

Examiners' Report
Principal Examiner Feedback

Summer 2024

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

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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 students 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. Students 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 showing their working clearly, which cost them marks.

It should be noted that students can use any blank space within the exam paper to complete answers if they have ran out of lines. If the blank space is directly underneath the lines provided, the student's writing will be seen and marked. It is also helpful to examiners if students indicate that answers are continued elsewhere. Furthermore, candidates should not cross out work unless they can replace it with a better answer – a number of candidates crossed out responses that would have gained a mark, and replaced those with incorrect answers.

For extended writing responses involving the design of an experimental procedure, some candidates opted to clearly display their variables first before beginning their answer. This facilitated the identification of those marking points, and meant those candidates generally produced a more structured and clear methodology.

Question 1(a)(i)

This multiple choice question tested students' ability to identify structures of a plant from a microscope image of a section of a plant stem. Most students correctly identified R as being the xylem, with P being the most common incorrect answer.

Question 1(a)(ii)

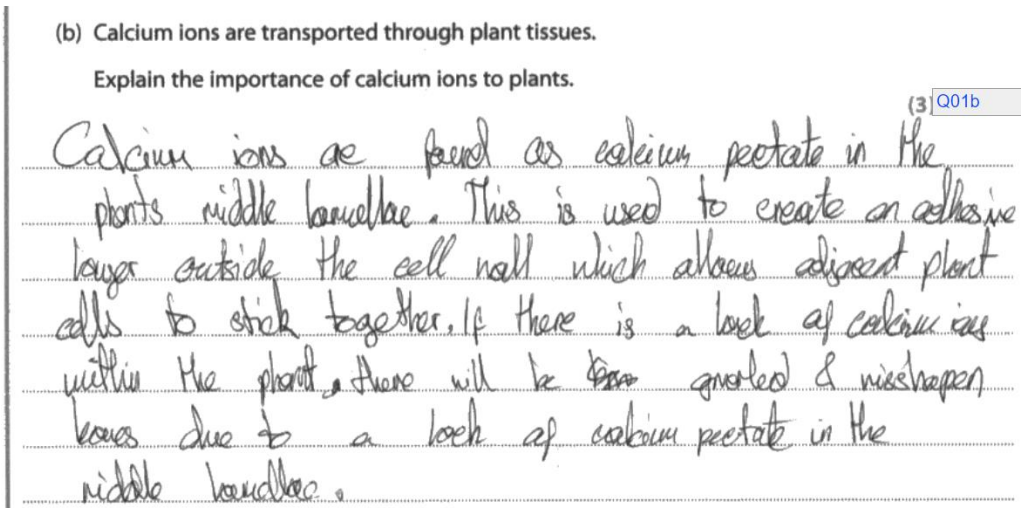
This multiple choice question was very well answered with most candidates remembering that the xylem transports mineral ions and water.

Question 1(a)(iii)

This question was very well answered with most candidates identifying the phloem as having sieve plates.

Question 1(b)

This question asked candidates to link calcium ions with its specific roles in the structure of plant cells. The question was mostly answered well, with most candidates gaining 2 or 3 marks for being specific about the calcium pectate, its location in the middle lamellae, and its role of joining adjacent plant cells. A number of candidates wrote vague answers about a lack of calcium ions resulting in stunted growth, or incorrectly stating that they are important for photosynthesis. An example of a 3 mark answer can be seen below.



(b) Calcium ions are transported through plant tissues.

Explain the importance of calcium ions to plants.

(3) Q01b

Calcium ions are found as calcium pectate in the plants middle lamellae. This is used to create an adhesive layer outside the cell wall which allows adjacent plant cells to stick together. If there is a lack of calcium ions within the plant, there will be stunted & misshapen leaves due to a lack of calcium pectate in the middle lamellae.

Question 2(a)(i)

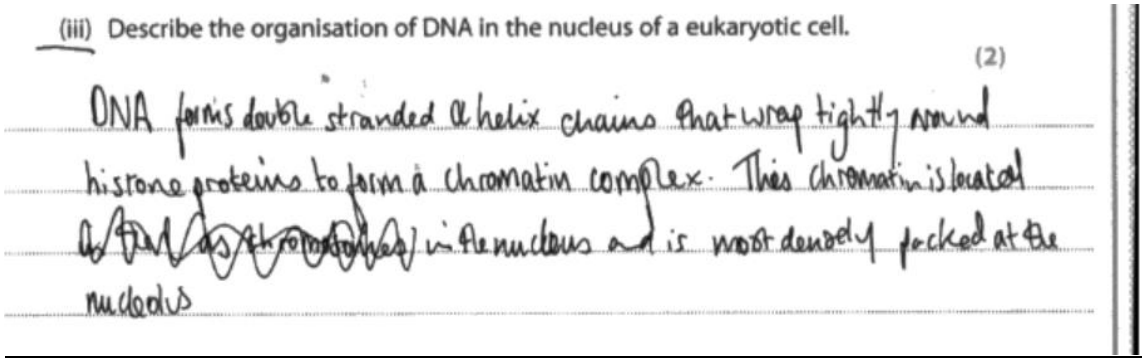
This question tested students' understanding of cell ultrastructure by asking them to draw and label the nucleolus. Most candidates were succesful in locating the nucleus and correctly drew and labelled the nucleolus as an ovoid shape. A small number of candidates drew the nucleolus outside the nuclear membrane, and a smaller number labelled the correct place of the nucleolus without including the drawing.

Question 2(a)(ii)

This question tested student's knowledge of organelles. Candidates had to recall that mitochondria and chloroplasts are the only eukaryotic organelles (other than the nucleus) to contain DNA. The modal wrong answer was plasmids.

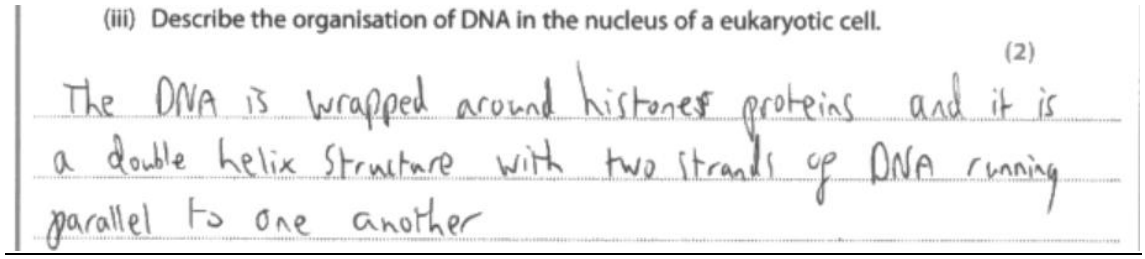
Question 2(a)(iii)

This question asked students to identify the organisation of the genetic material in eukaryotes. A large number of candidates produced good responses regarding the structure of histones and chromosomes, however a concerning number of candidates wrote about the DNA double helix or nucleotide structure, rather than the organisation. The first example below shows a good 2 mark answer, with the second example scoring 1 mark only due to the common mistake mentioned above.


(iii) Describe the organisation of DNA in the nucleus of a eukaryotic cell.

(2)

DNA forms double stranded α helix chains that wrap tightly around histone proteins to form a chromatin complex. This chromatin is located as [illegible] in the nucleus and is most densely packed at the nucleolus

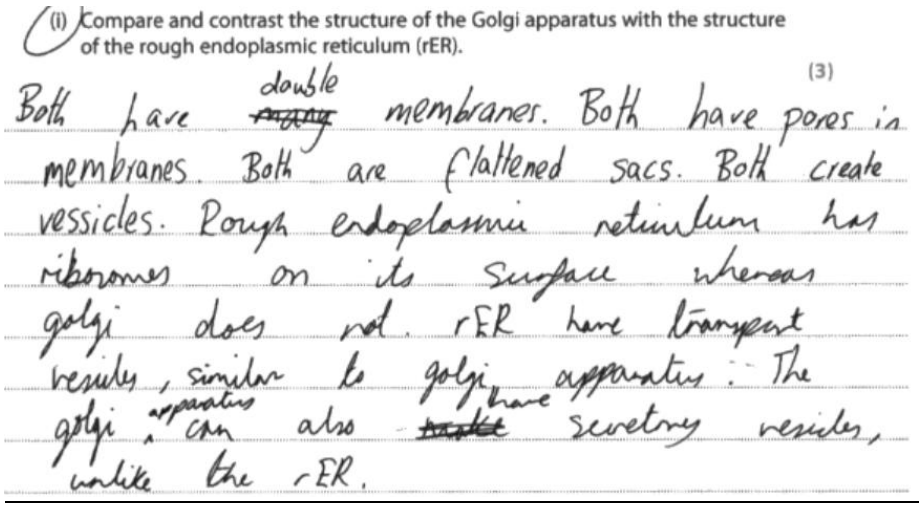

(iii) Describe the organisation of DNA in the nucleus of a eukaryotic cell.

(2)

The DNA is wrapped around histones proteins and it is a double helix structure with two strands of DNA running parallel to one another

Question 2(b)(i)

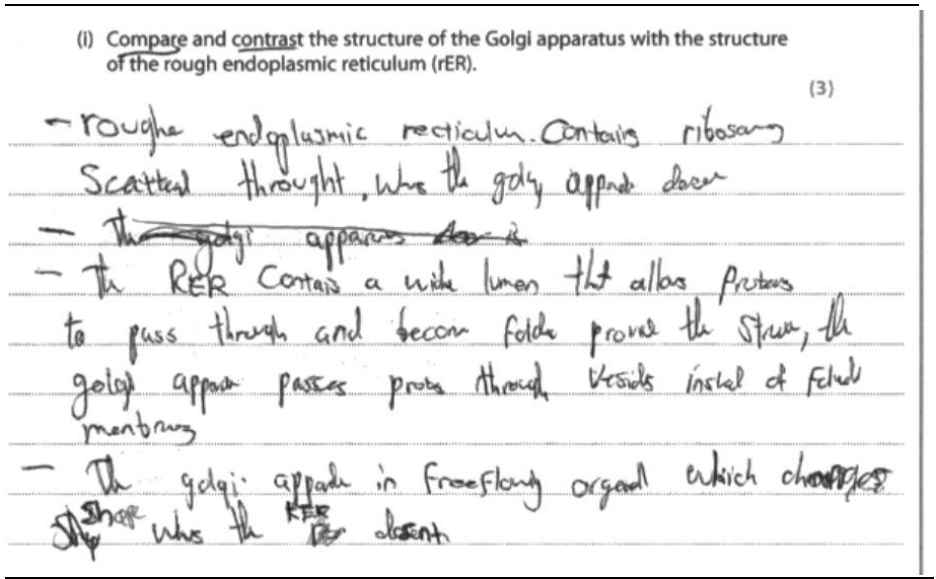
This question asked candidates to discuss the similarites and differences between 2 similar organelles – the rough endoplasmic reticulum and the Golgi apparatus. Most candidates showed a good understanding of the similarities and differences, with many writing that the rER has ribosomes but the Golgi apparatus does not and that they are both made up of flattened sacs and contain vesicles. Some candidates achieved a mark for realising that the rER is connected to the nuclear envelope, but the Golgi apparatus is not. A few candidates did not gain full marks because they mentioned the function rather than structure. The first example below shows a good 3 mark answer, with the second example only being awarded 1 mark, having lacked precise details.



(i) Compare and contrast the structure of the Golgi apparatus with the structure of the rough endoplasmic reticulum (rER).

(3)

Both have double membranes. Both have pores in membranes. Both are flattened sacs. Both create vessicles. Rough endoplasmic reticulum has riborsomes on its surface whereas golgi does not. rER have transport vesicles, similar to golgi apparatus. The golgi apparatus can also have secretory vesicles, unlike the rER.



(i) Compare and contrast the structure of the Golgi apparatus with the structure of the rough endoplasmic reticulum (rER).

(3)

- rough endoplasmic reticulum. Contains ribosomes Scatted throught, whre the golgi appa doesn
- ~~The golgi appa does n~~
- The RER Contain a wide lumen that allow Proteins to pass through and becom folds proved the Struc, the golgi appa passes prots through vesicls instead of felud membrane
- The golgi appa is Freeflowing organell which changes Shape whre the RER doesnt

Question 2(b)(ii)

This question was answered very well by most candidates, who were able to link the roles of the Golgi apparatus and the rER really clearly. A small number of candidates lost a mark for not being specific regarding the vesicles (transport or secretory) or not using scientific terminology. The first example below shows a good 3 mark answer, with the second example being awarded 0 marks for a lack of specificity.

(ii) Describe the roles of the rER and the Golgi apparatus in the processing of proteins.

(3)

Proteins are folded and processed in the rER and their secondary and tertiary structures are developed. They are then transported into transport vesicles and pinch off the rER and fuse with the cis face of the golgi body. Here, proteins are modified (their tertiary and quaternary structures further developed) and move through the golgi before being packaged in transport vesicles. These ~~fuse off~~ pinch off the golgi and fuse with the cell surface membrane where they can be released outside the cell by exocytosis.

(ii) Describe the roles of the rER and the Golgi apparatus in the processing of proteins.

(3)

The rER have ribosomes on the surface of their membrane creating proteins/amino acid chains (through transcription + translation) that are moved into vesicles and directed to the golgi, which take in the vesicle and begin the shaping and defining the protein or enzyme before sending of, potentially to the cell wall to become a protein receptor.

Question 3(a)

Most candidates were able to correctly identify the locus as the position of a gene on a chromosome.

Question 3(b)(i)

This is a question that asked candidates to discuss the possibilities of passing on a recessive, sex-linked disorder from a mother without the disorder. Some candidates found this question very challenging, with most candidates being awarded either 1 or 2 marks. Almost all candidates identified that the mother must be a carrier and she will pass on this allele to her child, with better answers correctly stating that a father with the recessive allele on his X chromosome could have a daughter with the disorder. Many candidates gained marks for a correctly drawn genetic diagram, showing clearly how alleles can be inherited and the offspring genotypes. However, some candidates failed to gain marks due to referring to genes instead of alleles. The example below shows an excellent 3 mark response, which included a genetic diagram.

(b) The gene for red-green colour deficiency is found on the X chromosome.

The allele for normal colour vision is dominant (B). ↳ sex-linkage

(i) Explain the ways that a mother with normal colour vision could have a child with red-green colour deficiency.

(3)

The mother is a carrier, meaning she is heterozygous. If the father ~~is~~ has red-green colour deficiency, there is a 25% chance of having a female offspring with the deficiency, and a 25% chance of having a male offspring with the deficiency. The female offspring would have to be homozygous recessive for it to have the ~~deff~~ deficiency. For the male, he would have one recessive allele on the X chromosome, and no gene on the Y. The recessive allele will be expressed, meaning the child will have the deficiency. If the father does not have the deficiency, there is still 25% of a male colour-blind offspring, but there is no chance for a female colour-blind offspring. If the mother is homozygous dominant, she is not a carrier, and therefore she is unable to have a colour-blind offspring.

	X^B	X^b
X^b	X^BX^b	X^bX^b
Y	X^BY	X^bY

Question 3(b)(ii)

This question was misinterpreted by a significant number of candidates, who replicated their answers to the previous question without linking it to this question. The best responses were able to correctly link the presence of the dominant allele and its expression. Very few candidates achieved marking point 3, for stating that the correct protein is produced.

Question 3(b)(iii)

This multiple choice question was answered very well by most candidates, with many drawing a genetic diagram to help identify the correct probability.

Question 4(a)(i)

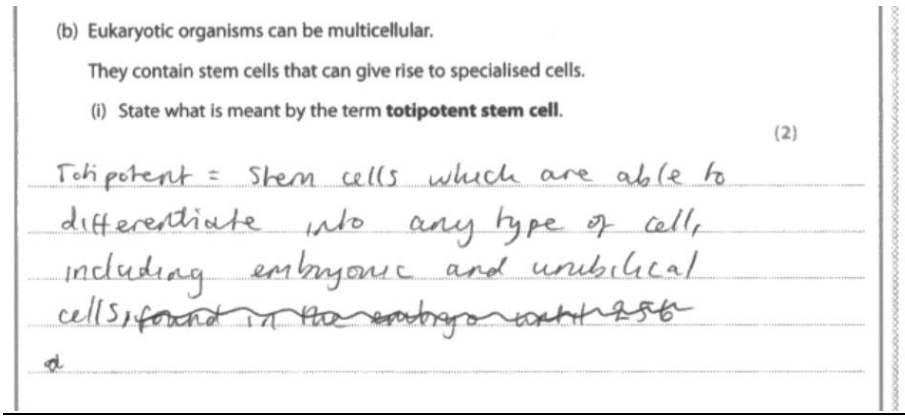
This multiple choice question was very well answered by the vast majority of candidates, who correctly identified the capsule as the outer layer of a bacterial cell.

Question 4(a)(ii)

This multiple choice question tested candidates' understanding of the differences between prokaryotic and eukaryotic cells, with the vast majority correctly recalling that bacteria have smaller ribosomes.

Question 4(b)(i)

This question asked students to define a totipotent stem cell. It was very well answered by the majority of candidates, who used correct key terminology such as 'differentiate'. The first example below shows this, gaining both marks, whereas the second example gained one mark only, as the first marking point required reference to 'differentiate' and not just 'give rise to'.



(b) Eukaryotic organisms can be multicellular.

They contain stem cells that can give rise to specialised cells.

(i) State what is meant by the term **totipotent stem cell**.

(2)

Totipotent = Stem cells which are able to differentiate into any type of cell, including embryonic and umbilical cells, ~~found in the embryo~~

(b) Eukaryotic organisms can be multicellular.

They contain stem cells that can give rise to specialised cells.

(i) State what is meant by the term **totipotent stem cell**.

(2)

An Undifferentiated cell which can give rise to all different cell types. OR None of the genes have been switched off. All genes are switched off

Question 4(b)(ii)

This question asked students to recall the process of a totipotent stem cell undergoing differential gene expression in order to differentiate. Most candidates answered this question really well, with the majority achieving 3 or 4 marks for linking the ideas of gene activation with transcription and translation of the protein. A small number of candidates did not achieve full marks due to not mentioning the stimulus at the beginning. Below is a 4 mark example.

(ii) Explain how totipotent stem cells can give rise to specialised cells.

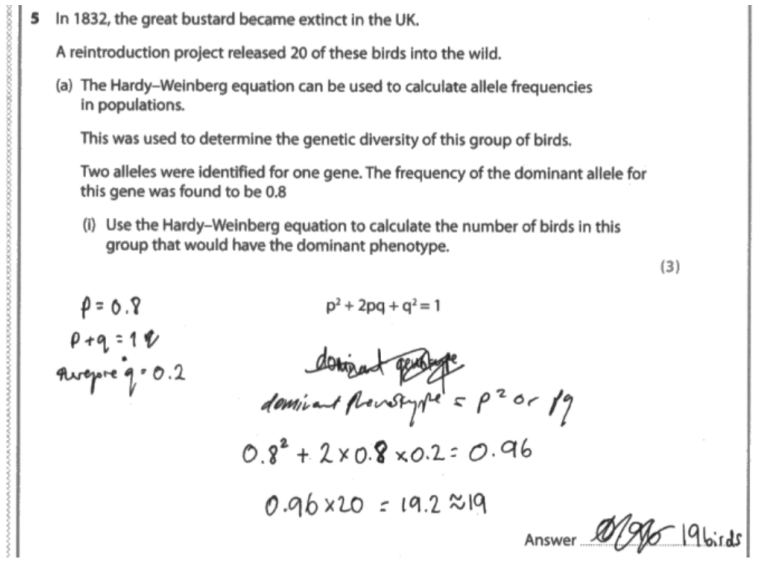
(4) Q04bii

- A stimulus causes different genes to be ~~expressed~~ activated or ~~and~~ repressed ★
- The ~~expressed~~ activated genes are transcribed and translated; repressed ones do not.
- The genes which are transcribed + translated help in the formation of a protein.
- Different proteins can cause changes to the cell's structure which can cause it to specialise into a different cell

★ within the stem cell. These stimuli can involve a change in environment or a transcription factor, making it more/less easy for RNA polymerase to bind to the DNA strand.

Question 5(a)(i)

This question asked candidates to use the Hardy-Weinberg equation to calculate the number of individual birds that would express the dominant phenotype. Just over half of candidates achieved 3 marks for this question, with many achieving 1 or 2 marks with a small number getting no marks. Candidates had to appreciate that both homozygous dominant and the heterozygous genotypes had to be taken into consideration, which increased the difficulty of the question. The vast majority of candiates were able to calculate the value of p as 0.64. The first example below is a 3 mark correct answer, while the second example achieved 2 marks for working out p^2 (0.64) and 2pq (0.32), but failing to add them together before multiplying by the whole population to get 19 as the correct answer. A small number of candidates also lost a mark for not rounding their answer to the nearest whole number, or not multiplying the value obtained by the total number of birds.



5 In 1832, the great bustard became extinct in the UK.

A reintroduction project released 20 of these birds into the wild.

(a) The Hardy–Weinberg equation can be used to calculate allele frequencies in populations.

This was used to determine the genetic diversity of this group of birds.

Two alleles were identified for one gene. The frequency of the dominant allele for this gene was found to be 0.8

(i) Use the Hardy–Weinberg equation to calculate the number of birds in this group that would have the dominant phenotype.

(3)

$p = 0.8$

$p + q = 1$

therefore $q = 0.2$

$p^2 + 2pq + q^2 = 1$

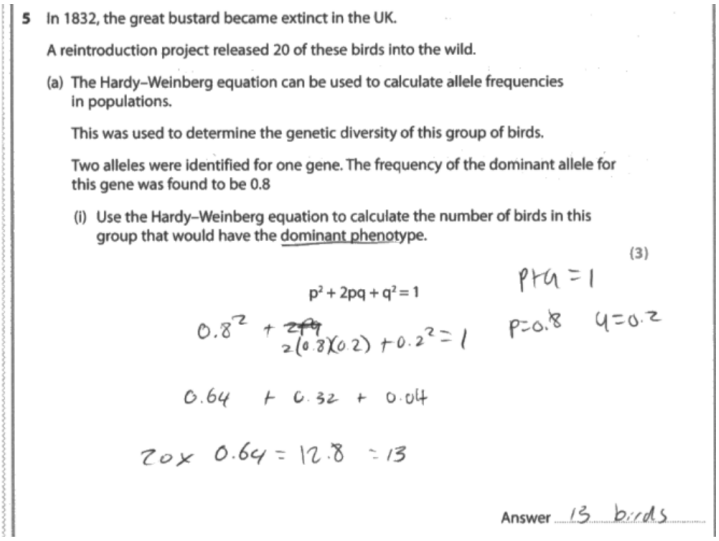
dominant ~~genotype~~

dominant phenotype = p^2 or 19

$0.8^2 + 2 \times 0.8 \times 0.2 = 0.96$

$0.96 \times 20 = 19.2 \approx 19$

Answer ~~0.96~~ 19 birds



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Two alleles were identified for one gene. The frequency of the dominant allele for this gene was found to be 0.8

(i) Use the Hardy–Weinberg equation to calculate the number of birds in this group that would have the dominant phenotype.

(3)

$p^2 + 2pq + q^2 = 1$

$p + q = 1$

$0.8^2 + 2(0.8)(0.2) + 0.2^2 = 1$

$p = 0.8 \quad q = 0.2$

$0.64 + 0.32 + 0.04$

$20 \times 0.64 = 12.8 = 13$

Answer 13 birds

Question 5(a)(ii)

This multiple choice question asked candidates to select which of the 3 statements is applicable to the context. Most candidates indentified that only 2 were correct (option C), with the most common incorrect answer being D.

Question 5(b)(i)

This recall question tested whether candidates can remember the definition of a niche, with the vast majority of candidates writing the correct key word.

Question 5(b)(ii)

For this question, candidates had to appreciate the link between introducing animals from different regions and the increased genetic diversity and survivability benefits of the population. Most candidates achieved 2 out of 3 marks for discussing the increased genetic diversity and the wider gene pool with different alleles. The best answers made the above links to the increased adaptability and survival chances of the population. The first example below shows such a 3 mark answer, with the second example showing a 2 mark answer.

(ii) Explain the genetic benefits of reintroducing birds collected from different regions.

(3)

Birds located in the same place will usually have less genetic ~~deter~~ diversity, as they have reproduced, so certain alleles will have become more common. Birds from different regions will likely have different alleles however. Therefore, reintroducing birds from different regions will increase the genetic diversity in the group, which increases their adaptability to new selection pressures, and as such their chances of survival.

(ii) Explain the genetic benefits of reintroducing birds collected from different regions.

(3)

Birds from different Regions have Different Alleles to eachother as they have been Reproductively isolated. ~~So mixing the~~ So letting the Birds mate will give a increased Genetic diversity as their offspring is likely to inherit a mix of the Alleles of the Parents.

Question 5(c)

This question asked candidates to recall the ways in which zoos increase genetic variation in population. Most candidates achieved one mark for mentioning stud books or preventing inbreeding depression, with a large number of candidates scoring full marks for also mentioning the exchange of individuals or gametes between zoos. Below is a 3 mark answer.

(c) Explain how breeding programmes in zoos can maximise genetic variation in populations before reintroduction to their natural habitat.

(3)

Stud books are used to prevent inbreeding. They allow exchange of animals between zoos. Captive breeding programmes prevent inbreeding depression

Question 6(a)

This question asked students to give similarities and differences between cellulose and starch. The question was very well answered, with most candidates achieving 4 marks, and almost all candidates achieving at least 2 or 3 marks. The best answers mentioned 1-4 glycosidic bonds and polysaccharides being similarities, whilst 1-6 bonds and branching being found only in starch. A small number of candidates missed out on full marks by not making comparative statements, not mentioning both similarities and differences, or by making generic, unqualified statements such as 'they both contain C, O and H'. Below is a 4 mark example, followed by a 3 mark example.

6 Fibres can be extracted from tissues of some plants. There is often variation in the composition of these fibres.

(a) Plant fibres contain cellulose. There are similarities and differences between the structures of cellulose and starch.

Compare and contrast the structures of molecules of cellulose and starch.

(4)

Both cellulose and starch are polymers held together by 1-4 glycosidic bonds (formed by condensation reaction) to form chains. They both contain Carbon, Hydrogen and Oxygen only. Both are very compact.

However, cellulose contains β glucose monomers whereas starch contains α glucose. Cellulose contains 1-4 glycosidic bonds only ~~however starch contains~~ none so is long and unbranched however starch contains amylopectin which contains both 1-4 and 1-6 glycosidic meaning starch is highly branched allowing for rapid hydrolysis.

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6 Fibres can be extracted from tissues of some plants. There is often variation in the composition of these fibres.

(a) Plant fibres contain cellulose. There are similarities and differences between the structures of cellulose and starch.

Compare and contrast the structures of molecules of cellulose and starch.

(4)

- Starch is compact as it is a storage molecule whereas cellulose is straight because it is a structural molecule
- Cellulose contains ~~alternating~~ inverted beta-glucose monomers whereas starch contains ^ up-right alpha glucose monomers
- Starch is ~~composed~~ composed of amylose and ~~amylopectin~~ whereas ~~starch~~ cellulose
- ~~Both~~ Starch is a branched molecule whereas Cellulose is unbranched
- Both Cellulose and Starch contain glycosidic bonds
- Both contain the ~~molecules~~ element C, H and O in their structures.
- Starch containing terminal glucose molecules to be quickly hydrolyzed whereas cellulose does not contain any terminal glucose molecules.

Question 6(b)

This question tested the candidates' ability to analyse and interpret data from the table, and to recognise that the command word 'determine' requires some element of data manipulation to justify any explanation. The best answers, such as the first example below, made it clear that mixing jute decreases its tensile strength and that polypropylene decreases tensile strength significantly more than epoxy, with some sort of calculation to support this statement. The second example below highlights a common mistake of making generic comments and simply reading from the table, without any inferences or calculations, which cost some candidates marks. Overall though, the question was very well answered, with the majority achieving at least 2 marks out of 3.

(b) Jute fibres can be used on their own or mixed with other materials to form a composite.

An investigation determined the tensile strength of jute fibres and two composite fibres containing jute.

The table shows the results of this investigation.

Fibre	Tensile strength / MPa
Jute	563
Jute-epoxy	513
Jute-polypropylene	44

Determine the effect on tensile strength of mixing jute with other materials.

(3)

- When jute is mixed with other materials, Tensile strength reduces.
- Poly Propylene heavily reduces tensile strength as it may cause break down of the middle lamella
- As jute-epoxy has a 50 MPa lower tensile strength than regular jute so also reduces Tensile Strength
- This indicates jute is a strong material when isolated in terms of tensile strength.

(b) Jute fibres can be used on their own or mixed with other materials to form a composite.

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The table shows the results of this investigation.

Fibre	Tensile strength / MPa
Jute	563
Jute-epoxy	513
Jute-polypropylene	44

Determine the effect on tensile strength of mixing jute with other materials.

(3)

As shown in the table, the fibre with the greatest ~~tensile~~ tensile strength was just Jute, with a tensile strength of 563MPa, whilst Jute-epoxy and Jute-polypropylene had strengths of ~~563 and~~ 513MPa and 44MPa respectively. Since ~~Jute on it~~ Jute fibres on their own were stronger than the composites, it shows that mixing Jute with other materials reduces the tensile strength.

Question 6(c)

This question asked students to write a method to investigate how the concentration of sodium hydroxide affects the tensile strength of jute fibres. Students had to identify the variables, provide a description of how to carry out the practical, and include a method or formula for determining the tensile strength. The best answers included a clear methodology that highlighted the importance of controlled variables such as the fibre width, length, age, temperature or time left in the solution. Most candidates achieved 3 or 4 marks, with many candidates scoring the full 5 marks. Overall the question was answered very well, with most candidates displaying a detailed understanding of this experiment. A significant proportion of candidates lost a mark for not mentioning force divided by area. The second example below shows such a 4 mark answer, with the first example showing a good 5 mark response.

Devise an investigation to determine the concentration of sodium hydroxide that produces the highest tensile strength in plant fibres.

(5)

Collect samples of a jute plant. Soak in distilled water for 24 hours such that fibres are easier to remove. Isolate 10 fibres from the same area of the plant and of the same length, diameter, health / condition. Prepare solutions of 100cm³ sodium hydroxide solution at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10% concentration (dilute with distilled water appropriately). Place in a 25°C water bath for 10 minutes. Place a fibre in each solution (in beakers) and leave in water bath for 24 hours. Remove the fibres, rinse with distilled water and clamp between 2 clamp stands. Incrementally add known value masses to the plant fibre, and record the maximum mass added before the fibre breaks. Multiply by 9.8 to find force in newtons. Divide by cross sectional area ($A = \pi r^2$) to find tensile strength. Plot tensile strength against concentration and analyse the value of concentration producing the greatest tensile strength. Repeat at least 4 more times with different plant species, finding averages and discarding anomalies, then repeat to test different plant species.

Devise an investigation to determine the concentration of sodium hydroxide that produces the highest tensile strength in plant fibres.

(5)

Set up beakers of sodium hydroxide solution of concentrations 0%, 5%, 10%, 15%, and 20%. Place these in water baths to ensure the temperature is controlled with a thermometer. Let the solutions equilibrise. Pick out 15 plant fibres of the same material, length, and thickness. Place these fibres, 3 fibres in each beaker, and leave for 5 minutes. Then take the fibres. One at a time, hang a fibre from a clamp, and hang a hook on it. The fibre should be tied in a circle with the hook hanging from it. Determine the maximum weight the fibres can support before breaking by increasing the mass on the hook. Afterwards, divide the masses by 2 to account for the circular knot.

Question 7(a)(i)

For this question, candidates had to extract data from a bar chart and determine the ratio. The vast majority achieved the mark, with a small number of candidates losing a mark for writing the inverted ratio. It should be noted that although there was no penalty for writing the ratio as 4:17 (as the question did not ask for the ratio to be given in its simplest form), it is better practice to write the ratio as 1: 4.25.

Question 7(a)(ii)

This question increased the challenge by asking candidates to explain what they can infer from a bar chart. A significant number of candidates achieved full marks, by mentioning that the gene increases crossing over, leading to more recombinants (this was the most commonly mentioned point) and to increased genetic variation in gametes. Mentioning how the longer chromosomes are more affected also gained credit. The first example below shows a good 3 mark answer, linking the aforementioned points. The second example only achieved 1 mark for failing to mention that the gene *increases* crossing over. Many responses included generic comments such as 'affects crossing over', which do not gain credit, it being a common misconception by students that 'affects' is sufficient, but it does not indicate whether there is an increase or decrease.

(ii) Deduce the effect of the MSH4 gene on the gametes produced.

(3)

The MSH4 gene produces gametes with a higher genetic Variation as there are more recombinants. This does not appect chromosomes 5 and 8, and the longer the chromosone the higher the percentage of recombinants and thus the more Crossing over occurs. This means gametes will have greater variation due to the MSH4 gene, as more crossing over occurs during meiosis

(ii) Deduce the effect of the MSH4 gene on the gametes produced.

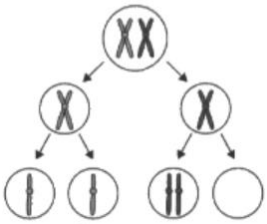
(3)

When the MSH4 gene is active, percentage of recombinants increases by a significant amount. this therefore means ~~pause~~ MSH4 gene ~~lead~~ controls crossing over during meiosis.

Question 7(b)

This question was very poorly answered by the majority of candidates. The question provided a diagram showing a model of chromosome non-disjunction, from which candidates had to infer that gametes would contain an incorrect number of chromosomes and therefore at fertilisation, the zygote will have an odd number of chromosomes or would not be diploid. The first example below shows a good 2 mark response. However, a disappointingly high number of candidates inferred from the diagram that one gamete would inherit all chromosomes, and the other would have 0 chromosomes. This led to a large number of responses receiving 0 marks.

(b) During the process of meiosis, chromatids may not separate properly.
The diagram shows this effect.

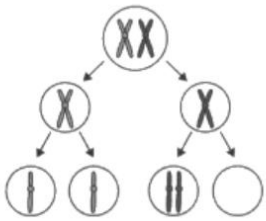


Deduce how this can cause problems at fertilisation.

(2)

Aneuploidy means gametes have the incorrect number of chromosomes. This means at fertilisation the gametes are not a diploid cell is not produced properly as a chromosome may have too many or too few (gaining or losing) chromatids. for instance, down syndrome may be developed where too many chromosomes are present. The issue occurs at fertilisation as the gametes are not both haploid so cannot properly fuse to form diploid zygote.

(b) During the process of meiosis, chromatids may not separate properly.
The diagram shows this effect.



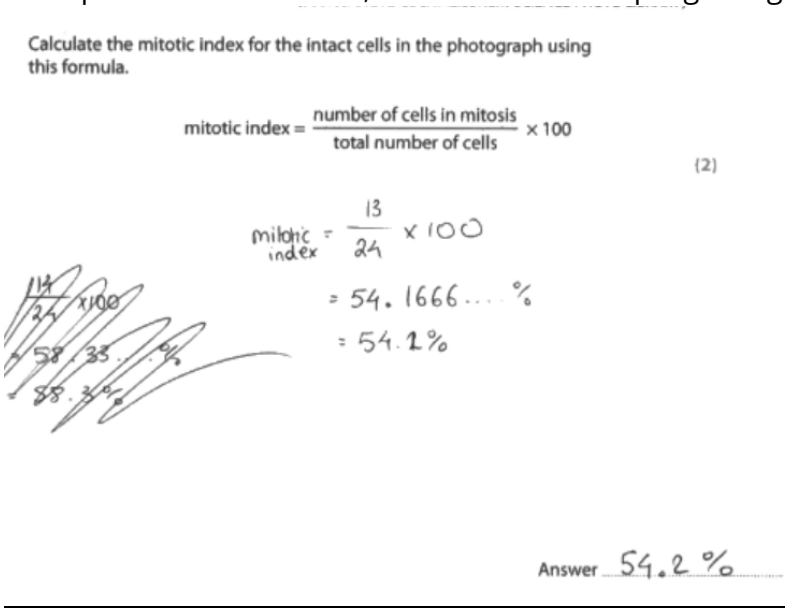
Deduce how this can cause problems at fertilisation.

(2)

well now one gamete has 46 chromosome instead of its intended 23 and another gamete has 0 chromosomes instead of its 23. so when fertilised the first gamete will have way to many chromosomes as 23 + 46 = 69 chromosomes and the other with only have 23 chromosomes.

Question 7(c)

This calculation question asked candidates to use the formula provided to calculate the mitotic index for a number of cells. It was acknowledged that there could be some element of variation in interpretation of what was occurring in some of the cells in the image, so a small degree of variability was allowed in terms of numbers of cells (11 – 14 cells in mitosis and 21 – 24 total cells). Candidates who used the numbers within this range for their calculation generally received both marks, unless the calcualtion was incorrect. A significant number of candidates had identified numbers that were outside one or both of the ranges above, but had a correct calculation using their values. Those candidates achieved one mark for using the formula for mitotic index correctly and not penalised for misidentification of cells. The second example below shows this, with the first example gaining 2 marks.



Calculate the mitotic index for the intact cells in the photograph using this formula.

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}} \times 100$$

(2)

mitotic index $= \frac{13}{24} \times 100$

$= 54.1666\ldots\ \%$

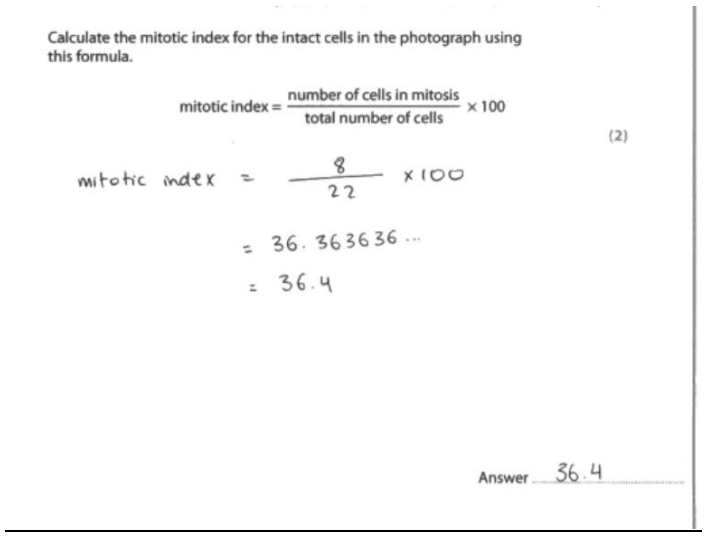
$= 54.2\%$

~~$\frac{14}{24} \times 100$~~

~~$= 58.33\ldots\ \%$~~

~~$= 58.3\%$~~

Answer 54.2 %



Calculate the mitotic index for the intact cells in the photograph using this formula.

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}} \times 100$$

(2)

mitotic index $= \frac{8}{22} \times 100$

$= 36.363636\ldots$

$= 36.4$

Answer 36.4

Question 7(d)

This question asked candidates to devise an experiment to observe the rate of mitosis in three plant species. The vast majority of candidates immediately appreciated that this required a root tip squash investigation to determine mitotic index and planned their answer accordingly. Almost all candidates achieved 2 or 3 marks for using hydrochloric acid, describing the correct stain and macerating the root tip, and then observing and going on to comparing mitotic index. The best answers also included a brief description of the standardisation of the root sample and appreciated that the plant species had to be grown in similar conditions. Some candidates lost marks for failing to mention that when observing under a microscope, both the number of cells in mitosis *and* the number of total cells must be taken into account. Below are examples of a 5 mark answer and a 2 mark answer.

Describe how root tip squashes can be used to find out if chromosome number affected mitosis in these species of strawberry plant.

(5)

Take samples of roots from genetically identical plants of each species. Isolate two millimetres of root tip from the growing side from healthy roots of each plant of the same length, age, diameter. For each sample leave in 25% distilled water for 5 minutes, then transfer to a test tube with 1 cm^3 of, 25°C or concentrated HCl (Hydrochloric acid) to soften sample. Count the temperature with a water bath. Leave for 5 minutes again measured with a stopclock then place back in distilled water for 5 minutes. Place on a white tile and macerate with a mounted needle. Place on a microscope slide add two drops of toluidine blue and leave for 2 minutes. Place a cover slip on the sample and press down firmly with no horizontal movement to isolate one layer of cells. Remove excess dye with filter paper then place under the microscope and turn on the light. Count the number of cells undergoing mitosis (condensed chromosomes or cells seperating) the whole field of view then divide by total number of cells in view to calculate the mitotic index. Repeat 4 more times with each species from to find averages and discard anomalies. Compare average mitotic index to see if this varies with chromosome number.

Describe how root tip squashes can be used to find out if chromosome number affected mitosis in these species of strawberry plant.

(5)

Cut of small parts of the ends of the roots of the different species, around 5 each. Ensure that the samples are located at the very end of the roots, and they are are roughly the same length. Place the samples in some hydrochloric acid to break down the middle lamella. Leave for 3 minutes. After, carefully take out the samples and place them in water to rid them of hydrochloric acid. The samples of the 3 species should be kept separate. After 3 minutes, take out the samples and dry on paper towels. Place one sample at a time on a microscope slip, and stain with fuluodine blue. After cutting the sample to be one cell thick. Press down a cover slip and compare the mitosis in the samples of the different species.

Question 8(a)

This question produced surprisingly varied responses. Candidates had to recall the importance of genetic diversity and species diversity, with the majority recalling at least one idea. A high number of candidates lost marks for mentioning species evenness or using quadrats and transects.

8 Biodiversity is affected by agricultural methods such as the practice of monoculture.

Monoculture involves growing a single crop with no other species of plant.

(a) State **two** methods for measuring biodiversity in a habitat.

(2)

1 heterozygosity index

2 index of diversity

8 Biodiversity is affected by agricultural methods such as the practice of monoculture.

Monoculture involves growing a single crop with no other species of plant.

(a) State **two** methods for measuring biodiversity in a habitat.

(2)

1 Count the number of species
species richness

2 See if a species dominates the habitat species evenness

Question 8(b)

This multiple choice question was really well answered, with most candidates identifying the method of reproduction as a physiological adaptation.

Question 8(c)

This question asked candidates to apply their knowledge of sustainability to cotton plants. The question allowed most candidates to gain full marks, with some losing marks for simply stating the definition of sustainability or discussing biodegradability. The response below gained 2 marks.

(c) Cotton is an example of a crop grown as a monoculture.

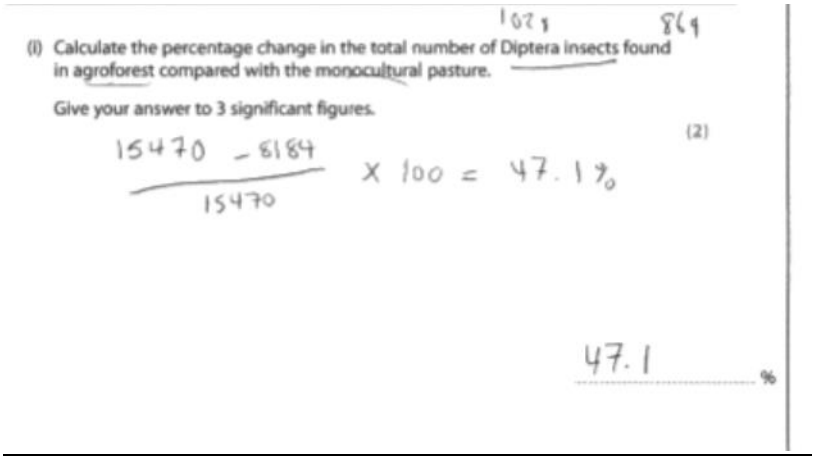
Explain why the production of cotton fibres from cotton plants is sustainable.

(2)

because Cotton fibres come from plants that can be regrown. so comes from a renewable resource. So will still be available for future generations.

Question 8(d)(i)

This calculation question asked candidates to determine the percentage change using data from a table. Circa half of candidates achieved full marks, however a high number of candidates achieved only 1 mark for the correct calculation of change, but an incorrect calculation of percentage change (dividing by the final value, instead of the initial value). The first example shows the correct working out and answer of 47.1%. The second example achieved 0 marks, due to the incorrect calculation. Note that even if the answer had been the correct value, it would have lost a mark for being given to the incorrect number of significant figures.



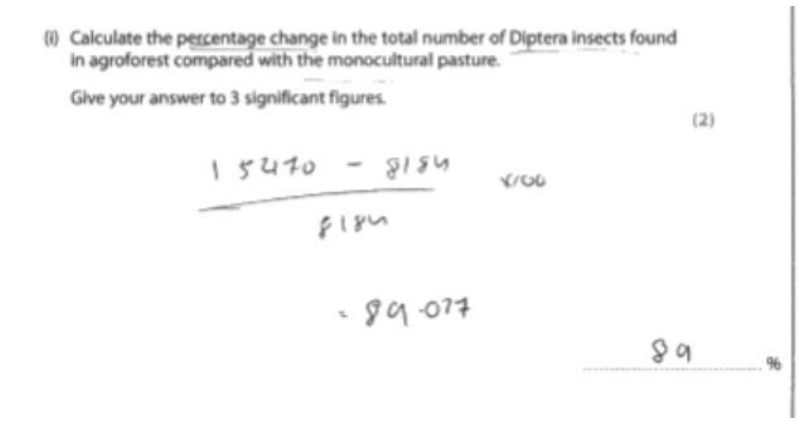
(i) Calculate the percentage change in the total number of Diptera insects found in agroforest compared with the monocultural pasture.

Give your answer to 3 significant figures.

(2)

$\frac{15470 - 8184}{15470} \times 100 = 47.1\%$

47.1 %



(i) Calculate the percentage change in the total number of Diptera insects found in agroforest compared with the monocultural pasture.

Give your answer to 3 significant figures.

(2)

$\frac{15470 - 8184}{8184} \times 100$

$= 89.077$

89 %

Question 8(d)(ii)

This 6 mark question asked candidates to use *all the data available* to explain the increase in biodiversity between agroforestry and monocultures. This question discriminated well between the different candidates. The best answers made sustained, linked explanations involving niches, food, shelter, the different biotic and abiotic factors and included data from all sources. The first student response below achieved the full 6 marks. The majority of candidates however, had excellent explanations and sustained reasoning, but failed to mention any data from the table of insect populations, thereby capping themselves at the top end of level 2 (4 marks). This could be due to the insect table being slightly earlier in the question, on another page, so many candidates may have forgotten about it, or thought that it was not necessary. The second example shows such a 4 mark response. A significant number of candidates showed a poor understanding of biodiversity and data analysis, as they were simply stating the definition of biodiversity, or making simple basic claims, without any explanations.

Explain how a change from monocultural pasture to agroforestry can increase biodiversity.

(6)

Agroforestry increases the number of plant species dramatically from monoculture farming. This increase in plant diversity provides more niches for other animals, which allows for an increase in animal diversity. Large mammals benefit the most from this as there is an increase of 44% in agroforestry compared to monoculture. The percentage of farms containing animals increases for every animal species shown, as there is a greater variety of niches and greater biodiversity that can support a larger ecosystem. There is a median increase of 3 plant species in agroforestry compared to monoculture. The number of species of insects increases for every species of insect shown in agroforestry compared to monoculture. The total number of Diptera flies decreased however, and this is due to the fact that the Diptera do not outcompete all other species as they would in monoculture due to feeding on the singular type of crop grown. The greater number of plant species allows for more herbivore species and insect species as there are a greater number of food sources available, and this increases the number of carnivores present as there are a greater population of herbivores able to support them.

Explain how a change from monocultural pasture to agroforestry can increase biodiversity.

(6)

As shown in the figure, the biodiversity of almost every type of animal in agroforestry compared to monoculture. This is because in agroforestry, there is a much greater variety of plants, providing a suitable habitat for a much greater number of species. For example, using conventional farming, monkeys were only present on 48% of farms whereas for agroforests, they were present on 67% of farms. This shows that changing from monocultural pasture to agroforestry will significantly improve the biodiversity at a farm, which further improves the sustainability, and helps prevent extinction.

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