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Examiners' Report
June 2023

GCE Biology B 9BI0 02

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June 2023

Publications Code 9BI0_02_2306_ER

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Introduction

The examiners all commented on the high quality of many of the exam scripts. Many candidates and centres had clearly prepared very well for the examination and had worked very hard. Most candidates showed good factual knowledge of most topics and wrote answers that were detailed and contained information that was of an A level standard. Some candidates underestimated the level of detail needed and tended to lack confidence using key scientific vocabulary. It is important to use all vocabulary accurately. Mathematical skills were generally very good, and most candidates seemed to have made every effort to work through all the mathematical requirements in the specification. Some candidates confused the demands of the different command words, for example, a common error was to give descriptions of data instead of giving explanations. The revised specifications have more emphasis on data handling and analysis, and it was pleasing to see that many candidates were confident when applying their knowledge to unfamiliar concepts. Some candidates still lack confidence when handling data and should be encouraged to practice as much data handling as possible prior to the examinations. The longer, six-mark questions were generally answered very well, and the examiners thought that the way that candidates now approach these questions is much improved compared with previous sessions. Overall, the examiners thought that the standard was very good, and candidates and centres should be commended for their hard work. Where candidates did less well, it was typically due to underestimating the depth needed at A level or lacking confidence when applying their knowledge to unfamiliar data series. During the exam, it is important for candidates to pace their work so that they do not get left short of time. When answering questions, they should be guided by the mark allocation rather than trying to ensure that they fill every line.

Question 1 (b)

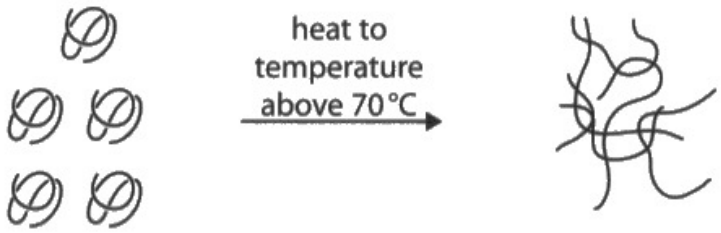
This question presented candidates with a scenario about the effect of high temperature on the structure of egg white albumin protein. Many strong answers were seen that gained at least two marks, but fewer went on to gain all three. Most candidates recognised that proteins denature with higher temperature, and many went on to explain that this denaturation is due to the breakage of bonds such as hydrogen and ionic bonds. A significant number of candidates incorrectly suggested that covalent bonds such as disulfide and peptide bonds would also break. Fewer candidates explained that hydrophilic, charged amino acids would be on the outside of the proteins due to interactions with water and that after heating, the hydrophobic amino acids would be exposed so that they tend to associate together. The question stem stated that there were both polar and non-polar amino acids present – candidates should always be aware that information in a question is usually given for a reason.

(b) Raw egg white is a liquid containing dissolved ovalbumin, a globular protein.

Ovalbumin has some amino acids with polar R-groups and some amino acids with non-polar R-groups.

If raw egg white is heated to a temperature above 70 °C, it irreversibly changes into a solid.

The diagram shows how the structure of ovalbumin changes when heated.



ovalbumin in raw egg white

ovalbumin in solid egg white

Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid.

(3)

It is because if you heat a protein up to 70°C, the structure of the protein changes as it is getting denatured. The egg white

ResultsPlus Examiner Comments

This answer gained one mark for the idea that protein denatured. No further detail was given.

ResultsPlus Examiner Tip

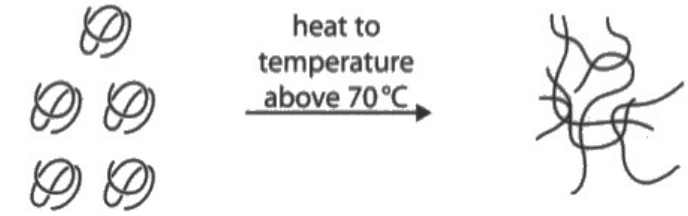
When referring to denaturation, always state which bonds are broken.

(b) Raw egg white is a liquid containing dissolved ovalbumin, a globular protein.

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ovalbumin in raw egg white

ovalbumin in solid egg white

Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid.

(3)

When the ovalbumin is heated above 70°C, the globular protein (soluble structure because it's hydrophilic on the outside, and has a circular structure) looses it's bonds between the R groups present in the molecule (broken down by high temperatures) (Hydrogen bonds, disulphide, ionic bonds), so it looses it's tertiary structure and ~~the~~ so it's R-groups are no longer polar, so it cannot form hydrogen bonds with water to dissolve in it, therefore it becomes insoluble, and becomes ~~a~~ solid, ~~a~~ non circular structure.

ResultsPlus
Examiner Comments

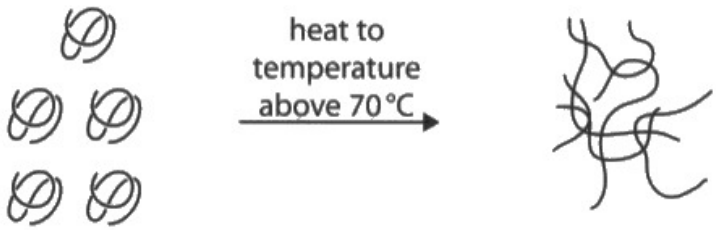
This answer gained three marks. The candidates states that hydrogen bonds are broken leading to the loss of tertiary structure and also states that the hydrophilic amino acids are dissolved in water on the outside. There are a few confused aspects in the answer but the three points are not negated.

(b) Raw egg white is a liquid containing dissolved ovalbumin, a globular protein.

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If raw egg white is heated to a temperature above 70 °C, it irreversibly changes into a solid.

The diagram shows how the structure of ovalbumin changes when heated.



ovalbumin in raw egg white

ovalbumin in solid egg white

Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid.

(3)

when the substance ovalbumin is exposed to high temperatures its structure changes. Proteins are enzymes so this can be considered an example of an enzyme denaturing because it is at a point beyond its optimum temperature. The tertiary structure is diminished and the coils of ~~proteins unwind~~ amino acids unwind. This is an irreversible change so once an egg white is cooked, it turns solid and cannot be restored to its initial liquid form.

ResultsPlus
Examiner Comments

This answer gained one mark for the idea of denaturation.

Question 2 (b)

This maths question required candidates to calculate the volume of protein digested. Candidates needed to calculate the volume of the cylinder before and after incubation. The volume digested was calculated by subtracting the initial volume by the final volume. The answer also required units to be converted from cm into mm and the answer given to two significant figures. Many strong answers completed the calculation to gain all three marks. Common errors where candidates did not gain full credit were:

- only calculating the volume of the cylinder at the end.
- not giving the answer to two significant figures.
- incorrectly converting units from cm into mm.

(b) A student investigated the digestion of gelatine protein by pineapple juice.

This is the method used.

Step 1: Make a solid disc of gelatine protein, with a depth of 1 cm, in a Petri dish.

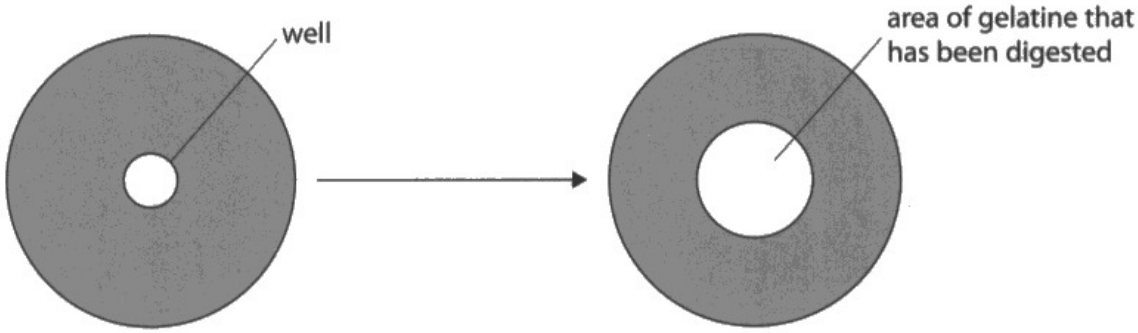
Step 2: Cut out a circular well with a diameter of 2 cm in the centre of the disc.

Step 3: Fill the well with pineapple juice.

Step 4: Incubate the dish for one hour at 37 °C.

Step 5: Measure the diameter of the area that has been digested by the bromelain enzyme.

The diagram shows a gelatine disc before and after incubation with the pineapple juice.



The diameter of the circular area that had been digested after one hour was 6 cm.

Calculate the volume of gelatine that had been digested.

Give your answer, in mm^3, to two significant figures.

Volume of a cylinder = $\pi r^2 l$

$\pi = 3.14$

(3)

Volume of digested area : $3.14 \times 30^2 \times 10 = 28260 mm^3$

Volume of well : $3.14 \times 10^2 \times 10 = 3140 mm^3$

$28260 - 3140 = 25120 mm^3$

Answer 25120 mm^3

ResultsPlus
Examiner Comments

This answer gained two marks. The volumes, unit conversion and subtraction have been calculated correctly but the answer was not given to two significant figures.

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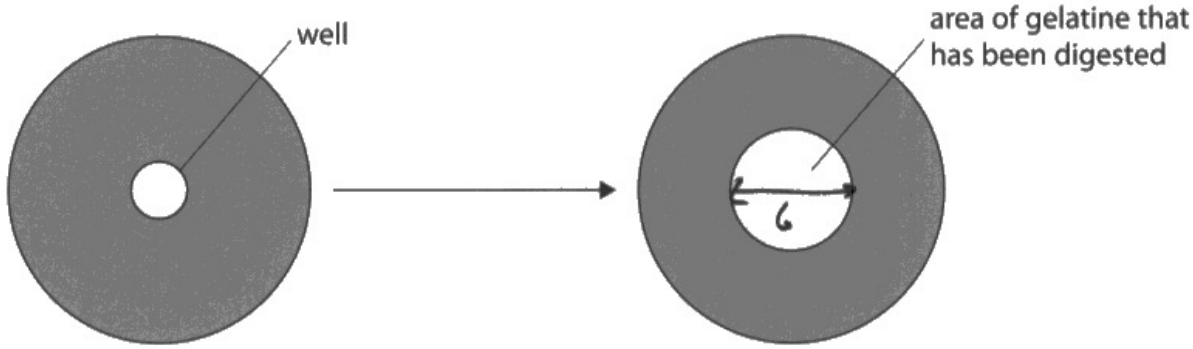
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Calculate the volume of gelatine that had been digested.

Give your answer, in mm^3, to two significant figures.

6 → 60
cm → mm

Volume of a cylinder = $\pi r^2 l$

$\pi = 3.14$

(3)

V = $3.14 \times 30^2 \times 10$

d = 60 mm
r = 30 mm
l = 10 m

Answer 28260 mm^3

ResultsPlus
Examiner Comments

This answer gained one mark. The final volume has been calculated but the initial volume has not been calculated.

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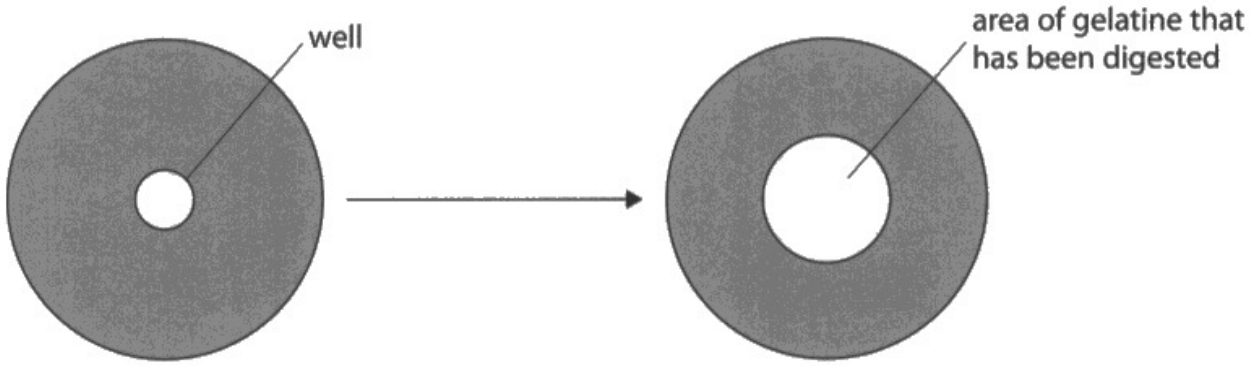
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The diameter of the circular area that had been digested after one hour was 6 cm.

Calculate the volume of gelatine that had been digested.

Give your answer, in mm^3, to two significant figures.

Volume of a cylinder = $\pi r^2 l$

$\pi = 3.14$

1 cm = 10 mm

$\pi(1)^2$

$\pi(1)^2 \times 1 = 3.14$

$\pi(3)^2 \times 1 = 28.26$

$\pi(10)^2 \times 10 = 3160$

$\pi(30)^2 \times 10 = 28260$

$28260 - 3160 = 25120$

(3)

Answer ~~25120~~ 25000 mm^3

ResultsPlus
Examiner Comments

This correct answer gained all three marks. All the working is very clear – this is an example of good practice as even if the final answer is incorrect, some credit may be gained from the working.

ResultsPlus
Examiner Tip

Always show working for calculations – you may get some credit even if the final answer is incorrect.

(b) A student investigated the digestion of gelatine protein by pineapple juice.

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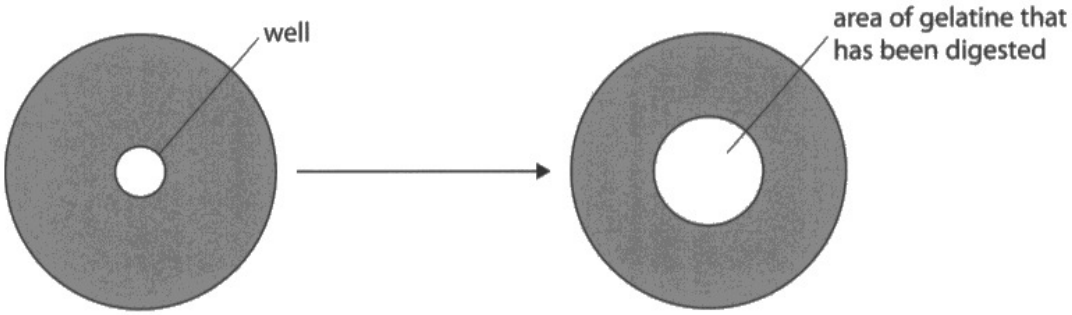
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Calculate the volume of gelatine that had been digested.

Give your answer, in mm^3, to two significant figures.

Volume of a cylinder = $\pi r^2 l$

$\pi = 3.14$

Before incubation:

$\pi \times r^2 \times l$

$\pi \times 10^2 \times 10 = 1000\pi$

$9000\pi - 1000\pi = 8000\pi$ (3)

After incubation

$\pi \times r^2 \times l$

$\pi \times 30^2 \times 10 = 9000\pi$

Answer 25,000 mm^3

ResultsPlus
Examiner Comments

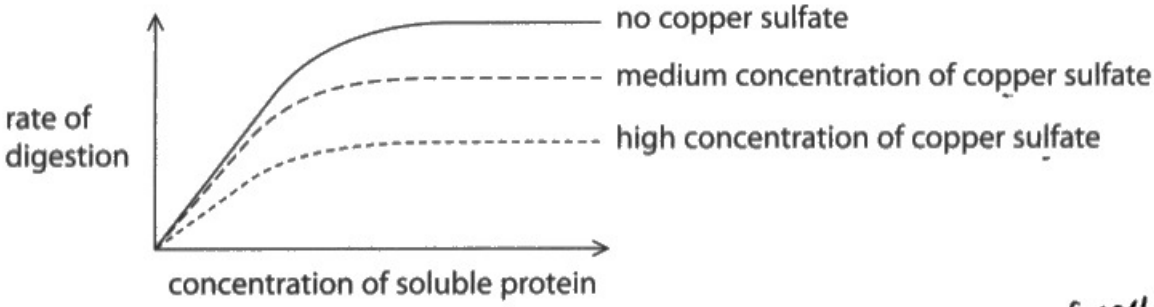
This is another good example of a correct answer that gained all three marks. The working is very clear.

Question 2 (c)(i)

This question assessed the candidates knowledge of the effect of increasing substrate concentration on enzyme activity. Strong answers described the increase in rate, followed by the levelling off and went on to explain that increasing the substrate concentration increases the rate due to more enzyme-substrate complex formation and the rate levels off when the enzyme concentration becomes limiting. Weaker answers tended to just give descriptions and some candidates did not read the question carefully and compared the rates at different concentrations of copper sulfate.

(c) Bromelain also digests other proteins.
The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.



(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein.

(2)

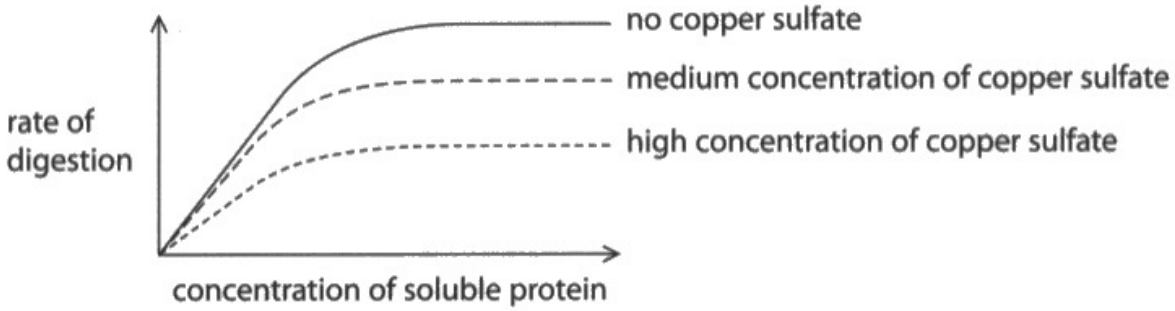
→ initialy increasing substrate concentration increases the rate of digestion as there are more substrate molecules which can form more enzyme-substrate complexes with enzyme bromelain so there is an increased chance → so more protein is hydrolysed and peptide bond broken.
→ but rate of digestion eventually plateus even with increasing substrate concentration because the concentration + number of enzymes becomes a limiting factor as all the active sites

ResultsPlus
Examiner Comments

This is an excellent answer that gained both marks. There is a clear description of the increase in rate and levelling off and explanations given for the increase and levelling off.

(c) Bromelain also digests other proteins.
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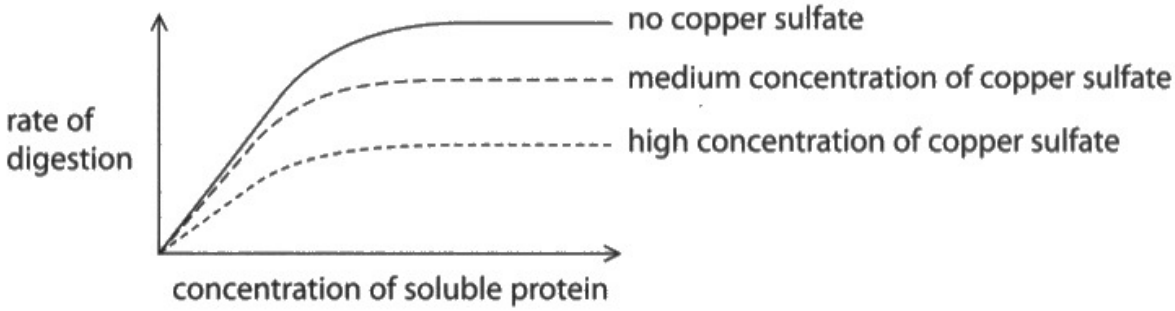
The rate of digestion increases with the concentration to a point where it no longer rises. This is due to all the active sites, bon of the Bromelain being bonded to a soluble portion at any one time.

ResultsPlus
Examiner Comments

This answer gained two marks. There is a description of the increase and level off and the candidate goes on to explain that the rate levels off as all the active sites are occupied.

(c) Bromelain also digests other proteins.
The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.



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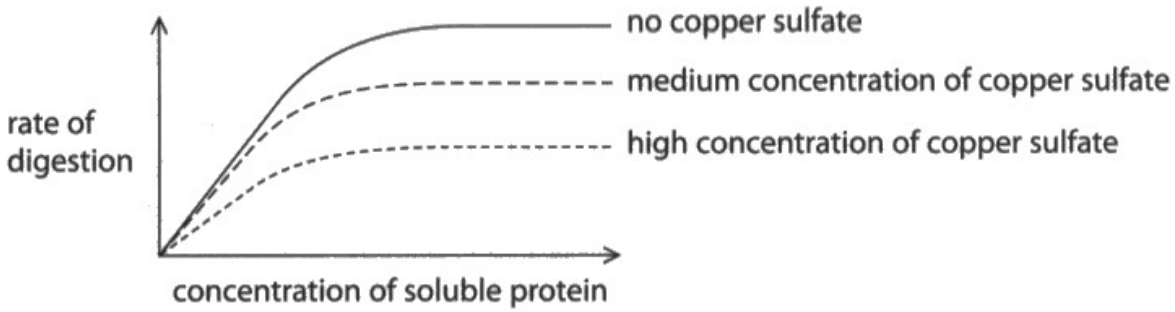
Increasing substrate concentration increases the rate of reaction and so the rate of digestion, but this then levels off as the substrate has been used up.

ResultsPlus
Examiner Comments

This answer gives a correct description for one mark but there is no correct explanation for the levelling off.

(c) Bromelain also digests other proteins.
The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.



(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein.

(2)

The the rate of digestion increases the concentration of soluble protein also increases and then levels off. This is because as it increases enzyme-substrate compleres are being formed, and when it levels off, there are ~~no~~ no available enzymes or substrates. Increasing substrate concentration means the rate of digestion increases as substrates are more likely to come into contact with enzymes.

ResultsPlus
Examiner Comments

This is an excellent answer that gained both marks. There is a clear description and the candidate clearly explains both the increase in rate and the levelling off.

Question 2 (c)(ii)

This question presented candidates with the effects of adding different concentrations of copper sulfate on the rate of digestion of protein by the enzyme. Most candidates recognised that the copper sulfate was acting as an inhibitor although a significant number incorrectly stated that it was a competitive inhibitor or stated that it was either competitive or non-competitive. The rate never reaches the maximum rate even when there is a high concentration of substrate so that the inhibitor would not be competitive. Strong answers explained that the copper sulfate would cause a change in the shape of the enzyme so that the substrate would no longer fit into the enzyme's active site. Some candidates gave very impressive answers correctly referring to allosteric binding and how it changes the active site shape. Weaker answers tended to give vague descriptions of the results.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

(2)

As the concentration of copper sulfate increases, the rate of digestion decreased, this is shown by a less steep line of the graph. Furthermore as concentration of copper sulfate increased the graph flattened ~~out~~ faster this can suggest that copper sulfate acts as an inhibitor so that substrates do not bind to the enzyme.

(Total for Question 2 = 8 marks)

ResultsPlus
Examiner Comments

This very good answer gained two marks. The candidate states that the copper sulfate is an inhibitor and prevents the substrate from binding with the enzyme.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

(2)

Increasing the concentration of copper sulfate ~~increased~~ decreased rate of digestion ~~fast~~ and at higher concentrations of $CuSO_4$, the rate became even slower because $CuSO_4$ acts as a non-competitive inhibitor and binds to the allosteric site which changes the shape of the active site and prevents the ~~enzyme~~ substrate from binding to the enzyme so the rate of digestion reached a lower maximum at higher concentration

ResultsPlus
Examiner Comments

This excellent answer gained both marks. The candidate clearly states that the copper sulfate is a non-competitive inhibitor and binds to allosteric sites.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

(2)

Copper sulfate acts as a non-competitive inhibitor limiting the rate ~~of~~ at which digestion of ~~copper sulfate~~ bromelain occurs

ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating that copper sulfate is a non-competitive inhibitor.

Question 3 (a)(ii)

This question required candidates to calculate the width of a cell when given the diameter of the image and the magnification. The question also required a unit conversion and the final answer to be given to one decimal place. Most candidates were able to gain at least one mark with many gaining both. The main error was incorrectly converting between cm and micrometres. Candidates should be fully familiar with how to convert between units.

(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (μm), of cell X.

Give your answer to one decimal place.

(2)

0mm ×1000 8000 µm



$m = \frac{S}{AS}$

$\text{actual} = \frac{\text{size}}{\text{mag}} = \frac{8000}{1500} = \frac{16}{3}$

$= 5.3\dot{3}$

Answer 5.3 µm

ResultsPlus
Examiner Comments

This is a good answer that scores two marks. The candidate has also shown all their working clearly.

(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (μm), of cell X.

Give your answer to one decimal place.

(2)

$M = 1/A$ $A = 1/M$ ×1000

$= \frac{0.8}{1500} = 0.00533$

0.00533mm = 0.53μm 0.5

Answer ..... μm

ResultsPlus Examiner Comments

This answer gained one mark for a correct magnification calculation but the final answer is wrong due to an incorrect unit conversion.

(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (μm), of cell X.

Give your answer to one decimal place.

(2)

$A = \frac{I}{m} = \frac{0.8}{1500} = 5.33 \times 10^{-4}$ cm

$= 5.33 \times 10^{-6}$ m

$\therefore = 5.33$ μm

1 m = 1×10^{6} μm

Answer 5.33 μm

ResultsPlus Examiner Comments

This answer gained one mark. The calculation is correct but the final answer has been given to two decimal places.

Question 3 (b)(i)

This question was well answered and most candidates were able to interpret the histogram to determine the correct number.

Question 3 (b)(ii)

This question discriminated well generating a wide range of scores. Candidates were presented with unfamiliar data regarding the percentage of DNA damage in sperm and the risks of pregnancies not going to term. Candidates were then asked to evaluate whether the data and investigation supported a conclusion. With evaluation questions, full marks cannot be awarded if only one side of the argument is given. Strong answers often stated that there was a higher percentage of sperm with more than 25% DNA damage associated with pregnancies not going to full term and that when there was little DNA damage, there was a high chance of pregnancies going to full term. Stronger answers also went on to consider the investigation and often referred to other factors that may affect the pregnancies, such as maternal health and the unevenness of the group sizes. Weaker answers tended to get one or two marks, often for a description of how the data supported the conclusion and / or one reason why the investigation may not be fully valid.

(b) Some pregnancies do not develop to full term, so no baby is born.

Damage to the DNA of sperm is thought to be one cause of pregnancies not developing to full term.

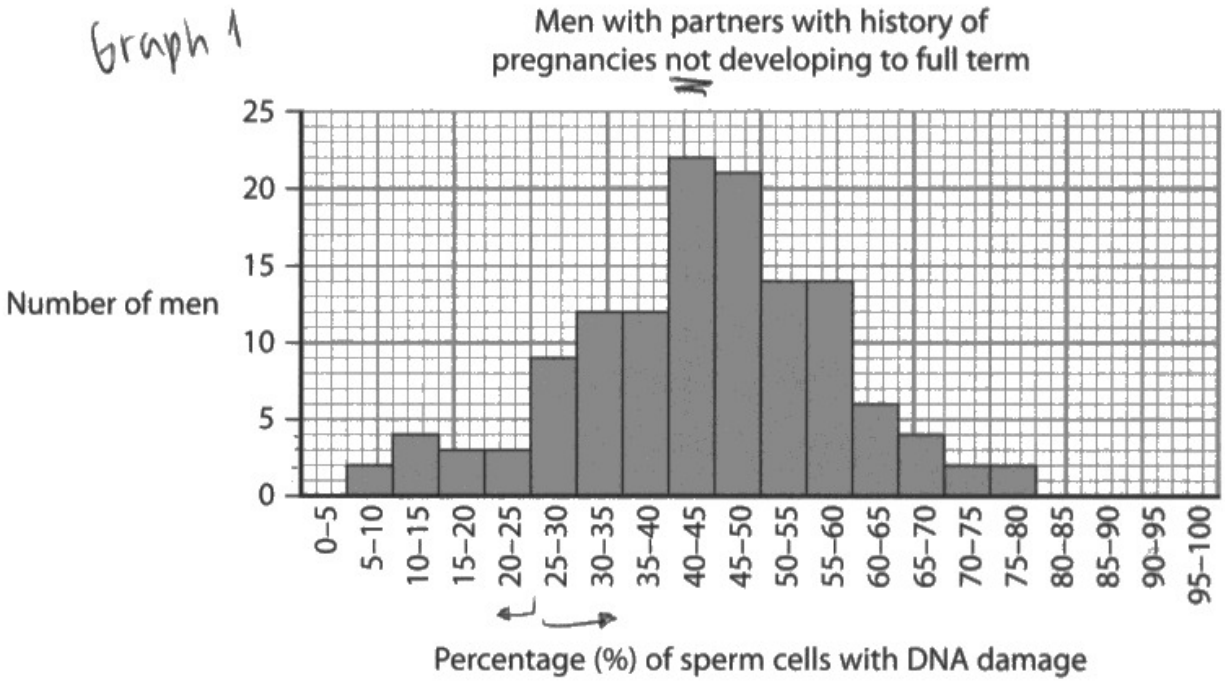
Scientists investigated if there is an association between the production of sperm with damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for 130 men where there was a history of pregnancies not developing to full term.

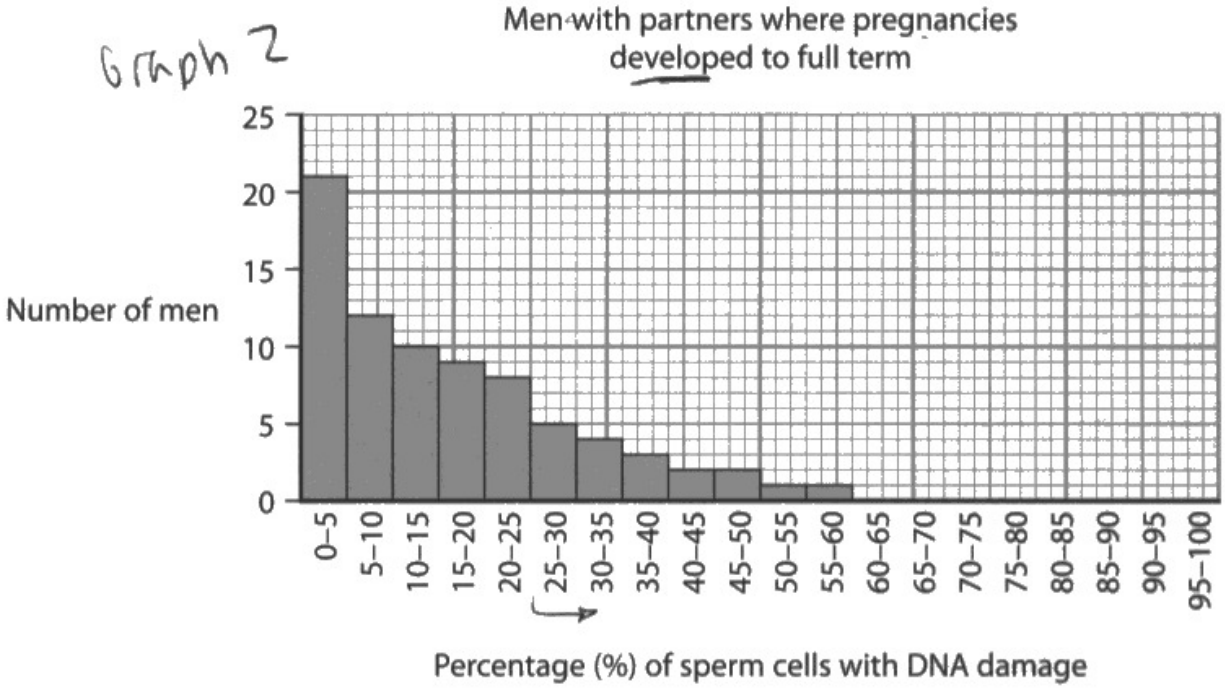
The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.

Graph 1



Graph 2



(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

Analyse the data to evaluate this conclusion.

(4)

The conclusion is not valid because data is not reliable as the sample size is too small. The data shows correlation but not causation. The pregnancies not developing to full term might be due to other factors. However, it could be said the conclusion is valid because the first graph shows the highest number of men (22) had between 40 and 45 %. ~~DNA damage of sperm~~ sperm with DNA damage while graph 2 had the highest number of men (21) with between 0 and 5% of sperm with DNA damage, a much lower ~~number~~ percentage suggesting more DNA damage of sperm leads to more men ~~with a~~ with partners whose pregnancies don't develop to full term. This is also seen by the distribution of the bars in the two graphs. In the first one most men have more than 25%. damaged sperm but in the second one most men have less than 25%. Not valid conclusion because many less men in group where pregnancies develop to full term. ~~Graph 1~~ No men with more than 80% damaged sperm

(Total for Question 3 = 8 marks)

ResultsPlus
Examiner Comments

This is an excellent answer that gained all four marks. The candidate has considered the reliability of the data (sample size), the possibility of other factors and how the data supports the conclusion from both graphs.

ResultsPlus
Examiner Tip

With evaluate questions, make sure that you have points that both support and counter an argument or conclusion.

(b) Some pregnancies do not develop to full term, so no baby is born.

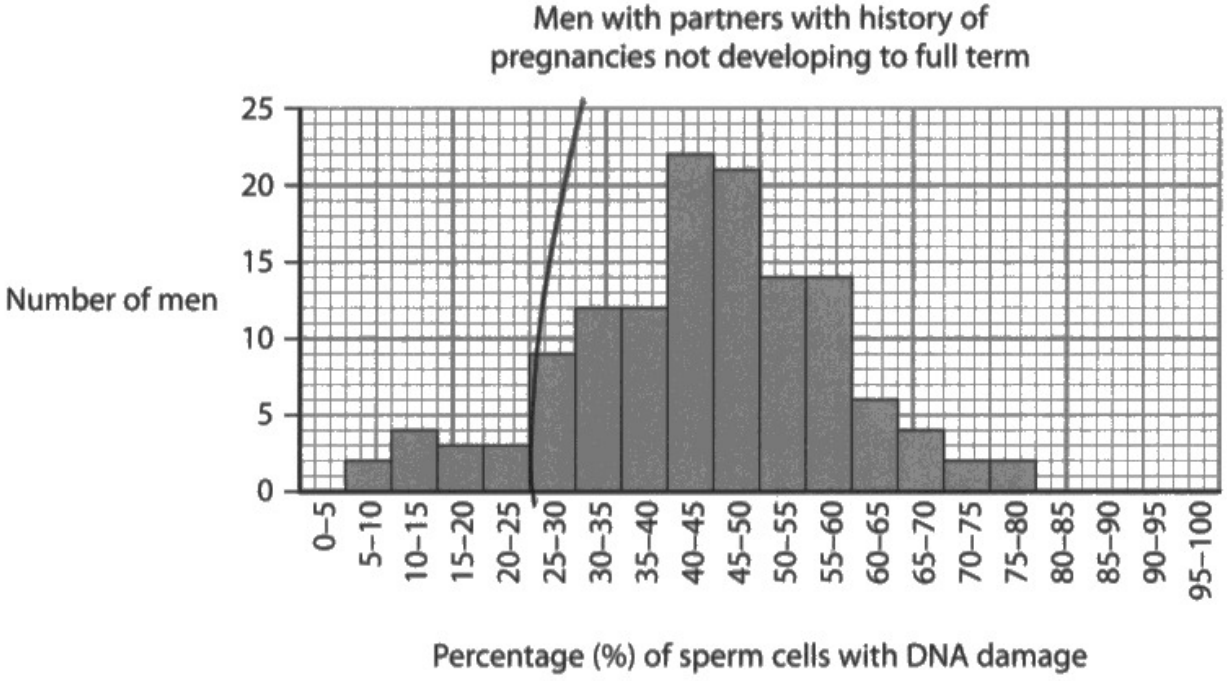
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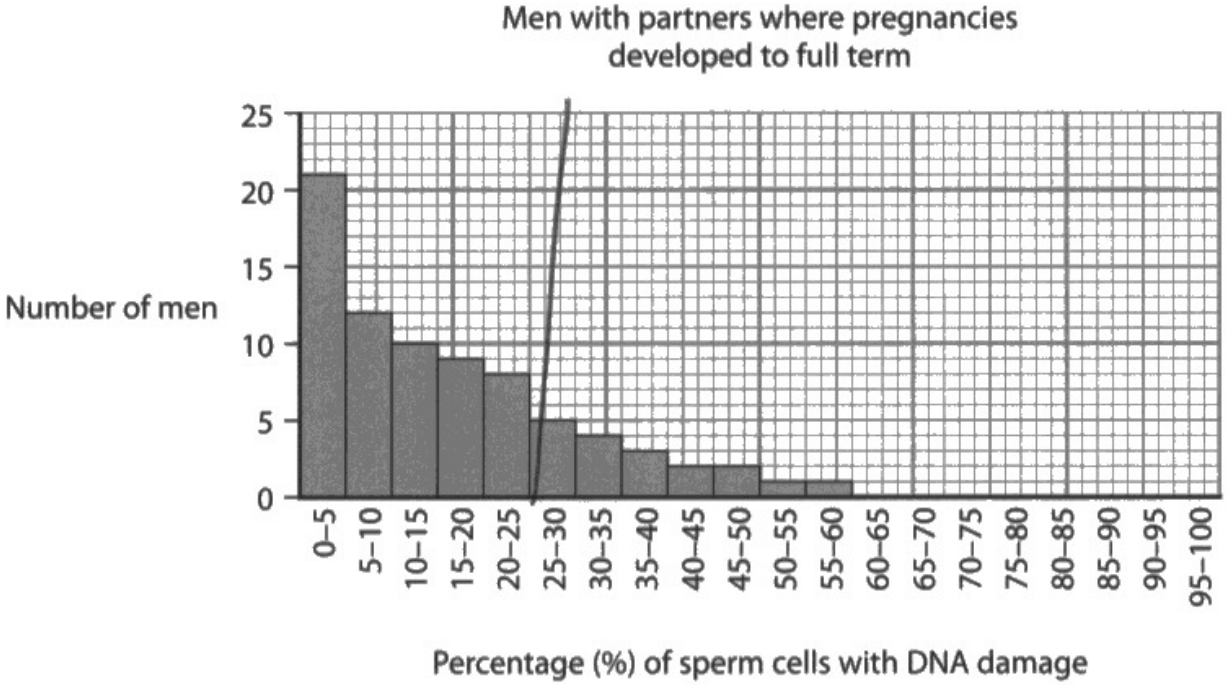
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The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.





(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

Analyse the data to evaluate this conclusion.

(4)

The first graph shows supports the conclusion as the highest number of men with damaged sperm that didn't have successful pregnancies with partners were those with 40-45% damaged sperm. The second graph shows that barely any men with over 25% sperm damaged had full term pregnancies compared to those with little to no damage sperm (21 men with 0-5% damage vs only 3 men at 40-45% damage).

ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has correctly stated that there is an increase in the number of men with more than 25% of sperm with DNA damage associated with pregnancies not going full term and that when pregnancies do go full term, there is a high number of men with 0-5% damage.

(b) Some pregnancies do not develop to full term, so no baby is born.

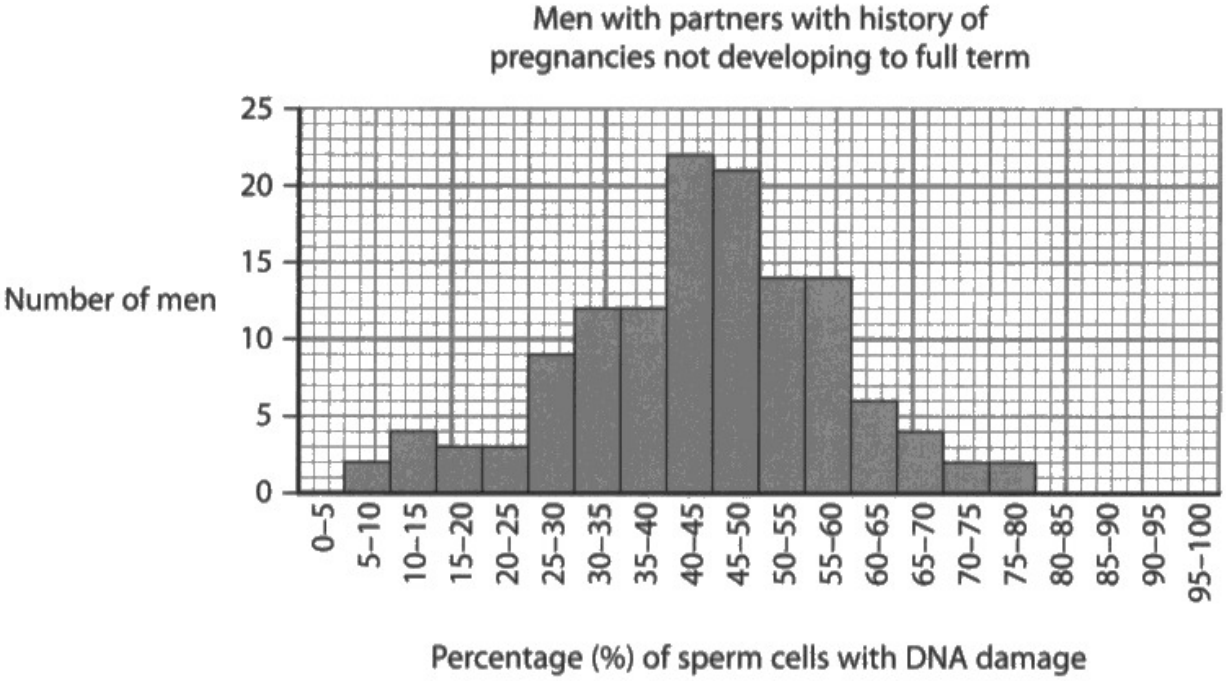
Damage to the DNA of sperm is thought to be one cause of pregnancies not developing to full term.

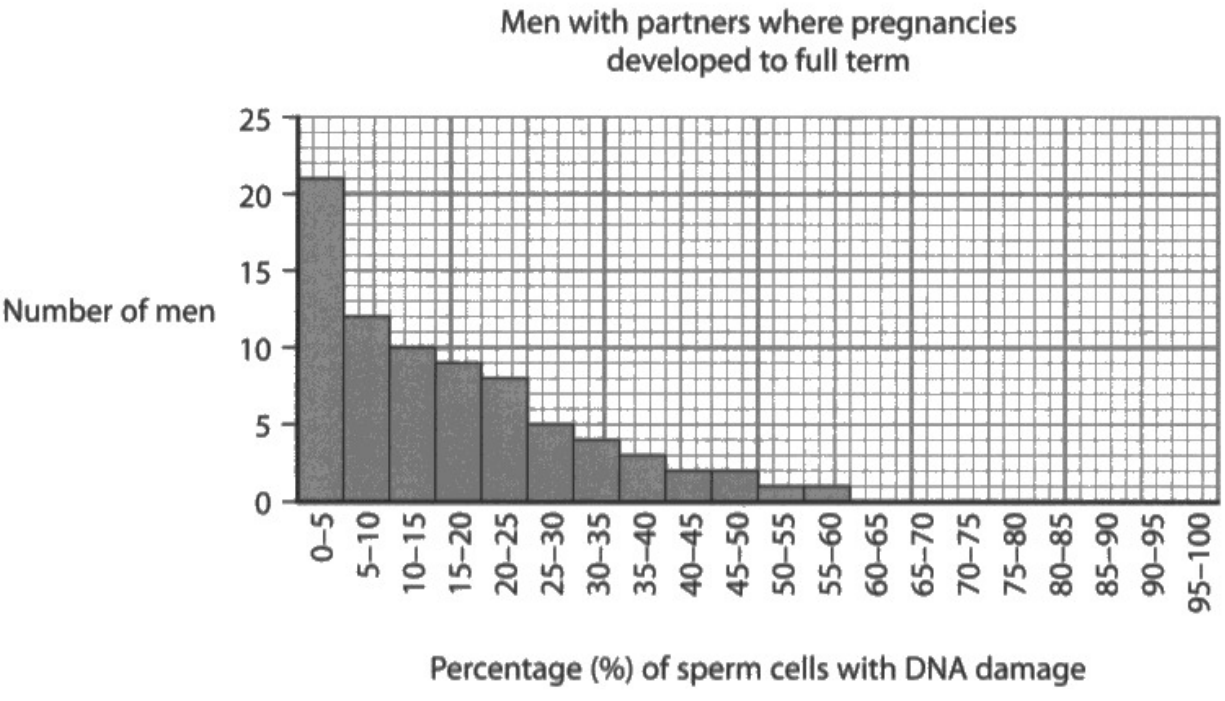
Scientists investigated if there is an association between the production of sperm with damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for 130 men where there was a history of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.





(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

Analyse the data to evaluate this conclusion.

(4)

- The number of men that have a history of full term ~~preg~~ pregnancies with ~~a~~ percentage of 25% or lower of the sperm cells with DNA damage is much higher than 12
- This shows that having a lower 25% DNA damage gives a much higher chance of Sucessful pagnancies.
- ~~On the graph, they B are~~ the data 9850 shows the 118 out of 130 men have ~~have~~ have more than 25% sperm damage.
- that is over 90% of the men having a high risk of pregnancies not developing full term
- This conclusion is valid as the data proves it

ResultsPlus
Examiner Comments

This answer gained one mark for stating that there are more sperm with greater than DNA damage associated with pregnancies not going to full term. No consideration of the quality of the investigation is given.

(b) Some pregnancies do not develop to full term, so no baby is born.

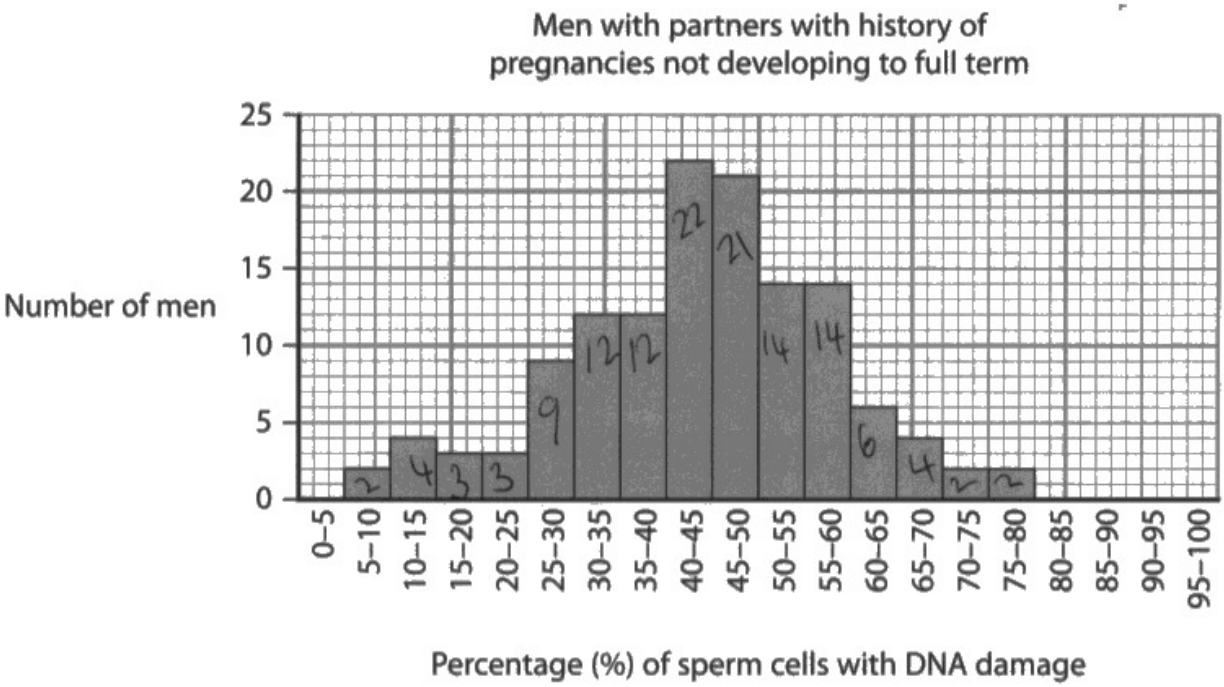
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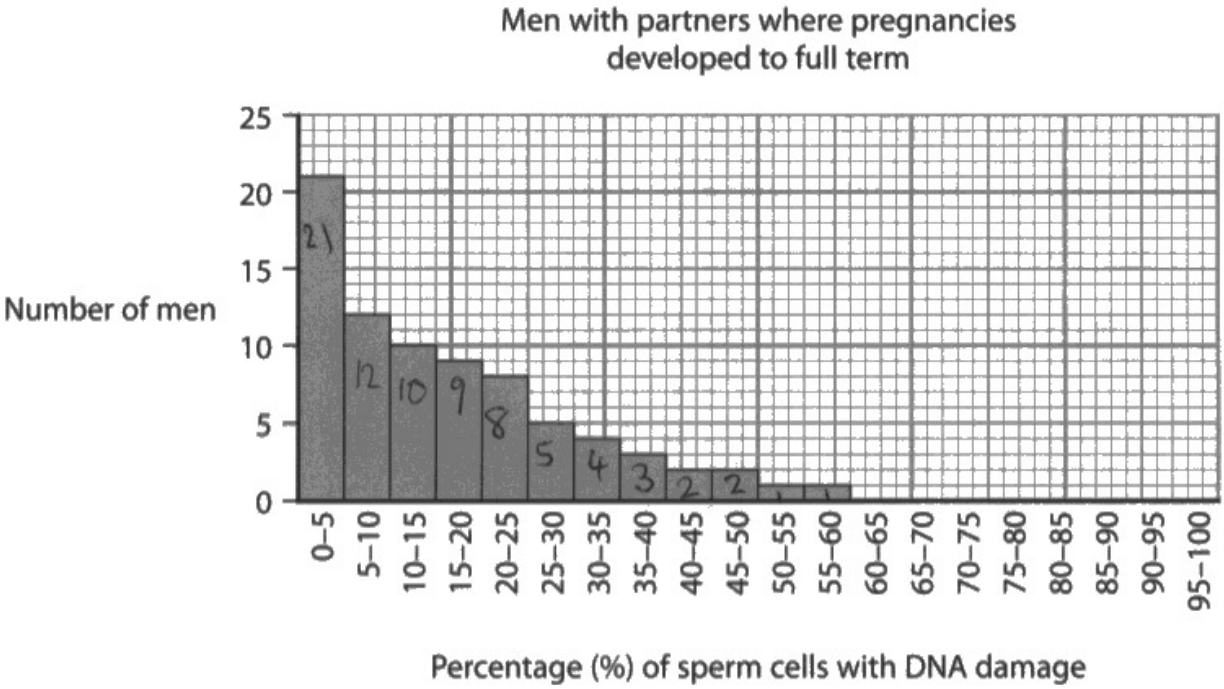
Scientists investigated if there is an association between the production of sperm with damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for 130 men where there was a history of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.





(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

Analyse the data to evaluate this conclusion.

(4)

- most men where pregnancies of partners developed to full term (60 men) had 25% or less DNA damaged sperm cells, suggesting that less than 25% damage doesn't have a high risk of not developing to full term
- most men (118) with ~~damaged~~ pregnancies not developing to full term had more than 25% damaged DNA so more than 25% does lead to a highe risk of not developing to full term.
- However, results are not reliable as 80 men were tested with pregnancies not developing to full term and only 78 for developing to full term, which is a smaller sample size
- We don't know other factors that may cause results - age of men, health of men, or any information about female's genetics that could cause undeveloped pregnancies.

ResultsPlus
Examiner Comments

This is an excellent answer that gained all four marks. The data is used to explain how it supports the conclusion and the candidate then goes on to explain that the samples are uneven, there are other factors and that maternal health needs consideration.

Question 4 (a)(ii)

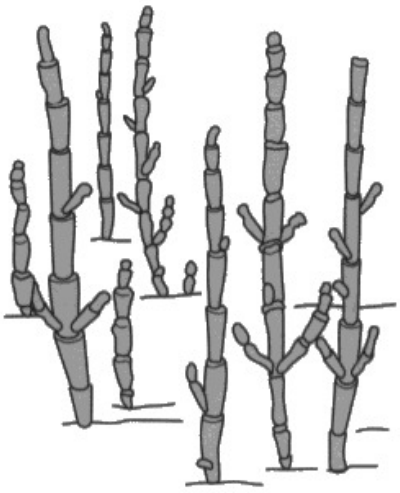
This question presented candidates with diagrams and information about the structure of samphire and asked them to explain how samphire is adapted to live in areas next to the sea where it is often flooded with sea water. Strong answers explained:

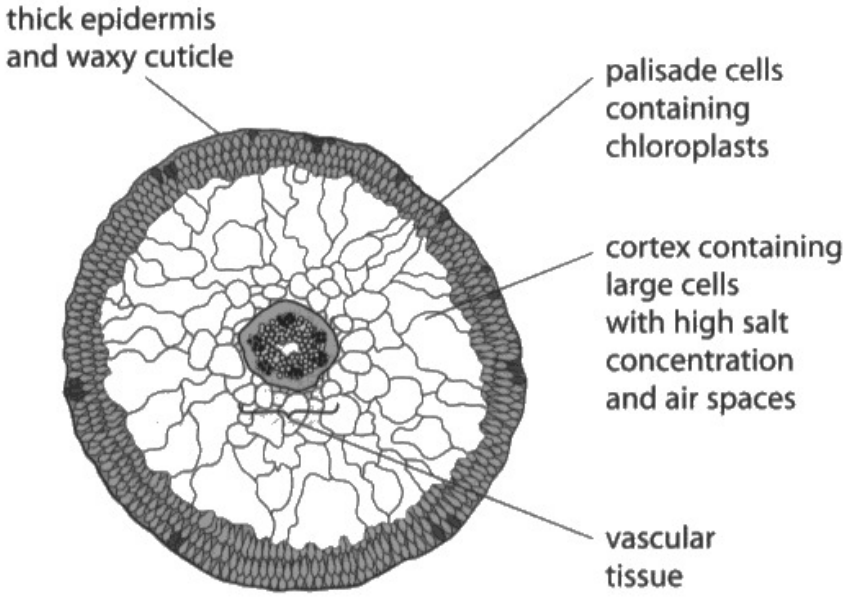
- the small leaf surfaces and thick cuticle that prevent transpiration and evaporation of water.
- the presence of air spaces to store carbon dioxide for photosynthesis.
- the use of the stem as an organ of photosynthesis since the leaf surface area is small.
- the presence of salt in the cells to lower the water potential and prevent water loss by osmosis.

Weaker answers tended to pick up one or two marks, often for the reduced water loss due to the small leaf surface area and thick epidermal layer. Some candidates simply gave descriptions of the adaptations rather than explanations – it is important to be fully familiar with all the command words. Weaker answers often referred to the salt concentrations but did not refer to water potentials or the prevention of water loss by osmosis. At A level, it is important to refer to water potentials rather than concentrations.

(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.





Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

Swollen stem to be able to resist the ~~weight~~ wind and remain upright. Large surface area for increased rate of ~~gas exchange for~~ photosynthesis, as more light and carbon dioxide absorbed. Thick waxy cuticle to prevent water loss via ~~water~~ transpiration so the water can be used for photosynthesis. Cortex with air spaces to increase gas exchange and high salt concentration to lower water potential meaning water can move in via osmosis. Chloroplasts in palisade cells to absorb sunlight for photosynthesis there more growth.

ResultsPlus
Examiner Comments

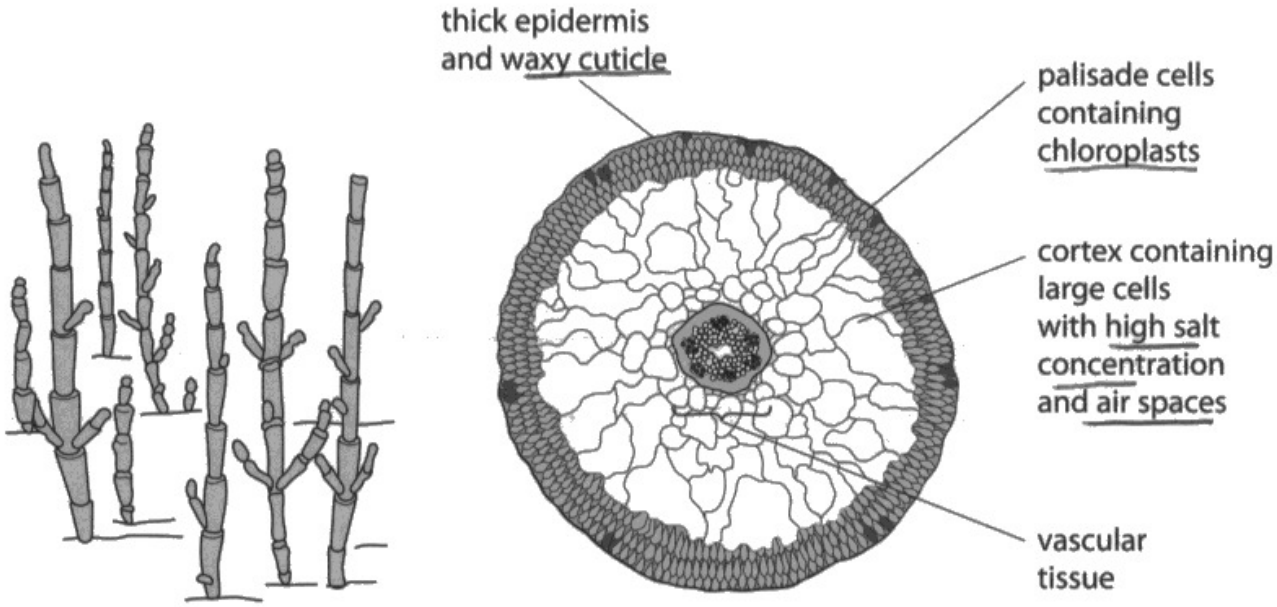
This is a very good answer that gained all four marks. The candidate explains that the waxy cuticle reduces water loss and that the high salt concentration lowers the water potential, reducing water loss by osmosis. The candidate also correctly points out that the palisade cells in the stem contain chloroplasts and so are photosynthetic.

ResultsPlus
Examiner Tip

Make sure that you know what all the different command words require. For example, explain and describe require different types of answer.

(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

• samphire is adapted for it has a thin epidermis & waxy cticle which reduces the water loss from the plant. which helps due to the high rate of transpiration at the coast.

• the cortex with high salt concentration = low high low water potential = water moves to cortex by osmosis.

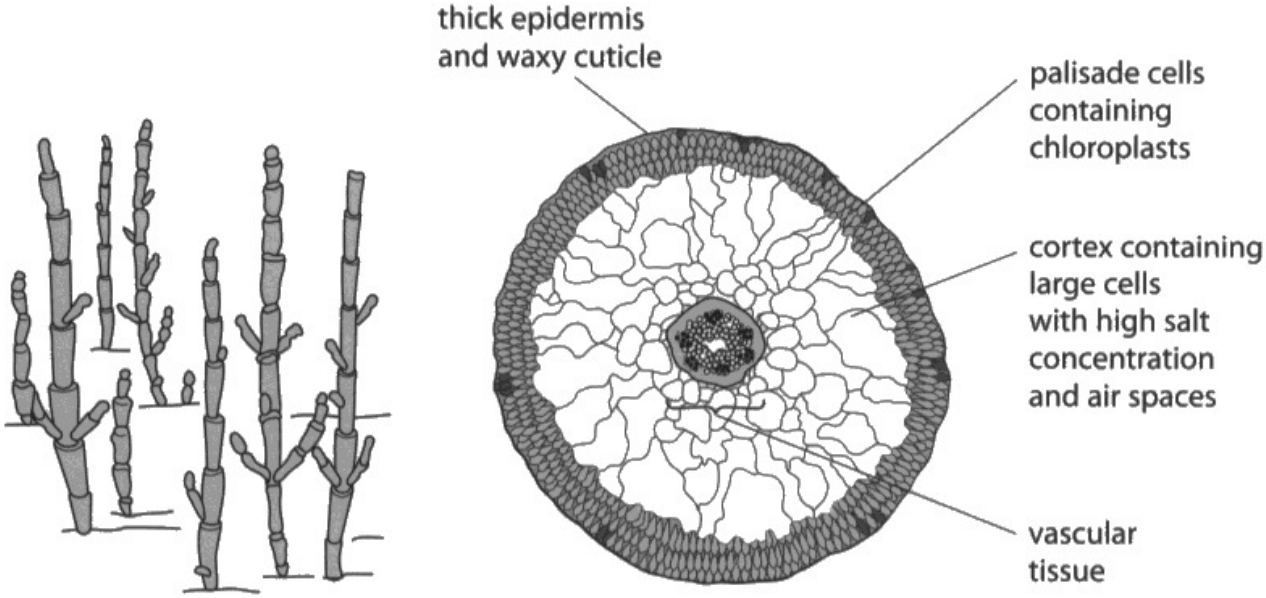
• palisade cells containing chloroplast = to photosynthesis it able to occur the whole way around the plant = closest have leaves which maximises photosynthesis & subsequent absorbing rate of the plant due to being submerged & surrounded by sea = tidal.

ResultsPlus
Examiner Comments

This answer gained four marks. The candidate has correctly stated that the samphire has a thick epidermis to reduce transpiration, there is a lower water potential in the cells reducing water loss by osmosis and that the palisade cells in the stem perform photosynthesis.

(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

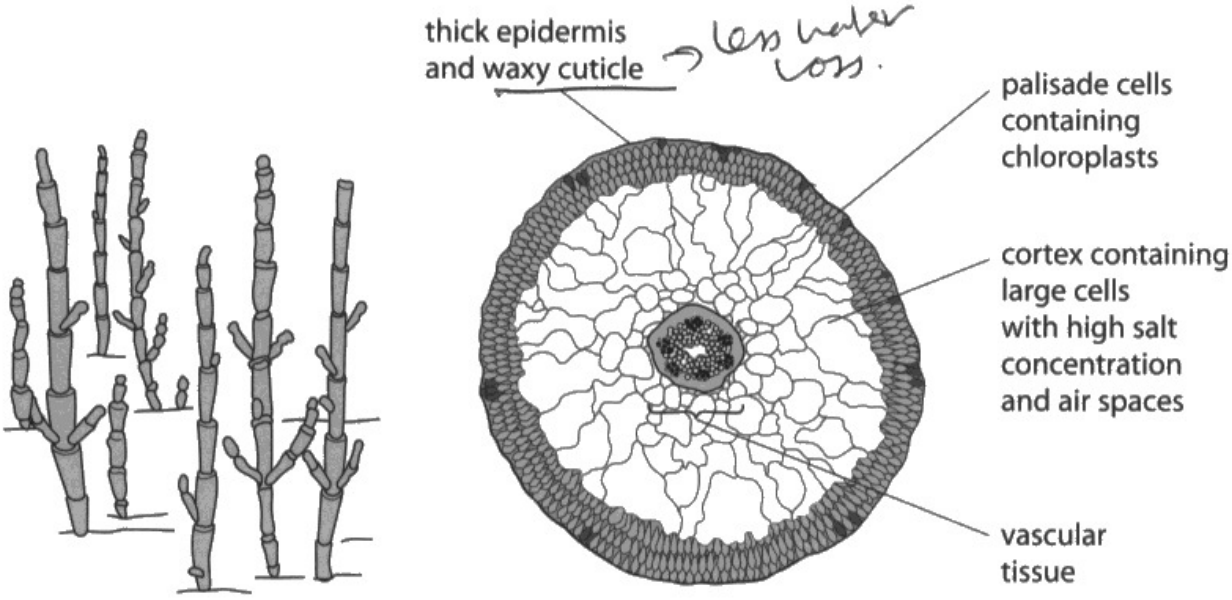
As wind Speed causes a high rate of transpiration (water loss) and Samphire's grow near the Sea where it is windy, one adaptation is having very Small leaves which results in less water loss through the Stomata. They also have a Swollen Stem that contains a thick epidermis and waxy cuticle which will Stop water loss from the Stem/xylem and add protection to wind. and the Salt in cortex will absorb moisture and water

ResultsPlus
Examiner Comments

This answer gained two marks for correctly explaining that the reduced leaf surface area reduces transpiration and that the thick epidermis will also reduce water loss from the surface.

(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

As the coast is windy and this increases the rate of transpiration and evaporation, samphire have waxy cuticles. This reduces water loss. The cortex ~~tissue~~ has cells with a low water potential, meaning that when salt water washes over the plants, only fresh water will move in via osmosis and not salt ions. They grow tall so so their ~~leaves~~ palisade cells with chloroplasts can carry out photosynthesis.

ResultsPlus
Examiner Comments

This answer gained four marks for the idea of the waxy cuticle reducing water loss, the lowering of water potential in the root cells, reducing water loss by osmosis and the role of the palisade cells in photosynthesis.

Question 4 (b)(i)

This question presented candidates with data about biodiversity of species near the coast and asked them to give two limitations with using ACFOR data. Strong answers referred to ACFOR data not being qualitative, being subjective and not being able to be used for statistical testing. Most candidates were able to gain at least one mark with many going on to gain both.

(b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

The factors measured were:

- ACFOR scales for samphire, sea lavender, and scurvy grass
- index of diversity of all plant species
- percentage of silt (mud) made up of organic material.

The results are shown in the table.

Factor		Distance from sea / m				
		0	5	10	15	20
ACFOR scales	Samphire	Abundant	Common	Rare	Absent	Absent
	Sea lavender	Absent	Rare	Common	Common	Rare
	Scurvy grass	Absent	Absent	Rare	Occasional	Abundant
Index of diversity for all plant species		0.20	0.54	0.85	2.54	2.85
Percentage of silt made up of organic material (%)		15	10	25	35	55

(i) Give **two** limitations of using ACFOR scales to compare the distribution of different plant species.

(2)

The scale is subjective so the same number of species could be counted differently and it is not numerical so it cannot be precisely compared with other values.

ResultsPlus
Examiner Comments

This answer gained both marks for correctly stating that ACFOR data is subjective and not numerical.

(b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

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Percentage of silt made up of organic material (%)		15	10	25	35	55

(i) Give **two** limitations of using ACFOR scales to compare the distribution of different plant species.

(2)

- Qualitative, not quantitative (i.e. only 3 categories (abundance is subjective))
- Only 5 categories of abundance examined)

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that ACFOR data is qualitative and subjective.

(b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

The factors measured were:

- ACFOR scales for samphire, sea lavender, and scurvy grass
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Percentage of silt made up of organic material (%)		15	10	25	35	55

(i) Give **two** limitations of using ACFOR scales to compare the distribution of different plant species.

(2)

Depends on what people class as the each ranking. Someones common may be someone elses Rare. Also, it's not precise in which it doesn't provide numbers.

ResultsPlus
Examiner Comments

This answer gained two marks for the idea that the data is subjective and that it is not numerical.

Question 4 (b)(ii)

This question presented candidates with information about how the organic material in the soil and abundance of different plant species changed with distance from the sea. The question explained to candidates that as distance increases, the age of the land increased suggesting that the coast area was an example of succession. Many candidates recognised that succession had occurred, and that samphire was an example of a pioneer species that helps to stabilise the substrate. Strong answers also explained that the plant species numbers changed with distance from the coast as each species has its own niche and the plants compete with each other. Many candidates also correctly explained that abiotic factors such as salinity and exposure change with distance from the sea and the plant species all have their own adaptations. Weaker answers tended to simply describe the data in the table without giving any explanations for the changes, for example, many candidates pointed out that the mass of organic material increases with distance from the sea but did not link this to decay or release of mineral ions.

(ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

Explain the changes in distribution of the species as distance from the sea increases.

(4)

The samphire is the pioneer species, able to survive 0m from the sea, where sea lavender and scurvy grass cannot survive. The samphire then decomposes and releases nutrients into the soil, forming a humus layer, making the land habitable for sea lavender, as seen by the presence of sea lavender 5m from the sea where the land is older. This process (succession) is then continued, with scurvy grass able to colonise the marsh 10m from the sea. These changes increase the % of organic material in the silt over time, allowing for a greater diversity of plant species, with samphire eventually outcompeted by 15m from the sea and sea lavender rare by 20m, but by this point scurvy grass has become abundant.

ResultsPlus
Examiner Comments

This is an excellent answer that gained four marks. The candidate explains that samphire is a pioneer species, succession has occurred and explains the release of nutrients due to decomposition. The candidate also explains how the different species must compete with each other at different areas of the land.

(ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

Explain the changes in distribution of the species as distance from the sea increases.

(4)

Samphire is abundant closest to the sea as it is the most well adapted to the conditions there. It needs ~~little~~ low percentage of to organic material (15%). As the index of diversity increases up the shore, its frequency decreases due to ~~feats~~ biotic factors such as competition. Scurvy grass requires a higher perentage of organic material in order to grow: it is absent at 15% and abundant at 55%. Sea lavender becomes more common at 10-15 ~~ft~~ m from the sea. This is due to there being a higher perentage of organic matter in the silt from the decomposition of samphire over the years.

ResultsPlus
Examiner Comments

This answer gained two marks for the explanation about how samphire is adapted to live close to the water and how decomposition produces the organic material in the soil.

(ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

Explain the changes in distribution of the species as distance from the sea increases.

(4)

Across the saltmarsh, there are different stages of succession that has occurred, at 0 m to the sea there is low diversity of plant species because there is less silt of organic material so the soil is less rich with organic matter that decays to add nutrients to the soil, therefore less plant species are supported by a thinner humus layer. Samphire is abundant closer to the sea because it has specific adaptations that allow it to survive in that habitat. As distance from the sea increases the index of diversity increases because the soil will be more matured and contain more ~~the~~ dead organic material that decays to build up the humus layer because there is also more silt that adds nutrients to the soil. therefore more species of plants can be supported, which results in more niches so even more different species colonise the area further away from the sea.

ResultsPlus
Examiner Comments

This excellent answer gained all four marks. The candidate explains that succession has occurred and only samphire has the adaptations to live by the sea. The candidate also explains that decomposition releases nutrients into the soil and that there are different niches at different distances.

Question 5 (a)(ii)

This question tested the candidates understanding of the sensitivity of different areas of the retina. Most candidates recognised that the central area contains more cones than rods and many went on to explain that rods are more sensitive due to the summation of input onto bipolar neurones. Some candidates confused rods and cones and incorrectly stated that there are more rods in the central area of the retina.

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2)

~~rod cells are less sens~~

- rod cells are high sensitive to light
- whereas cone cells are less sensitive to light and take in bright light
- cone cells located in centre of retina
- rod cells located in outer areas

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that the central area of the retina has more cones and that cones are less sensitive to light.

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2)

The fovea, or centre, has cone cells unlike the rod cells which are less sensitive to light than rod cells as they have no summations, each cell leads to one ganglion cell unlike the generator potentials being added as with rod cells to create lower light intensities.

ResultsPlus
Examiner Comments

This answer gained both marks for correctly stating that the fovea has more cone cells and that the cone cells are less sensitive.

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2)

The centre known as the fovea contains cone cells which are less sensitive to low light. Whereas outer areas contain rod cells which have high sensitivity to light as they have low visual acuity due to synaptic convergence.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that the fovea contains more cone cells which are less sensitive. The candidate also correctly explains that the rod cells have synaptic convergence.

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2)

This is the fovea, which only contains cone cells, ~~and~~ each of which are only synapsed to one bipolar cell each, so require high density light for a higher voltage in order to generate ~~for~~ an action potential in the ~~bipolar~~ bipolar cell. ~~which~~ And rods contain less pigment, with no ~~re~~ rhodopsin, while outer region is made up of rods, which due to summation and presence of rhodopsin, the sub-threshold potentials can add up to be sensitive to low density light.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that the centre of the retina has more cones and that cones contain less sensitive iodopsin rather than rhodopsin.

Question 5 (b)(ii)

This question tested the candidates understanding of X-linked conditions by presenting them with a pedigree diagram of a family with red-green colour blindness. Candidates were asked to select one aspect of the diagram to explain how it showed that the condition is caused by a recessive allele. Most candidates were able to correctly gain one mark for identifying a cross where parents did not have the condition, but offspring did. Many then went on to explain that the genotype of the mother must be $X^H X^h$ if the son had the condition. Some candidates incorrectly stated that both parents would be heterozygous (as the father has only one X chromosome) and others did not give a specific example of a cross that showed that the condition is recessive.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

Person 6 and person 7 are both not colour blind, ~~the~~ 7 = $X^R Y$ and 6 = $X^R X^r$ because they have a child 11 who is colour blind, if it was dominant then more children would be colourblind. 6 must be a carrier hence phenotype of colourblind not present in her.

ResultsPlus
Examiner Comments

This very good answer gained two marks. The candidate has stated that parents 6 and 7 are not colour blind yet 11 is. They then go on to explain that the genotype of the mother must be heterozygous.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

Person 6 and person 7 do not have the condition but their child, person 11, does have the condition so they must have been heterozygous for the recessive allele.

Person 4 has to be a carrier for the condition as her daughter had the condition but and her husband had it too.

ResultsPlus
Examiner Comments

This answer gained two marks for selecting the cross with parent 4 and then going on to state that parent 4 must be heterozygous since her daughter has the condition and the father also has the condition.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

Parents 6 and 7 must be heterozygotes that carry the recessive gene which is passed on to 11

Males only have one X chromosome and so they are more likely to have recessive allele

ResultsPlus
Examiner Comments

This answer gained one mark for the selection of the correct cross but did not gain the second mark as the candidate stated that both parents would be heterozygous.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

Cross between 3 and 4 produces male without colour blindness and ~~female~~ female with colour blindness.
So female 4 must be heterozygous

ResultsPlus
Examiner Comments

This answer gained two marks for selecting a correct cross and then explaining that female 4 must be heterozygous.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

Family number 8 (female with colour blindness) could only have inherited colour blindness if both alleles were recessive. The mother was a carrier and the father was colour blind, resulting in the child to have colourblindness. However number 8's siblings did not have the ressesive allele, unless number 10 is heterozygous and a carrier.

ResultsPlus
Examiner Comments

This answer gained two marks for identifying a correct cross and giving the correct genotype of the mother.

Question 5 (c)(i)

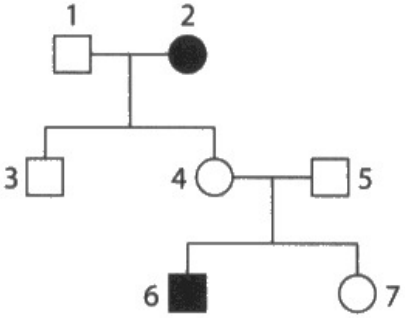
This challenging question was well answered by many candidates. Most were able to gain at least one mark, typically for deducing that the allele was recessive. Many outstanding answers were seen that explained that the allele must be recessive and autosomal (or not sex-linked) and then gave evidence from the cross to support their answer. The examiners were impressed with how well many candidates understood the pedigree diagram. It was clear that many candidates annotated the script to show the genotypes of each individual – this is good practice (although not essential) as it helps candidates work out how the alleles are passed through the generations.

(c) Pingelap is an isolated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.



Key:

- male without achromatopsia
- male with achromatopsia
- female without achromatopsia
- female with achromatopsia

Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.

(3)

- IT'S CAUSED BY AN AUTOSOMAL recessive ~~allele~~ allele
- 4 & 5 MUST be carriers of CONDITION ∴ heterozygous, causing individual 6 to have the CONDITION bc homozygous recessive.
- NOT sex-linked because if mother 2 HAD CONDITION, she WOULD have PASS IT TO SON 3, who is unaffected (bc would get X chromosome from mom)

ResultsPlus
Examiner Comments

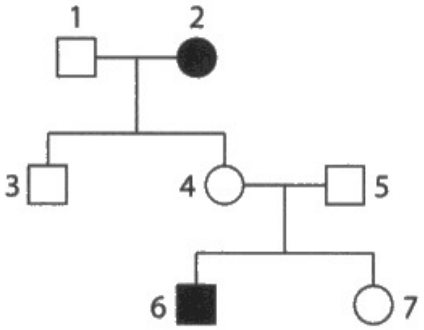
This excellent answer gained three marks. The candidate has stated that the allele is autosomal and recessive and identified two crosses to explain their deduction.

(c) Pingelap is an isolated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.



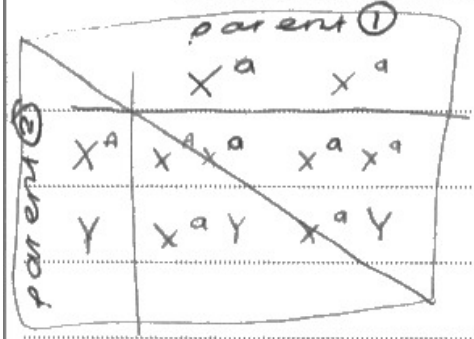
Key:

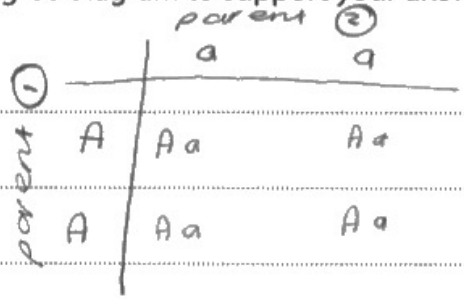
- male without achromatopsia
- male with achromatopsia
- female without achromatopsia
- female with achromatopsia

Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.

(3)





~~* sex-linked recessive disorder~~

* Non-sex linked recessive disorder, parents 1 and 2, despite 2 having achromatopsia have two children (3 & 4) ~~neither~~ with neither displaying with achromatopsia.

* this demonstrates the condition can't be sex-linked, as ~~both~~ child 3, would have achromatopsia

* Recessive as both 4 & 5 don't have achromatopsia, but their child 6 does, indicating 4 is a carrier.

ResultsPlus
Examiner Comments

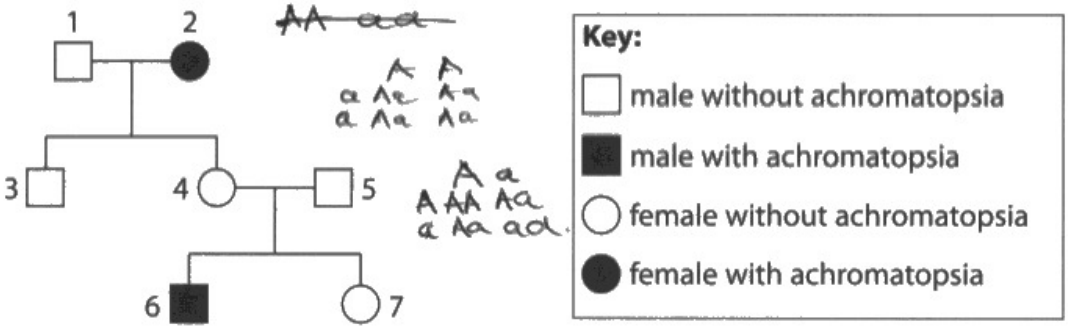
This excellent answer gained three marks for stating that the condition is not sex-linked, is recessive and gives the correct evidence from the diagram to support their answer.

(c) Pingelap is an isolated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.



Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.

(3)

- It is not sex linked it is autosomal as if it was sex linked the son of 1 and 2 who is 3 would have the achromatopsia.
- Moreover it is a recessive condition due to the fact 4 doesn't have achromatopsia so it is a carrier and 5 also doesn't have achromatopsia so is a carrier this is because 6 has the achromatopsia so both 4 and 5 are heterozygous for that condition.
- So achromatopsia is autosomal recessive disease.

ResultsPlus
Examiner Comments

This is an example of another excellent answer that gained three marks for correctly deducing that the allele is recessive and not sex-linked and explains how the diagram shows this.

Question 5 (c)(ii)

This question required candidates to use their knowledge of population genetics to explain why colour blindness is more common on the island of Pingelap. Many candidates were correctly able to recognise that a genetic bottleneck / founder effect had occurred that reduced the gene pool and made it more likely that carriers of the allele would have children together. A few candidates gave vague answers about genetic variation being reduced but most were able to gain at least one mark with many going on to get both.

(ii) In 1755, a tsunami reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

(2)

Due to reduced population it means genetic variation is less. Due to this individual in Pingelap will have less people to pick to mate with. Due to this the recessive allele is passed on more as it is present more compared to countries with greater population as there genetic variation is higher.

ResultsPlus
Examiner Comments

This answer gained one mark for the idea of reduced variation but there is no explanation as to why there is reduced variation.

(ii) In 1755, a tsunami reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

(2)

• a bottleneck effect has occured, significantly reducing diversity of alleles ~~(gene pool)~~

• so ↓ alleles ~~such~~ for achromatopsia frequency increases in population, and has greater chance of getting inherited by next generation.

ResultsPlus
Examiner Comments

This answer gained both marks for correctly referring to a bottleneck and the effects of this on the diversity of alleles.

(ii) In 1755, a tsunami reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

(2)

The tsunami caused a genetic bottleneck due to the population size being suddenly reduced. This means a smaller population remaining has a reduced gene pool with less variety of alleles and reduced genetic diversity. As a result inbreeding depression occurs, because it is more likely that an individual inherits two recessive alleles, because the allele frequency has increased. It is therefore more likely for offsprings to be homozygous recessive, carrying two recessive achromatopsia alleles.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that a genetic bottleneck had occurred and linking this to a reduced gene pool.

Question 6 (a)(ii)

This question asked candidates to explain how the membrane of a neurone depolarises. Most candidates were able to gain at least one mark with many going on to gain two. Most candidates recognised that the sodium ion channels close whilst potassium ion channels open. A few candidates incorrectly stated that the potassium ions would enter the neurone. Candidates should always be careful to refer to the movement of ions rather than simply referring to the movement of potassium or sodium.

(ii) Explain how membrane proteins cause the change in potential between Y and Z.

(2)

• ~~Nacl~~ Sodium ion voltage gates close membrane becomes ~~impear~~ impermeable to Na^+ ions, ~~while~~ but potassium ion voltage gates open causing K^+ ions to ~~.~~ diffuse out membrane causing ~~incre~~ inside of membrane to become more negative, also sodium potassium pump still working pumping 3 Na^+ ions out causing ~~hyperpolarizing~~. hyperpolarization.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly stating that the sodium channels will close and the potassium channels will open. The candidate also states that the potassium ions will diffuse out.

ResultsPlus
Examiner Tip

Always refer to sodium or potassium ions when describing their movement.

(ii) Explain how membrane proteins cause the change in potential between Y and Z.

(2)

• they close all the channels in the ~~membr~~neurone membrane so no ions can enter, but Na^+ and K^+ are both still actively being pumped out causing hyperpolarisation in the neurone

ResultsPlus
Examiner Comments

This answer gained no marks as the candidate has not stated which channels are closed.

(ii) Explain how membrane proteins cause the change in potential between Y and Z.

(2)

The sodium channel close, and potassium channel open. more positive ion moves out, less positive ion move in, decreasing potential difference

ResultsPlus
Examiner Comments

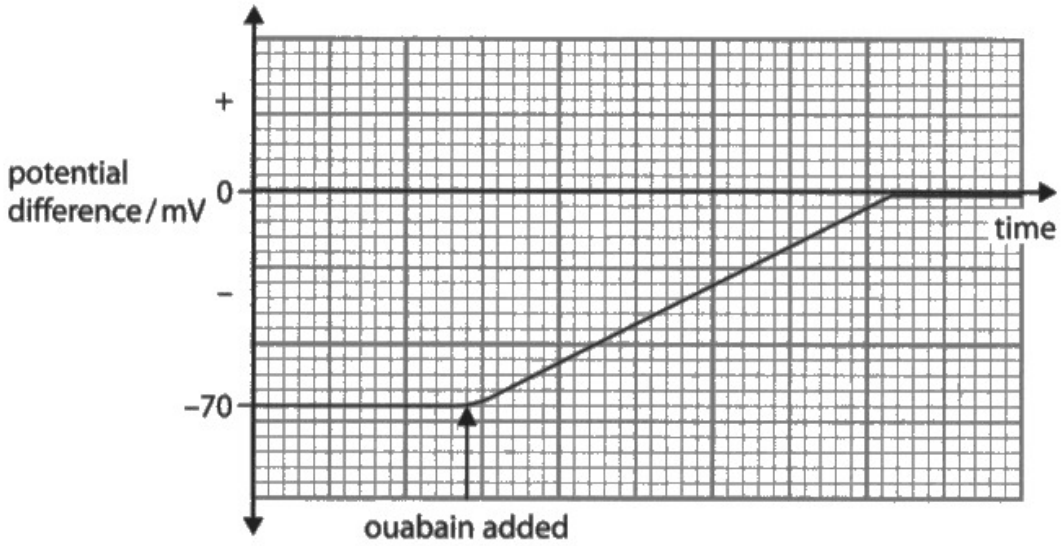
This answer gained two marks for correctly stating that the sodium channels are closed and the potassium channels open.

Question 6 (b)(ii)

Many candidates found this question challenging. The question required candidates to analyse the effect of ouabain, an inhibitor of the sodium-potassium exchange pump, on the activity of a motor neurone. The candidates were shown the effect of the ouabain on the resting potential across the neurone membrane. Strong answers explained that the resting potential was unable to be maintained as there is no pumping of sodium ions out or potassium ions in, so that there would not be a gradient of sodium ions across the membrane, thus preventing depolarisation when stimulated. Weaker answers tended to suggest that the ouabain prevented stimulation of the membrane from reaching a threshold potential or suggested that the ouabain acted on sodium or potassium channels directly. Some candidates gave vague answers restating the question stem by simply stating that the sodium-potassium exchange pump no longer works.

(ii) Ouabain inhibits sodium–potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



Explain how ouabain prevents the transmission of nerve impulses.

(3)

- The resting potential of the neurone remains at −70 mV until the ouabain was added.
- Sudden increase in the potential difference because the Na^+/K^+ pump is stopped. This prevents the exchange of Na^+ and K^+ from the outside to the inside.

↓

This doesn't effectively generate a generator potential and hence the transmission of nerve impulse decreases. This as a result blocks the neurotransmitter and prevents the brain from processing it and sending signals to the motor neurone – no response from the effectors e.g. muscles / glands.

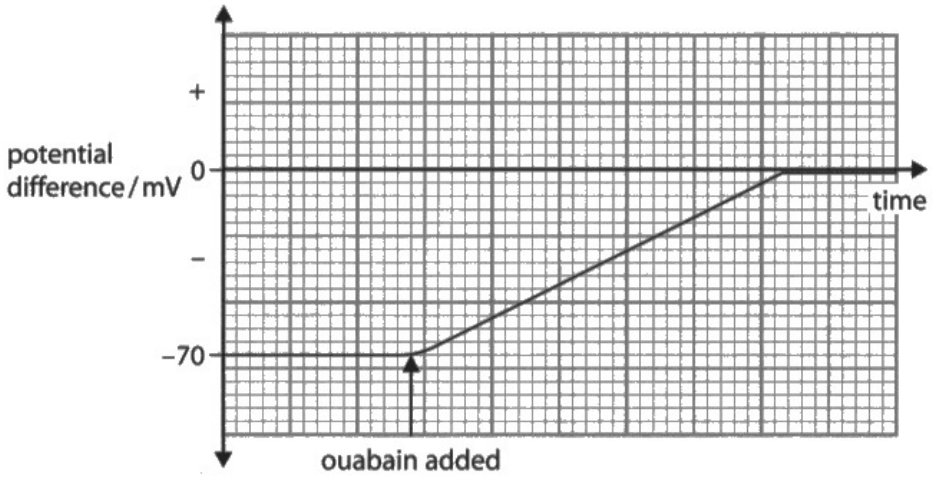
(Total for Question 6 = 7 marks)

ResultsPlus
Examiner Comments

This answer gained no marks. The candidate has referred to the sodium-potassium exchange pump stopping but not given a direction for the movement of the ions. There is no reference to preventing depolarisation in the correct context.

(ii) Ouabain inhibits sodium–potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



Explain how ouabain prevents the transmission of nerve impulses.

(3)

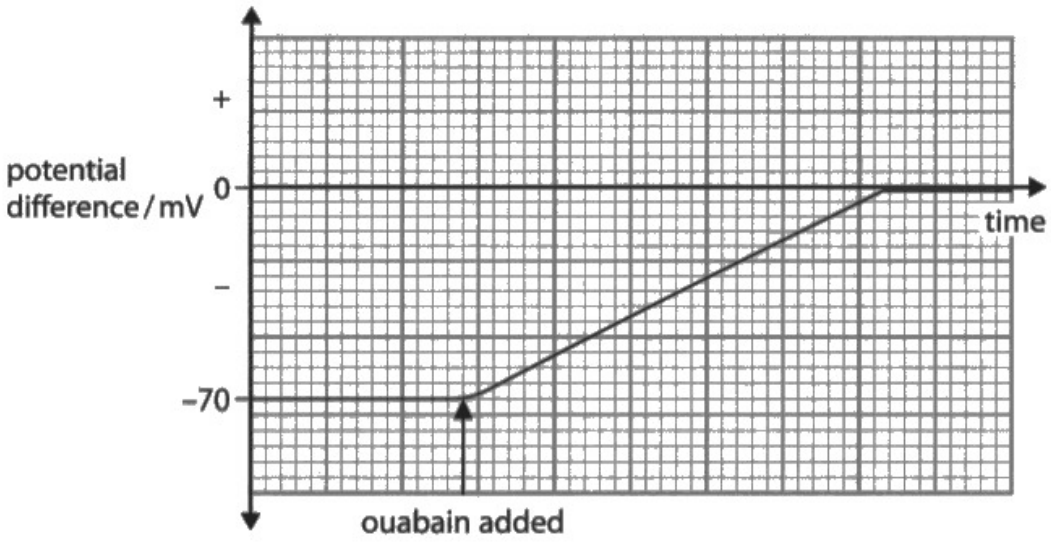
Ouabain blocks Na^+/K^+ pumps so that the resting potential of a neurone cannot be kept constant since Na^+ can't be pumped out and K^+ can't be pumped in. Since naturally Na^+ builds up in neurone p.d is made more positive and the concentration of K^+ and Na^+ inside is the same as outside, hence no once an impulse arrives, when Na^+ Voltage operated gates open, Na^+ won't flood in down a Concentration gradient, hence no depolarisation ∴ no impulse.

ResultsPlus
Examiner Comments

This answer gained all three marks. The candidate clearly states that the pump can no longer pump sodium ions out and potassium ions in. The candidate goes on to state that this means that the potential difference across the membrane rises and so it is unable to depolarise.

(ii) Ouabain inhibits sodium–potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



Explain how ouabain prevents the transmission of nerve impulses.

(3)

since the sodium-potassium pumps are inhibited due to ouabain the resting potential is not maintained as Na^+ ions are not pumped out and K^+ ions are not pumped in by active transport meaning the ions reach an equilibrium so instead of the cytoplasm being more negative than the outside (polarised) it has the same potential difference as the outside. this means nerve impulses can't be transmitted as repolarisation and hyperpolarisation can't occur.

ResultsPlus
Examiner Comments

This is a very good answer that explains that the sodium ions are no longer pumped out and potassium ions not pumped in, meaning that the resting potential is not maintained. The candidate goes on to correctly state that the membrane reaches an equilibrium.

Question 7 (a)(ii)

This question asked candidates to explain why DNA sequences of genes are more variable than the sequences of amino acids in proteins. Most were able to correctly state the code is degenerate so that there are many different codons that can produce the same amino acid. Fewer candidates went on to gain a second mark for recognising that there are non-coding regions or introns within genes or that changing amino acid sequences may affect protein function (which may lead to organisms not surviving).

(ii) Explain why the DNA sequences of genes are more variable than the sequences of amino acids in the proteins coded for by these genes.

(2)

Several different DNA codons can code for the same amino acids as the DNA code is degenerate. There are also non-coding regions which mean that there are variable regions in the DNA which lead to no increase in the variability of the aminoacid sequences.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly describing that the code is degenerate and that non-coding regions also exist.

(ii) Explain why the DNA sequences of genes are more variable than the sequences of amino acids in the proteins coded for by these genes.

(2)

Because DNA is degenerate so many different ~~amino~~ gene triplets code for the same amino acid. Genes also contain non-coding regions called introns, which are removed from the mRNA before translation into amino acids, these introns are very varied.

ResultsPlus
Examiner Comments

This excellent answer also gained two marks for describing the code as degenerate and stating that mutations may occur within introns.

Question 7 (a)(iii)

This question tested the candidates knowledge of the use of DNA technology in classification, a subject covered in Topic 3 of the specification. Most candidates were able to correctly gain at least one mark, typically for referring to gel electrophoresis or DNA sequencing. A significant number of candidates went on to gain a second mark for explaining how the sequences could be analysed using bioinformatics or comparison of banding patterns from gel electrophoresis.

(iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar.

(2)

DNA cut into fragment placed Gel electrophoresis DNA binding dye allow fluorescent another dye run pass thru current off. current thread on -ve DNA more +ve compare bands of DNA from species to see how similar. Also through bioformatics able to put data DNA into technology identify how similar.

ResultsPlus
Examiner Comments

This answer gained two marks for the use of gel electrophoresis and the comparison of banding patterns. The candidate has also correctly stated that bioinformatics can be used.

(iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar.

(2)

Use gel electrophoresis and observe if banding patterns are similar like the position of bands & width of bands are the same - then it is similar. Also use RNA sequencing + bioinformatics.

ResultsPlus
Examiner Comments

This strong answer gained two marks for correctly stating that gel electrophoresis can be used, the banding patterns compared and that bioinformatics can be used.

(iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar.

(2)

- DNA sequencing can be used by duplicating the DNA fragments and sequencing them by electrophoresis, then compare the ~~code~~ gel patterns found to see which ~~two~~ 2 patterns are most similar

ResultsPlus
Examiner Comments

This answer gained two marks for correctly describing the use of DNA sequencing and comparing fragment sizes using gel electrophoresis.

Question 7 (b)

This longer answer, level-based question assessed candidates ability to analyse data relating to the use of seed banks as a method of conservation. The data showed the differences in genetic diversity of different groups of plants in seed banks compared with in the wild. Data also showed how much the genetic diversity of seeds changes depending on the length of time spent in the seed banks. Strong answers gave detailed descriptions of how the genetic diversity differed or increased over time, went on to suggest explanations such as the effects of mutations when growing in the wild, genetic drift, and natural selection, and discussed the validity of the data by explaining overlapping error bars and the number of outliers present in the graph. Weaker answers tended to gain one or two marks for giving pure descriptions of the data. When discussing data in these longer questions, candidates should give descriptions, identify patterns, suggest explanations, and comment on the validity of the data.

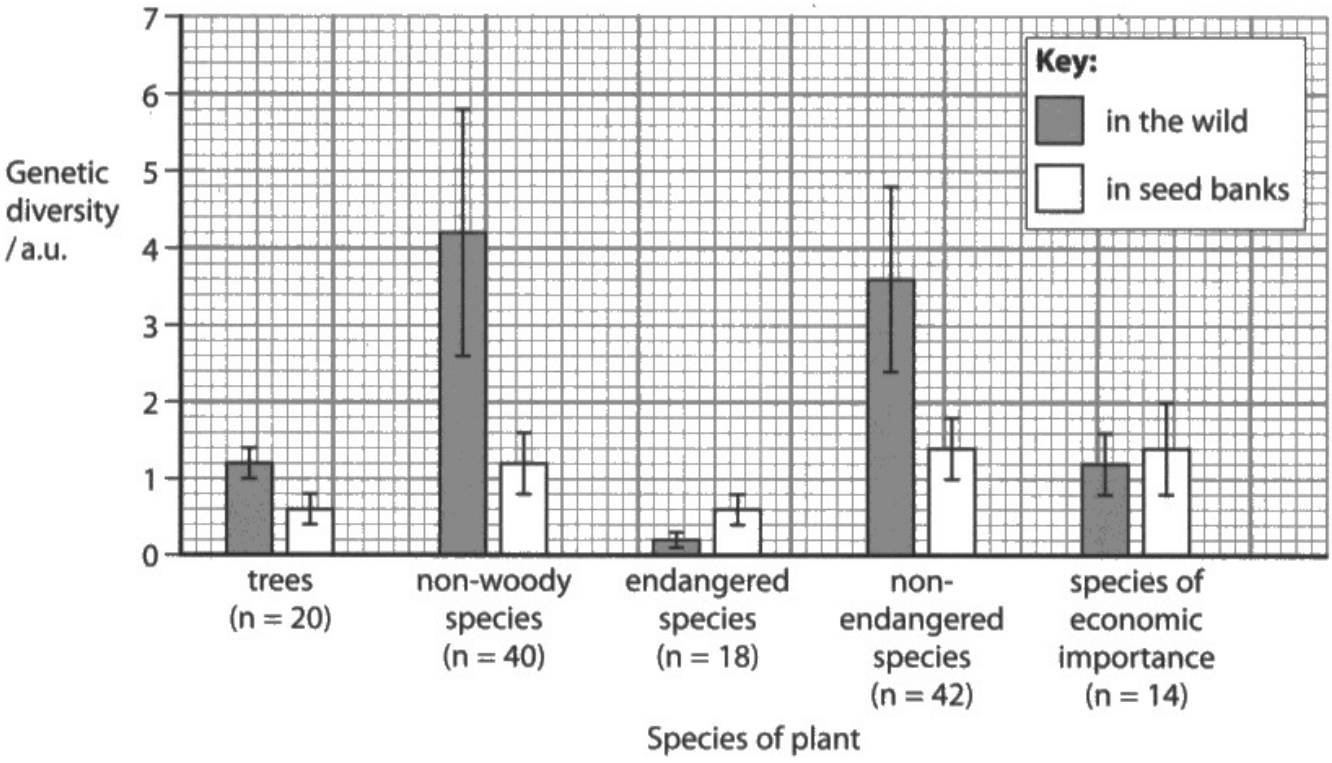
*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

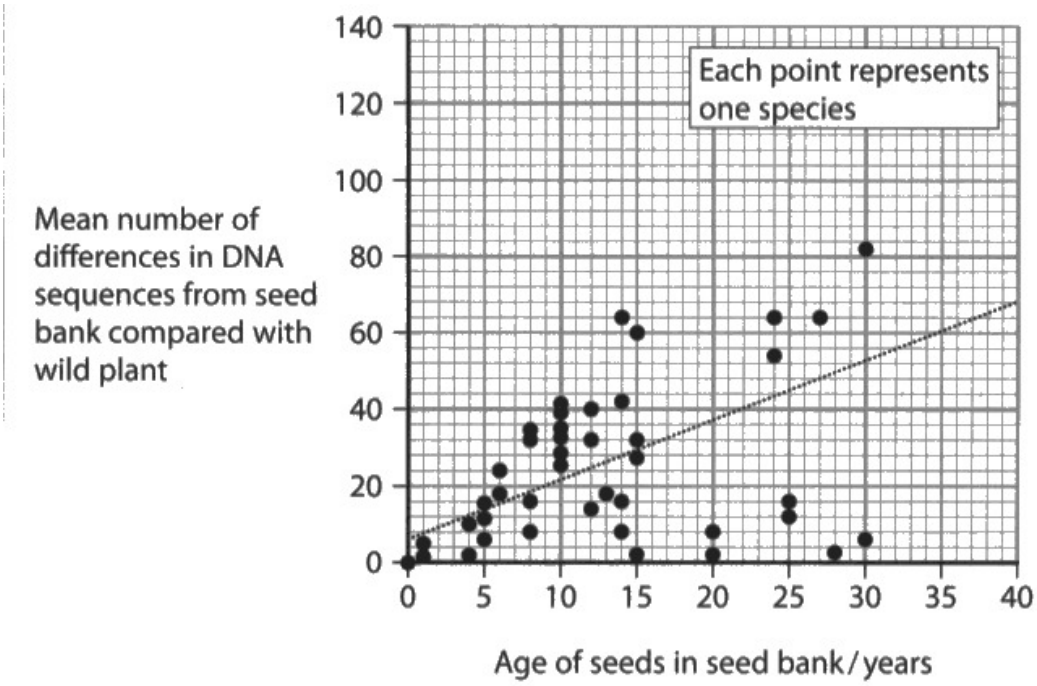
- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/−1 standard deviation
n = number of different species



Analyse the data to discuss the results of this investigation.

(6)

From the first graph, it is clear that there is more genetic diversity in the wild than seed banks for trees, non-woody species and non-endangered species. However, there is more genetic diversity in endangered species in seed banks than the wild, and slightly more for species of economic importance too. For the latter categories, the sample size was smaller. This suggests that ex situ conservation is providing good conservation of endangered species due to the increased genetic diversity. These results are significant with no error bar overlap for all but species of economic importance which only have 1 au difference between genetic diversity in situ and ex situ. From the second graph, it is evident that as age of seeds in seed banks increase, the genetic material of the seeds vary more from the wild plant. ~~This suggests~~ For example, seeds only just added to the bank had no difference in DNA sequences whereas some had 82 by 30 years. However, others remained with low levels of differences, so seed banks can still be a valid tool. In addition, seeds in the wild

experience differences in DNA sequences due to genetic variation, which is not taken into account here. Therefore, while seed DNA may change, this could be reflective of the wild population, and it is very evident from the first graph that seed banks help preserve genetic diversity of endangered species which could otherwise be lost completely.

ResultsPlus
Examiner Comments

This is a good answer that gained four marks. The candidate has described several patterns in the data and has discussed the validity of the data. There are few attempts at an explanation so the answer is classed as Level 2.

*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.

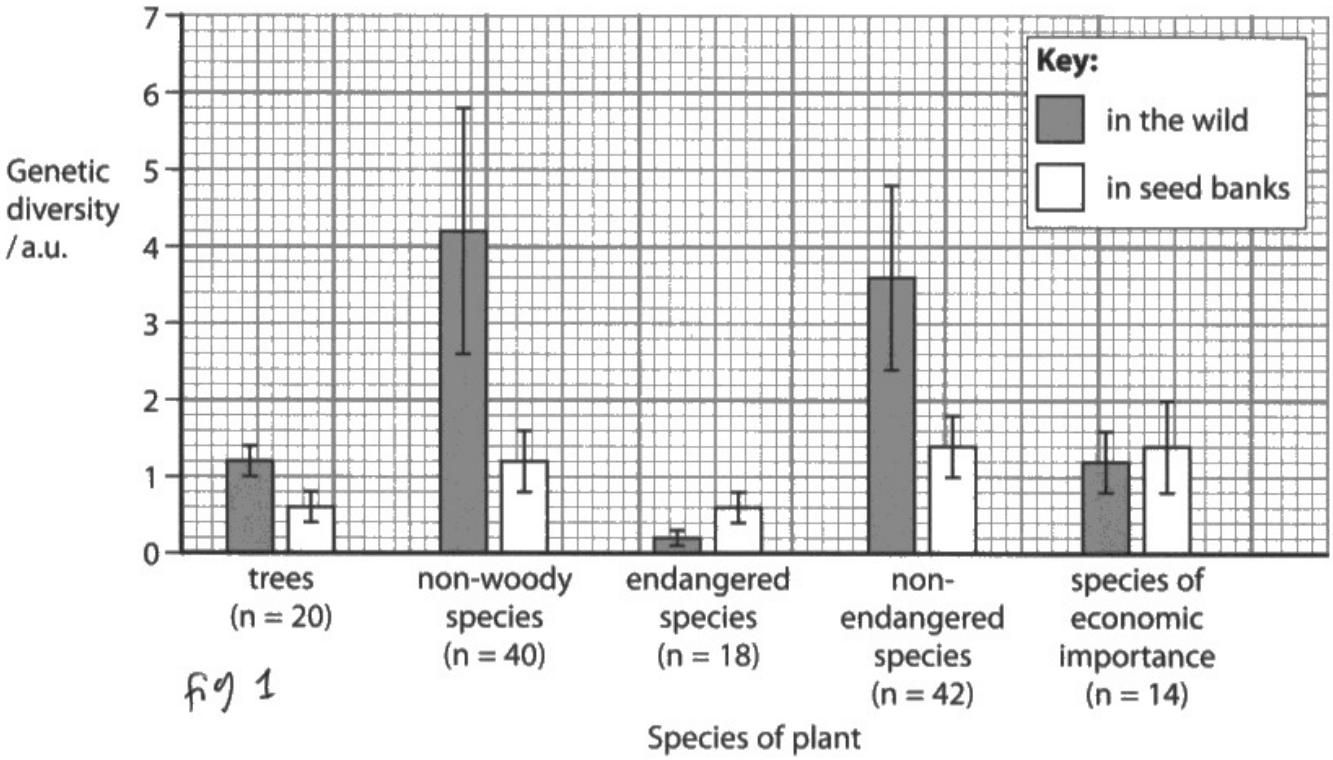


fig 1

Error bars represent +/−1 standard deviation
n = number of different species

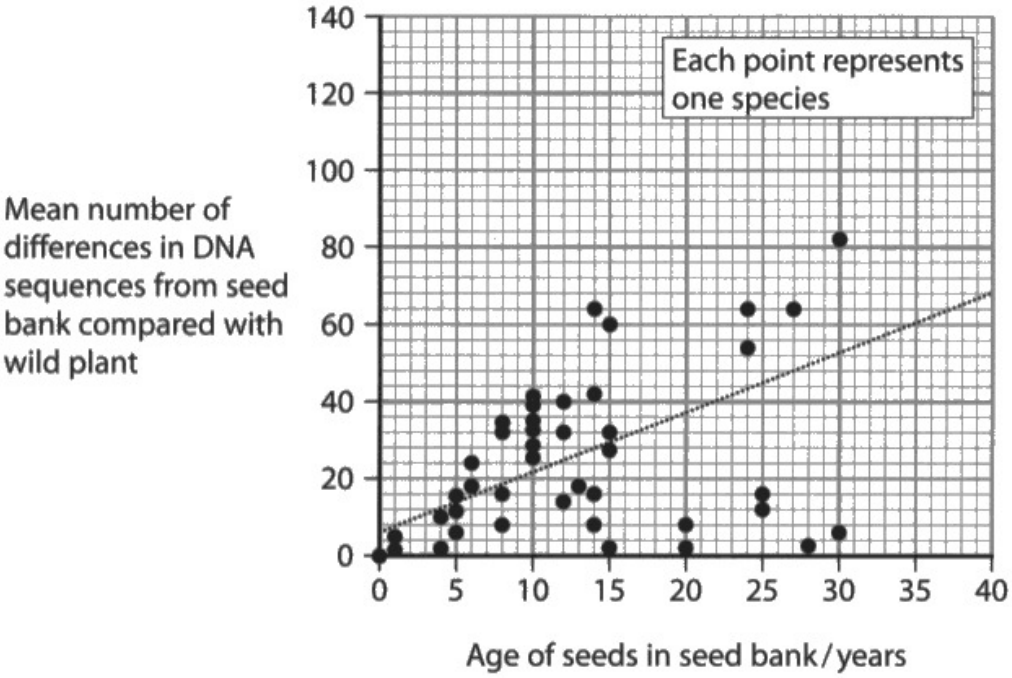


fig 2

Analyse the data to discuss the results of this investigation.

(6)

for most species in figure 1, genetic diversity in all species apart from endangered species and species of economic importance is significantly higher in the wild than in seed banks. This is due to the different conditions; in the wild, there is more competition, harsher conditions like extreme weather and risk of disease. This forces species to adapt to conditions for survival and natural selection takes place, where species with advantageous alleles survive and reproduce offspring. The reason for genetic diversity being higher in seed banks for endangered species is because seed banks have a higher amount of seeds to reproduce compared to the wild where the species is facing possible extinction - the higher the population, the greater the the genetic diversity due to greater gene pool. In figure 2, as the age of seeds in seed bank increases, the mean number of differences in DNA sequences from seed banks compared with wild plants. This is because of, again, different environmental conditions that either inhibit or encourage natural selection but also more mutations occur in the wild than in controlled environment, like seed banks. Overall, genetic diversity is higher in wild plants/seeds compared to species from seed banks.

ResultsPlus
Examiner Comments

This is a good, strong answer that gained four marks. The candidate describes several patterns in the data and gives explanations for differences in genetic diversity. There are no real attempts to discuss validity so the answer is Level 2.

*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

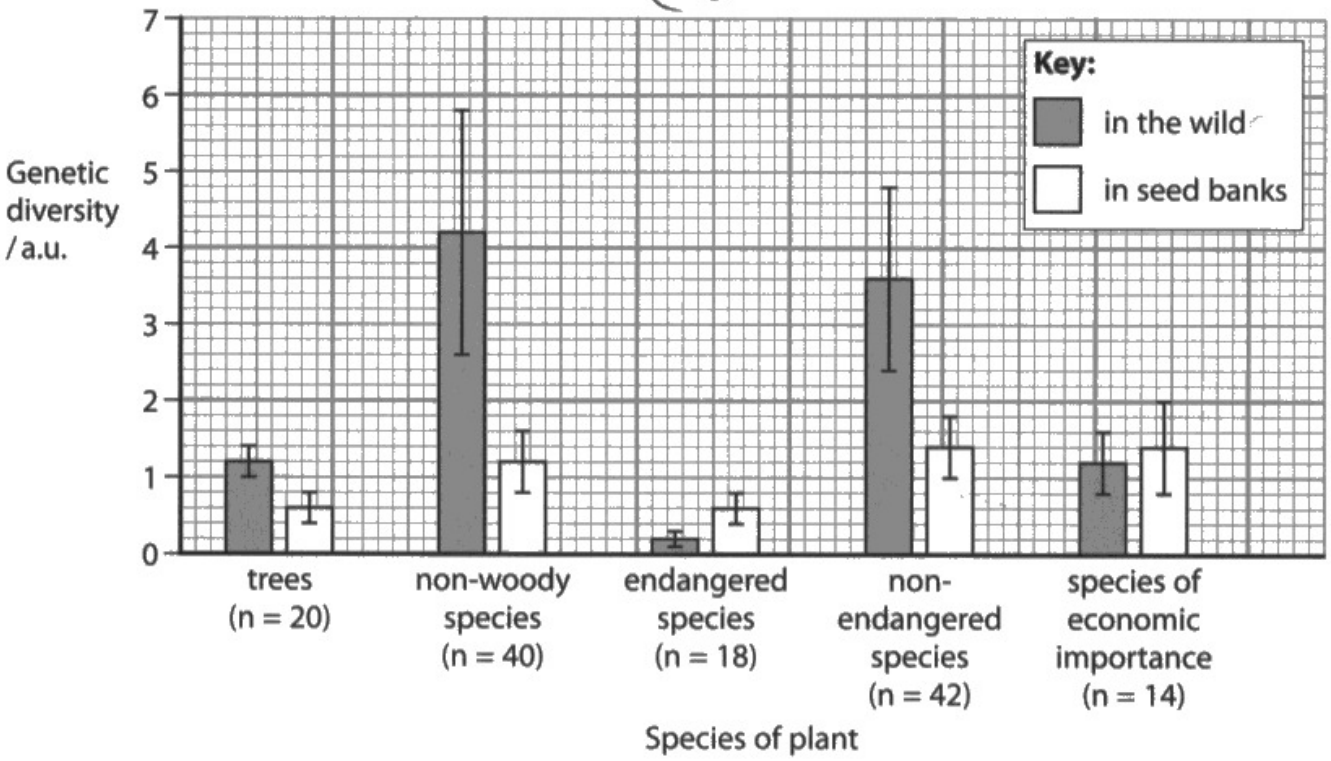
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- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

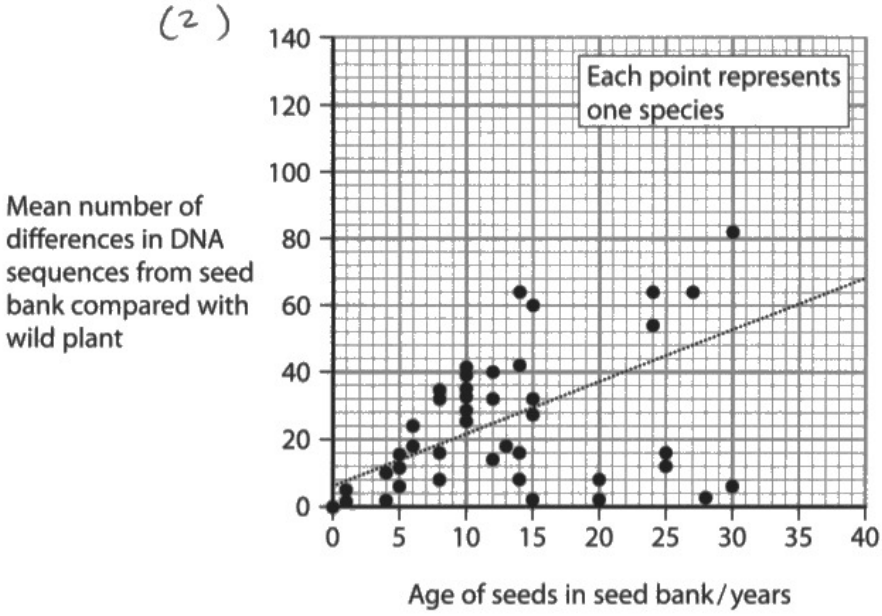
The graphs show the results.

(graph 1)



Error bars represent +/−1 standard deviation
n = number of different species

graph (2)



Analyse the data to discuss the results of this investigation.

(6)

* The graph 2 shows a positive correlation but the data is a bit spread out so it isn't a very strong correlation. ~~Graph~~

* In graph 1, all the results relate, ~~to at least 1 other~~ so non-woody species in the wild has a cross-link with non-endangered species in the wild. Species of economic importance have a cross-link with non-endangered species in seed banks, non-woody species in seed banks and trees in the wild.

ResultsPlus
Examiner Comments

This is a weak answer that gained just one mark for one descriptive idea.

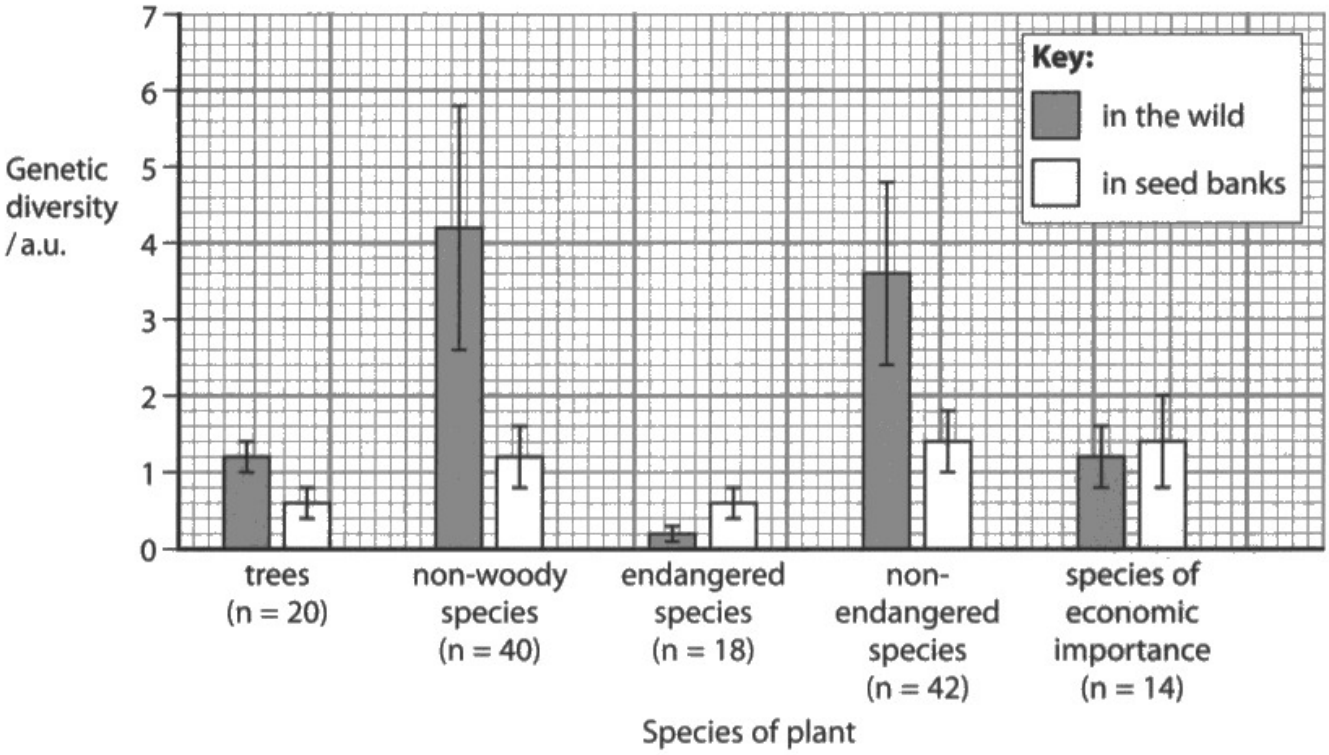
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The species examined included:

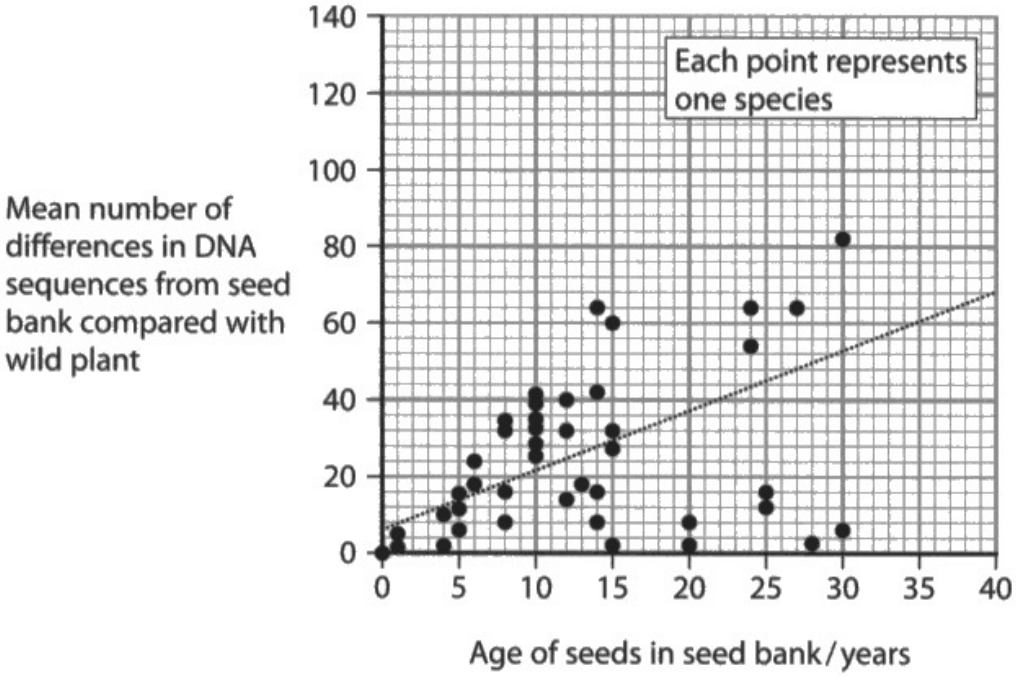
- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/−1 standard deviation
n = number of different species



Analyse the data to discuss the results of this investigation.

(6)

There is a weak positive correlation between age of seeds in the seed banks and mean number of differences in DNA sequences from seed banks compared with wild plant so as age increases so does mean number for the most part.

ResultsPlus
Examiner Comments

This is a weak answer that gained one mark for the description of a positive correlation.

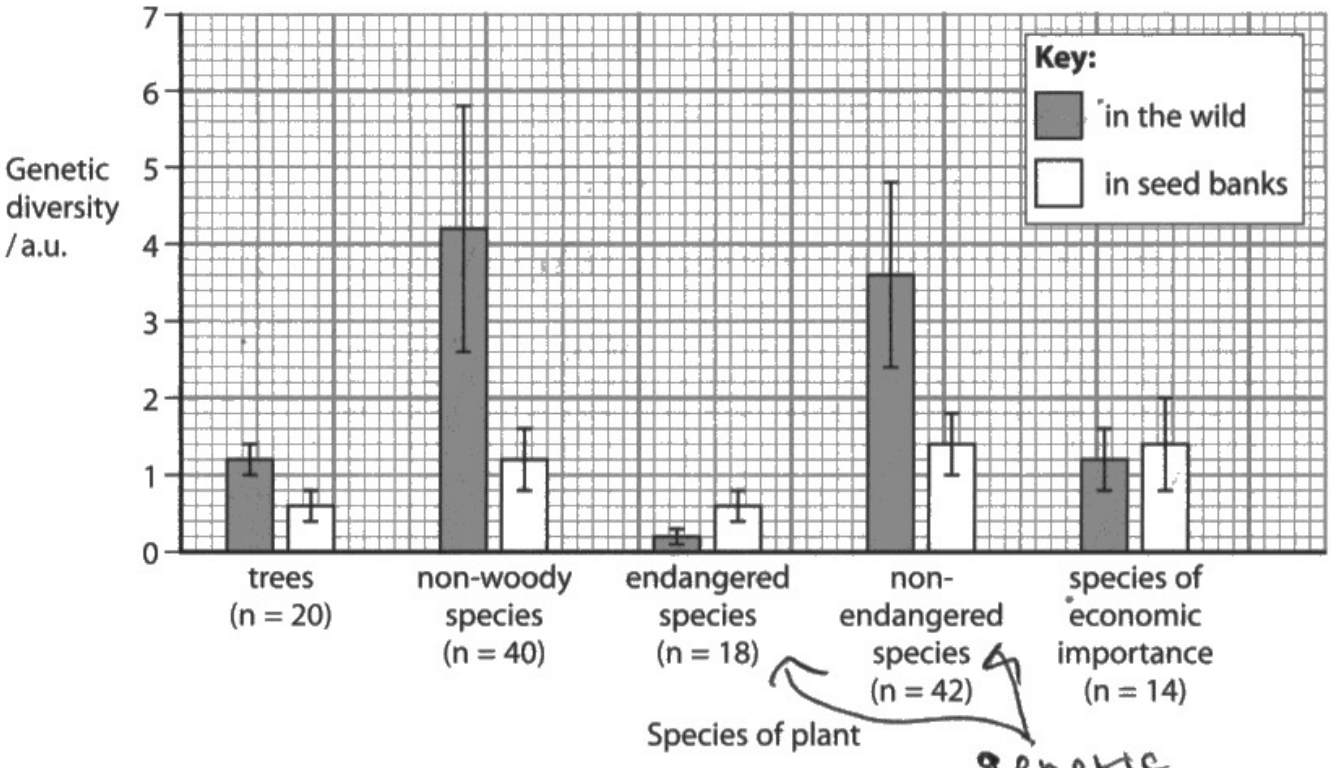
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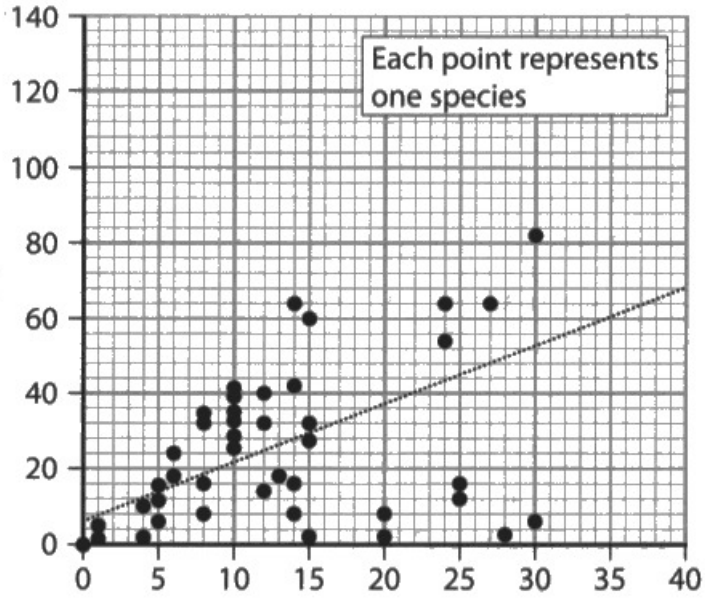
The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/−1 standard deviation
n = number of different species

genetic diversity of wild = higher species except for



Analyse the data to discuss the results of this investigation.

(6)

The data indicates that overall the genetic diversity of plants in the wild is greater than plants in seed banks - this may be species due to fewer seeds in seed banks ∴ there ~~are fewer alleles~~ is a reduced gene pool. However, for an endangered species this ~~statement~~ does not apply as for the wild endangered species genetic diversity = 0.3 a.u, however for the ~~seed banks~~ in banks of this species the genetic diversity = 0.6 a.u. This may be as an endangered species will have fewer individuals and may have ~~an~~ a specific alleles which have been advantageous ∴ survival was due to directional selection. The largest difference between the genetic diversity is in non woody plants which have a difference of 4.2 - 1.2 = 3 a.u. There are no overlaps in the species

suggesting that the data is significant besides the data for the species of economic importance, indicating this ~~data~~ shows no significant difference and is unreliable.
Also there is a positive correlation between the differences in DNA and age of seed bank, this may be due to the wild species having more time to experience different environments and selective pressures - e.g predators and temperature leading to mutations and changes within the genome - and diverging species.

(Total for Question 7 = 11 marks)

ResultsPlus
Examiner Comments

This is a strong answer that gained six marks. The candidate has given descriptions of patterns in the data, offered explanations, and commented on the validity and significance of the data. This makes the answer Level 3.

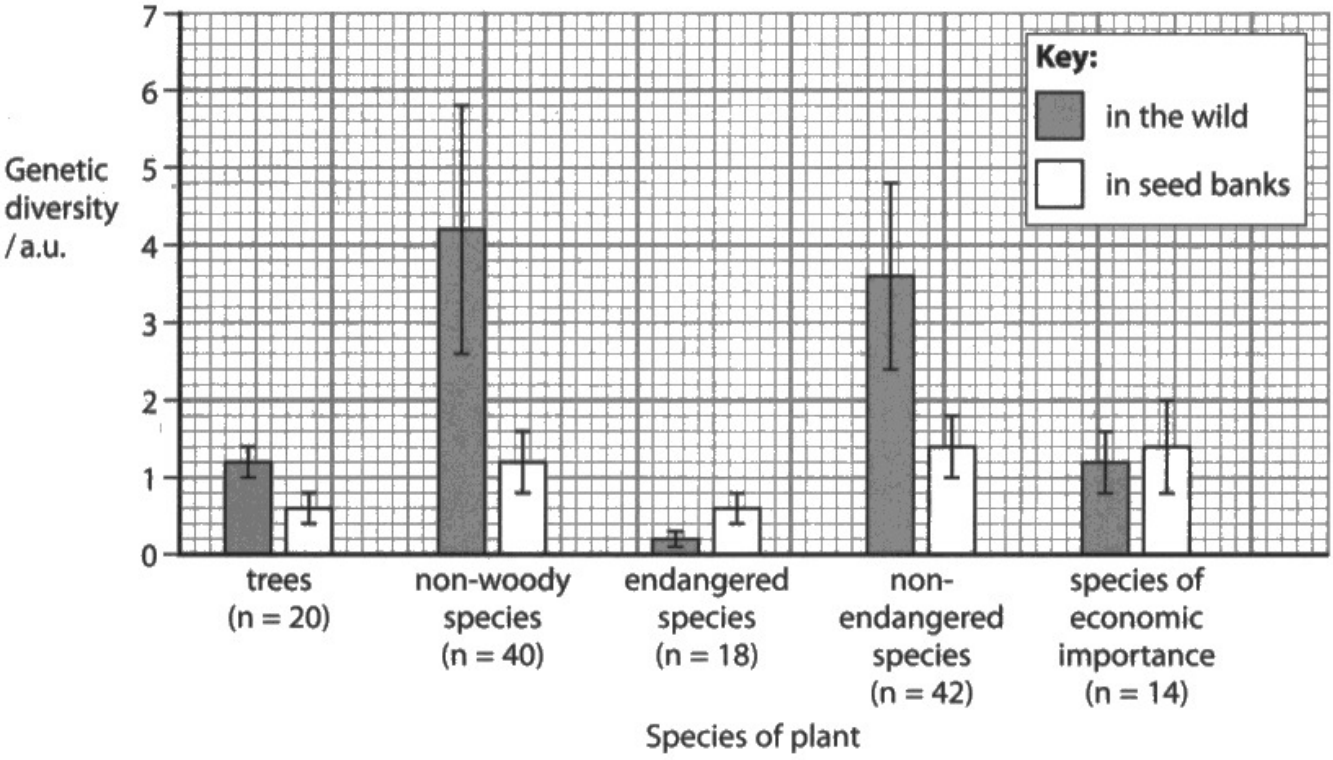
*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

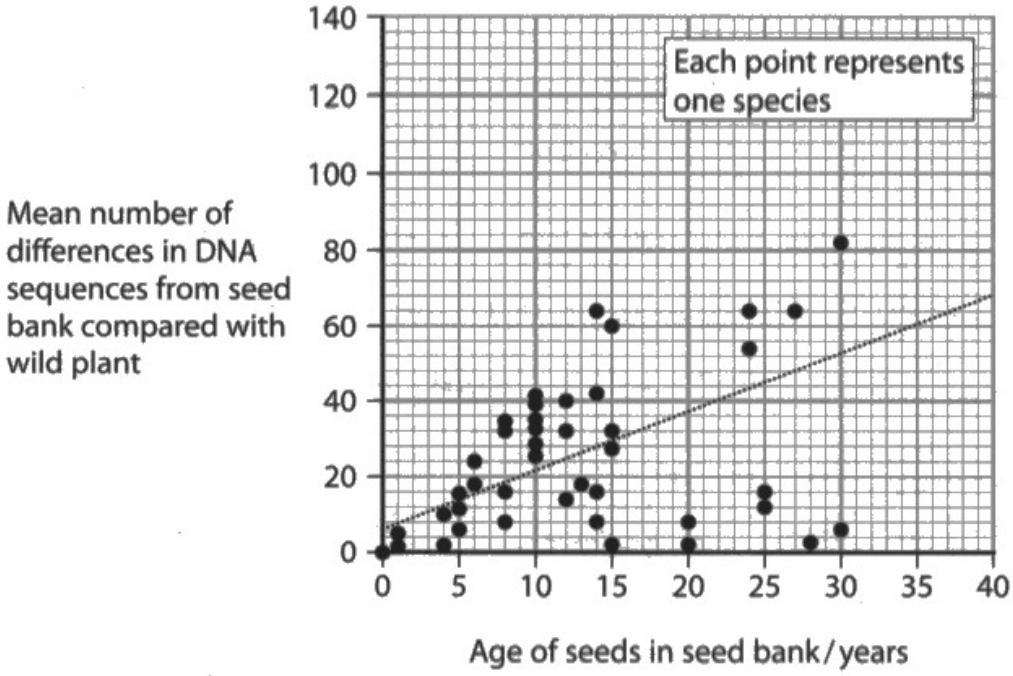
- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/−1 standard deviation
n = number of different species



Analyse the data to discuss the results of this investigation.

(6)

- Graph shows that species in the wild mostly had more genetic diversity. Biggest difference (3a.u) seen between wild and seed banked non-woody species. Error bars non-overlapping
- ~~Now~~ Due to the fact that lots of woody species exist in the wild are able to reproduce sexually, producing varied gametes by meiosis (variation by mutation, crossover, independent assortment) and increasing genetic variation as large gene pool. In seed banks, seeds ~~are~~ harvested from low number of plants ~~and~~ with limited genetic variance (often grown in controlled, sterile conditions where cannot breed freely).
- Species of economic importance had little difference (error bars overlap ∴ might not be statistically significant) as farmed species ~~may~~ in wild may be cloned / grown as a monoculture with little crossbreeding and low genetic diversity.

- Endangered species in the wild had less genetic diversity as low number of individuals, small gene pool, population bottleneck leads to lots of inbreeding and genetic drift & alleles lost and genetic diversity low. In seed banks, plants harvested may have purposely ~~be~~ interbred to maximise diversity using shed tools and artificial pollination & have higher diversity.
- Other graph shows that difference in DNA ~~also~~ increases with age of seeds.

(Total for Question 7 = 11 marks)

- This is because seeds in seed banks are not germinated (kept in airtight, cold, low moisture conditions) whereas wild plants are growing and evolving by natural selection as they adapt to new selection pressure. Random mutations may increase in population as they could provide selection advantage to selection pressure so inherited, causing change in population DNA
- However, results may not be entirely reliable as different sample sizes for experiment one and relatively weak correlation in experiment two (experiment two may also not be causal relationship) contamination or procedural error may have occurred.

ResultsPlus
Examiner Comments

This is another excellent answer that gained six marks. Descriptions of data patterns are given, explanations are offered and there are comments about validity at the end of the answer.

Question 8 (a)

This question asked candidates to explain the role of a double circulation in the maintenance of a high metabolic rate. Most candidates were able to gain at least one mark with many gaining both. Common correct answers included the double circulation allowing different pressures to be maintained in the systemic and pulmonary circulatory systems and separating the oxygenated and deoxygenated blood. Some candidates did not mention that the rapid supply of oxygen enables a high respiration rate but only referred to metabolic rate that was in the question stem.

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

(2)

Seperates oxygenated and deoxygenated blood allowing it to go to where it needs to be to deliver the O_2 or collect some.

ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating that oxygenated and deoxygenated blood are kept separate. There is no reference to oxygen supply for respiration.

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

(2)

The The double circulatory system allows for higher blood pressure in the arteries to the body and lower to the lungs. This means more blood can be oxygenated at the lungs and more oxygenated blood can be delivered around the body. Better Respiring cells therefore have better oxygen supply so they can perform more aerobic respiration to produce more ATP as an energy source for metabolic reactions. keeping oxygenated and deoxygenated blood separate also means there are steeper concentration gradients so more gas exchange can occur at the lungs and more at the respiring tissues.

ResultsPlus
Examiner Comments

This answer gained both marks for correctly stating that oxygenated and deoxygenated blood is kept separate and that this enables a rapid supply of oxygen for respiration.

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

(2)

- Deoxygenated and oxygenated blood doesn't mix making it more efficient meaning more blood can be transported at higher pressure therefore more oxygen is delivered around the body therefore more respiration can occur meaning metabolic rate increases as there is more ATP.

ResultsPlus
Examiner Comments

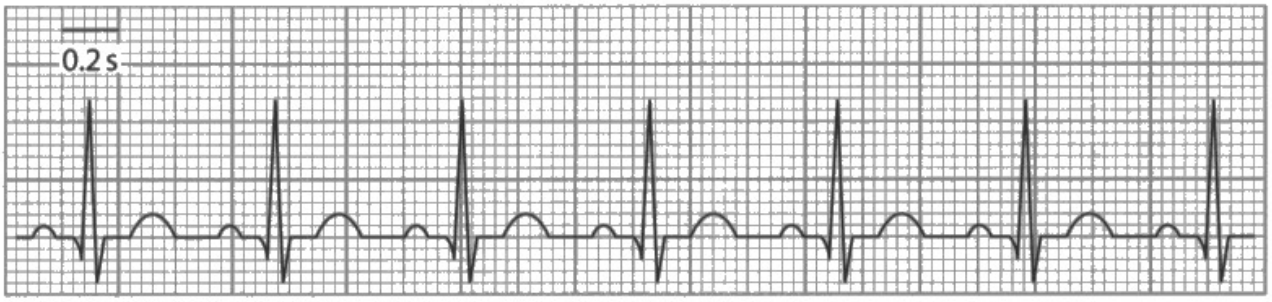
This answer gained two marks for stating that oxygenated and deoxygenated blood are kept separate and that oxygen is supplied for respiration.

Question 8 (b)(i)

This mathematical question required candidates to calculate a heart rate. Many excellent answers were seen that gained both marks for correctly determining the time taken for one beat and then dividing 60 by this time. Some candidates gained one mark for a correct method after calculating the wrong time for one heartbeat. A few candidates misread the scale on the graph but often gained a mark for a correct method.

(b) Abnormal heart rhythms can be identified in ECG traces.

The diagram shows ECG traces of a person with a regular, healthy heart rhythm and a person with an abnormal heart rhythm.



Person with regular heart rhythm



Person with abnormal heart rhythm

(i) Calculate the heart rate, in beats per minute, of the person with an abnormal heart rate.

Give your answer to the nearest whole number.

(2)

0.84s

$\frac{60}{0.84} \approx 71.43$ BPM

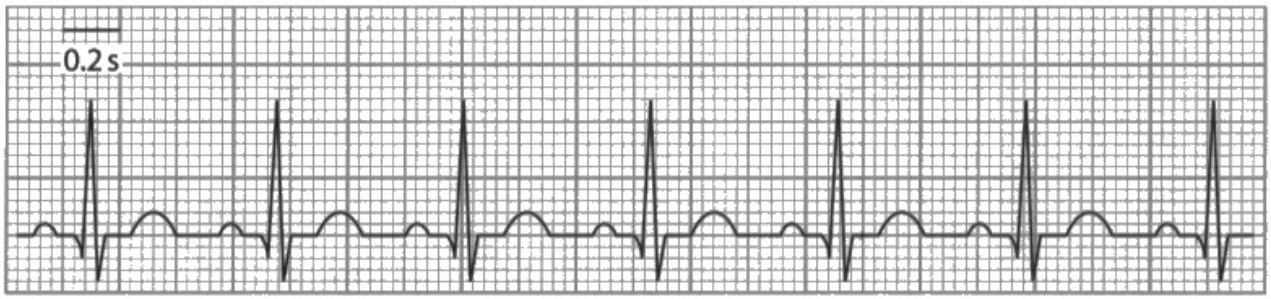
Answer 71 beats per minute

ResultsPlus
Examiner Comments

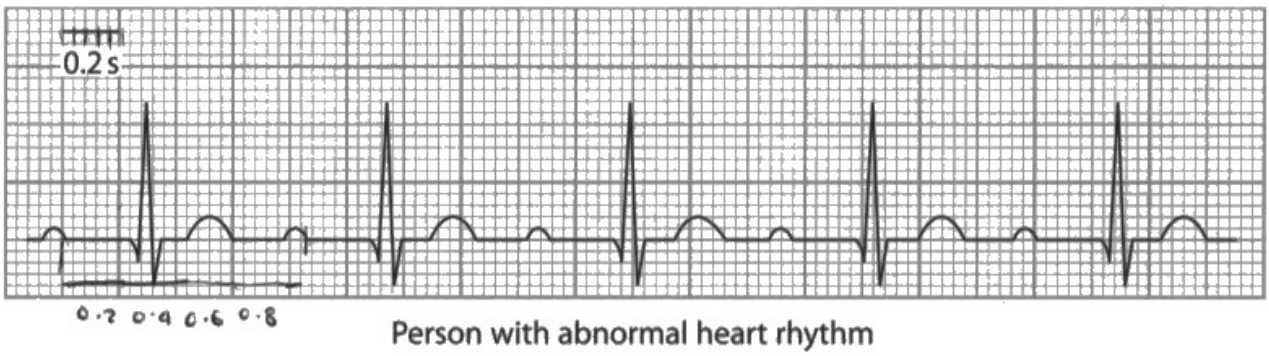
This is an example of a correct answer that gained two marks. The candidate has shown their working clearly.

(b) Abnormal heart rhythms can be identified in ECG traces.

The diagram shows ECG traces of a person with a regular, healthy heart rhythm and a person with an abnormal heart rhythm.



Person with regular heart rhythm



Person with abnormal heart rhythm

(i) Calculate the heart rate, in beats per minute, of the person with an abnormal heart rate.

Give your answer to the nearest whole number.

(2)

$$\frac{60}{0.825} = 72.7272$$

73

Answer 73 beats per minute



This is an example of a correct answer that gained both marks.

Question 8 (b)(ii)

This challenging question required candidates to analyse the ECG trace for a patient and explain how the trace showed that there was damage to the septum. Some excellent answers were seen that clearly stated that there was a longer gap between the P and QRS complex, although some candidates showed confusion with labelling the letters on the trace. A significant number of candidates recognised that there was a delay between atrial and ventricular systole and also went on to state that there may be damage to the bundle of His or Purkinje fibres in the septum.

(ii) **Explain how the ECG traces show this abnormal heart rhythm is due to damage to the septum in the centre of the heart between the left and right sides.**

(2)

There is a longer delay between the P wave and QRS complex, so there is a longer delay between atrial depolarisation and ventricular depolarisation. This means conduction of the wave of depolarisation from the atrioventricular node ~~is delayed~~ across the ventricles is delayed, so the wave of depolarisation is not ~~travelled~~ being transmitted down the bundle of His ~~and~~, which is located in the septum between the left and right side. This means ventricular systole is delayed because ~~trans~~ the wave of depolarisation takes longer to pass from the AV atrioventricular ~~node~~, node, down the bundle of His and purkinje fibres.

ResultsPlus
Examiner Comments

This excellent answer gained both marks and illustrated all three mark points. The candidate describes the delay between the P and QRS complex and goes on to state that there is a delay between atrial and ventricular systole, possibly due to damage to the bundle of His.

(ii) Explain how the ECG traces show this abnormal heart rhythm is due to damage to the septum in the centre of the heart between the left and right sides.

(2)

~~The abnormal ECG~~ The ECG of the person with the abnormal heart rhythm shows that the p wave happens too quickly. The depolarisation of the atria occurs, and then there is a lapse before the QRS complex which represents the repolarisation of the ventricles. Damage to the septum would mean that ~~deoxygenated and oxygenated blood would mix~~ impulses would not be able to travel down the septum, through the bundle of HIS and through the purkinje fibres causing ventricular systole, hence the delay in the QRS complex.

ResultsPlus
Examiner Comments

This strong answer gained two marks for correctly stating that there is a long delay between the P and QRS complex and that this may be due to damage to the bundle of His.

Question 8 (b)(iii)

This question presented candidates with information about the structure of atropine and asked them to explain how its action can lead to an increase in heart rate. Many excellent answers were seen that explained that the atropine would bind to acetylcholine receptors and prevent acetylcholine that had been released from parasympathetic neurones from binding. Most candidates were able to gain at least one mark with many going on to gain all three.

(iii) Bradycardia is a heart condition that results in a heart rate that is slower than normal.

Atropine is a drug that can be used to treat some forms of bradycardia.

Atropine is a competitive inhibitor of acetylcholine.

Explain why atropine will lead to an increase in heart rate.

(3)

Acetylcholine (ACh) is a neurotransmitter used in the parasympathetic nervous system to lower the heart rate. Atropine has similar shape to Ach and binds to acetylcholine receptors on the postsynaptic membrane of SAN to prevent acetylcholine from binding and lowering heart rate

ResultsPlus
Examiner Comments

This strong answer gained three marks. The candidate states that acetylcholine is released from the parasympathetic nervous system and slows the heart rate. The candidate then goes on to explain that atropine will bind to the receptors and prevent acetylcholine binding.

(iii) Bradycardia is a heart condition that results in a heart rate that is slower than normal.

Atropine is a drug that can be used to treat some forms of bradycardia.

Atropine is a competitive inhibitor of acetylcholine.

Explain why atropine will lead to an increase in heart rate.

(3)

Acetylcholine is a transmitter that is sent down the parasympathetic nerve to decrease the heart rate. If atropine is a competitive inhibitor, this means that acetylcholine can no longer bind to receptors to decrease the heart rate, further leading to an increase in heart rate because nothing slowing heart rate down and acetylcholine can no longer bind.

ResultsPlus
Examiner Comments

This very good answer gained three marks. The candidate correctly states that acetylcholine is released by the parasympathetic nervous system and slows the heart rate. The candidate also goes on to state that atropine will prevent acetylcholine binding to receptors.

Question 8 (b)(iv)

This question assessed the candidates understanding of how exercise leads to the stimulation of the medulla so that heart rate is increased. Many excellent answers were seen that gave excellent detail. Stronger answers referred to the release of carbon dioxide from respiration, the decrease in pH of the blood, and the detection of this by chemoreceptors in the aorta and carotid artery. A few candidates wrote answers that lacked detail, for example, they would refer to chemoreceptors but not give a location, or they would refer to respiration but not mention the release of carbon dioxide. Some candidates confused baroreceptors with chemoreceptors and some candidates explained how the sympathetic nervous system causes an increase in heart rate due to noradrenaline release.

(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

(4)

As we exercise more CO_2 will ~~enter~~/be produced in the body. As a result this decreases PH of blood and Chemoreceptors detect this change. As a result of this signals must be sent to the brain to increase heart rate which we know is controlled by the medulla oblongata. ~~as this reaction~~ By doing this the medulla oblongata will increase heart rate so more oxygen enters the body and CO_2 is removed from the body.

ResultsPlus
Examiner Comments

This answer gained two marks. The candidate stated that the pH of the blood would decrease leading to the stimulation of chemoreceptors. Carbon dioxide is mentioned but not linked to respiration.

(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

(4)

Exercise causes a ~~increase~~ decrease in pH due to an increase in CO2 levels, this is received by chemoreceptors which send an impulse to the medulla to increase impulses down the parasympathetic nerve to increase depolarisation by the SAN

ResultsPlus
Examiner Comments

This answer gained two marks for the role of chemoreceptors and the sending of impulses to the medulla. Carbon dioxide is not linked to respiration and the pH fall is not linked to the blood.

(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

(4)

when exercising the CO_2 concentration in our bodies ~~in our blood~~ increases which leads to a lower pH. this is detected by the chemoreceptors in the carotid arteries, aorta and body which then sends impulses to the cardio centre in the medulla oblongata to be processed by the brain.
due to respiration and lactate building.

ResultsPlus
Examiner Comments

This answer gained four marks. The candidate states that the blood pH falls and that this is detected by the chemoreceptors in the carotid artery which send impulses to the medulla.

Question 9 (a)

This question presented candidates with pyramids of biomass for a marine food chain in two sequential months, and the pyramid of energy for the whole year. Most candidates were able to gain one mark with many going on to gain two or three. Many candidates correctly described the changes in phytoplankton and zooplankton between November and December but some only described the changes in one trophic level or described the pyramid for one month. Many candidates were able to describe the decreasing energy along the food chain and give a reason for the decrease in energy such as excretion or indigestible material. Some of the strongest answers explained that the pyramid of energy was taken for the whole year and the pyramids of biomass are 'snapshots' of one month.

9 Phytoplankton are producer organisms in marine ecosystems.

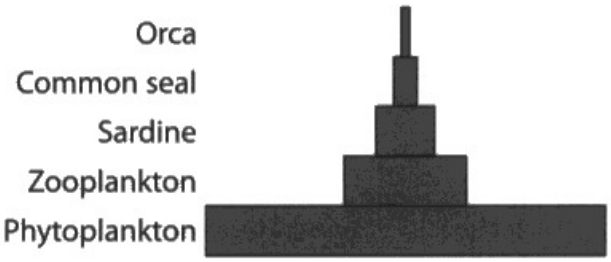
Zooplankton are small animals that live in the surface waters of the oceans.

The diagram shows a food chain for the South Atlantic Ocean.

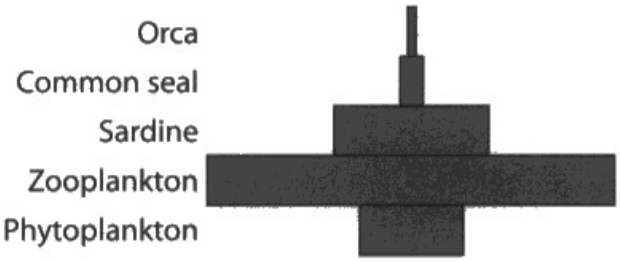
phytoplankton → zooplankton → sardine → common seal → orca

The diagrams below show ecological pyramids for this food chain.

Pyramid of biomass for November



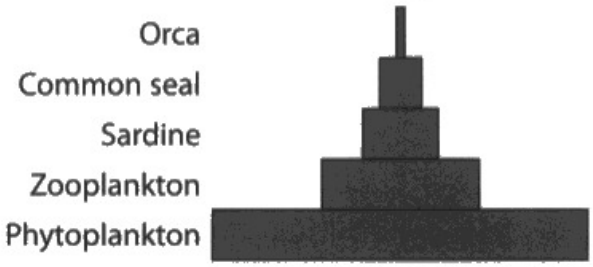
Pyramid of biomass for December



The units for biomass are $kg\,m^{-3}$

The units for energy are $kJ\,m^{-3}\,yr^{-1}$

Pyramid of energy for one whole year



(a) Comment on the shapes of these three ecological pyramids.

(3)

Both pyramid of biomass & energy narrow at the top meaning less energy is transferred from producer → primary consumer & so on (different trophic levels) the pyramid of biomass shows a large increase and widening at zooplankton but the narrows again towards the top. Zooplankton must be efficient at maintaining their biomass/ energy.

ResultsPlus
Examiner Comments

This answer gained one mark for the correct idea of a decrease in energy along the food chain. The description of the changes in phytoplankton and zooplankton is confused.

9 Phytoplankton are producer organisms in marine ecosystems.

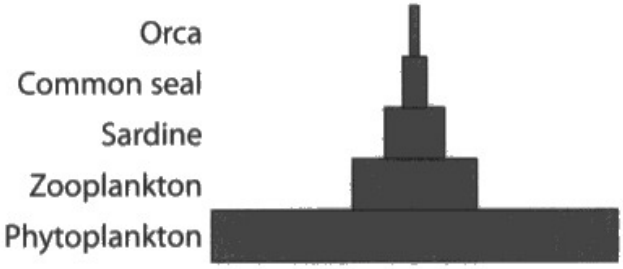
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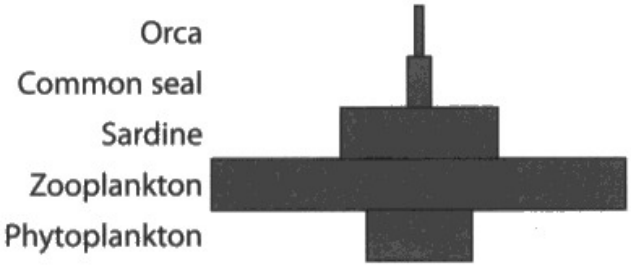
phytoplankton → zooplankton → sardine → common seal → orca

The diagrams below show ecological pyramids for this food chain.

Pyramid of biomass for November



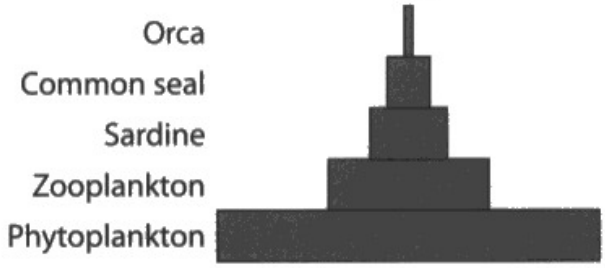
Pyramid of biomass for December



The units for biomass are $kg\,m^{-3}$ ←

The units for energy are $kJ\,m^{-3}\,yr^{-1}$ ←

Pyramid of energy for one whole year



(a) Comment on the shapes of these three ecological pyramids.

(3)

Pyramid of biomass for november and energy for one year are similar. So energy recieved similar to energy of the orca per kg. Pyramid of biomass each for december different than for november with zooplankton having the largest biomass in december and phytoplankton having more biomass than compared to November.

ResultsPlus
Examiner Comments

This answer gained one mark for a correct description of the changes of phytoplankton and zooplankton biomasses between November and December.

9 Phytoplankton are producer organisms in marine ecosystems.

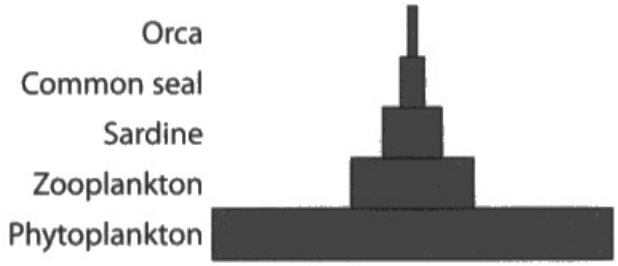
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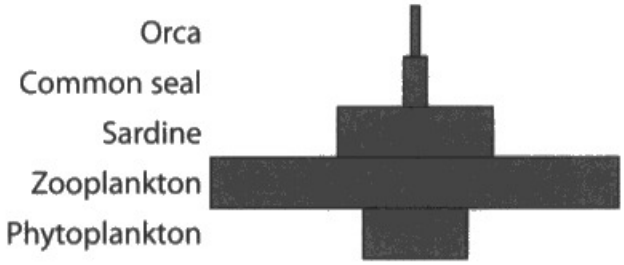
phytoplankton → zooplankton → sardine → common seal → orca

The diagrams below show ecological pyramids for this food chain.

Pyramid of biomass for November



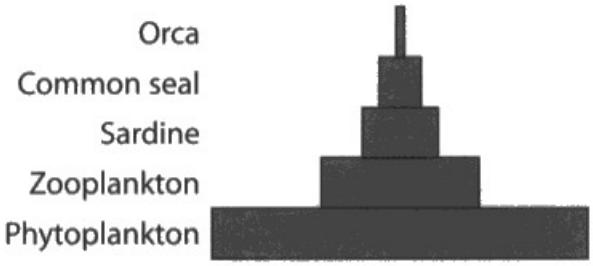
Pyramid of biomass for December



The units for biomass are $kg\ m^{-3}$

The units for energy are $kJ\ m^{-3}\ yr^{-1}$

Pyramid of energy for one whole year



(a) Comment on the shapes of these three ecological pyramids.

(3)

" Over the year, the produces of phytoplankton provides the most energy. Each trophic level uses up different amount of energy. Primary, secondary, tertiary consumers have less energy as more is wasted in metabolic processes such as heat loss and movement. This is why the energy pyramid is a triangle shape.

The pyramid shows how not all energy is passed on to next trophic level as some is lost through excretion, waste (urine) or simply not consumed. For pyramid of biomass, there is a huge decrease from in number
november to december of phytoplankton due to the increase of zooplankton which means there are more of them to consume and eat phytoplankton.

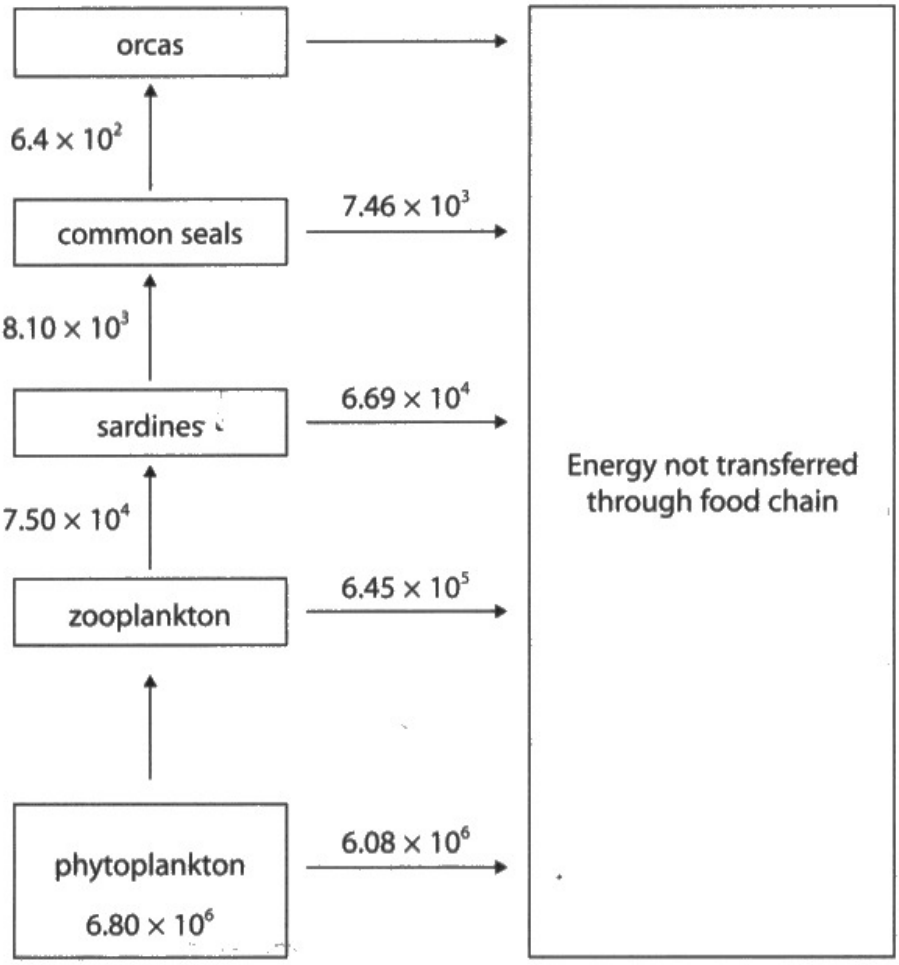
ResultsPlus
Examiner Comments

This strong answer gained three marks. The candidate describes the changes in biomass correctly and explains that the zooplankton will have consumed the phytoplankton. The candidate also goes on to explain why the pyramid of energy decreases.

Question 9 (b)(i)

This question required candidates to calculate the efficiency of energy transfer between two trophic levels. Most candidates were able to complete the calculation correctly although a few did not give their answer to the nearest whole number as instructed.

(b) The diagram shows the flow of energy through this food chain.



All values are measured in $kJ\,m^{-3}\,yr^{-1}$

(i) Calculate the percentage efficiency of energy transfer between the phytoplankton and the zooplankton.

Give your answer to the nearest whole number.

(2)

6800000 608

$\frac{6800000 - 6080000}{6800000} \times 100 = 10.58$

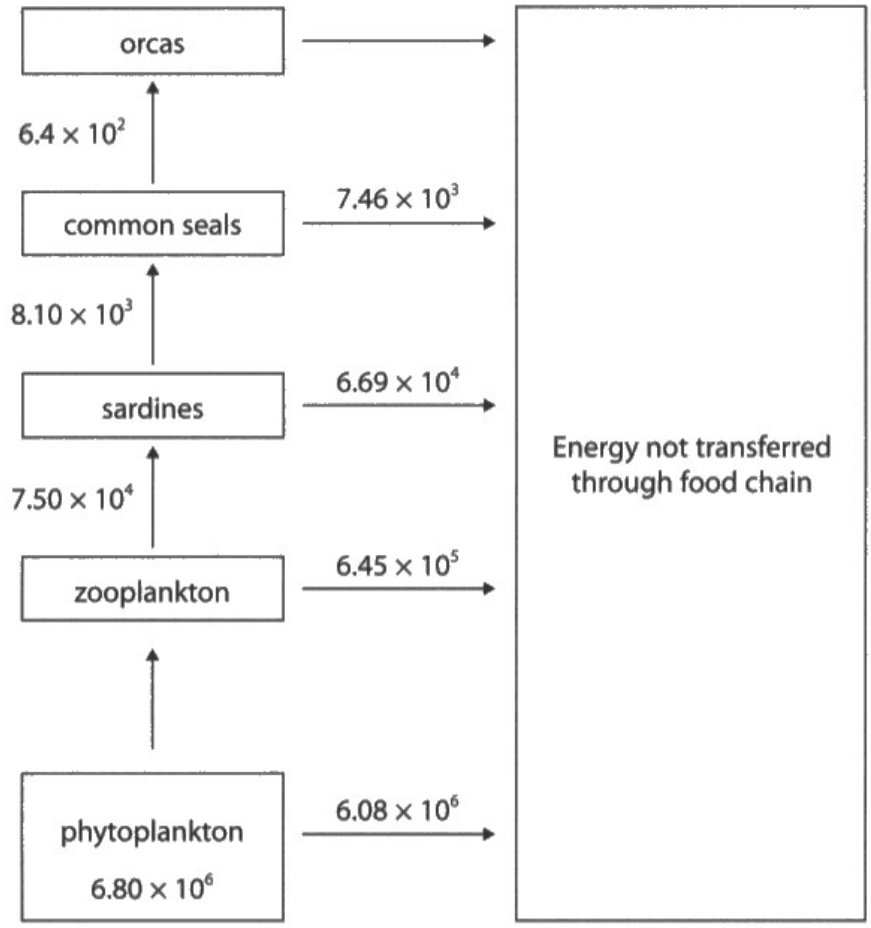
11%

Answer 11 %

ResultsPlus
Examiner Comments

This correct answer gained both marks. The candidate has also shown their working clearly.

(b) The diagram shows the flow of energy through this food chain.



All values are measured in $kJ\,m^{-3}\,yr^{-1}$

(i) Calculate the percentage efficiency of energy transfer between the phytoplankton and the zooplankton.

Give your answer to the nearest whole number.

$6.8 \times 10^6 - 6.08 \times 10^6 = 720\,000$ (2)

$\frac{720\,000}{6.8 \times 10^6} \times 100 = 10.588\,\%$

Answer 10.59 %

ResultsPlus
Examiner Comments

This answer gained one mark. The candidates has completed the calculation correctly but has not given the answer to the nearest whole number.

Question 9 (b)(ii)

This challenging question asked candidates to explain why the transfer of energy along a food chain is less efficient when an endotherm is in the chain compared with an ectotherm. The question assessed the candidates knowledge of thermoregulation and energy transfer through food chains. Some excellent answers were seen that explained that endotherms regulate their body temperature, lose more heat, and so have a higher metabolic rate. A significant number of candidates were confused by the terms ectotherm and endotherm and incorrectly suggested that ectotherms will continuously lose more heat energy and so have higher metabolic rates. Candidates should be fully conversant with all technical terms used in the specification.

(ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

(3)

Sardines are ectotherms. Sardines use alot more energy during metabolic processes than zooplankton. Hence, more energy is wasted during excretion. More energy is lost through feces. More energy is lost as movement ⇒ there are more indigestible parts of sardines such as bones ⇒ energy transfer is less efficient.

ResultsPlus
Examiner Comments

This answer did not gain any credit. The candidate has some correct concepts, for example, the idea of energy lost from uneaten food, but the context is incorrect and suggests that the sardines will lose more energy.

(ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

(3)

- ectotherms rely on environment to control body heat.
- endotherms produce own body heat through exothermic metabolic reactions (eg respiration)
- common seals are endotherms & lose lots of energy as have a much higher metabolic rate (lose energy as heat energy produced) so energy transfer less efficient
- Sardines lose less energy to environment as have a much slower metabolic rate

ResultsPlus
Examiner Comments

This strong answer gained all three marks. The candidate correctly states that endotherms will lose more heat, have to regulate their body temperature (and ectotherms do not), and so have a higher metabolic rate.

(ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

(3)

Seals ~~Orcas~~ use energy in the maintain-ence of a stable internal temperature + so release heat to the surroundings. ∴ not all is transferred to orcas.

~~Orcas excrete~~ Seals excrete energy as faeces they digested from sardines + the orca does not eat all of the seal.

~~Seal~~ Sardines do not need to use energy from zooplankton to maintain temperature.

ResultsPlus
Examiner Comments

This answer gained all three marks. The candidate has stated that seals regulate their body temperature and lose more heat. They also explain that there is energy loss from excretion.

Question 9 (c)(i)

This question asked candidates to define the term net primary productivity. Most candidates were able to gain the mark, often by giving the formula for NPP (NPP = GPP-R).

(c) Scientists investigated the impact of global warming on marine productivity.

They determined the effect of temperature and light intensity on the net primary productivity (NPP) of phytoplankton.

Phytoplankton were exposed to different light intensities at three different temperatures for one month. After one month, the scientists measured the increase in dry biomass of phytoplankton.

The results are shown in the table.

Light intensity / arbitrary units	Mean increase in dry biomass of phytoplankton / g		
	10 °C	20 °C	30 °C
5	4	6	2
10	8	10	4
15	10	20	15
20	12	24	28
25	12	28	35

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

(1)

energy available for next trophic level
GPP – R.

ResultsPlus
Examiner Comments

This answer gained the mark for correctly giving the formula for NPP.

(c) Scientists investigated the impact of global warming on marine productivity.

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5	4	6	2
10	8	10	4
15	10	20	15
20	12	24	28
25	12	28	35

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

Nett primary productivity is the ~~total~~ net energy produced by an ecosystem per g mass unit per time. NPP = GPP - R (1)

net primary productivity = gross primary productivity − Respiration.

ResultsPlus
Examiner Comments

This is another example of an answer that gained one mark for correctly defining NPP using the formula.

Question 9 (c)(ii)

This final question on the paper required candidates to analyse a statement about the effect of fossil fuel use on orca populations. They were required to draw together information from an experiment into the effect of light intensity and temperature on the growth of algae with their own knowledge and the food chain given in the question. Stronger answers stated that the data showed that NPP generally increased with temperature, but at lower light intensities the NPP decreased when temperatures were higher. This suggests that at low light intensities, respiration increases but photosynthesis is limited. High quality answers described the patterns shown by the experimental data and linked them to other information in the question, such as an increase in cloud cover causing a decrease in light intensities, reducing NPP lower at higher temperatures. Strong answers also referred to the reduced availability of nutrients such as nitrates limiting protein synthesis. To reach Level 3, candidates needed to describe the data patterns, give explanations about how an increasing temperature could increase and / or decrease NPP (and the impacts on the food chain), and discuss the role of fossil fuels in the process. Weaker answers tended to be either purely descriptive or gave consequences of global warming without linking it to the data.

*(ii) Some effects of global warming include the following:

- Atmospheric carbon dioxide could cause an increase in temperature.
- Increased atmospheric temperature could increase cloud cover.
- Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
- The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.
- Analyse the data in the table and the information given to discuss this conclusion.

(6)

As light intensity increases so does mean increase in biomass as more photosynthesis takes place. As temperatures increase So does mean biomass as enzymes have ~~have~~ more kinetic energy and therefore have a faster rate. However past a certain temperature and enzymes will denature. The burning of fossil fuels produces CO_2 which causes an increase in temperature. If temperatures go to high and enzymes denture phytoplankton will die. This will lead to a fall in orca populations as orcas rely on phytoplankton in the food chain. Increased cloud cover from fossil fuels reduces light intensity limiting photosynthesis.

ResultsPlus
Examiner Comments

This answer gained six marks. There is a basic description of the patterns in the data, some explanations given (eg light limiting photosynthesis) and a link to fossil fuel usage.

*(ii) Some effects of global warming include the following:

- ✓ Atmospheric carbon dioxide could cause an increase in temperature.
- ✓ Increased atmospheric temperature could increase cloud cover.
- ✓ Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
- The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.
- Analyse the data in the table and the information given to discuss this conclusion.

(6)

→ less light

→ less nutrients for phytoplankton

- Burning fossil fuels causes CO_2 to be released
- The increased temperature alone would not be beneficial to the biomass of phytoplankton as at over 20°C the biomass decreases except in very high light intensity
  ↳ due to enzymes starting to denature
- The increased temp could increase cloud cover which would decrease light intensity
  ↳ this would decrease the biomass as less photosynthesis could take place
  ↳ this would reduce the amount of energy passed to up the food chain to the orcas and could decrease a population
- Less nutrients in the sea bed mean less nutrients for the phytoplankton which would decrease photosynthesis
- Experiment needs to be repeated many times to validify the statement
- Experiment needs to be done on orca population to see if this changes.

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

ResultsPlus
Examiner Comments

This answer gained six marks and is Level 3. The candidate gives descriptions of the data, gives explanations and links their answer to fossil fuel usage, also considering validity.

*(ii) Some effects of global warming include the following:

- Atmospheric carbon dioxide could cause an increase in temperature.
- Increased atmospheric temperature could increase cloud cover.
- Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
- The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.
- Analyse the data in the table and the information given to discuss this conclusion.

(6)

Fossil fuel usage increases global warming as more CO_2 released As global warming causes an increase in temperature due to CO_2, the mean increase of dry ~~weight~~ biomass of phytoplankton reduces such as from 4g to 2g over a 20°c increase in temperature. Therefore there is less phytoplankton, so ~~more~~ fewer zooplankton, sardines and seals survive as less food. Therefore orcas have less food so they fall in population. More CO_2 results in high temperatures which cause high cloud cover so ~~less~~ cover light intensity. As light intensity reduces from 25 to 5 au, phytoplankton biomass reduces by ~~22~~ 33g at 30°C so lower biomass of phytoplankton means less food for orcas due to the food chain. The higher sea temperatures also cause less ~~not~~ mineral ions such as nitrates to move to surface water, where zoo-plankton grow. So they have fewer nitrates for protein synthesis so grow less and less likely to reproduce and survive. So lower biomass of zooplankton reduces food for seals so less food for orcas so their population declines

(Total for Question 9 = 15 marks)

ResultsPlus
Examiner Comments

This answer gained six marks. Descriptions of the data, possible explanations and a link to fossil fuel are given making the answer Level 3.

*(ii) Some effects of global warming include the following:

- Atmospheric carbon dioxide could cause an increase in temperature.
- Increased atmospheric temperature could increase cloud cover.
- Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
- The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.
- Analyse the data in the table and the information given to discuss this conclusion.

(6)

~~The rise in surface temperature due to increased CO_2 in atmosphere as a result of fossil fuel consum~~

Atmospheric carbon dioxide could cause an increase in temperature and increased cloud cover. At high temp 30°C and low light intensity of 5 arbitary units NPP of phytoplankton is lowest possible. As phytoplankton become less productive in these conditions the amount of ~~biomass~~ energy created will be lower. As a result secondary consumers (zooplankton) will have less food and will reduce in population. This will have the same effect and all predators above such as sardines, ~~seals~~ and common seals. As population of common seals is reduced Orcas will have less food and may see a fall in population so conclusion is valid

(Total for Question 9 = 15 marks)

ResultsPlus
Examiner Comments

This answer gained two marks. The candidate has explained the consequences of global warming but unfortunately has not linked this to the experimental data or the use of fossil fuels, keeping the answer in Level 1.

*(ii) Some effects of global warming include the following:

- Atmospheric carbon dioxide could cause an increase in temperature.
- Increased atmospheric temperature could increase cloud cover.
- Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
- The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.
- Analyse the data in the table and the information given to discuss this conclusion.

(6)

Having an increase in cloud cover means that there is going to be less light as the sun will be behind the clouds, and in the table it shows that less light intensity causes a decrease in biomass of phytoplankton. Having an increase in temperature means that there is going to be more heat and in the table it shows that higher heat temperatures with less light intensity causes a decrease in biomass of phytoplankton.

Both of these effects will reduce the amount of phytoplankton there are which is detrimental to the food chain as if there isn't any producer organisms in the environment then the other animals in the food chain (eg orcas) have nothing to feed on, leading to the extinction of orcas and other animals.

(Total for Question 9 = 15 marks)

ResultsPlus
Examiner Comments

This answer gained four marks and is Level 2. The candidate gives descriptions of the data and explanations of the impacts but does not link this with fossil fuel or discuss validity.

Paper Summary

Based on their performance on this paper, candidates should:

- Be fully familiar with the requirements of all the command words.
- Practice data analysis using unfamiliar sets of data prior to the examination.
- Explore all aspects of data presented in longer questions.
- Make sure that they use accurate and precise scientific vocabulary.
- Make sure that they work at an even pace throughout the exam. Focus on mark allocations for questions rather than trying to fill every line.
- Consider the validity of investigations when tackling longer discussion and evaluate questions.

Grade boundaries

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

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