Extended Response Questions (Topics 3 and 4): Edexcel SNAB A Level Biology Exam Questions

12 questions · 75 marks · about 90 minutes. Answer in the spaces, then check the mark schemes at the end.

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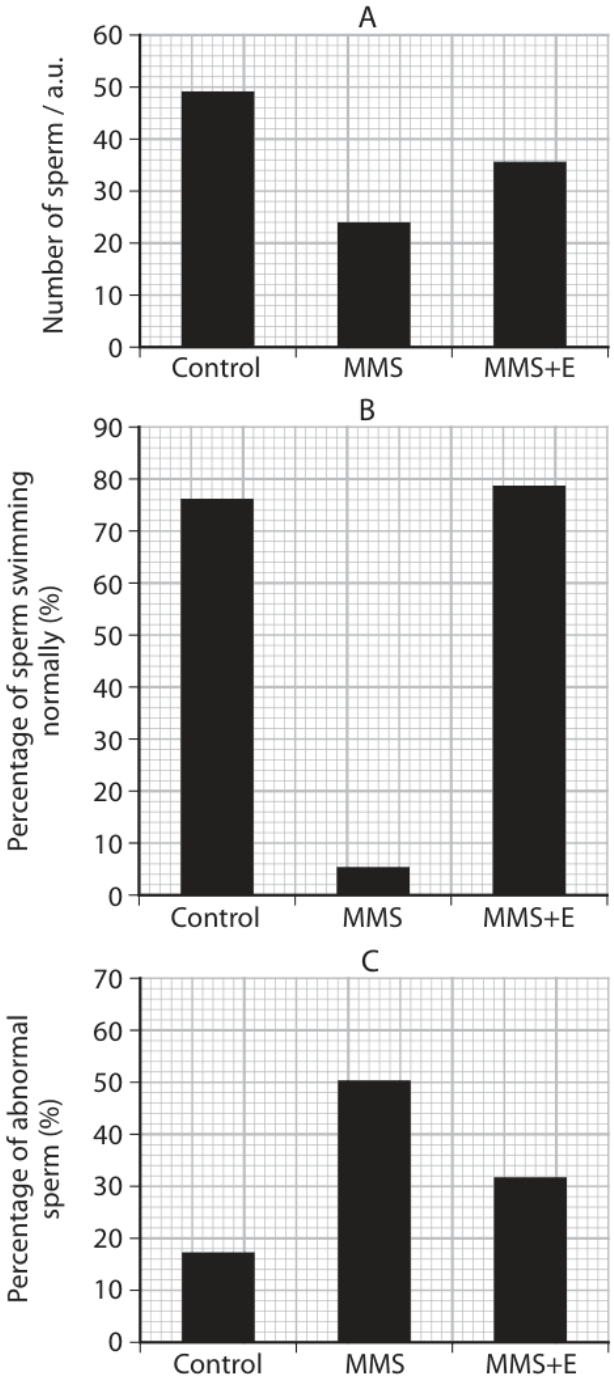
Question 1 · information from earlier in the question

(b) Methyl methanesulfonate (MMS) can be used as a cancer treatment. One side effect associated with MMS is teratozoospermia.

Three groups of rats were exposed to the following additives to their diet as shown in the table.

Group	Additive to diet
Control	distilled water
MMS	methyl methanesulfonate
MMS+E	methyl methanesulfonate followed by vitamin E

The graphs show the results of the study of the sperm cells produced by these three groups of rats.



Deduce the effects of MMS on the production of sperm cells in rats.

(3)

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Question 1 · AS Paper 2 · June 2019 · Q6(c) · 6 marks

*(c) Discuss the potential use of vitamin E as a fertility treatment for people with teratozoospermia.

(6)

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Question 2 · AS Paper 2 · June 2023 · Q8(b)(ii) · 6 marks

*(ii) In 2019, stem cell transplants were given to 1714 people in the UK.

Stem cell transplants require a matching donor to provide the stem cells.

Stem cells from umbilical cord tissue can give rise to every type of cell in the blood.

Stem cells from donated bone marrow can also give rise to all types of blood cell.

Parents may be given the option to store umbilical cord tissue as a bank of stem cells for future use.

Stem cells are used to treat children with blood disorders. These could be blood cancers, such as leukaemia, or genetic diseases.

Discuss the issues concerning the use of stem cells from the following sources:

- embryos
- bone marrow from donors
- stored umbilical cord tissue.

(6)

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Question 3 · information from earlier in the question

(c) Polyspermy occurs when more than one sperm cell enters the egg.

This is usually prevented by the hardening of the zona pellucida shortly after the arrival of the first sperm cell.

In an investigation, the effects of varying sperm cell concentrations on the fertilisation of eggs was measured. This was repeated using egg cells with the zona pellucida removed.

The table shows the results of these investigations.

Sperm cell concentration / $\times 10^3$ cm^{-3}	Zona pellucida intact		Zona pellucida removed	
	Percentage fertilisation (%)	Percentage polyspermy (%)	Percentage fertilisation (%)	Percentage polyspermy (%)
50	84	3	94	3
100	99	17	95	33
200	99	18	98	52

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Question 3 · AS Paper 2 · October 2020 · Q4(c)(iii) · 6 marks

*(iii) During IVF treatment, egg cells are extracted from the ovaries.

Large numbers of sperm cells can be added to these egg cells in a Petri dish to increase the chances of successful fertilisation.

In a study of 200 extracted egg cells, there was damage to the zona pellucida of 13 of these egg cells.

Comment on the frequency of polyspermy due to IVF procedures.

(6)

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8 Prostate cancer is one of the most common forms of cancer in adult men.

A number of investigations have been carried out to study prostate cancer in a large number of men in Denmark, Finland and Sweden.

(b) In another investigation, the effect of diet on the development of prostate cancer was studied.

Data were collected on prostate cancer death rates and the intake of sugar. Some of the data are shown in the table.

Daily sugar intake per person / kJ	Prostate cancer death rate / 100 000 of the male population
420	5.0
840	8.5
1260	12.0
1680	16.0
2100	20.0

The male population size of Denmark is 2.86 million.

Calculate the number of men likely to die from prostate cancer if their daily sugar intake was 1260 kJ.

(2)

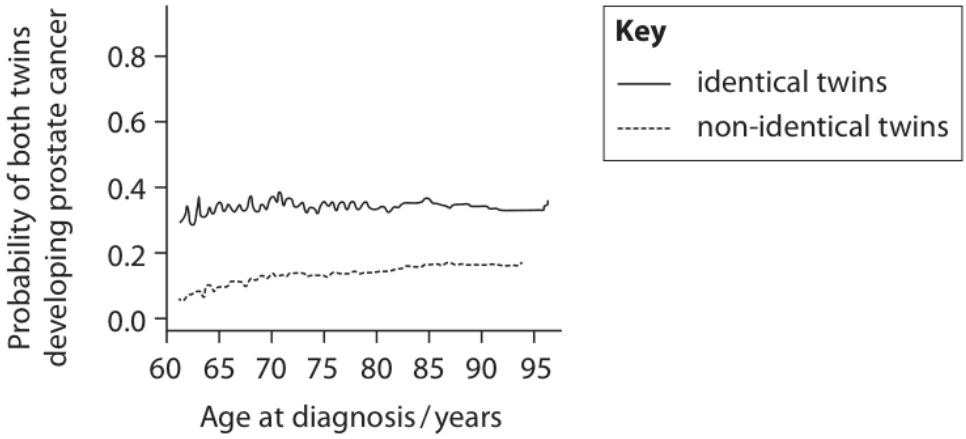
Answer .....

(c) In a third investigation, prostate cancer in identical and non-identical male twins was studied.

Data were collected on the probability of one male twin developing prostate cancer if his twin brother had prostate cancer.

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*(ii) The graph shows the results of this investigation.



Analyse the data from these three investigations to evaluate the likely causes of prostate cancer.

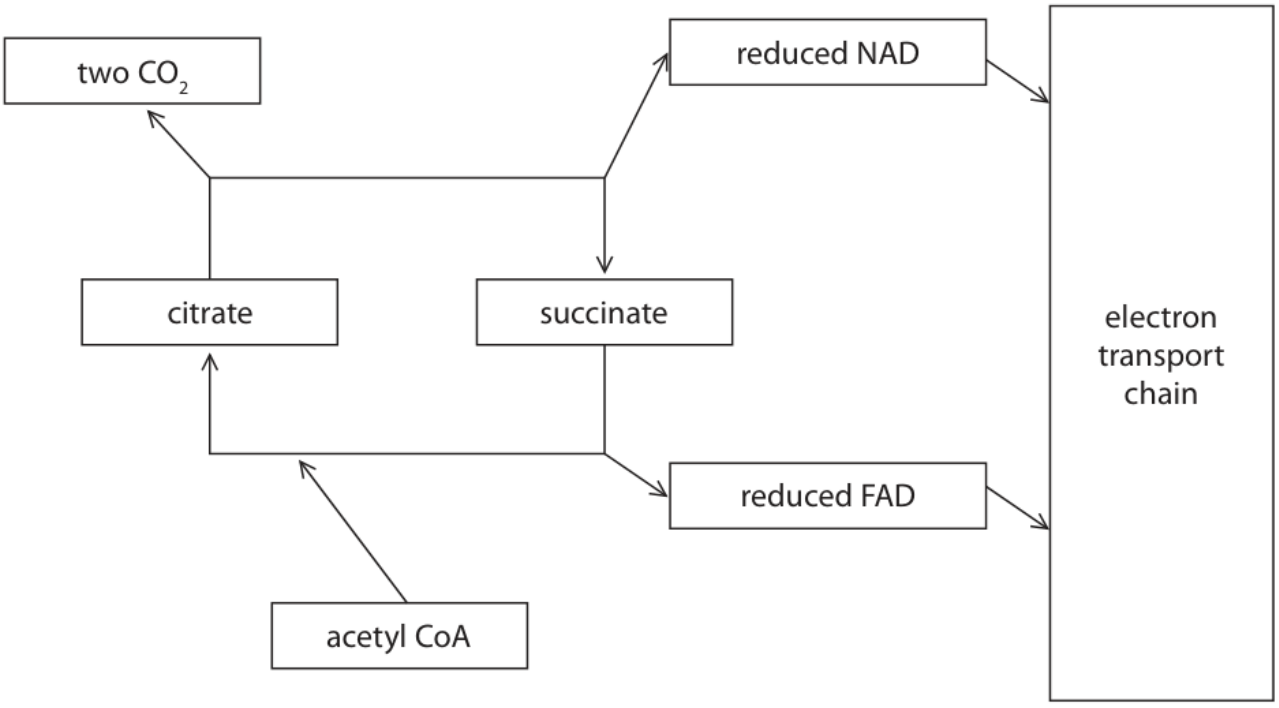
(6)

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Question 5 · information from earlier in the question

10 Respiration occurs in all healthy living cells.

(a) The diagram shows part of the Krebs cycle and the electron transport chain.



(iv) A mutation in the gene that codes for the enzyme succinate dehydrogenase stops the conversion of succinate into citrate.

Which row states the change in concentration of citrate and reduced FAD as a result of this mutation?

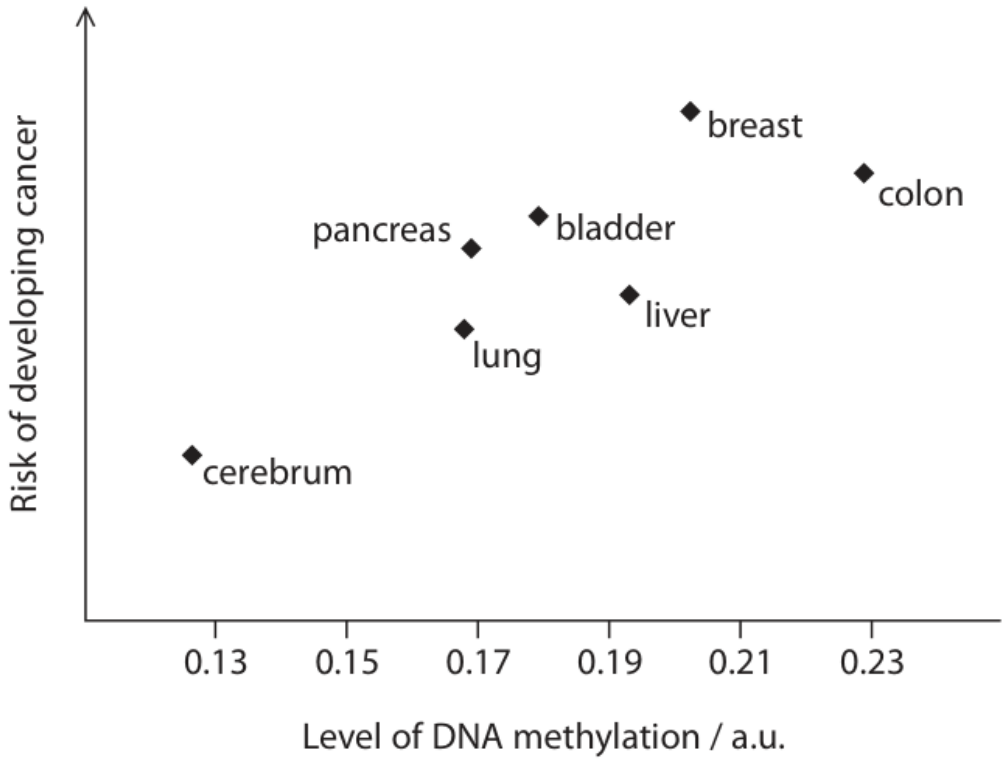
(1)

	Concentration of citrate	Concentration of reduced FAD
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

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(b) There is a link between the methylation of certain regions of DNA and the risk of developing cancer.

The graph shows the relationship between the level of methylation of these regions of DNA and the risk of developing cancer in different parts of the body by the age of 70.



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Question 5 · A level Paper 2 · October 2020 · Q10(b)(iii) · 6 marks

*(iii) Scientists have found that a high level of succinate leads to the inhibition of an enzyme called TET.

The function of TET is to remove methyl groups from DNA.

Explain how a mutation in the gene for succinate dehydrogenase can increase the risk of developing cancer.

(6)

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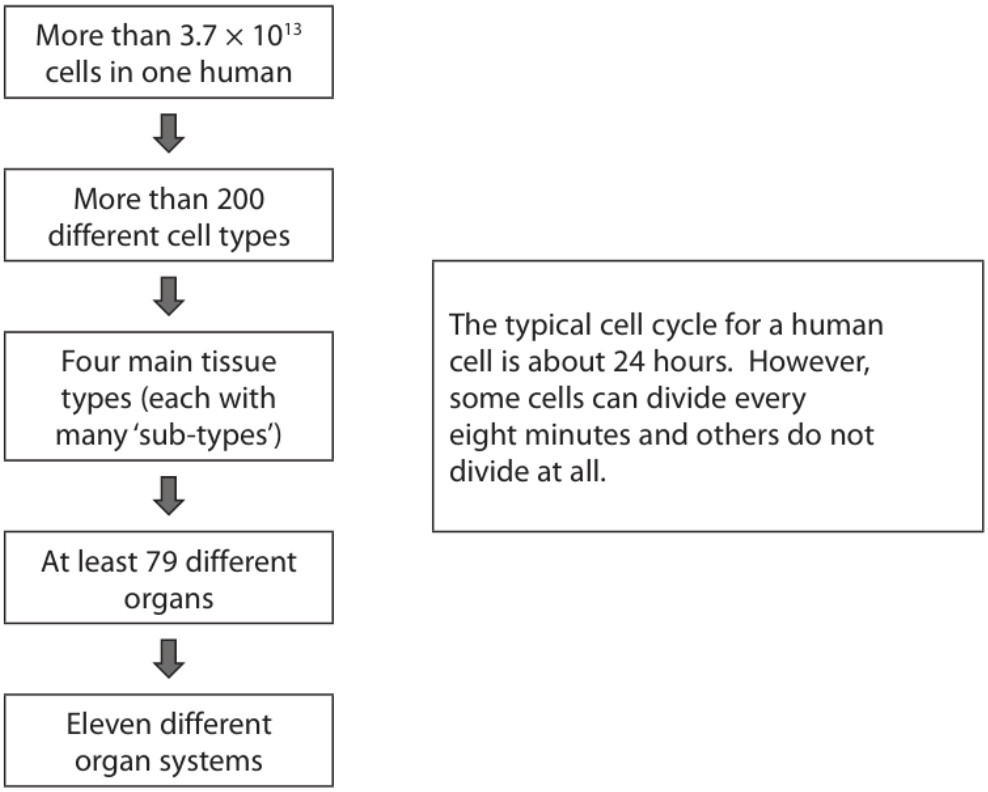
Question 6 · A level Paper 3 · November 2021 · Q7 · 9 marks

***7** Humans are complex multicellular organisms.

Cell division is involved in:

- the production of gametes
- the development of tissues
- the development of tumours
- the response to infection in humans.

The figure summarises some information about the organisation of cells in a human.



The table summarises some information about human genetics and cancers.

Number of protein coding genes	Approximately 20 000
Number of different genetic disorders	Approximately 2200
Proportion of cancers caused by an inherited genetic defect	5 to 10%

Evaluate the role of cell division in processes affecting human health and disease.

(9)

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Question 7 · AS Paper 2 · June 2016 · Q3(c) · 6 marks

*(c) Lead ions can be toxic to plants.

Different plants are killed by different concentrations of lead ions.

The toxic concentrations for different plant categories are shown in the table.

Toxic lead ion concentration / ppm	Tolerance category of plant
<300	low
300–999	medium
1000–2000	high
>2000	very high

Devise a laboratory investigation to determine the tolerance category of tomato plants to lead ions.

(6)

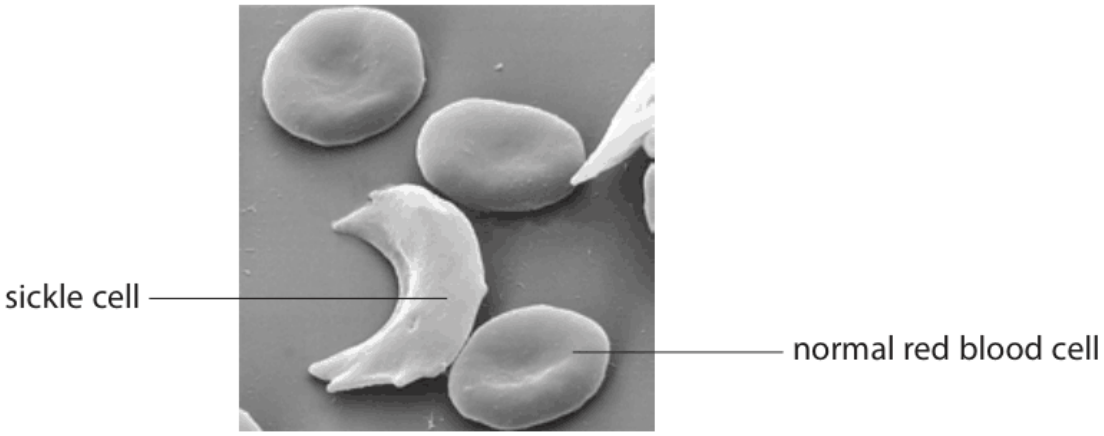
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Question 8 · information from earlier in the question

(b) Sickle cell anaemia is a genetic condition.

People who are homozygous for the sickle cell allele have red blood cells that become deformed in shape when they are deoxygenated.

The electron micrograph shows these deformed sickle cells alongside normal red blood cells.



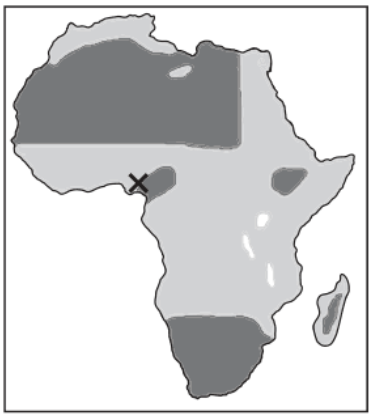
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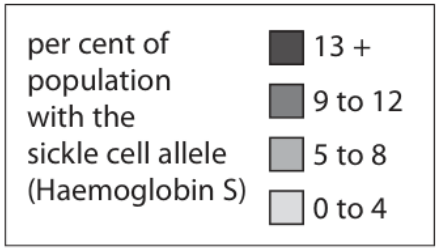
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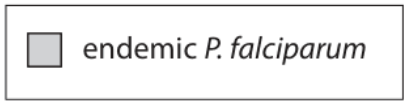
*(iii) Individuals who are heterozygous for this condition are resistant to a severe form of malaria, called cerebral malaria, that affects the brain. Individuals who are homozygous for the sickle cell allele are more likely to develop severe sickle cell anaemia.

The maps show the percentage of the population with the allele for sickle cell anaemia and the distribution of *P. falciparum* in Africa. The location of the Yoruba people is indicated with a cross (✕).









Analyse the data to explain how malaria has affected the percentage of individuals in the Yoruba population with the allele for sickle cell anaemia.

(6)

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(d) Cattle farming in Brazil has made use of monoculture pasture.

The native grassland ecosystem has been replaced with pastures sown with grass plants not native to Brazil.

This has resulted in a loss of biodiversity.

Agroforests have been introduced to enhance biodiversity. These aim to provide food for cattle and restore biodiversity.

Agroforest involves growing a mixture of trees, shrubs and grasses.

Scientists monitored the biodiversity of insect species in an area of monocultural pasture and an area of agroforest.

Some of their results are shown in the table.

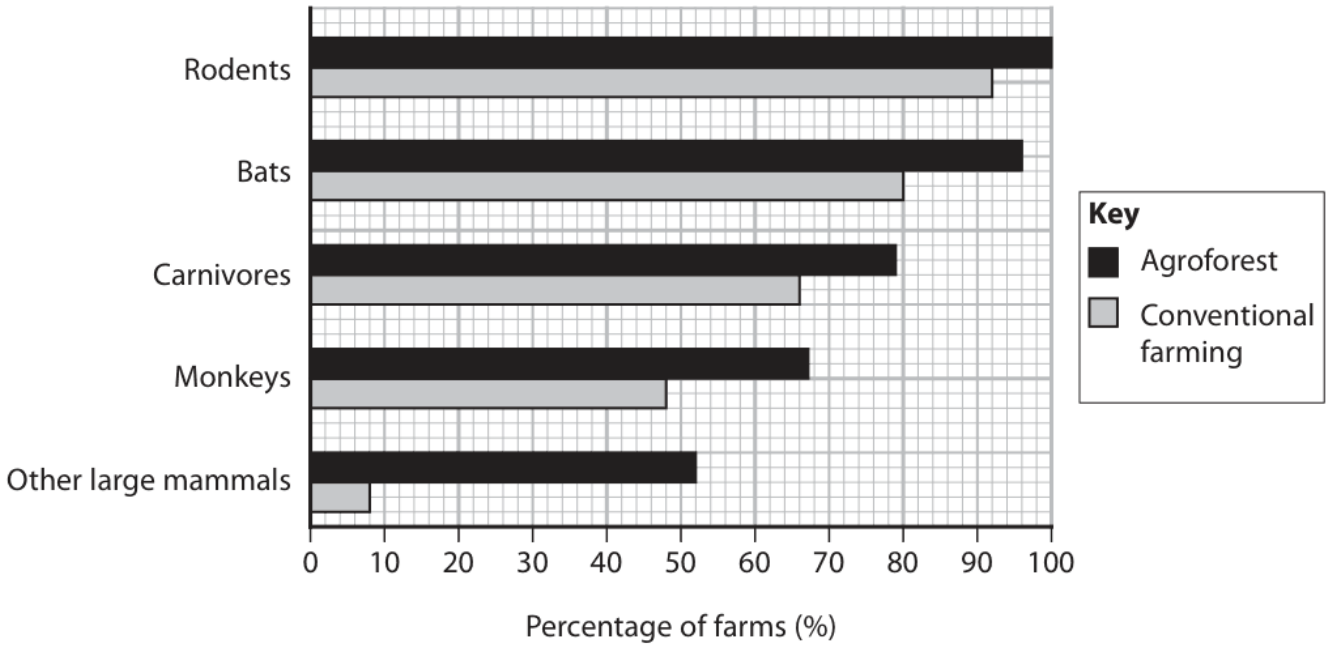
Group of insects	Total number of insects		Number of species	
	Agroforest	Monocultural pasture	Agroforest	Monocultural pasture
Hemiptera (bugs)	23 133	18 571	111	89
Hymenoptera (bees and wasps)	12 503	7 075	348	270
Diptera (flies)	8 184	15 470	219	203
Coleoptera (beetles)	2 772	171	348	306
Mantodea (mantids)	13	10	3	1

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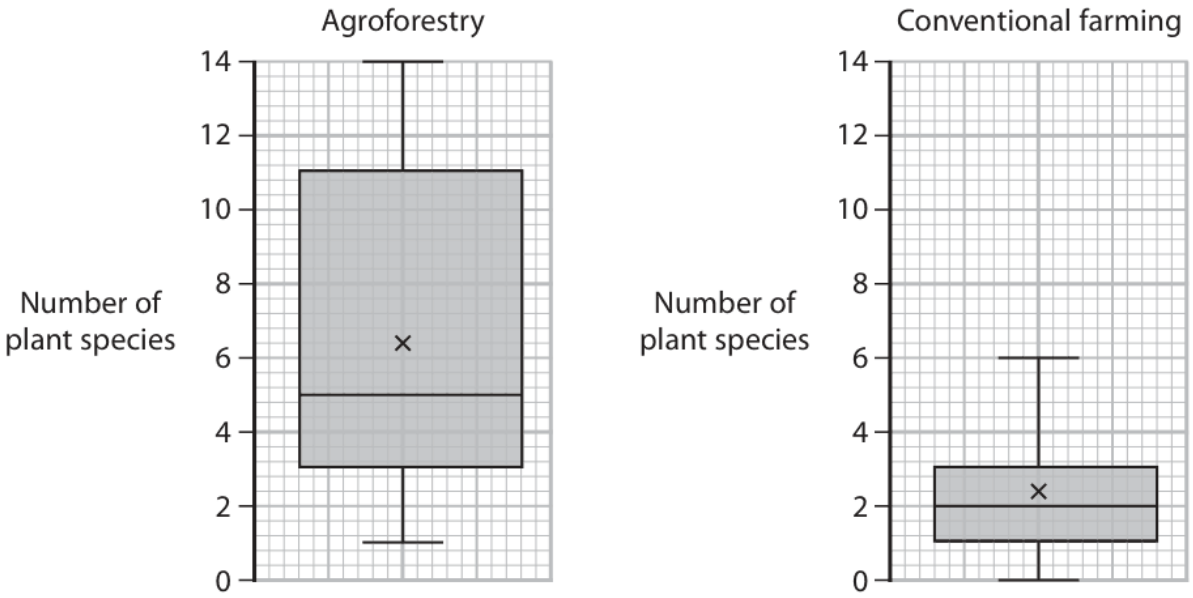
*(ii) Another study in Brazil recorded which mammal species farmers had observed.

The study involved 75 farms using agroforestry and 64 farms using conventional farming methods such as monoculture pasture.

The graph shows the percentages of farms recording the presence of the different types of mammal.



The boxplot graphs show the number of plant species found in these two types of farm. The x represents the mean, the line inside the box shows the median.



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

(6)

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10 Scientists have studied behavioural, anatomical and genetic variation in elephants.

The table shows some information about two populations of African elephants.

Population	Location	Feeding behaviour	Anatomical differences
Forest elephant	tropical forest of central and West Africa	feeds on leaves and fruits of high-growing plants such as shrubs and trees	• lower jaw longer and narrower • tusks straighter and downward facing • overall a much smaller size
Savannah elephant	African savannah	feeds on grass and leaves of low-growing shrubs	• lower jaw shorter and wider • tusks more curved and upward facing • overall a larger size

The photographs show elephants from the two populations.



Forest elephant



Savannah elephant

DNA samples were collected from these two populations of elephants.

(a) One of the genes showing variation was the GBA gene. The table shows the frequency of the alleles of the GBA gene in the two populations.

GBA allele	Frequency of allele in the elephant population	
	Savannah elephant	Forest elephant
J	0.05	0.43
K	0.00	0.57
L	0.95	0.00

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Question 10 · A level Paper 1 · June 2017 · Q10(b)(i) · 6 marks

(b) Scientists have concluded that the forest elephant and the savannah elephant are two different species.

*(i) Analyse the data and the information provided to comment on the validity of this conclusion.

(6)

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Question 11 · A level Paper 1 · October 2020 · Q8(b)(ii) · 6 marks

*(ii) Land use has changed over time in Borneo, with areas of forest being removed due to logging. The land may then be used for planting oil palms, which are not a suitable habitat for orangutans.

The following comments refer to other issues concerning the conservation of orangutans in Borneo.

- Over the past 100 years, 80% of suitable habitat for orangutans has been lost.
- Only 2% of the remaining forest suitable as orangutan habitat is protected.
- From 1999 to 2015, the orangutan population decreased by 50%.
- Captive-bred orangutans may spread human diseases into wild populations.
- When captive-bred orangutans are released, their offspring often die young because the females have not learnt parenting behaviour from older individuals.
- Large numbers of orangutans are hunted in Borneo, even though they are a protected animal.

It has been stated that habitat protection is more important than captive breeding programmes for the conservation of orangutans in Borneo.

Evaluate this statement.

(6)

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Question 12 · information from earlier in the question

(b) In humans, calcium ions are important for structure as part of bone material. These ions are also involved in physiological processes in soft tissue. Soft tissue is non-bony material.

The table shows some data relating to humans.

mean mass of an adult	80 kg
mean percentage of body mass that is bone	4%
mean mass of calcium ions per adult	1000 g
mean percentage of calcium ions present in soft tissue	1%

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Question 12 · A level Paper 2 · June 2022 · Q10(b)(ii) · 6 marks

*(ii) Calcium ions are also found in the tissue of plants.

The calcium ion concentration in one species of plant has been measured.

It was found to be 170 $\mu g\, g^{-1}$ of plant tissue.

A student made the conclusion that:

Calcium ions are more important in the tissue of plants than in animals.

Evaluate this conclusion.

(6)

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Mark schemes

Question 1 · AS Paper 2 · June 2019 · Q6(c) · 6 marks

Question Number	Answer
6*(c)	Answers will be credited according to candidate's knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • There is a positive effect of vitamin E shown from the trial on reducing number of abnormal sperm and improved motility • Reference to data from graphs to compare results with vitamin E and control groups • Increased motility will increase probability that sperm will reach the egg • Increases in sperm count will increase the chance of fertilisation • The low numbers of sperm may not be the reason for infertility • Trials conducted on rats not humans therefore results may not be the same in people • The trial only involved examples of teratozoospermia that are caused by MMS • Other causes of teratozoospermia may not respond to Vitamin E **(6)**

.evel 0	**0**	No awardable content	
.evel 1	**1-2**	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	Description of positive effect of vitamin E e.g. reference to an improvement such as improved sperm motility, reduced abnormalities
.evel 2	**3-4**	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	Discussion of how specific effects of vitamin E treatment would improve fertility or analysis of data from graphs, e.g. comparing vitamin E treatment data with control groups. Reference to tests only being carried out on rats or results from trials on humans necessary. Other causes of teratozoospermia apart from MMS not considered.
.evel 3	**5-6**	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Full discussion of evidence for potential use of vitamin E to treat infertility. Detailed discussion of limitations due to experimental design or other causes of infertility.

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Question 2 · AS Paper 2 · June 2023 · Q8(b)(ii) · 6 marks

Question Number	Indicative content
8(b)(ii)	Answers will be credited according to candidate's knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** All could be used to treat medical conditions and be used to replace tissues damaged by disease or faulty genes. **Embryos** • Stem cells are totipotent and have more potential • Use of embryonic stem cells destroys embryos • Embryos cannot give consent / have potential to become a human being **Bone marrow donors** • Stem cells are pluripotent – have less potential but still have potential to become all types of blood cell • May not match the recipient and be rejected • Bone marrow donor DNA will have a different genome **Umbilical cord tissue** • Stem cells are pluripotent – still have potential to become all types of blood cell • Will be genetically identical to the recipient • No chance of rejection / no need for immunosuppressant medication • May not be able to treat a genetic condition • Not all patients have umbilical cord tissue stored / storage issues such as cost (?) or degradation of tissue over time (6 marks)

Level	Marks		Additional guidance
0	0	No awardable content	
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Basic points made. Some links made to either potential benefits or concerns, but not both.
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	At least two sources of stem cell discussed. Some links made between sources of stem cells and their potential as well as practical or ethical concerns.
3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	All three sources of stem cells discussed. Issues discussed should consider the relative potential for each type of stem cell in therapeutic treatments as well as practical or ethical concerns.

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Question 3 · AS Paper 2 · October 2020 · Q4(c)(iii) · 6 marks

Question Number	Indicative content
4(c)(iii)	Answers will be credited according to candidate's knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • {removing the zona pellucida causes an increase in polyspermy • because it prevents a physical barrier being formed • the effect is increased at higher sperm cell concentrations • because more sperm cells reach the (egg cell) membrane at the same time. • there is an increased concentration of sperm around the egg in IVF • due to shorter distance that the sperm have to swim / fewer sperm die on the way to the egg • even with zona pellucida intact there are some incidences of polyspermy • there is a delay while the cortical reaction takes place • physical damage to zona pellucida can prevent effectiveness of cortical reaction

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Damage to zona pellucida increases risk of polyspermy OR increased number of sperm increase risk of polyspermy
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Reference made to data showing polyspermy increases with increase in sperm 'concentration' OR increases when zona pellucida removed. Link made to either lack of hardening of zona pellucida or increased probability to more than one sperm entering if there are more of them.
3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Reference to data on both sperm 'concentration' and presence of zona pellucida, linked to cortical reaction which would otherwise prevent polyspermy. Answer links all the data and makes reference to reasons why IVF could result in increased risk of polyspermy.

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Question 4 · A level Paper 2 · June 2019 · Q8(c)(ii) · 6 marks

Question Number	Answer
8(c)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content Investigation 1 • effects of age on probability of getting prostate cancer • effects due to country of origin – e.g. gene pool differences, or environmental differences Investigation 2 • effects of one lifestyle / one dietary factor on prostate cancer death rate • high sugar intake may lead to obesity, linked to higher risk of cancer Investigation 3 • genetic effects on risk of getting prostate cancer • probability is higher in identical twins that non-identical twins • suggests {genetic / inherited / familial} factors • example given e.g. both have a mutation in the DNA • as probability is at {0.4 / not 1.00} / {low / lower} correlation for non-identical twins suggests {not just due to inheritance / environmental factors} Overall evaluation • idea that it is multifactorial, interaction between genotype and environment • validity of investigations depends on sample size etc

Level	Mark	Descriptor	Additional Guidance
0	0	No awardable content.	
1	1 - 2	Limited scientific judgement made with a focus on mainly just one investigation. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	e.g. relationship between age and development of prostate cancer Basic conclusion from the data described.
2	3 - 4	A scientific judgement is made through the application of relevant evidence from the investigations. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Discussion of evidence from at least two investigations. Conclusion drawn using evidence from studies discussed e.g. relationship between both age and sugar intake on prostate cancer. e.g. environmental effect as there is a greater incidence in some countries than others
3	5 - 6	A scientific judgement is made, which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information for all the investigations A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Evaluation of all three investigations. Links made between genotype and environment / lifestyle and phenotype. e.g. twin studies, sugar intake and obesity Link made between age and time of exposure to environmental factors. Reference to mutations and multifactorial nature of disease.

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Question 5 · A level Paper 2 · October 2020 · Q10(b)(iii) · 6 marks

Question Number	Indicative content
*** 10(c) (iii)**	Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant. Give examples of relevant biological knowledge and understanding: • mutation is a change in the { base sequence in DNA / gene } / different amino acid sequence / primary structure of the enzyme succinate dehydrogenase • succinate dehydrogenase { less / non- } functional • succinate therefore accumulates • accumulation of succinate inhibits TET • therefore methyl groups not removed / increased methylation of DNA • affects transcription of a gene / therefore alters amount of product formed • greater methylation is of DNA is associated with increased risk of cancer

			Additional Guidance
Level 0	Marks	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Only one point of basic information referred to: e.g. mutation results in more succinate, or high succinate and inhibition of TET, or less TET and more methylation of DNA
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Link between high levels of succinate and inhibition of TET
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Links made to include all of these points: mutation leads to higher levels of succinate, which inhibits TET, therefore increasing DNA methylation, which increases risk of cancer Logical explanation of the reasons why a mutation in the enzyme succinate dehydrogenase can increase risk of developing cancer

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Question 6 · A level Paper 3 · November 2021 · Q7 · 9 marks

Question Number	Indicative content
7	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Mitosis for growth and repair • (Zygote to fetus) proliferation and differentiation • Meiosis for genetic variation • Production of gametes • Inheritance of alleles predisposing to genetic disease / some cancer • Mutations result in loss of control of cell division in cancers • Clonal amplification in immune system • Binary fission of bacterial cells • Some antibiotics work by inhibiting bacterial cell division

Level	Mark	Descriptor	Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-3	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Use of factual information provided Give credit for use of different resources (bullet points, figure and table)
Level 2	4-6	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Linking / explaining information in terms of mitosis or meiosis Give credit for each clearly explained example
Level 3	7-9	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information.	Linking information provided to both meiosis and mitosis

		A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Give credit for each clearly explained example.

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Question 7 · AS Paper 2 · June 2016 · Q3(c) · 6 marks

Question Number	Indicative content
*3(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • use of similar, healthy plants grown in the same conditions up to the start of the experiment • control of the growing environment, e.g. light intensity, temperature • use of growth medium with an adequate concentration of all other necessary ions • measurement of an appropriate specified dependent variable, over the same growing period for all plants • data collection from at least five plants at each concentration of lead, used to calculate mean values • use of different concentrations of lead ions, and a control with no lead • lead concentrations to include 300, 999/1000 and 2000 ppm (boundary concentrations for tolerance categories) • description of how the results would be interpreted to determine the tolerance category

Level	Mark	Descriptor	Additional Guidance
0	0	No awardable content	
1	1-2	A description of the investigation may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The description will contain basic information with some attempt made to link knowledge and understanding to the given context.	Controlled variables / repeats. Use of tomato plants and lead ions.
2	3-4	A description of the investigation will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The description shows some linkages and lines of scientific reasoning with some structure.	Level 1 indicators plus one of the following: - use of correct core practical technique - a measurable dependent variable - range of lead concentrations spanning 300-2000
3	5-6	A description of the investigation is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The description shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.	All level 1 indicators, at least 2 indicators from level 2 plus either: - lead concentrations of 300, 999/1000 and 2000 - details of how the results can be used to determine the tolerance category

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Question 8 · AS Paper 2 · June 2017 · Q4(b)(iii) · 6 marks

Question Number	Answer		
*4(b)(iii)	Answers will be credited according to candidate's knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • sickle cell anaemia is more frequent in those areas where malaria is also found (as shown on the maps) • highest proportions of populations with allele for sickle cell anaemia are in areas where there is malaria • the Yoruba people live in an area where *P.falciparum* is found • malaria can be fatal and acts as a selection pressure • individuals heterozygous for sickle cell anaemia more likely to survive malaria • these individuals pass on alleles for sickle cell anaemia to their offspring • over time the number of individuals in the population with alleles for sickle cell anaemia has increased		
Level	**Marks**	**Descriptor**	**Additional guidance**
0		No awardable content	
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just **one** piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	eg. 9-12% Yoruba have sickle cell allele / Malaria and Sickle cell anaemia are found in the same place OR Heterozygotes resistant to malaria
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of **more than one** piece of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Two from level 1 Malaria is a selection pressure
3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of **all pieces** of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Individuals with sickle cell allele survive malaria and pass on allele to offspring. Over time frequency of sickle cell allele increases in Yoruba population

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Question 9 · AS Paper 2 · June 2024 · Q8(d)(ii) · 6 marks

Question Number	Indicative content
* 8(d)(ii)	Answers will be credited according to candidate's knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Basic information • Greater number of insect species of all groups with agroforestry • More farms with mammals with agroforestry • More plant species with agroforestry • Agroforestry has greater biodiversity / species richness Linkages • Reference to data in table of insects – more species for each type of insect and greater numbers of each, except the Diptera (flies) where there were more in monoculture • Reference to data on mammals –percentage of farms with each group of mammals higher for agroforestry • Reference to different number of plant species in agroforestry from box plots mean is 6.4 compared with 2.4, median 5 compared to 2 Sustained reasoning • Agroforestry provides more {habitats / niches} • Different types of plant – trees, shrubs and grasses provide more habitats • Monoculture with non-native plants not suitable habitat for native insect species • Greater range of plant species provides more food for animals • More smaller mammals allows more feeding opportunities for carnivores • Monoculture – non-native plants, not suitable for native insects 6 marks

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Basic observation on agroforestry: more insects / mammals / animals / plants Greater biodiversity / species richness with agroforestry
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of all pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Linkage to at least one source of data:– • Table of data on insects e.g. more species of all groups of insects • Mean number of species of plants higher with agroforestry • Greater percentage of farms with mammals More habitats / more niches / reference to feeding relationships
3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of all pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Analysis of all three sets of data on insects, mammals and plants. Link made between: species richness of plants with greater variety of habitats /niches leading to more insect species / greater percentage of farms with mammals.

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Question 10 · A level Paper 1 · June 2017 · Q10(b)(i) · 6 marks

Question Number	Answer
*10(b)(i)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • feeding behaviours • anatomy • genetic differences • no information on whether they can interbreed to produce fertile offspring • different locations do not indicate that they are different species • no information on number of elephants used for DNA analysis • GBA alleles K and L are exclusive to one type of elephant / genetic isolation

Level	Mark	Descriptor	
Level 0	Marks	No awardable content	
Level 1	1-2	An answer may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The answer will contain basic information with some attempt made to link knowledge and understanding to the given context.	Makes reference to one of behavioural, phenotypic, anatomical or genetic differences
Level 2	3-4	An answer will be given with occasional evidence of analysis, interpretation and/or evaluation of more than one pieces of scientific information. The answer shows some linkages and lines of scientific reasoning with some structure.	Makes reference to more than one of behavioural, phenotypic, anatomical or genetic differences Also includes an interpretation of allele data **or** considers reasons why may not be different species
Level 3	5-6	An answer is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of all pieces of scientific information. The answer shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Also includes an interpretation of allele data **and** considers reasons why may not be different species

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Question 11 · A level Paper 1 · October 2020 · Q8(b)(ii) · 6 marks

Question number	Answer	Mark
***8(b)(ii)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content Basic information • captive breeding will increase population size • deforestation is reducing the habitat • captive animals will be protected from hunters Evidence of linkages • orangutan numbers are declining and captive breeding will increase population size • as loss of habitat is a major reason for the decline, animals should be released into areas of forest in protected areas • more of the forest needs to be protected to reduce the rate at which habitat is being lost • captive bred animals show behaviour that may make them unable to compete in the wild • loss of habitat would lead to increased competition due to reduced food availability Evidence of sustained scientific reasoning • it is important to restrict passage of disease from humans to the wild population by minimising contact and releasing animals away from wild populations • if deforestation is not reduced – or protected areas increased – there will not be enough habitat left in which to release captive-bred orangutans • judgement on relative importance of captive breeding and habitat protection taking into account rate of deforestation and loss of suitable habitat • releasing animals if there is insufficient habitat could lead to an increased vulnerability to predation and poaching	**(6)**

Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Captive breeding will increase numbers of orangutar Habitat loss is increasing
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Discussion of benefits of both captive breeding and habitat protection. Separate discussions of habitat loss and captive bree Linkages made for each aspect but not compared.
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Conclusion that without habitat protection, captive breeding is limited as there is less suitable habitat in which to release the animals Comparative evaluation of the benefits of habitat protection and captive breeding. Reference made to the data.

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Question 12 · A level Paper 2 · June 2022 · Q10(b)(ii) · 6 marks

Question Number	Answer	Mark
*10(b)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.	(6)

	The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content ***Relating to the data*** • Data compared in humans and one plant species • Idea that concentration is not same as importance • No evidence that more than one plant used ***Roles of calcium ions in plants and animals*** • Used for plant cell walls • Detail of how used in plant cell walls: calcium pectate • In humans used at synapse, muscle contraction, blood clotting, bone tissue • Details of how used in synapse, muscle contraction, blood clotting ***Comments on study*** • Only one plant species used / this plant species may not be representative of all plant species • Humans not necessarily representative of all animals	

Level 0	Marks	No awardable content	Additional Guidance
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths / weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Basic description of role of calcium ions in plants and in animals. OR Basic conclusion or a comment on the data.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Details provided for roles of calcium ions in both animals and plants Comparison of data e.g. more calcium ions in plant tissue than human tissue. Only one species of plant considered
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Details of roles of calcium ions in animals and plants. Data compared. Higher concentration – but calculated value for humans was for soft tissue and not bones. Evaluation of data provided – only from humans, not all animals. Data compared. Higher concentration – but calculated value for humans was for soft tissue and did not include bones. Idea that concentration is not the same as importance.

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