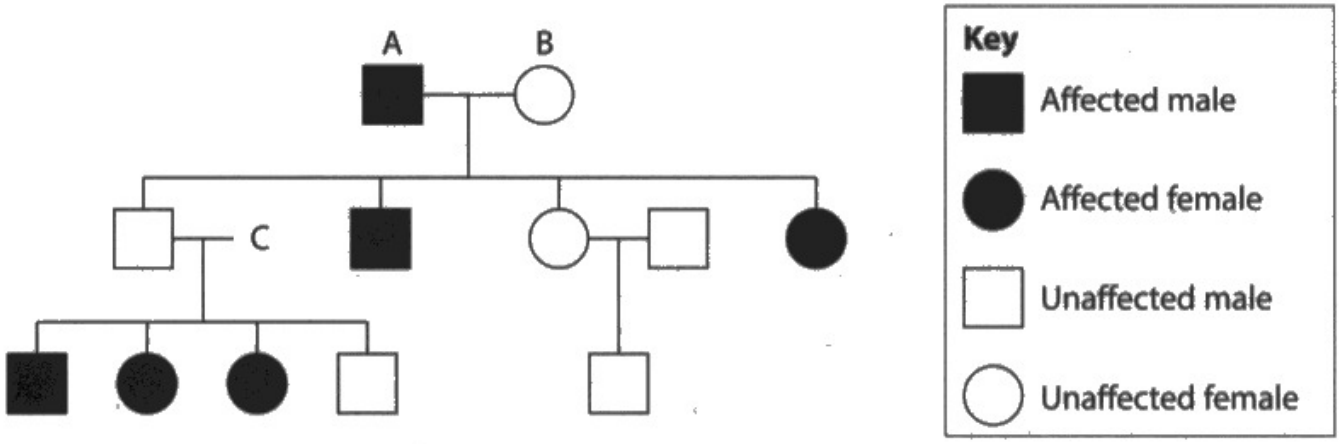
Some candidates seem to confuse genotype with gender.

Some of the responses seemed to be learned responses from a different situation.

Candidates should be encouraged to analyse the information given and use it to determine their answer.

(b) Porphyria is caused by a dominant allele and may not develop until later in life.

The pedigree diagram shows a family in which some individuals have porphyria.



(i) State the genotype and phenotype of person C.

(1)

Affected male heterozygous for Porphyria. (Pp)

ResultsPlus
Examiner Comments

Both parts of the answer are correct for 2 marks.

ResultsPlus
Examiner Tip

Always consider the information you are given and work through it logically.

→ (i) State the genotype and phenotype of person C.

(1)

The phenotype is ~~unaffected~~ affected but the genotype is heterozygous.

ResultsPlus
Examiner Comments

A correct answer gains 1 mark.

Question 5 (c)

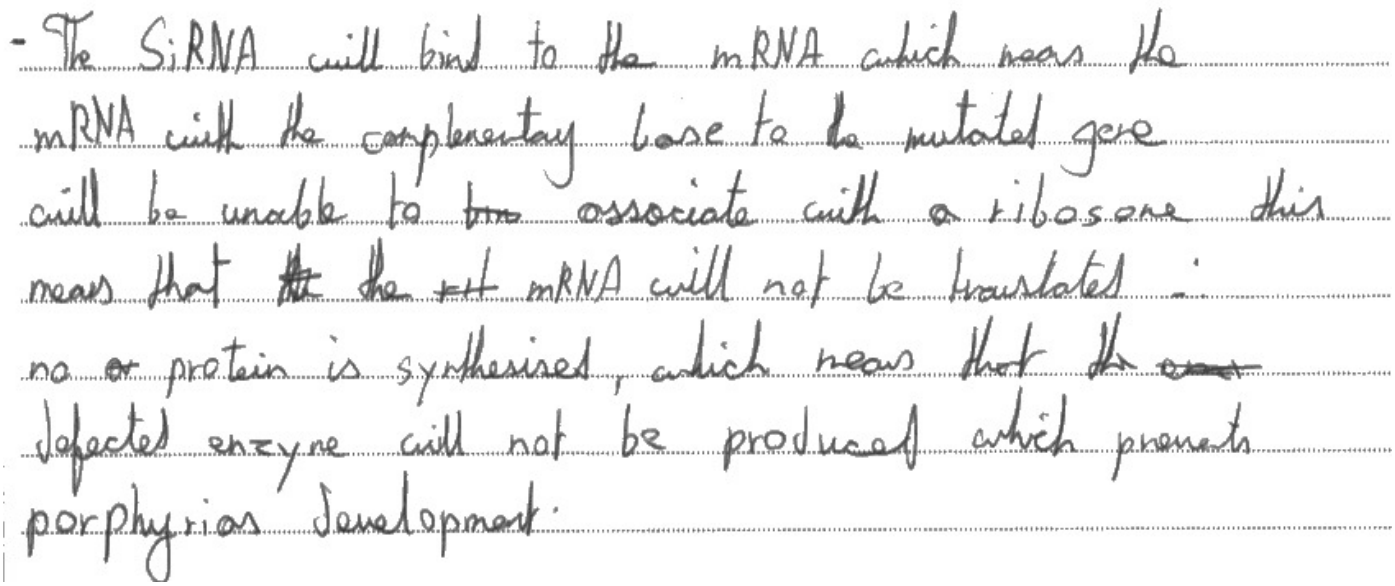
Many candidates understood that tRNA couldn't bind to mRNA and this prevented synthesis of the protein. However, the stem of the question was often repeated. Only the better candidates realised that it was the faulty enzyme that would not be produced.

(c) **A new technique known as gene silencing has been developed to treat this disease.**

Molecules known as small interfering RNA (siRNA) combine with mRNA to prevent translation.

Deduce how siRNA may be used to prevent the development of porphyria.

(4)



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Examiner Comments

A well-constructed answer that clearly explains how siRNA prevents the development of porphyria.

It gains 4 marks.

ResultsPlus
Examiner Tip

Always read the command word. Deduce requires application of the information given.

(c) A new technique known as gene silencing has been developed to treat this disease.

Molecules known as small interfering RNA (siRNA) combine with mRNA to prevent translation. prevent tRNA from bus

Deduce how siRNA may be used to prevent the development of porphyria.

(4)

siRNA may bind to certain places on the mRNA and prevents tRNA from binding* and hence prevents the joining of amino acids by a condensation reaction to form a polypeptide chain, here the protein will not be synthesised. siRNA could also block the nucleotides as a whole to prevent any tRNA from binding. Could also prevent mRNA from being translated by the ribosome.

(Total for Question 5 = 10 marks)

* Occupies the promoter region of the mRNA

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Examiner Comments

This response gains 3 marks, for siRNA binding with mRNA, preventing tRNA from binding, therefore the protein isn't synthesised.

Question 6 (a)

Candidates were asked to draw and label a mitochondrion.

This was not answered as well as expected.

The most common mistake was to draw a triple membrane, with 3 lines.

(a) Draw and label a mitochondrion. (2)

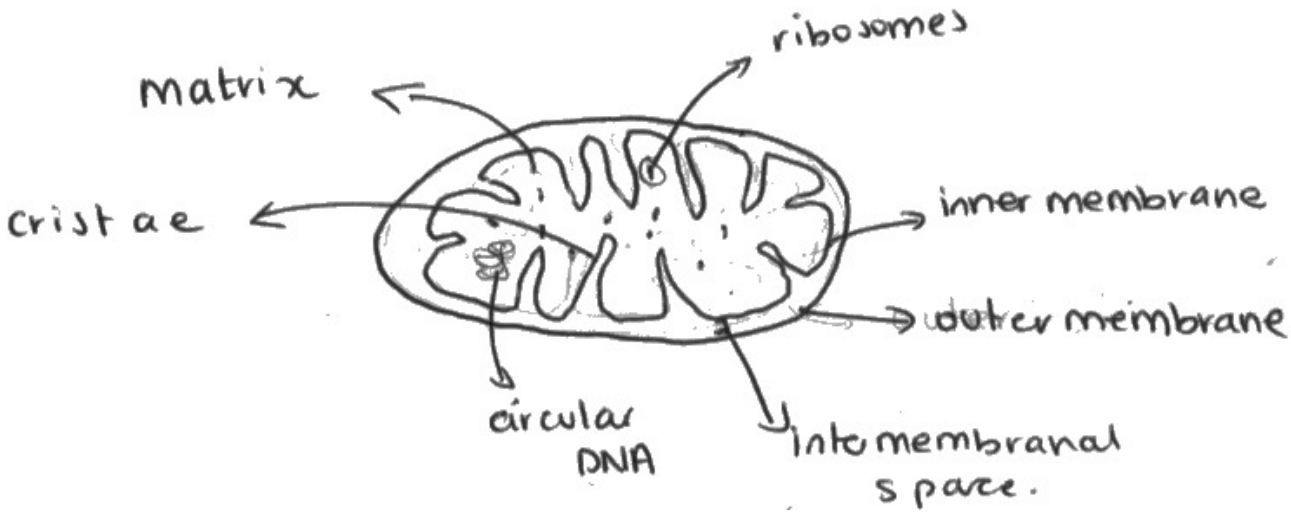


ResultsPlus
Examiner Comments

This gained 1 mark for the drawing, but nothing for the labels as they are incorrect.

(a) Draw and label a mitochondrion.

(2)



ResultsPlus
Examiner Comments

2 marks were awarded here for a clear drawing, well labelled.

Question 6 (b)

Candidates did not score as well as they may have done on this question because the answers were too vague.

A common mistake was to say that the mitochondria are maternal or from the mother.

It is important to state that they are from the egg cell.

(b) Mitochondrial diseases such as Leigh syndrome are passed on by the mother during fertilisation.

Explain why a fertilised egg cell will contain only maternal mitochondria.

(2)

This is because the tail of the sperm which contains paternal mitochondria ~~does not fuse~~ does not fuse with the egg cell, it is cut off therefore only maternal mitochondria can be made.

ResultsPlus
Examiner Comments

This response gains the second mark point for stating that the part of the sperm that contains the mitochondria does not fuse with the egg cell.

ResultsPlus
Examiner Tip

Take care that your answer does not repeat the question. A mark would not be awarded for saying all the mitochondria are maternal.

(b) Mitochondrial diseases such as Leigh syndrome are passed on by the mother during fertilisation.

Explain why a fertilised egg cell will contain only maternal mitochondria.

(2)

During fertilisation, only the ~~new~~ sperms nucleus enters the egg, the remaining organelles of the sperm do not enter the egg cell and are therefore not combined during fertilisation. Therefore the fertilised egg only contains maternal mitochondria.

ResultsPlus
Examiner Comments

2 marks for stating that only the nucleus from the sperm enters the egg, the remaining organelles do not enter.

Question 6 (c)(i)

Many candidates recognised that the mitochondria came from the donor egg cell but few went on to explain that these mitochondria do not carry the mutation.

Some candidates assumed that this question related to transplanting the nucleus from a donor egg cell without realising that the mutation was in the mitochondria, therefore stating that there would be no mitochondrial disease because there was no mutation in the DNA.

(c) Using IVF it is possible to produce an embryo that does not have the mitochondrial disease.

The nucleus is removed from a donor egg cell from another individual.

The nucleus from a fertilised egg from a mother with the mutation is then placed in the egg cell from the donor.

egg nuclei ≠ have mitochondria of mother.

(i) Explain why the resulting embryo does not develop mitochondrial disease.

(2)

- Mothers mitochondria will not be inherited.
- Mothers mitochondria consists of the mitochondrial disease.
- The donors mitochondria will be inherited instead of the mothers mitochondria.

ResultsPlus
Examiner Comments

This response gains 1 mark for recognising that the donor mitochondria are inherited.

(c) Using IVF, it is possible to produce an embryo that does not have the mitochondrial disease.

The nucleus is removed from a donor egg cell from another individual.

The nucleus from a fertilised egg from a mother with the mutation is then placed in the egg cell from the donor.

(i) Explain why the resulting embryo does not develop mitochondrial disease.

(2)

The resulting embryo doesn't contain the mutation because the embryo~~e~~ contains the mitochondria of the donor egg cell.

ResultsPlus
Examiner Comments

1 mark for stating that all the mitochondria are from the donor egg cell.

ResultsPlus
Examiner Tip

Always read the question carefully before you start to compose your answer.

Question 6 (c)(ii)

This 'comment' question requires candidates to distinguish between characteristics contrlloed by nuclear DNA and mitochondrial DNA.

Many candidates confused this with the inheritance of characteristics from the donor via the nucleus, or simply stated that the offspring would inherit all characteristics from the parents.

(ii) Comment on the inheritance of parental characteristics in offspring produced in this way.

(3)

parental characteristics are ~~th~~ inherited as ~~nucle~~ nucleus contains parental ~~gene~~ DNA, ~~ge~~ however genes from mitochondria are not inherited ~~by~~ from mother to child.

ResultsPlus
Examiner Comments

This gains 1 mark for stating that the nucleus contains parental DNA.

Although there is an understanding that the mitochondrial genes are not from the mother, it does not state where they come from or what effect that will have.

(ii) Comment on the inheritance of parental characteristics in offspring produced in this way.

(3)

The ~~genetic mater~~ genetic material in the nucleus is the same as the parents. However, the mitochondrial is not. ~~The same~~ as it's from dad. The offspring will have the same genetic material ~~parental characteristics~~ ~~if mother mitchondrial but everything~~ as parents i.e. characteristics too except the mito chordrial DNA.

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Examiner Comments

This is awarded 1 mark for stating that the genetic material in the nucleus is from the parents. It is too confused to gain another mark.

Question 7 (a)(i)

Most of candidates were able to carry out this % calculation. Some lost a mark because the answer was not given to 3 significant figures.

Year	Number of cases of measles	Percentage of children vaccinated (%)
2012	1564	91.2
2013	1855	92.3
2014	135	92.7
2015	71	92.3
2016	556	91.9
2017	216	91.6

(a) (i) Calculate the percentage change in the number of cases of measles from 2013 to 2014.

Give your answer to three significant figures.

(2)

$\frac{1855 - 135}{1855} \times 100 = 92.7\%$

92.7%

%

ResultsPlus
Examiner Comments

Correct answer gains 2 marks.

Question 7 (a)(ii)

Candidates found this question difficult to answer. Many just repeated the data. One mark was available for selecting correct data to answer the question but as this is an 'explain' question, full marks can only be obtained by making links with the immune system.

(ii) One conclusion from the data is that it takes time for an increase in vaccination rate to reduce the number of cases of measles in children.

Explain why this is a valid conclusion.

(4)

There appears to be a delay of 1 year between a change in vaccination uptake and the number of cases. Between 2012 and 2013, the percentage of children vaccinated increased from 91.2% to 92.3%, whilst the number of cases rose by 291. The following year, the number of cases then fell dramatically, by 712, as a consequence of the increased vaccination uptake. This is because the immunity conferred by the vaccination takes some time to manifest itself, as time is needed for the primary immune response and the production of memory cells to take place.

ResultsPlus
Examiner Comments

This response was awarded 2 marks for selecting examples from the data and explaining that it takes time for memory cells to be produced.

(ii) One conclusion from the data is that it takes time for an increase in vaccination rate to reduce the number of cases of measles in children.

Explain why this is a valid conclusion.

(4)

Vaccinations ~~are~~ are injections of a weakened version of the measles pathogen which stimulates a primary response in the child creating ~~memory cells and~~ B and T memory cells against measles. It takes time for these cells to be produced as magrophages have to become APCs by engulfing the weakened pathogen which trigger the t helper cells which stimulate mitosis to produce memory cells. Additionally once this primary response is had it takes time for the children to catch the contagious disease and be able to fight it off and not get the measles.

ResultsPlus
Examiner Comments

This gains 1 mark for explaining that it takes time for memory cells to be produced. The extra details of the immune response are not relevant to the question.

ResultsPlus
Examiner Tip

Always read the question carefully and select the information required.

Question 7 (b)(iii)

Many candidates produced vague answers that did not make the links needed to score marks. There was much repetition of the stem of the question. Some candidates assumed that it was the measles vaccine that was repeated.

The most common mark was for saying that vaccinations would produce more memory cells.

(iii) Explain why, following a measles infection, it may be advisable for children to repeat other vaccinations they have had.

(3)

- As measles may have affected the bodies immune cells, it destroys B memory cells & antibodies
- This means these B memory cells ~~may no longer be able to~~ are no longer presented, so fasts & ~~protect~~ stronger secondary response cannot occur as the antigen is foreign again & can't be quickly recognised so they must repeat vaccinations to produce more B memory cells
- If not they may lose immunity to certain diseases

ResultsPlus
Examiner Comments

A clear answer that says there is no secondary immune response, vaccination will lead to more memory cells because otherwise immunity will be lost.

3 marks awarded.

(iii) Explain why, following a measles infection, it may be advisable for children to repeat other vaccinations they have had.

(3)

- ~~The~~ By repeating vaccinations, it will prompt a secondary (immune) response in the children and this is a much quiker immune response as memory B cells can quickly produce the complementary antibodies and ~~ret~~ ~~litt~~ ~~im~~repress infection before symptoms are observed
- This means that our immunity is renewed, like a booster jab does and so our body can immediately be ready for reinfection and ~~this~~ vaccination gives artificial active immunity

(Total for Question 7 = 11 marks)

ResultsPlus
Examiner Comments

2 marks awarded for explaining that vaccination will lead to a secondary immune response so antibodies can be produced quickly.

ResultsPlus
Examiner Tip

Make sure that the information in your answer doesn't repeat the stem of the question.

Question 8 (b)

Many candidates understood that the waxy cell wall protects the bacterium and that the bacteria are within tubercles.

Fewer went on to explain why this gives protection.

(b) *M. tuberculosis* bacteria can remain dormant in the body after infection.

Explain why these dormant bacteria are not destroyed by the immune system.

(3)

The dormant bacteria ~~the~~ are sealed in tubercles which have a thick waxy coat and so ~~as~~ they aren't recognised by the immune system. The ~~b~~ TB bacteria prevent the phagocyte they are inside from binding to lysosome, or a result a phagolysosome ~~phagolysosome~~ isn't formed and lysozyme are not secreted, this means the bacteria are not destroyed. The bacteria also prevent antigen representation on the phagocyte (don't form APC), therefore the antigens are not recognised by the immune system.

ResultsPlus
Examiner Comments

A concise answer that gains all 3 marks.

(b) *M. tuberculosis* bacteria can remain dormant in the body after infection. encase in waxy coat tubercules

Explain why these dormant bacteria are not destroyed by the immune system.

(3)

Once TB has entered the lungs this causes an inflammatory response and TB is engulfed by macrophages via phagocytosis. They are then encased in tubercules. surrounded by lymphocytes, ~~However when the~~ which prevent it from leaving and infecting other cells in the body. However when the immune system is compromised e.g. by HIV infection the TB becomes active and leaves the tubercules.

ResultsPlus
Examiner Comments

2 marks awarded for stating that the bacteria are inside macrophages, and they are encased in tubercules.

Question 8 (c)(i)

Many candidates were able to carry out this % calculation correctly.

HIV status	Percentage of people with TB in 2008 (%)	Estimated number of patients with TB who died in 2008	Percentage of deaths due to TB (%)
HIV positive	15	521 700	37
HIV negative	85	1 278 400	16

(i) Calculate the percentage of TB patients infected with HIV who died of TB.

(2)

9.4 million × 0.15 = 1,410,000

$$\frac{521\,700}{1\,410\,000} \times 100$$

37 %



Correct answer-2 marks.

HIV status	Percentage of people with TB in 2008 (%)	Estimated number of patients with TB who died in 2008	Percentage of deaths due to TB (%)
HIV positive	15%	521 700	37%
HIV negative	85%	1 278 400	16%

(i) Calculate the percentage of TB patients infected with HIV who died of TB.

(2)

9400 000

15% 1410000 521700

37 %

ResultsPlus Examiner Comments

Correct answer-2 marks.

ResultsPlus Examiner Tip

Always show your working in a calculation question.

If your answer is correct you will gain full marks, but if you have made a mistake there may still be a mark for your working.

Question 8 (c)(ii)

Very few candidates studied the data in detail, therefore many stated that there were more deaths in people who were HIV positive without referring to the % of deaths, giving an incorrect answer.

(ii) Describe the effect of HIV on the number of deaths from TB. (2)

- A person who is positive for HIV and ~~TB~~ has TB is much more likely to die from TB than someone who is HIV negative but has TB, this is shown as 37% of those who are positive with TB and HIV die whereas in those negative for HIV but positive for TB, it is only 16% (a decrease by 21%).
- This is because HIV weakens the immune system so TB can more easily overpower it, thus causing organ failure and death, explaining the increase in death rate

ResultsPlus
Examiner Comments

1 mark awarded for comparing the percentages.

(ii) Describe the effect of HIV on the number of deaths from TB. (2)

HIV positive increases the ~~number~~ percentage ~~percent~~ of ~~death~~ deaths by TB ~~and H~~ in comparison to HIV negative ~~the~~ which has a lower percentage of death due to TB by more than a half.

ResultsPlus
Examiner Comments

A clearly stated comparison between the % deaths.

1 mark awarded.

Question 8 (c)(iii)

This level-based question required candidates to analyse the 2 sets of data they are given and apply their knowledge of both the action of HIV and the role of T helper cells in the immune system to explain the effects of antiviral drugs. There were many Level 2 answers, with candidates making linkages and analysing both sets of data. Some candidates were able to give evidence of sustained reasoning and application to reach Level 3.

Explain the effect of using anti-viral drugs to treat HIV on the number of deaths from TB.

(6)

by these drugs stop binding of gp 120 receptor to CD4 t-helper cell receptor. This stops the nucleic acids and reverse transcriptase from being released. This stops viral dna to incorporate into genome. This would stop translation of HIV particles. This would lead to less t-helper cells destroyed so they can fight of any infection e.g. tb and not lead to opportunistic disease. t-helper cell more HIV mean more immune responses and t-killer cell activated to release enzymes released to neutralise them. This means less to become dormant and so anti-viral drugs lead to less deaths from tb. (opportunistic death).

ResultsPlus
Examiner Comments

Linkages made between the action of HIV, the effect of antiviral drugs and the increase in T helper cells. An explanation is given of the effect of the increase in T helper cells on the immune system and why this reduces deaths from TB.

A Level 3 answer-5 marks.

ResultsPlus
Examiner Tip

Make sure you use both sets of data when answering a level-based question, otherwise you will be limited to Level1.

Explain the effect of using anti-viral drugs to treat HIV on the number of deaths from TB.

(6)

Antiviral drugs will reduce the number of death from TB. This is because the antiviral drugs reduce viral replication resulting in fewer viral proteins being formed. As a result more T-helper cells will be available to detect antigen presenting macrophages which are formed when a bacterium is engulfed. The CD4 receptors on the T-helper cells will bind to the antigen presenting macrophage which which will stimulate the release of T-helper cells and T-killer cells. This will also result in the activation of B cells which are antigen presenting. The B cells bond to the CD4 receptors on the T-helper cells which stimulates the release of B effector and B memory cells. The B effector cells will undergo clonal expansion and differenciate into plasma cells that will create antibodies. These antibodies can be used to destroy other pathogens which are at risk of killing the patient. Therefore antiviral drugs allows an immune response to occur. This is represented in the graph as the T-helper cells increases by from 100 mm^{-3} to 300 mm^{-3}, the TB incidence decreases by 16.5 au to 5.5 au.

ResultsPlus
Examiner Comments

A Level 3 response that refers to the data, explains the action of the antiviral drugs and links this to the action of HIV and gives a detailed account of the immune response. Linkages are made and there is detailed scientific explanation.

Question 9 (b)

Most candidates were able to explain what an endemic species is. Not all linked it to extinction of this species.

Very few candidates understood the effect of this on global biodiversity. Some thought that protecting species could increase biodiversity.

(b) Biodiversity hotspots have at least 1500 endemic plant species.
These hotspots have lost at least 70% of their natural vegetation.

Explain how protection of these hotspots can affect global biodiversity.

(2)

Protection of these hotspots majorly increases biodiversity as they contain 1500 endemic plant species. These plants are unique to that particular location and not found anywhere else in the world. By protecting them we are increasing the variety of living organisms.

ResultsPlus
Examiner Comments

This gains 1 mark for explaining endemic.

(b) Biodiversity hotspots have at least 1500 endemic plant species.
These hotspots have lost at least 70% of their natural vegetation.

Explain how protection of these hotspots can affect global biodiversity.

(2)

- Endemic means those plant species are only found in that specific place / a habitat / space which in this case is the biodiversity ~~hotos~~ hotspots
- This means that if we lose the natural vegetation in these hotspots, some of these plant species will be completely lost and since they are only found there, ~~the species that~~ will go extinct thus reducing global biodiversity as number of species is reducing
- By protecting these hotspots, you are preventing the loss of vegetation and preventing these species from going extinct, this prevents the reduction of global ~~hotsp~~ biodiversity so the protection will help maintain biodiversity

ResultsPlus
Examiner Comments

2 marks awarded for a clear explanation of endemic and the effect on extinction.

ResultsPlus
Examiner Tip

If a question is about biodiversity, be careful to use maintain where appropriate, not increase.

Question 9 (c)(ii)

A straightforward substitution into the equation that many candidates answered correctly.

(ii) The values from the population in the USA can be taken as the expected values and a χ^2 test can be carried out.

Gene	Allele richness (Finland population) X (observed)	Allele richness (USA population) Y (expected)	X – Y	$(X - Y)^2$	$(X - Y)^2 / Y$
1	6	14	8	64	4.57 ✓
2	4	5	1	1	0.2 ✓
3	7	13	6	36	2.77 ✓
4	7	15	8	64	4.27 ✓
5	6	6	0	0	0 ✓
6	8	12	4	16	1.33 ✓
7	2	3	1	1	0.33 ✓
8	4	4	0	0	0 ✓
9	4	9	5	25	2.78 ✓
10	3	4	1	1	0.25 ✓

Complete the table to calculate the χ^2 value, using the formula

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$(O-E)^2 =$

(3)

Sum of all $\frac{(O-E)^2}{E} =$

Answer 16.5

ResultsPlus
Examiner Comments

A correct answer gaining 3 marks.

Question 9 (c)(iii)

Many candidates could give the correct degrees of freedom and state that chi-squared is less than the critical value, but few went on to explain the relevance of this.

There seems to be a lack of understanding of the null hypothesis.

(iii) The table shows the critical values of chi-squared at different levels of probability.

Degrees of freedom	Probability	
	p=0.10	p=0.05
1	2.706	3.841
2	4.605	5.991
3	6.251	7.815
4	7.779	9.488
5	9.236	11.070
6	10.645	12.592
7	12.017	14.067
8	13.362	15.507
9	14.684	16.919
10	15.987	18.307

Deduce the effect of a small founder population on the allele richness in the population of white-tailed deer in Finland.

(3)

16.5 < 16.919 ∴ the x^2 is less than the critical value, with 9 degrees of freedom (9) at a 5% significance level, therefore there is no difference in allele richness in the popularon of deer in Finland and null hypomeir can be accepted.

ResultsPlus
Examiner Comments

A clearly stated, correct answer that gains 3 marks.

(iii) The table shows the critical values of chi-squared at different levels of probability.

Degrees of freedom	Probability	
	p=0.10	p=0.05
1	2.706	3.841
2	4.605	5.991
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10	15.987	18.307

Deduce the effect of a small founder population on the allele richness in the population of white-tailed deer in Finland.

(3)

- There is no significance that a small founder population affects the allele richness in the population of white-tailed deer in Finland
- I chose probability (16.5) p = 0.05 used degrees of freedom 9. (10-1=9)
- the ~~3~~ value is smaller than ~~16.919~~ the critical value (16.919)

ResultsPlus
Examiner Comments

Correct degrees of freedom, statement of probability and correct understanding of the table.

3 marks awarded.

ResultsPlus
Examiner Tip

When analysing data you are given, look at it carefully, without any expectation of what it shows.

Question 9 (d)

This question concerned natural selection. Most candidates scored at least 1 mark, many scored the 2 marks that were genetic, but full marks on a question such as this require the answer to relate to the context that is given. Candidates had to make the link between heterozygosity index and genetic diversity.

(d) The table shows the heterozygosity index for each population of white-tailed deer.

Heterozygosity index for Finland population	Heterozygosity index for North American population
0.692	0.742

Climate change may affect the habitat of both populations of deer.

Explain which population is more likely to adapt to changing conditions.

(4)

the north american population, as it has a higher heterozygosity index, this means, it has a ~~long~~ less recessive, homozygous phenotypes and is more likely to survive a change in the environment by natural selection. It will have a greater genetic diversity, and more likely to have an advantageous allele, which can be passed down to its offspring and adapt and survive and reproduce better when there is a change in selection pressure by the climate change, on the habitat.



3 marks awarded for greater genetic diversity, more likely to have an advantageous allele and therefore more likely to survive and reproduce.

(d) The table shows the heterozygosity index for each population of white-tailed deer.

Heterozygosity index for Finland population	Heterozygosity index for North American population
0.692	0.742

Climate change may affect the habitat of both populations of deer.

Explain which population is more likely to adapt to changing conditions.

(4)

The north American population is more likely to ~~[illegible]~~ adapt to changing conditions as it has a higher heterozygosity index. This means it ~~is has higher allele frequency and~~ has more genetic variation and diverse gene pool, and so would be more likely to adapt to changing conditions as a larger gene pool means increased chance of having an advantageous allele in the population. The individual possessing the advantageous allele would survive and reproduce, increasing the frequency of the advantageous allele in the population.

ResultsPlus
Examiner Comments

A well-expressed answer gaining all 4 marks.

ResultsPlus
Examiner Tip

Questions relating to natural selection or evolution will always be in a specific context. Make sure your answers relate to that context.

Question 10 (a)(i)

Some candidates only gave either the % or the species, which only gained one mark. A question where the command word is 'determine' will always require a calculation. Therefore, both parts of the answer are required for full marks.

10 Some plants are adapted to grow in shady conditions.

A study was carried out to compare the effect of growing in different light intensities on rates of photosynthesis of plants.

The plants are rated for levels of shade tolerance.

Plant seedlings of nine species were grown in either 25% or 5% of full sunlight. All other abiotic factors were controlled.

These seedlings were grown for six weeks and then exposed to full sunlight for 15 minutes. The rate of photosynthesis was measured during the exposure to full light.

The table shows the results of this investigation for four species of plant.

Species	Shade tolerance	Rate of photosynthesis / a.u.	
		Seedlings grown in 25% of full sunlight	Seedlings grown in 5% of full sunlight
A	Intolerant	410	415
B	Intermediate	300	275
C	Tolerant	180	210
D	Very tolerant	150	215

(a) (i) Determine which species had the greatest percentage change in rate of photosynthesis when grown in lower light intensities.

(2)

(A) → $\frac{(410-415)}{410} \times 100 = -1.22\%$

(B) $\frac{(300-275)}{300} \times 100 = 8.3\%$

(C) $\frac{(180-210)}{180} \times 100 = -16.7$

(D) $\frac{(150-215)}{150} \times 100 = -43.3\%$

Answer species D. -43.3%.

ResultsPlus
Examiner Comments

Both parts of the answer given, gaining 2 marks.

10 Some plants are adapted to grow in shady conditions.

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A	Intolerant	410	415
B	Intermediate	300	275
C	Tolerant	180	210
D	Very tolerant	150	215

(a) (i) Determine which species had the greatest percentage change in rate of photosynthesis when grown in lower light intensities.

(2)

D → $\frac{65}{150} \times 100 = 43\%$ increase

Answer species D.

ResultsPlus
Examiner Comments

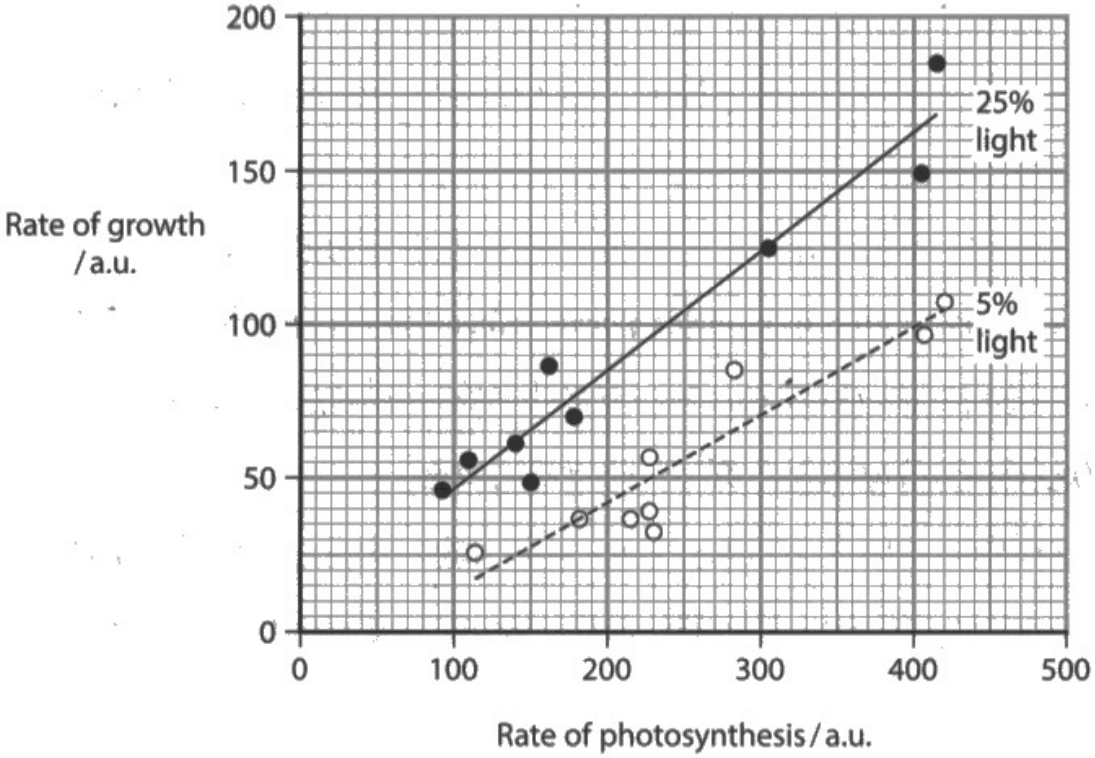
Both parts of the answer can be seen in the answer space, so 2 marks awarded.

Question 10 (a)(ii)

Most candidates gained at least 1 mark for linking the light intensity to rate of growth and many went on to explain the role of light in the light independent reactions. Fewer candidates made the link between growth and the rate of photosynthesis, and very few linked an increase in glucose to respiration.

(ii) The rate of growth for all nine species of plant was also measured.

The graph shows the effects of the rate of photosynthesis on the rate of growth of these plants.



Explain the effect of light intensity during the first six weeks of growth on the growth rate of these species of plant.

(4)

Increase light intensity resulted in a greater rate of growth, due to a greater rate of photosynthesis. Rate of light dependent reaction increases as more light energy excites electrons to a higher energy in photosystems. More electrons are accepted by electron carrier proteins and passed along in a series of redox reactions. The energy lost is used for ATP synthesis, which is needed for the light independent reactions. Electrons combine with hydrogen ions from photolysed water and NADP to form reduced NADP needed for light independent reaction. ~~[illegible]~~ Light independent reaction can occur at greater rate forming more glucose. Glucose used in respiration for growth, so rate of growth increases.

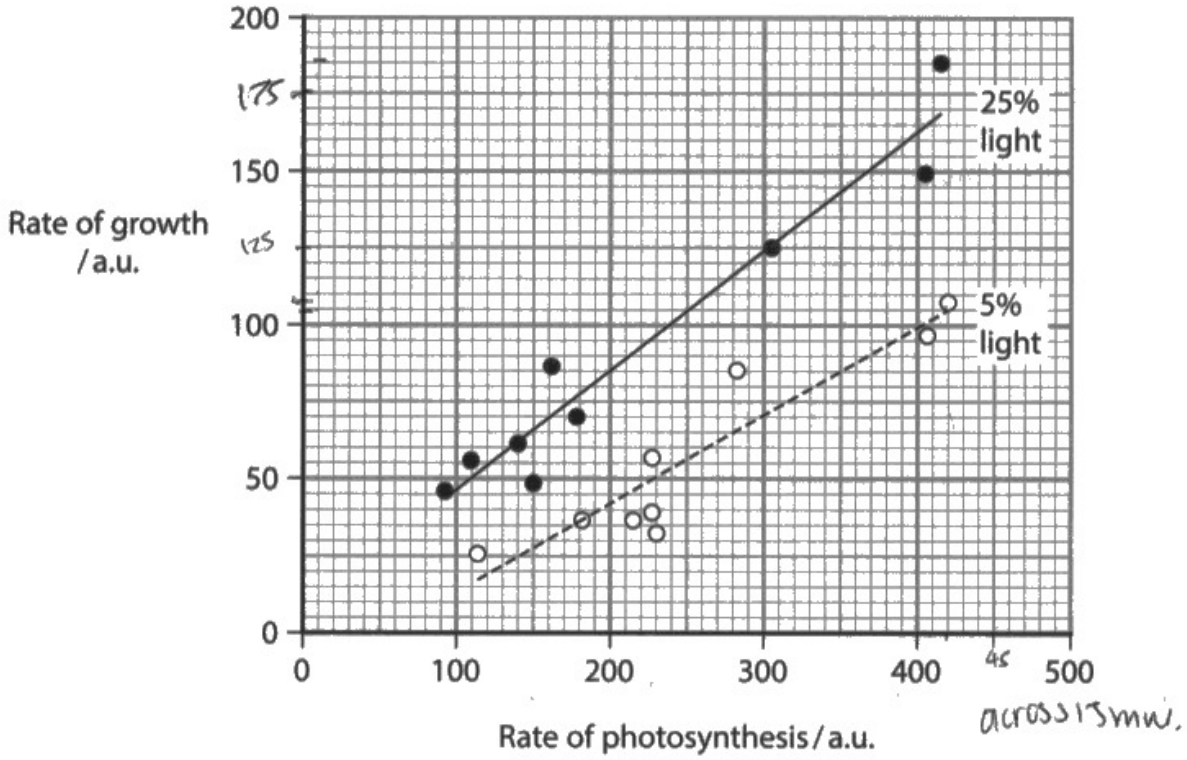
ResultsPlus
Examiner Comments

A good answer gaining all mark points.

4 marks awarded.

(ii) The rate of growth for all nine species of plant was also measured.

The graph shows the effects of the rate of photosynthesis on the rate of growth of these plants.



Explain the effect of light intensity during the first six weeks of growth on the growth rate of these species of plant.

(4)

- plants with a lower light intensity of 5% showed overall a lower growth rate, reaching a maximum of 110 au at 420 au rate of photosynthesis.
- plants with a light intensity of 25% showed a higher rate of growth by reaching a maximum of 185 au rate of growth at 420 au of photosynthesis. This is 75 au rate of growth higher than the plants of lower intensity.
- initially the rate of growth was low for both groups of light intensity at around ~ 50 - 100 au rate of growth.
- the rate of growth was slower/less for plants with lower light intensity as they are undergoing less photosynthesis, therefore produces less products such as glucose from the calvin cycle which need to respire and continue growing.

ResultsPlus
Examiner Comments

Links made between the rate of growth and both light intensity and photosynthesis. An explanation is given of the effect on glucose production.

3 marks awarded.

Question 10 (b)

This level-based question asked candidates to compare the rate of photosynthesis in two types of plant at different light intensities. They were expected to use the Hill reaction.

Many candidates gave a Level 2 answer, using both types of plants at different light intensities, and correctly describing the Hill reaction. The better candidates were able to achieve Level 3.

Candidates who simply described the Hill reaction were limited to Level 1 as they were not modifying the investigation or making any linkages or scientific reasoning.

*(b) Differences in the rate of photosynthesis may be due to the light-dependent reactions in chloroplasts.

Devise an investigation to compare the rate of the light-dependent reaction in shade tolerant and shade intolerant plants grown at different light intensities.

(6)

Shade intolerant

Have 5 different plant seedlings that are all genetically identical and use a pestle and mortar to grind up their leaves and add a buffer sucrose solution and centrifuge this in a cuvette. Remove the supernatant and add the buffer solution again to these cuvettes and centrifuge again. Add 3 drops of DCPIP into each cuvette and keep one in the shade and keep the other 4 at different distances away from a bench lamp such as (5cm, 10cm, 15cm, 20cm). Leave them for 24 hours and pass each cuvette through a colorimeter and measure the absorbance. The one in the dark should remain blue and a have 100% absorbance. Plot a graph of absorbance against % transmission. Repeat this for the shade tolerant plants. The results should be the opposite. DCPIP acts as the oxidising agent as it turns the solution colourless as it itself is reduced (like NADP in the light dependent reaction). centrifuging isolates the chloroplasts and the plants chlorophyll.

ResultsPlus
Examiner Comments

A response that correctly describes using the Hill reaction on the two types of plants at different light intensities. Factors that need to be identified are clearly described. The role of DCPIP is explained.

Level 3 – 5 marks

*(b) Differences in the rate of photosynthesis may be due to the light-dependent reactions in chloroplasts.

Devise an investigation to compare the rate of the light-dependent reaction in shade tolerant and shade intolerant plants grown at different light intensities.

(6)

~~Grind extract of the plants~~ get a 5g extract of the shade tolerant ~~plant~~ and place it in a centrifuge. decant the aqueous layer at the top leaving the isolated chloroplast underneath. Then decant this solution into 6 test tubes of equal volume. place a ice cold, buffered sucrose solution ($30cm^3$) in each of the tubes to inhibit enzyme activity and maintain the osmotic pressure (remains isotonic) Then, ~~expose each test tube to different light~~ and add $10cm^3$ of DCPIP to each test tube. expose each test tube to different light intensities (keep 1 test tube in the dark as a control) and then check whether the DCPIP remains blue or has turned colourless. Measure the relative absorbance using a colourimiter and then record results in a table. Repeat for shade intolerant to determine the rate of light ~~dependent~~ dependent reaction, higher absorbance - higher rate.

ResultsPlus
Examiner Comments

A good level 2 answer.

4 marks.

Paper Summary

Based on their performance on this paper, students should

- make sure they are familiar with the command words used in the question
- use the command word when formulating their answer
- read the question carefully and select the information needed to answer it, putting your knowledge into the correct context
- do not just repeat the data they are given-this will not gain any credit
- level based questions require analysis of both sets of data given-make sure you refer to them both in your answer.

Grade boundaries

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