

Examiners' Report
Principal Examiner Feedback

Summer 2025

Pearson Edexcel GCE Advanced Subsidiary
In Biology A Salters Nuffield (8BN0)
Paper 02: Development, Plants and the Environment

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Summer 2025
Publications Code 8BN0_02_2506_ER
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Introduction:

This paper tested the knowledge, understanding and application of material from Topic 3: Voice of the Genome and Topic 4: Biodiversity and Natural Resources.

The range of questions provided opportunity for candidates to demonstrate their grasp of these topics and apply their knowledge to unfamiliar contexts.

The questions on this paper yielded a wide range of responses and some very good answers were seen. The paper appears to have worked very well with all questions achieving the full range of marks available. There were some straightforward questions that were answered well in the majority of cases and some more challenging questions that discriminated well. Candidates in this year have shown a greater appreciation for the need to address the context of the question instead of producing generic responses, however a small number of candidates were applying their generally extensive knowledge to the wrong context, which shows they were not reading the question fully.

Questions that required recall of factual information were generally well answered, as were the majority of the calculation questions, however a number of candidates were not precise in using the correct terminology and therefore lost marks.

Candidates still struggled with interpreting data from various graphs and tables, with many candidates losing marks for simply stating data, instead of manipulating the data. Furthermore, graph drawing was a skill that many candidates still lost marks on, emphasising the need for further practice on scientific drawings, drawing tables and graphs.

This year saw many more candidates than usual opt for using extra paper. It should be noted that candidates can and should write on any of the blank spaces around their answers, as all of that space is scanned and visible to examiners. Candidates are encouraged to be more concise and precise with their answers to extended writing questions, as those who wrote on extra paper did not necessarily achieve more of the marking points.

Candidates are encouraged to not cross out any answers unless they can replace them with a better answer. This year has also seen a few correct points being crossed out. For extended writing responses involving the design of an experimental procedure, candidates are advised to number their steps to allow a clearer order of events to be more easily and logically sequenced.

Question 1ai

This question appeared to be unexpectedly challenging to many candidates, with the majority failing to identify the organelle as a chloroplast. Most candidates achived one mark for stating that prokaryotic cells do not have membrane-bound organelles. The first example below shows a 2 mark answer that identifies the organelle as membrane-bound, and stating that prokaryotic cells do not have membrane-bound organelles.
However, a high number of candidates lost both marks for identifying the organelle as a nucleus and then continuing along this line, stating that prokaryotic cells do not store their DNA in the nucleus, but in the cytoplasm. The second example shows such a response, which received 0 marks.

(i) This organelle is not found in prokaryotic cells.

Explain why this type of organelle is present only in eukaryotic cells and **not** in prokaryotic cells.

(2)

Because it is membrane bound, whereas prokaryotic cells do not have membran boun d organelles.

(i) This organelle is not found in prokaryotic cells.

Explain why this type of organelle is present only in eukaryotic cells and **not** in prokaryotic cells.

(2)

nucleus, because, nucleus hold all the chromosomes of cell and is now it involved in mitosis, however prokaryotic cell only a coil of dna, it doesn't need a power house cell.

Question 1aii

This question required candidates to measure the image size and to use the magnification equation to calculate the actual size of the image, giving their final answer in micrometres. The majority of candidates scored both marks, however many candidates lost a mark for incorrectly converting the millimetres to micrometres, often as a consequence of measuring in centimetre and not millimetres.

Question 1bi

This multiple choice question was well answered by candidates. Most were able to identify the structures in the electron micrograph and correctly selected option C.

Question 1bii

This multiple choice question was also very well answered. A few more incorrect responses than 1bi, with B being the most common incorrect response.

Question 2a

This multiple choice question was well answered by candidates, who showed a good understanding of the word 'endemic' and the vast majority selected option B. A small proportion selected other options, with option D being the most common incorrect answer.

Question 2bi

Candidates performed well on this multiple choice question, showing a good understanding of adaptations. The vast majority selected the correct answer of C.

Question 2bii

This 5 mark question asked candidates to apply their knowledge of the process of natural selection to an unfamiliar organism. Overall, candidates performed well on this question, with most gaining at least 3 marks. The first example shows a 4 mark response, where the candidate gained credit for mentioning genetic variation, and for stating that individuals with the advantageous characteristics were more likely to survive and reproduce and pass on those alleles to offspring, leading to a change in allele frequency. The candidate missed a mark for not giving a relevant example of the adaptation, or mentioning an example of a selection pressure.

(ii) The Pyrenean desman is thought to have evolved from a land-living animal similar to a mole.

Explain how the Pyrenean desman could have evolved by natural selection from a land-living animal similar to a mole.

(5)

There must have been some form of genetic variation can be through mutations or independent assortment or crossing over involved in meiosis. A previously neutral allele will have become beneficial due to a selective pressure or a change in environment. This allele will have then been passed down through generations and be of higher frequency within the gene pool. Animals with this advantageous allele are more likely to survive and reproduce. This leads to evolution as the species has changed to suit its habitat

Candidates mainly failed to get marking point 1 due to not including the word 'genetic' when describing variation. Others mentioned mutations, but did not link this to new alleles being formed or to genetic variation, and therefore missed out on that mark. An example of this is shown in the answer below, which was awarded 3 marks.

(ii) The Pyrenean desman is thought to have evolved from a land-living animal similar to a mole.

Explain how the Pyrenean desman could have evolved by natural selection from a land-living animal similar to a mole.

(5)

* There is a mutation in the DNA base sequence, causing some animals have advantageous allele
* A selection pressure is acted on the population e.g disease / predation
* Population with the advantageous allele is able to outcompete the non-advantageous population for water / food
* Population with the advantageous allele can survive and mate via reproduction / breeding
* Advantageous alleles are passed on to the offspring

The example below shows a good, 5 mark response.

(ii) The Pyrenean desman is thought to have evolved from a land-living animal similar to a mole.

Explain how the Pyrenean desman could have evolved by natural selection from a land-living animal similar to a mole.

(5)

A Mutation had occured which is a change in DNA base sequence which causes there to be genetic variation. There were selection pressures such as predation or competition for food which caused them to evolve. This caused the adapted species to pass on their advantageous alleles which meant they would survive and reproduce to pass the advantageous alleles to their offspring. Over time this led to a change in allele frequency

Question 3a

This question was not well answered by the majority of candidates, with many simply stating that organs are a group of tissues, without specifying that they are made of **different** tissues, and therefore losing the mark.

Question 3bi

This multiple choice question was answered well by candidates, although a small proportion thought that only xylem contains lignin, with a surprising number of candidates also selecting option A.

Question 3bii

Candidates performed well on this question, with many being awarded 3 or 4 marks. The first example below shows a good 4 mark response for correctly linking the structure of xylem to its function.

(ii) Explain how the features of xylem vessels are related to its functions.

(4)

Xylem vessels are dead, hollow, stacked cells which underwent autolysis wherein the contents of the xylem are digested by enzymes, leaving behind a hollow cell with only a cell wall that is no longer alive. This maximised the volume of water which can be transported through the xylem from the root cells to the other cells in a plant. The xylem vessels also have lignin deposited in their cell walls, waterproofing them to prevent the cell absorbing the water but also increasing the strength of the xylem enabling it to provide some support to the structural integrity of the stem and leaves. However some parts of the xylem cell have not been lignified and are called pits which enable the flow of water into other cells and between vessels. The end walls of the cells making up the vessel are also heavily perforated to ~~enable~~ the point where the end walls are ~~almost~~ effectively entirely gone enabling the uninterrupted flow of water.

Many candidates lost MP3 for simply stating that the xylem is lignified but failing to specify that the lignin is in the xylem walls. Other candidates wrote about the xylem being made up of dead cells and providing descriptions of this, which gained no credit – the important feature being the lack of cytoplasm. The example below shows a 2 mark response where the candidate has made both of these mistakes.

(ii) Explain how the features of xylem vessels are related to its functions.

(4)

The xylem vessels are hollow allowing for the movement of water and mineral ions through it. Xylem vessels are lignified which ~~provides structural support as well as~~ making it waterproof allowing for water to be transported through it without leaking. The xylem vessels are made of dead cells which means they don't require energy.
Xylem vessels are lignified which makes them ~~stronger~~ have a higher tensile strength which is useful for ~~its~~ it structurally supporting the plant.

Question 3c

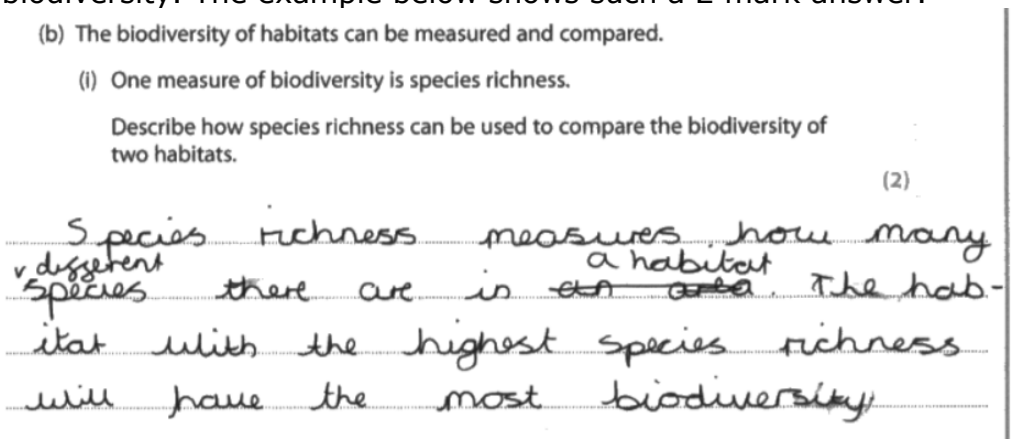
This question was well answered by candidates, with the majority gaining full marks. A significant proportion of candidates wrote about leaves being biodegradable, not filling up landfill sites which did not gain any credit in the context of sustainability. Furthermore, some candidates went into detail about oil-based platics leading to global warming and climate change, which was not the context of the question.

Question 4a

Most candidates achieved MP2 and recognised that members of the same species interbreed to produce fertile offspring, but many candidates did not appreciate that members of the same species also have similar characteristics, and therefore did not achieve MP1. It should also be noted that a few responses included the word **inbreeding** instead of interbreeding, and therefore lost MP2.

Question 4bi

This question was overall well answered by candidates, with many recognising that species richness is the number of different species in an area, and that a higher species richness would indicate a higher biodiversity. The example below shows such a 2 mark answer.



(b) The biodiversity of habitats can be measured and compared.

(i) One measure of biodiversity is species richness.

Describe how species richness can be used to compare the biodiversity of two habitats.

(2)

Species richness measures how many different species there are in a habitat. The habitat with the highest species richness will have the most biodiversity.

Very few candidates appreciated the need to count the number of species in the same sized area of the two habitats, and therefore MP2 was rarely awarded.

Question 4bii

This calculation question assessed whether candidates can interpret and use the index of biodiversity equation. Most candidates scored both marks for the correct answer of 5.94. The most common mistakes were candidates ignoring the Σ sign and therefore calculating the incorrect denominator, or failing to round their answer to 2 decimal places as instructed.

Question 4biii

Generally, candidates did not perform well on this question, with many answers lacking in detail. Many were unable to distinguish between the information that index of diversity provides and how it differs from species richness, with many candidates gaining 1 mark for stating that index of diversity takes into account species evenness or abundance. Many candidates lost MP1 for failing to be specific about why species richness is limited, and some candidates lost marks for implying that population refers to members of multiple species. The first example below shows a response that gained no marks for lack of detail.

(iii) Explain why an index of diversity is more useful than species richness for determining biodiversity.

(2)

- It's more precise because it uses number of individuals.
- doesn't give the results in a range so very specific.

(iii) Explain why an index of diversity is more useful than species richness for determining biodiversity.

(2)

index of diversity represents the population of the ~~5~~ species rather than just the fact that there is 9 species.

It is more accurate in determining biodiversity, as you know the proportion of different species

The second example above shows a response that gained 1 mark for mentioning that index of difersity includes the proportion of individuals.

Question 5ai

This question proved challenging for candidates, with many struggling to express in words what is meant by the term 'continuous variation'. Most candidates gained 1 mark for mentioning a good example of continuous variation, with height being the most common. A significant proportion of candidates wrote about continuous variation being caused by multiple genes or being a combination of genetics and the environment, which gained no credit.

Question 5aii

This question discriminated well between candidates, with many gaining 1 or 2 marks for mentioning multiple genes being involved from different loci. Only a small number of candidates went on to describe how these multiple genes each have a small effect on the phenotype, and even fewer stated that the effects are cumulative, so MP3 and MP4 were rarely seen. MP5 was more frequently awarded, with some gaining credit for being specific about the different shades of eye colour being caused by polygenic inheritance. Once again, candidates gained no credit for mentioning the effects of the environment. Some candidates used the word 'alleles' instead of genes. The first example below shows a 2 mark response where the candidate gained MP1 and MP2, however even though they mentioned eye colour, the lack of specificity meant that MP5 could not be awarded. The second example shows a better, 3 mark response from a candidate.

(ii) Explain how **polygenic inheritance** can give rise to continuous variation in characteristics such as eye colour in humans.

(4)

Polygenic inheritance means that the characteristics are controlled by multiple genes at different loci and the environment which means that people can inherit different combinations of alleles, resulting in various phenotypes for eye colour. Furthermore, the environment also influences eye colour in humans. However, the most advantageous combinations of alleles for eye colour will be the most common due to natural selection, resulting in continuous variation as the most extreme eye colours are less common.

(ii) Explain how **polygenic inheritance** can give rise to continuous variation in characteristics such as eye colour in humans.

(4)

Polygenic inheritance means that the characteristic inherited is affected by more than one gene at multiple loci. Therefore, the offspring would inherit a mixture of alleles which would affect eye colour of different shades and colours. Since the data for eye colour is continuous as there are no discrete values because eye colours can range, eye colour shows continuous variation.

Question 5b

This question discriminated well between candidates. Most candidates were awarded MP1, though some had difficulties articulating this point. Many candidates were also awarded MP5 for correctly interpreting the data and stating that 58% of dogs had normal hip joints. The next most commonly awarded marking point was MP2, especially in answers that already had MP1. The first example shows a 2 mark answer that includes MP1 and MP2. However, only the highest scoring candidates were able to identify the recessive nature of the alleles, or that the severity of the disorder is linked to the number of alleles present. A small number of candidates included 42% in their data, but could not be awarded MP4 because they did not link this to the commonality of the allele in the gene pool. Few candidates gained full 4 marks for this question. A 3 mark response is shown as the second example below.

Identify the evidence that canine hip dysplasia is a polygenic condition and not one caused by environmental factors.

Use the information provided and your own knowledge to answer the question.

(4)

- From graph 58% of Labrador dogs have ~~grea~~ grade 1 hip dysplasia.
- Next highest is grade 2 hip dysplasia with 20% of Labrador dogs.
- There is a significant difference between & Percentage of dogs with grade 1 hip dysplasia compared to other grades
- ~~This means~~ 40% of dogs have some type of hip dysplasia meaning there must be multiple alleles / genes causing the condition
- If it was due to enviromental factors then the number of dogs with some type of hip dysplapia would be alot less.

Identify the evidence that canine hip dysplasia is a polygenic condition and not one caused by environmental factors.

Use the information provided and your own knowledge to answer the question.

(4)

It is most common for dogs to have normal hip joints shown by 58% of the sample having normal hip joints. The data is continuous as the bar chart shows a range of different severities, suggesting that there is continuous variation and the disorder is affected by multiple genes at different loci, making it a polygenic condition. However, since the dogs in the sample are often likely exposed to the same environment and they are all the same type of dog, but there is still significant differences between results (for example a 37% difference between the dogs in the sample with normal hip joint and more on borderline hip joint), this suggests the disorder is not caused by environmental factors because you would expect to see more similarity between results.

(Total for Question 5 = 10 marks)

Question 6ai

Most candidates were awarded the mark to this multiple choice question, with A being the most common incorrect answer.

Question 6aii

Many candidates were awarded the mark here, but a small proportion chose B instead of C, which showed some candidates had difficulties interpreting the question or applying their knowledge of gene expression to an unfamiliar context.

Question 6bi

This question proved deceptively difficult for candidates, as the options had similar wording. This caught some candidates out, with all three incorrect options seen.

Question 6bii

This question produced a range of responses from candidates, proving challenging to many. Many candidates could not be awarded MP1 because they mentioned the armadillos being genetically identical, which was already mentioned in the question stem, and therefore could gain no credit. Most candidates only achieved 1 mark, with MP2 being far more common than MP1. A small number of responses mentioned ethics or the idea of armadillos being similar to humans, which were not relevant comments.

Question 6c

This question about the effects of DNA methylation on gene expression was answered very well, with most candidates scoring at least 2 marks. Most candidates showed a good understanding of DNA methylation and its effects on deactivating a gene. The first example shows a good 3 mark response.

(c) Epigenetic factors, such as DNA methylation, can affect the phenotype of an organism.

Explain how DNA methylation can affect the activation of a gene.

(3)

Methyl groups attach to DNA, usually to cytosine base, this DNA is wrapped around a histone, the attachment of methyl causes the DNA to tighten around the histone this makes transcription harder and can cause the gene to not be activated as ek

Some responses lost marks due to candidares being unsure as to whether DNA methylation activates or deactivates a gene. Other responses lacked detail, with some candidates failing to mention where the methyl groups attach, or which molecule is prevented from attaching to the DNA/promoter. The least seen marking point was MP2, which showed candidates were still unsure as to how methylation changes the DNA arrangement around the histone proteins. The second example below shows a 1 mark response, where only MP1 could be awarded.

(c) Epigenetic factors, such as DNA methylation, can affect the phenotype of an organism.

Explain how DNA methylation can affect the activation of a gene.

(3)

DNA methylation is where a methyl (CCH_3) group is added to the DNA. this can affect gene expression by turning on or off a gene. histone modification may also occur in epigenetic factors. This can lead to activation of a gene.

Question 6di

This question proved more difficult than intended, with very few candidates achieving full marks. MP1 was awarded most often, showing that candidates understood the data and the experiment, with fewer scoring MP2 for correctly deducing that methyl groups must have deactivated the agouti gene, resulting in offspring with brown fur. A high number of candidates did not score MP2, or more than 1 mark, because they referred to the brown gene being activated or deactivated. It was clearly stated in the question that the brown gene is always switched on, therefore candidates must appreciate the details within the experiment and must ensure that they carefully read all parts of the question to avoid losing marks unneccesarily. The example below shows a 1 mark response, which contained the aforementioned misconceptions.

(i) Deduce the effect of methyl groups in the diet on the features of the offspring of these mice.

(3)

Rich sources of methyl groups has positive effects on the offspring as they had good health, and due to them having brown fur, it means that no gene was switched off due to transcription occurring and producing mRNA, making a protein. Low sources of methyl groups has negative effects on the offspring as they had poor health. They had yellow fur, which means the gene for brown fur was switched off and the gene agouti was switched on.

Some candidates were able to deduce the effects of the methylation of the agouti gene on the health of the mice. Some attempts were made and candidates did suggest that methyl groups affect the health, but the mark was not awarded for omitting to state that it is the methylation of the *agouti gene* that affects health. The example below shows a good 3 mark response.

(i) Deduce the effect of methyl groups in the diet on the features of the offspring of these mice.

(3)

Diets rich in methyl groups likely lead to greater DNA methylation. Methyl-rich diets led to brown fur rather than yellow fur (like in methyl-deficient diets. Therefore methylation occurred in group A that switched off the gene coding for yellow fur (so the brown fur gene is always expressed). Methylation also switched off genes that were are harmful to the mice's health, whereas methyl-deficient mice were unable to do this so had poor health. The agouti gene masks the brown fur gene by epistasis in group B, as the brown fur gene is active but not expressed.

Question 6dii

Overall candidates found this question conceptually difficult, although it was assessing an aspect of the specification. The most frequent mark awarded was for MP2, with MP1 rarely being awarded. This showed candidates did not take into account the fact they had been previously informed that the mothers all had the same starting phenotype, and therefore the only change was the diet they were being fed. The example below shows a response which was awarded MP1.

(ii) Epigenetic changes to the DNA of the offspring happen during their development inside the mother.

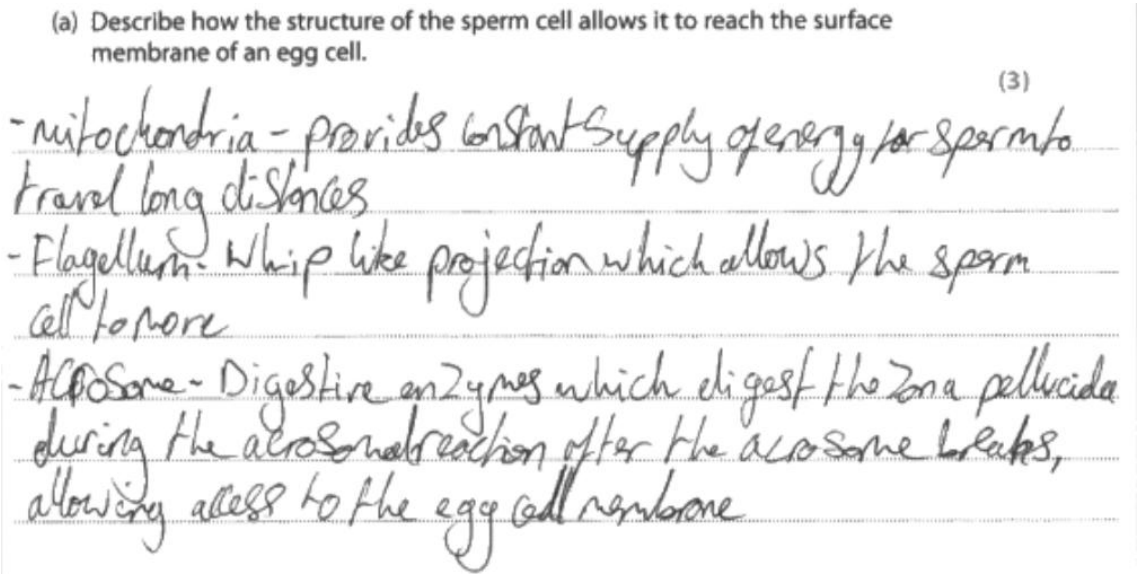
Explain how the results of this investigation support this statement.

(2)

As the mice all began with yellow fur (implying that in the early development the methyl may have occurred. low in sources of methyl group diet which caused ~~their~~ her offspring to have the agouti gene switch on to produce the yellow fur.

Question 7a

This question produced good responses from most candidates, with many being awarded full marks. Candidates mainly lost MP2, for suggesting that mitochondria '*produce* energy' rather than 'produce ATP' or 'release energy'. MP3 was not awarded to some candidates for failing to specify that enzymes from the acrosome break down the zona pellucida. A 3 mark response is shown below. Ideally, candidates should refer to the energy being used to move the flagellum.



(a) Describe how the structure of the sperm cell allows it to reach the surface membrane of an egg cell.

(3)

- mitochondria - provides constant supply of energy for sperm to travel long distances
- Flagellum - Whip like projection which allows the sperm cell to move
- Acrosome - Digestive enzymes which digest the zona pellucida during the acrosome reaction after the acrosome breaks, allowing access to the egg cell membrane

Question 7b

The investigation, coupled with the graph, was not well understood by candidates. This was evident with many candidates second guessing themselves, many wrote the correct conclusion only to cross it out and replace it with an incorrect deduction. The majority of candidates scored MP2, for correctly identifying that the drug increases the number of sperm cells with fully reacted acrosomes, but assumed that would increase fertility and not decrease it as they interpreted the data incorrectly, not realising that if the acrosome had already reacted there would be no enzyme to break down the zona pellucida, hence decreasing fertility. This misunderstanding prevented candidates from achieving some of the marks.
Below is a 2 mark example that was awarded MP2 and MP3, but contained the common misconception concerning fertility.

Deduce how sildenafil could affect fertility. have fused

(3)

It increases the amount of fully reacted acrosomes by 10%. This increases fertility as more sperm cells are reaching and fusing with the cell surface membrane. The number of partially reacted only fell by 5% overall still an increase of 5% in the numbers that have fused.
Decreases number not fused, increase fertility as less aren't fusing, more are so more chance of fertilising the egg cell. Fertilisation can only occur if multiple sperm reach the egg cell

The example below shows one of the few instances where a candidate has understood the effect of sildenafil on sperm cells, and therefore scored 3 marks.

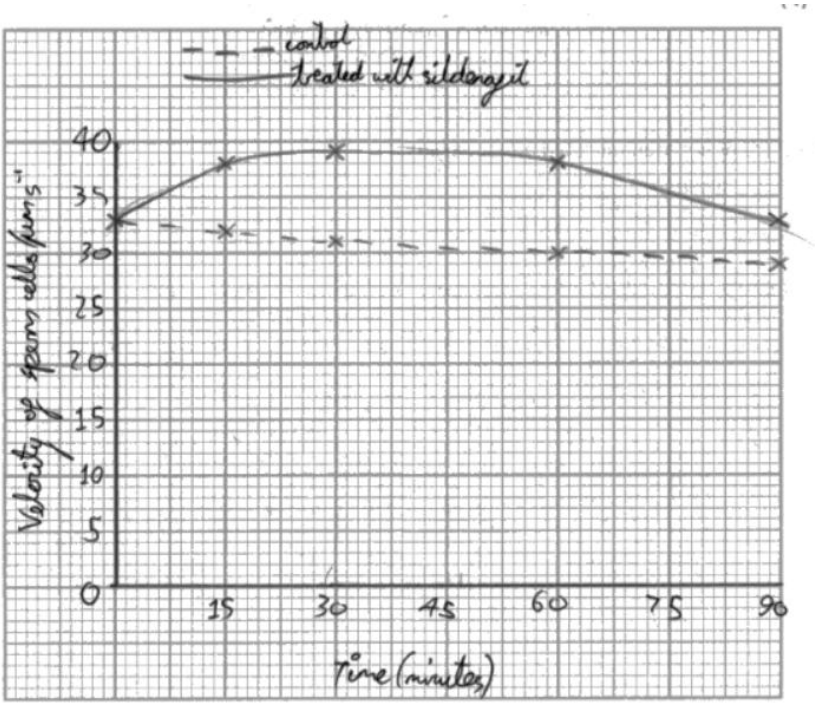
Deduce how sildenafil could affect fertility.

(3)

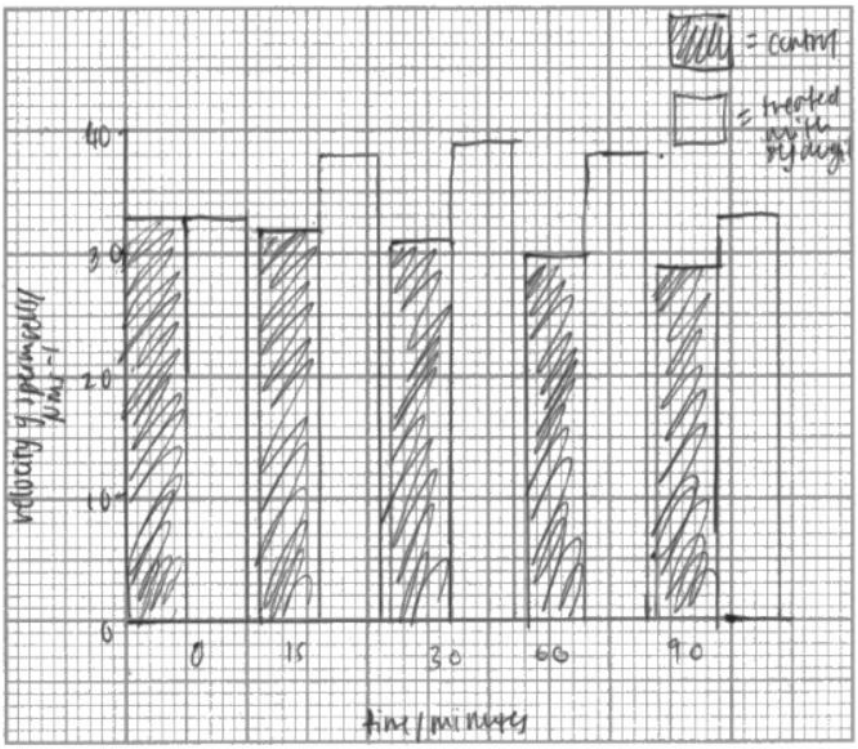
Sildenafil increases the percentage of fully reacted acrosomes and decreases the percentage of unreacted and partially reacted acrosomes. This decreases the percentage of sperm with acrosomes able to digest the zona pellucida and fertilise the egg cell, hence decreasing fertility.

Question 7ci

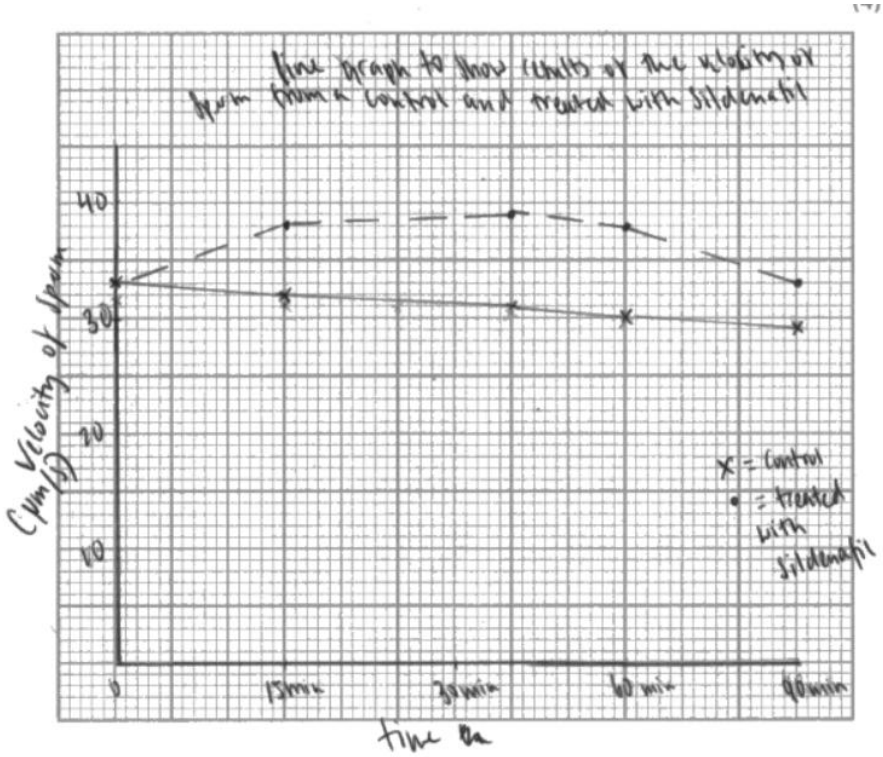
This question required candidates to draw a suitable graph on the grid provided, plotting data from a table. Selecting the correct graph for the data, drawing suitable, linear scales, including correct labels with units, having correct lines drawn and including labels, continues to be a challenging combination of skills for candidates to master. A surprisingly small proportion of candidates were awarded the full 4 marks for the correct line graph, and an example is shown below.



Many candidates were capped at a maximum of 3 marks because they chose to draw a bar graph instead, despite being provided with numerical data best displayed in a line graph. This prevented them from achieving the mark for linear scales. An example is shown below.



Other mistakes included incorrect scales, or labels without units. The example below shows a graph that lost a mark due to an incorrectly labelled x axis.



Question 7cii

This question produced a wide range of responses, with many candidates being awarded 1 or 2 marks. MP2 and MP4 were by far the most frequent marks awarded, showing that most candidates were able to compare the results with the control and provide a link to the function of the mitochondria. Fewer candidates were then able to link the function of the mitochondria to an improved function of the flagellum leading to a higher velocity. It should be noted that candidates must be specific when interpreting data, and they should give specific values rather than generic responses. MP1 was a straightforward mark that could not always be given for this very reason, with many candidates suggesting that sildenafil increased velocity of sperm cells, without referring to the relevant time range - from 0 to 30 minutes. The example below shows a concise, 4 mark response that achieved what most failed, in discussing the results of the investigation in relation to mitochondrial function.

(ii) It has been stated that sildenafil improves the functioning of mitochondria.

Discuss how these results support this statement.

(4)

as time increases, velocity of sperm cells with sildenafil increase until 30 minutes. velocity of sperm cells with sildenafil is always higher than velocity of control sperm cell except at 0 minutes showing time needed for sildenafil to work. As velocity is higher in sperm with sildenafil this means mitochondria respire aerobically more and therore provide more ATP for the movement of flagellum so flagellum propels faster in sperm cell with sildenafil.

Question 8ai

This question was very well answered by candidates, with many scoring full marks for correctly identifying germination and microbial growh as being stopped by the drying of seeds. MP1 was rarely mentioned, but MP2 and MP3 were very common. A small number of candidates made generic references, such as drying prevents seed *growth* rather than germination.

Question 8aii

This question assessed the effect of temperature on bacteria and many responses gained credit for the basic point that increasing temperature increases bacterial growth. MP4 was slightly less common, with few relating enzyme acitivty to kinetic energy, with more picking up on the denaturation of enzymes at high temperatures for MP5. A surprising number of candidates thought that enzymes denature at low temperatures and therefore gained no credit. A worrying number of responses did not even refer to enzyme activity, with many stating that bacteria denature or that bacteria themselves gain more kinetic energy, rather than enzymes and substrates. The first example shows a 1 mark response while the second example shows a 3 mark response.

(ii) The seeds of many plants are stored at very low temperatures.

Explain the effect of temperature on bacterial growth.

(3)

low temperature inhibits the likelihood of bacteria going because bacteria will divide in high temperature because this provides them with the energy needed to divide (Incorrect)

(ii) The seeds of many plants are stored at very low temperatures.

Explain the effect of temperature on bacterial growth.

(3)

At very low temperatures bacteria don't have their enzymes functioning properly due to low kinetic energy (so substates are less likely to bind with enzymes) thus bacteria cannot survive to reproduce and grow. At higher temperatures, bacterial enzymes work efficiently, causing the bacteria to reproduce and spread, however at very high temperatures bacteria die as their enzymes become denatured, preventing them from functioning properly and causing the bacteria to die and not reproduce, so they can not grow.

Question 8b

This question produced a wide range of responses, but generally it was well answered, with the modal mark being 2. Most candidates recognised that the leaves had the highest antimicrobial properties due to having the largest zone of inhibition. Those responses that were not awarded the first 2 marks had MP2 but did not link it to the antimicrobial properties or they had MP1, but did not phrase correctly the idea of the largest zone of inhibition. The example shown below is a typical 2 mark response, where MP1 and MP2 were both awarded.

Comment on the antimicrobial properties of the parts of the coffee plant tested.

(3)

The leaf extract had the most antimicrobial properties as it had the largest mean diameter of inhibition zone (16.67 ± 1.15) meaning that it killed the most bacteria. The ~~fruit~~ seed had the smallest zone of inhibition (12.33 ± 0.58) meaning it has the least amount of antimicrobial properties out of the three. All of the extract had an inhibition zone so all contained at least some antimicrobial properties as they killed some bacteria.

A significant number of candidates spotted that there was no significant difference between the fruit and the seeds, because their ranges overlapped. Below is an example of a 3 mark response.

Comment on the antimicrobial properties of the parts of the coffee plant tested.

(3)

There is overlap in the standard deviation* showing the results are not significant.

Leaf extract has no SD overlap therefore its results are significant. It has the highest antimicrobial properties as it has the largest zone of inhibition so no bacteria grew in that area.

* of seed and fruit extract

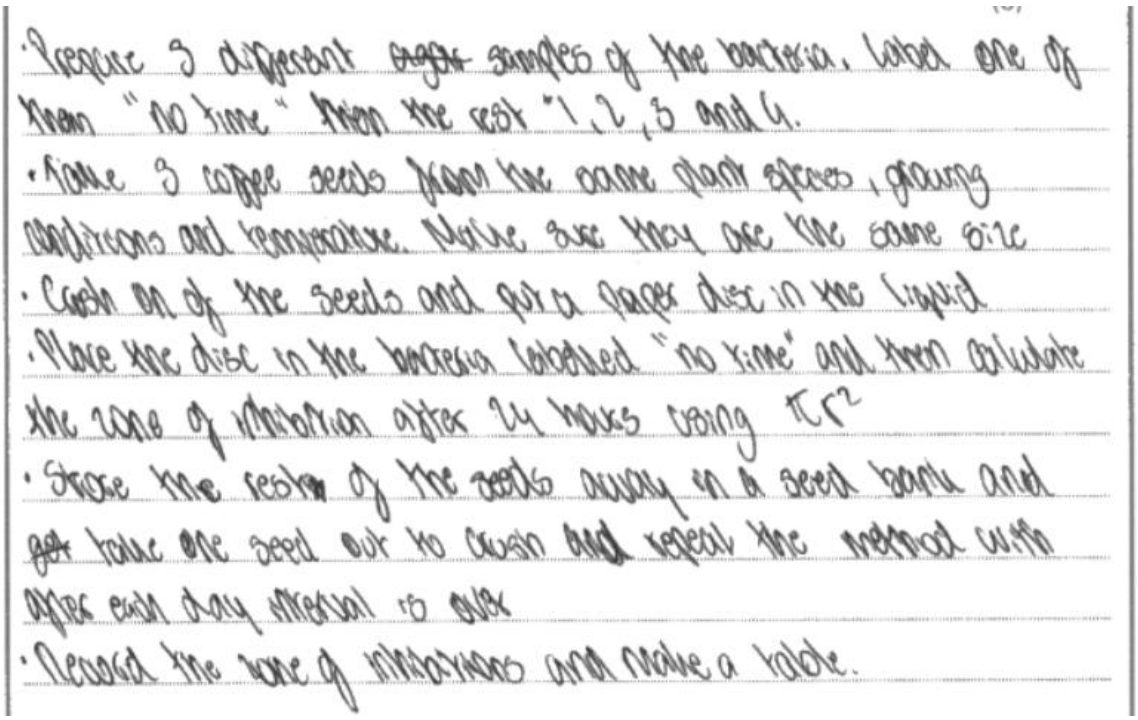
Question 8c

This question asked candidates to design an investigation to measure the impact of the storage time for coffee seeds on their antimicrobial properties. The candidates had to include a valid method, describing in detail how the independent variable should be changed, how the dependent variable would be measured and standardised, and how controlled variables would be kept constant.

This 6 mark question discriminated well between candidates, with a range of responses from Level 1 to Level 3. The majority of responses were Level 1 and Level 2 in almost equal proportions. However many

were unable to reach a Level 3 response due to a lack in detail regarding the preparation of an extract from the seeds (many putting whole seeds on the agar), or how to use aseptic techniques when handling bacterial cultures. Those responses that were awarded Level 3, were, for the most part, given 5 marks and not 6. Some responses were lacking in detail regarding how the variables should be changed, measured or controlled. Many candidates simply stated variables, without giving detail on *how* these variables are manipulated (techniques, measurements, equipment).

The example below shows a Level 1, 2 mark response. The reason this response was awarded Level 1 is that it lacked sufficient detail of the method, but it included points about the variables, especially around measuring the antimicrobial properties.


• Prepare 3 different ~~agar~~ samples of the bacteria. Label one of them "no time" then the rest "1, 2, 3 and 4.
• Take 3 coffee seeds from the same plant species, growing conditions and temperature. Make sure they are the same size
• Crush on of the seeds and put a paper disc in the liquid
• Place the disc in the bacteria labelled "no time" and then calculate the zone of inhibition after 24 hours using πr^2
• Store the rests of the seeds away in a seed bank and get take one seed out to crush and repeat the method with after each day interval to use
• Record the zone of inhibitions and make a table.

The responses that were awarded Level 2, had a good level of detail on either the preparation of the extract or demonstrated a sound understanding of aseptic techniques in order to inoculate bacteria on the agar plates. Their method had a few missing details, such as valid comparisons and details on the zones of inhibition, but overall the method could potentially lead to valid outcomes. The examples below show two Level 2 responses. The first was awarded 4 marks, and the second was awarded 3 marks.

Devise an investigation to determine the effect of storage time on the antimicrobial properties of coffee seeds stored in a seed bank.

(6)

- Store the coffee seeds for different periods of time, making sure that the coffee seeds are sourced from the same plant, having at least 5 different time periods.
- Crush 3 grams of each ~~age~~ storage time coffee seeds and add it to a methylated spirit (e.g. ethanol) of the same volume and concentration.
- Set up a petri dish with agar jelly and add bacteria of the same species onto the agar jelly.
- Make sure to use aseptic ~~tec~~ technique by making near a bunsen burner to set up a convection current and sterilise the work bench.
- Dip a paper disc into the coffee-seed-ethanol mixtures and let it dry to prevent excess mixture.
- Place the disc on the petri dish and ~~store~~ incubate the petri dishes at the same temperature (25°C) for the same period of time (e.g. 24 hours).
- Measure the diameters of the zone of inhibition for each of the storage time seeds with a ruler.

(Total for Question 8 = 14 marks)

Devise an investigation to determine the effect of storage time on the antimicrobial properties of coffee seeds stored in a seed bank.

(6)

- using seeds that have been stored for different amounts of time, crush them with a pestle and mortar, adding ethanol, as a solvent that evaporates to help soften them. , clearly label petri dishes.
- using aseptic technique, you make the agar plates, add a bacteria such as E.coli, B.subtilis or enterobacter, ensuring to keep hands clean by using gloves, flaming necks of bottles and foil on all keeping wires sterile by heating and cooling with a bunsen burner., place paper disk in the seed, and place on agar plate, and incubate to help speed up process, take mean diameter of inhibition zone, repeat several times to provide accurate results, you would be able to see if the inhibition zone has increased or decreased based on storage time.

The highest scoring candidates were able to access Level 3 by demonstrating a wide array of knowledge regarding the preparation of the extract and placing it on a paper disc, the inoculation of bacteria onto the agar jelly (many referred to either agar or bacteria and not both), with detailed presentation of how aseptic techniques would prevent contamination of the agar plates, as well as further details on how validity of results would be assured, such as using statistical tests. Almost no candidates mentioned statistical tests, which would be very useful in an investigation such as this. Below is a Level 3 answer that was awarded 5 marks.

Devise an investigation to determine the effect of storage time on the antimicrobial properties of coffee seeds stored in a seed bank.

(6)

- for this experiment use 6 different seed extracts to test. 1 that has not been stored at all before as a control, and 5 other ones that have been stored in the same conditions (temp & humidity) but for different lengths of time.
- prepare the agar in the petri dish & spread it using glass rod. spread the Vibrio Cholera onto petri dish.
- place paper discs in each one of the seed extracts and place carefully using tweezers onto petri dish & make sure they are spaced out. then incubate at 25°C - 37°C for 5 days then measure area of inhibition, draw a graph of results & make conclusion.

- For this experiment use aseptic techniques. disinfect the area / table of work. flame all of the equipment before use to prevent other Bacteria from growing. minimise time that petridish is open for. place all equipment in Hydrochloric acid after use.

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