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Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/02 Summer 2024 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

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Paper 2 series overview

The Biological Diversity paper assesses Modules 1, 2, 4 and 6.

Although there were some challenging questions, most candidates coped well with the topics and skills being assessed although there were some gaps in their knowledge of some learning outcomes from Modules 4 and 6. There were some candidates who scored highly across the paper but did not gain many marks on either Questions 18 (b) (i) (synthetic biology), 19 (a) (ii) (T-lymphocytes) or the whole of Question 20 (ecosystems).

Candidates who took note of the command words were more likely to gain marks on Question 18 (c) and waste less time on Question 20 (b) (i). Candidates who carefully read the stem of the question, provided better answers to Questions 17 (a) (i), 19 (b) (iv), 20 (b) (ii) and 21 (a) (ii).

The proportion of questions requiring mathematical skills remained at around 10%, as in all A Level Biology papers. Most candidates coped well with most of the questions in which a calculation was required, although some did not know how to use a graticule.

The first Level of Response (LoR) question, 18 (b) (i), was well done by some but revealed a gap in understanding from many candidates. The second LoR, Question 20 (b) (i), was more accessible however, strong candidates who had done well on other sections of the paper often produced a less high-quality answer here. Candidates' answers to LoR questions tended to me more concise than in previous sessions, but centres are reminded that an answer to a question worth 6 marks is expected only to be only twice as long as an answer to a question worth 3 marks. Responses that continue at length often struggle to retain enough coherence or relevance to achieve the upper mark within a given level. Although the answer spaces provided on the paper are meant to suggest an appropriate length of answer, many candidates find it necessary to continue their answer beyond the space provided. Examiners are pleased that candidates continue to indicate when an answer extends onto the additional answer space. It was pleasing to see fewer candidates being unnecessarily supplied with additional sheets or answer booklets before they had used the additional space at the back of the question paper. When candidates' answers need to overrun the provided answer space it is strongly recommended that they use the additional pages at the back where their answer will definitely be seen by examiners.

As usual there was some confusion about the meaning of key terms, particularly in genetics questions – genes, alleles, bases, nucleotides, etc. Many candidates would have scored more highly on Question 19 (a) (ii) had they used 'activate' and 'differentiate' rather than 'stimulate' and 'become'. Candidates are not expected to know particular examples of plants and animals that might be present in an ecosystem, but they are expected to know that fungi (and algae) are not plants and that bacteria are not animals.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read the questions carefully before beginning their answer • paid attention to command words • used any extra information given when constructing their answer • recalled and used precise key terms correctly.	• based their answer on the general idea of the question • did not pay attention to command words • used general rather than precise terms • confused precise terms that have a different meaning.

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Section A overview

Most candidates achieved 8 or 9 marks and there was some correlation between achievement in Section A and that in the paper as a whole.

Examiners noticed many examples of candidates' thought processes on the paper. Although not essential, annotations can help a candidate find their way to a correct answer. Many candidates are crossing out answers when they change their mind and writing their preferred answer next to the box. This is perfectly acceptable, and better than writing it on the additional pages, as long as the desired answer is unambiguous. A few candidates were overwriting previous letters and occasionally the resulting letter was open to interpretation. Such ambiguous responses were not given.

Question 1

1 Biomass is transferred through ecosystems.

What process makes biomass available for transfer to the next trophic level in the food chain?

A Excretion

B Growth

C Removal of undigested food

D Respiration

Your answer ☐ **[1]**

Fewer than half of candidates appeared to know that growth contributed to biomass.

Question 2

2 What explains why food chains rarely have more than five trophic levels?

A Parts of the food organism are not eaten by organisms higher in the food chain.

B Plants absorb only a small proportion of the Sun's energy.

C There is a limit to the size to which a predator can grow.

D Transfer of biomass between trophic levels is inefficient.

Your answer ☐ **[1]**

The vast majority of candidates achieved this mark.

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Question 3

3 The rate at which plants produce biomass is known as productivity.

What is a suitable unit with which to measure productivity at different depths in the ocean?

A kg day^{-1} m^{-2}

B kg day^{-1} m^{-3}

C kg $year^{-1}$ m^{2}

D m kg^{-1} $year^{-1}$

Your answer ☐ **[1]**

Only around a quarter of responses achieved this mark. The most common incorrect response was A, but it would not be appropriate to compare different depths by measuring area.

Question 4

4 Microscopes vary in terms of magnification and resolution.

Which option describes the terms magnification and resolution?

A Magnification is the size of an image under a microscope and resolution is the sharpness of that image.

B Magnification is the size of the image compared to the actual size and resolution is the ability to distinguish two objects from one another.

C Resolution is the ability to make small objects appear larger and magnification is the ability to distinguish two objects from one another.

D Resolution is the size of an image under a microscope and magnification is the sharpness of that image.

Your answer ☐ **[1]**

The vast majority of responses were correct.

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Question 5

5 Variation can be under genetic control.

Which statement about the genetic control of variation **cannot** be true for discontinuous variation?

A Variation is controlled by a single gene with multiple alleles.

B Variation is controlled by an epistatic interaction between two genes with multiple alleles.

C Variation is controlled by many genes on different chromosomes.

D Variation is controlled by two genes on the same chromosome.

Your answer ☐ **[1]**

Around half of candidates knew that discontinuous variation could not be under the control of many genes on different chromosomes.

Question 6

6 What is a direct consequence of the genetic code being degenerate?

A It is possible that a mutation could change the sequence of amino acids but leave the function of the protein unchanged.

B It is possible that a mutation could leave the primary structure of the protein unchanged.

C It is possible that a mutation could leave the sequence of bases unchanged.

D It is possible that a mutation could substitute one amino acid for another with similar properties.

Your answer ☐ **[1]**

Around 50% of candidates were able to apply the idea of a degenerate genetic code to the idea that a mutation could leave the primary protein structure unchanged.

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Question 7

7 Which of the statements describe(s) control of gene expression at the post-transcriptional level?

1 binding of a repressor protein to an operator sequence
2 the removal of introns to form mature RNA
3 editing of primary RNA

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

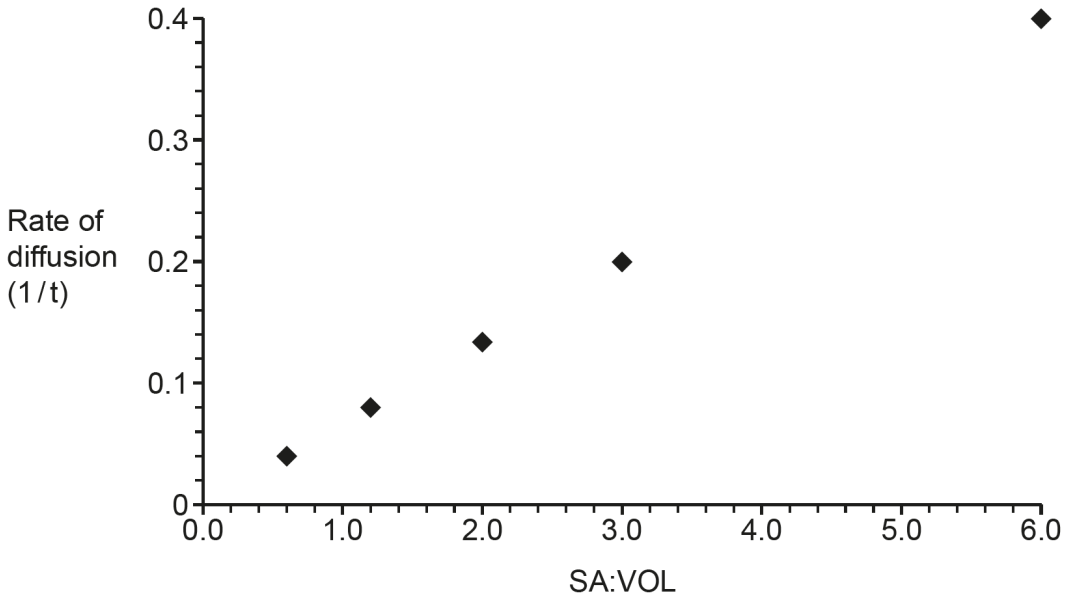
Your answer ☐ **[1]**

Around half of candidates got this right.

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Question 8

8 The graph shows the results of an investigation into diffusion rates in cubes of agar jelly with different surface area to volume ratios (SA:VOL).



Which option best describes the results of the investigation?

A SA:VOL is directly proportional to rate of diffusion.

B SA:VOL is inversely proportional to rate of diffusion.

C There is a negative correlation between SA:VOL and rate of diffusion.

D There is an inverse correlation between SA:VOL and rate of diffusion.

Your answer ☐ **[1]**

The vast majority got this correct.

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Question 9

9 Calculate the SA:VOL of a cube with edges 4 cm long.

A 0.25

B 0.67

C 0.96

D 1.5

Your answer [ ] **[1]**

Most candidates were able to perform this calculation correctly.

Question 10

10 Plants can be cloned artificially by taking cuttings.

Which of the following are important steps when cloning a plant by taking a cutting?

1 Keep it regularly watered.
2 Add rooting hormones to agar jelly.
3 Sterilise a small sample of plant material.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer [ ] **[1]**

Many candidates appeared to confuse taking a cutting with micropropagation by tissue culture and hence less than a quarter scored a mark here.

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Question 11

11 Microorganisms can be used to produce food.

Which option is **not** seen as an advantage of using microorganisms to produce food compared to traditional food production methods?

A Microorganisms grow more rapidly than plants or animals.

B Production can be easily varied to meet demand.

C Production can occur at low temperatures and pressures.

D There are no animal welfare issues.

Your answer ☐ **[1]**

Around half of responses were correct. Many candidates appeared to be conflating the use of microorganisms in food production with the use of microorganisms in biotechnology in general.

Question 12

12 Aseptic conditions are important when culturing microorganisms.

Which option is **not** a correct part of the procedure for spreading bacteria on an agar-filled Petri dish?

A Remove the lid of the Petri dish and rest it upside-down on the work surface.

B Replace the lid of the Petri dish and secure it with tape.

C Sterilise the area surrounding the experiment with disinfectant.

D Work near a Bunsen flame to create an upward draft of air.

Your answer ☐ **[1]**

Most candidates got this right.

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Question 13

13 A standard growth curve for a population of bacteria of the same species in a closed system involves a death phase.

Which option explains the death phase?

A Interspecific competition for nutrients, such as glucose, is high.

B Intraspecific competition for resources, such as oxygen, begins.

C Production of toxic waste products is at its highest level.

D Reproduction stops due to exhaustion of resources.

Your answer ☐ **[1]**

Fewer than half of candidates were able to correctly answer this question that tested detailed understanding of bacterial growth in a closed system.

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Question 14

This is an electron micrograph of an intestine cell.



Use the image to answer questions **14** and **15**.

14 Identify the structure labelled **X**.

A Centriole

B Lysosome

C Mitochondrion

D Nucleolus

Your answer ☐ **[1]**

Around a quarter of responses were correct. A large number of candidates identified the labelled structure in the micrograph as a lysosome. The presence of many lines within structure X are indicative of a mitochondrion.

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Question 15

15 Identify the structure labelled **Y**.

A Cell wall

B Cilium

C Plasma membrane

D Smooth ER

Your answer [ ] **[1]**

A small majority achieved this mark with all other distractors being seen.

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Section B overview

Most candidates were able to display a good understanding of PCR, phylogeny, statistical analysis, succession and the cell cycle. There were some clear gaps in knowledge and understanding relating to synthetic biology, T-lymphocytes and the variables than can practically be controlled in an ecological field investigation.

Question 16 (a)

16 DNA profiling is an important technique with many uses.

The steps involved in creating a DNA profile can be outlined as follows:

1. DNA extraction
2. Digestion
3. Separation
4. Analysis

(a) DNA profiling is used in the investigation of crime and in paternity cases.

State **one** other use of DNA profiling.

.....

..... **[1]**

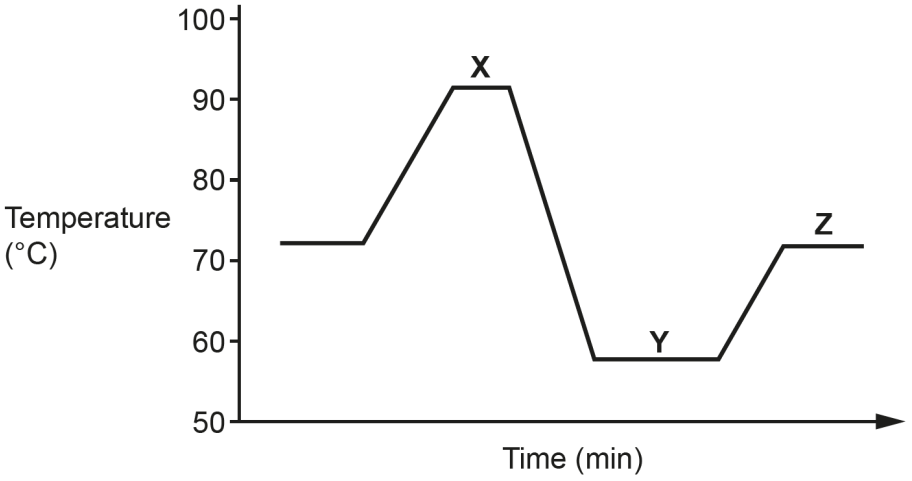
There were a range of acceptable answers to this question and most candidates gained this mark.

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Question 16 (b) (i)

(b) When creating a DNA profile from a crime scene, an intermediate step between DNA extraction and digestion, known as PCR, is usually carried out.

The technique of PCR involves a cycle of changes in temperature, shown in the graph.



(i) Name the technique known as PCR.

..... **[1]**

Over half of candidate know what PCR stood for. Some attempted to construct something plausible from the letters and others offered a range of incorrect suggestions, including 'DNA profiling'. Some candidates left the space blank.

Question 16 (b) (ii)

(ii) Outline the process of PCR, with reference to steps **X**, **Y** and **Z**.

X .....

.....

Y .....

.....

Z .....

.....

[3]

This question differentiated well between candidates of differing abilities. Most candidates achieved 2 marks, usually for X and Y. Many candidates stated that Z was the optimum temperature for DNA polymerase without a sufficient description of what stage Z is trying to achieve, i.e., synthesis of a new strand of DNA.

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Question 16 (b) (iii)

(iii) Explain why a temperature of 72–75 °C is used for step **Z**.

.....

.....

.....

.....

.....

..... **[3]**

This also differentiated well. Not very successful answers often achieved the optimum temperature mark and followed this with general discussions of enzyme action. Stronger responses knew that the enzyme used was Taq polymerase and explained why 72–75°C is an appropriate temperature range for that enzyme.

Question 16 (b) (iv)

(iv) Suggest why a PCR step is usually necessary when creating a DNA profile from a crime scene sample in particular.

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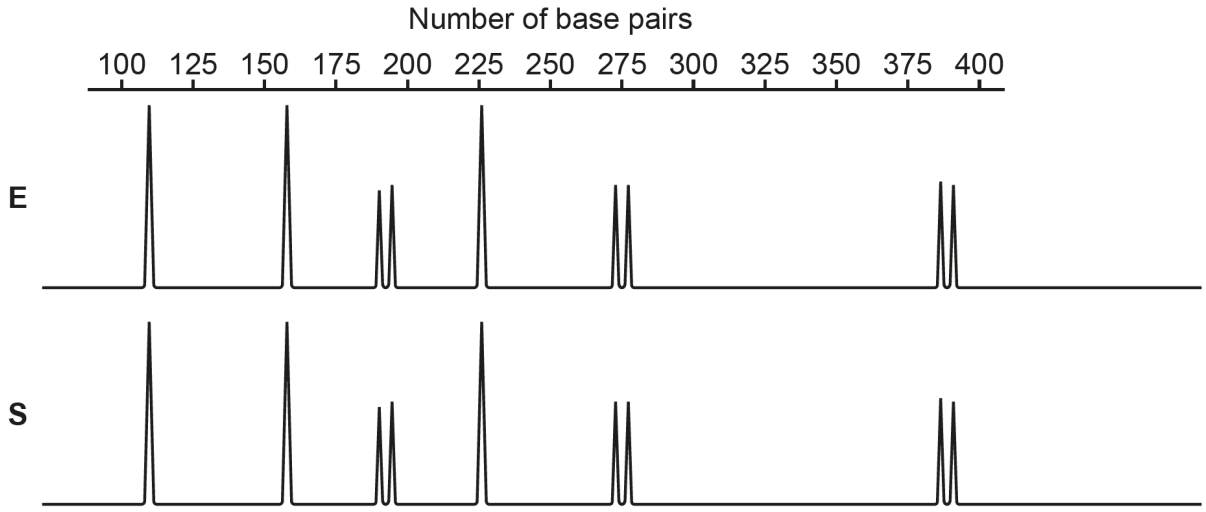
..... **[1]**

Around half of responses got this mark.

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Question 16 (c) (i)

(c) This is part of a DNA profile for six loci from a sample of DNA found at a crime scene (**E**), and DNA from a potential suspect (**S**).



(i) Suggest why some loci have two peaks but some have only one.

.....

.....

.....

..... **[2]**

This was a challenging question in which only around 1 in 10 responses scored any marks. Candidates were required to understand the context provided and use key terms correctly to express their ideas. Some responses had the right idea, but they confused key terms such as gene with allele, homologous with homozygous (and their hetero- equivalents), and polygenic with polymorphic. Autosomal linkage was often seen as an incorrect answer.

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Question 16 (c) (ii)

(ii) Using the evidence in the DNA profile it was claimed that suspect **S** had been at the crime scene.

Explain how strongly the evidence supports this claim.

.....

.....

.....

.....

.....

..... **[3]**

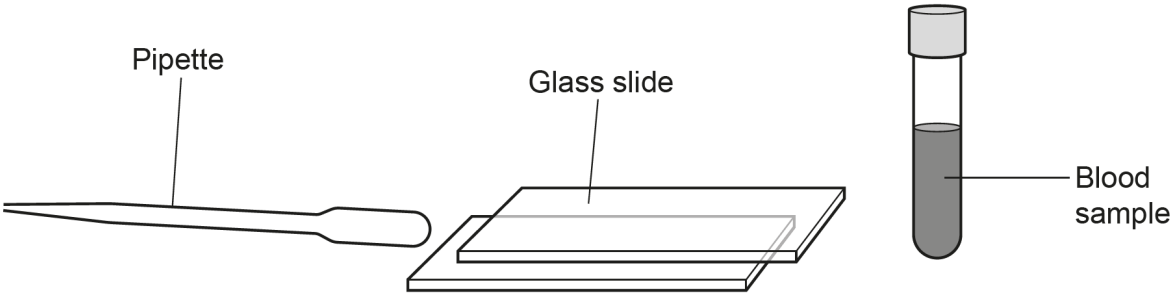
Most candidates gained the first marking point but then filled the rest of their answer space with examples to illustrate this point. An explanation of *how strong* support is requires some consideration of what might make the support weak, and few responses attempted to do this. A minority of candidates suggested that S might have belonged to the suspects twin, but many omitted the important detail about twin being identical (or monozygotic). Other marking points were seen, but rarely. Some answers went beyond the claim in the question and discussed whether the suspect was guilty.

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Question 17 (a)

17 Blood cells can be examined using microscopy.

(a) This is some equipment that could be used when preparing a blood smear.



Describe how to use the equipment to prepare a blood smear that could then be stained and viewed under a microscope.

.....

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.....

.....

.....

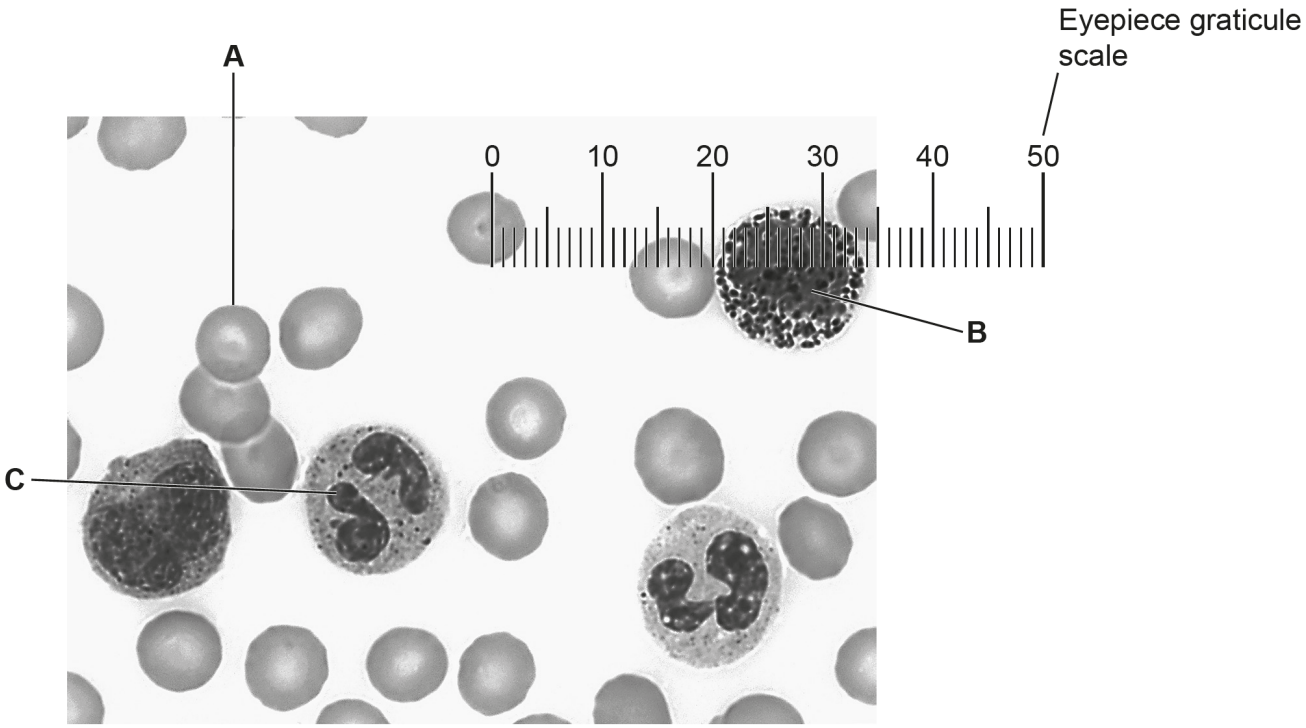
..... **[3]**

Most candidates scored at least one mark on this question, usually marking point 1, and many achieved all 3. Marking points 3 and 4 were also frequently given. No credit was given for describing staining or focussing as these were outside the scope of the question.

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Question 17 (b) (i)

(b) This is a light micrograph of a human blood smear.



(i) The cell labelled **A** is sometimes known as a red blood cell.

Name cell **A**.

..... **[1]**

Most candidates got this correct and examiners were tolerant of a range of phonetically similar spellings. Some candidates wrote 'red blood cell', despite the question ruling this out as an answer.

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Question 17 (b) (ii)

(ii) In the space below, draw a labelled diagram of cell **C**.

[4]

This question differentiated well. Almost all candidates drew one cell that was roughly circular. A small number of candidates included only one of the two visible parts of the lobed nucleus. The cell drawings were, by and large, a reasonable size, and most candidates attempted to use continuous, single lines without any shading or hatching. Most label lines were ruled. Some candidates labelled the two parts of the lobed nucleus as 'nuclei' or 'phagosome'. A number of candidates also attempted to draw and label structures that are not visible in the image, such as mitochondria, ribosomes and ER.

OCR support

Guidance on biological drawings is available in the drawing skills handbook at:

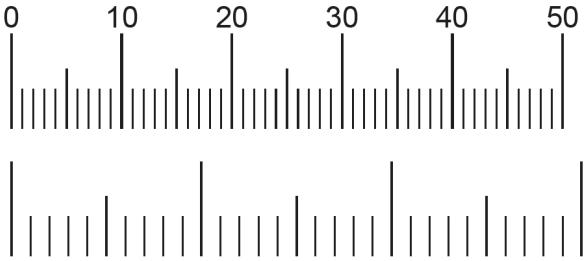
Drawing skills handbook

Biology Learner checklist: Graphs, Tables and drawings

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Question 17 (b) (iii)

(iii) The image was taken using a ×40 objective lens. The eyepiece graticule scale for the ×40 objective lens was calibrated using the stage micrometer shown below.



Eyepiece graticule scale

Stage micrometer scale

Each of the three large divisions on the stage micrometer scale measured exactly 0.01 mm.

Calculate the diameter of cell **B**.

Give your answer in μm to **2** significant figures.

Diameter = ... μm **[3]**

Only around half of candidates were able to use the scales to correctly measure the image and, of those, a small majority could successfully manipulate the units to micrometres. Having got that far, a minority of candidates then unnecessarily divided a perfectly serviceable answer by the objective lens magnification. Around 1 in 10 candidates achieved all 3 marks but the vast majority scored at least 1, usually for presenting an incorrect final answer to the correct number of significant figures.

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Question 18 (a) (i)

18 Bioinformatics, computational biology and synthetic biology are relatively new techniques in biology that have a variety of uses.

This is a preserved thylacine, *Thylacinus cynocephalus*, a large Australian carnivore that became extinct in 1936.



Many preserved thylacine specimens in museums contain DNA. Scientists have used DNA sequencing, bioinformatics and computational biology to reconstruct the genome of the thylacine. Some scientists hope to be able to use bioinformatics and synthetic biology to produce a living thylacine in the future.

(a) Much of the thylacine DNA present in the museum specimens has broken down. In order to assemble an entire thylacine genome, it is necessary to supplement the thylacine DNA with DNA from a living close relative of the thylacine.

The thylacine belonged to the order Dasyuromorphia. The table shows the classification of the thylacine and some living species of the order Dasyuromorphia.

Common name	**A**	**Genus**	**Species**
Thylacine	Thylacinidae	*Thylacinus*	*T. cynocephalus*
Tasmanian devil	Dasyuridae	*Sarcophilus*	*S. harrisii*
Quoll	Dasyuridae	*Dasyurus*	*D. maculatus*
Fat-tailed dunnart	Dasyuridae	*Sminthopsis*	*S. crassicaudata*
Numbat	Myrmecobiidae	*Myrmecobius*	*M. fasciatus*

(i) Name the classification taxon represented by the column headed **A**.

..... **[1]**

The vast majority of candidates achieved this mark. The most frequent incorrect answers were 'class' or 'phylum'. There was evidence of many candidates having written out mnemonic letters.

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Question 18 (a) (ii)

(ii) Using the information in the table, describe the evolutionary and genetic relationships between the species that are listed.

.....

.....

.....

.....

.....

..... **[3]**

This question was well answered, with most responses gaining 2 or more marks – usually for noticing that the three Dasyuridae belonged to the same family. This meant that their evolutionary relationship would be closer than that with the other species in the table. Lower-scoring responses tended to discuss the process of speciation.

Question 18 (a) (iii)

(iii) Explain why it is difficult to decide which of the other species would be the most appropriate to use as a source of DNA for constructing a thylacine genome.

.....

.....

.....

.....

..... **[2]**

Most candidates gained the first marking point, but few achieved the second. Those that did get full marks discussed the absence of further evolutionary information, such as a phylogenetic tree or the fact that the classification information they had been given may have been based on observable features rather than molecular biology.

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Question 18 (a) (iv)

(iv) All the species in the table belong to the animal kingdom.

Other than the presence or absence of vacuoles, state **two** features of the cells of these multicellular organisms that would mean they could be classified only in the animal kingdom.

1 .....

2 .....

[1]

Fewer than 1 in 5 answers scored the mark here. Common incorrect responses suggested the presence of a nucleus, membrane-bound organelles (notably mitochondria) or 80s ribosomes, all of which are present in plant cells. A few candidates suggested a lack of chlorophyll (as opposed to chloroplasts), but chlorophyll is not really a feature of a cell.

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Question 18 (b) (i)*

(b) Synthetic biology involves re-designing organisms for useful purposes. One such purpose could be the production of useful proteins.

Proteins can be produced by traditional genetic engineering but the range of proteins available is limited to those that are already produced by a living organism.

Bioinformatics and computational biology can be used in the production of new proteins that are not found anywhere in nature.

(i)* Explain how gene sequencing, bioinformatics and computational biology are used in the production of useful proteins in synthetic biology.

.....

.....

.....

.....

.....

..... **[6]**

Candidates who understood the basic idea of the three processes and who could discuss a DNA/protein topic without mixing up bases and amino acids were able to achieve Level 3 fairly easily. However, this question exposed an area that appears to have been poorly addressed in some centres. Many answers discussed genetic modification, electrophoresis and PCR at length to no credit and often at the expense of a quality of written communication mark. Some responses merely paraphrased the information given in the question. Although lengthy discussions of the mechanism of gene sequencing did not gain much credit, they were at least relevant, and did not affect the quality of written communication.

For a question such as this one, with three distinct parts, it is very helpful to candidates if they arrange their answer into three sections with a general introduction.

Assessment for learning

In Level of Response questions that cover two or more areas, such as gene sequencing, bioinformatics and computational biology, each of the sections needs to be addressed in order to achieve full marks. Subheadings are a very useful approach to organising answers and can often help with the quality of written communication.

OCR support

The Guide to Level of Response (LoR) questions supports students by providing guidance on how to answer the LoR questions with confidence.

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Exemplar 1

Gene sequencing involves determining the DNA sequence of an organism. This could be used to identify the DNA sequence coding for a particular protein in a plant, microorganism or animal, which may protect them against a specific pathogen. For example, ~~A penicillin is produced by~~ the base sequence coding for antibiotics in ~~fungi could~~ microorganisms could be determined. Bioinformatics facilitates the storage, organisation and analysis of large sets of biological data. Once the genome of an organism has been sequenced, it could be stored using bioinformatics. Moreover, it could be compared to ~~a~~ different genomes, to identify potentially useful regions of DNA, genes or alleles, ~~that exist in~~ *. Computational biology enables proteins to be modelled on a computer. ~~The shape of proteins~~ [6]

Extra answer space if required.

~~can be predicted based off their primary structure.~~ Computational biology may be particularly useful when producing new proteins not found in nature, as it would enable scientists to predict its 3° structure based off its amino acid sequence, 1° structure, and hence estimate whether it will

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18bi) ~~for~~ function for the desired purpose. This new protein could then by produced by synthetic biology.
* then used in synthetic biology to produce a protein.

This answer easily achieves L3 and there are no issues that detract from the communication. There are valid points about gene sequencing, computational biology and bioinformatics and the last two lines show that the candidate understands the principle involved.

Question 18 (b) (ii)

(ii) Suggest why some people might be concerned about the increase of synthetic biology.

.....

..... **[1]**

A small majority of candidates achieved this mark, usually for citing ethical issues. Fewer suggested that the novelty of these proteins might be associated with unknown consequences, which is a much more scientific answer. It is worth noting that tabloid-headline answers like, 'playing God', or 'designer babies', rarely get much credit in A Level Biology.

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Question 18 (c) (i)

(c) The thylacine finally became extinct in 1936 as a result of hunting by humans. However, its population had been in decline for many years before.

Some scientists have concluded that the thylacine was particularly vulnerable to extinction because of low genetic diversity within the species.

The table shows the proportion of heterozygous loci in a range of Australian mammal species together with information about how endangered they are.

Species	Genetic diversity (proportion of heterozygous loci)	Conservation status
Brown antechinus	0.0040	least concern
Fat-tailed dunnart	0.0037	least concern
Common wombat	0.0017	least concern
Koala	0.0013	vulnerable
Tammar wallaby	0.0007	least concern
Tasmanian devil	0.0003	endangered
Thylacine	0.0001	extinct

(i) Describe the evidence in the table that supports the conclusion that low genetic diversity contributed to the extinction of the thylacine.

.....

.....

.....

.....

..... **[2]**

Most responses scored here, and all marking points were regularly seen. Merely citing a single supporting example (other than the Thylacine itself) did not gain any credit as there were much more convincing pieces of evidence, such as those described in the 2nd and 3rd marking points, which could be offered. Answers that did not score tended to explain why low genetic diversity might lead to extinction rather than to offer evidence in support of a conclusion.

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Question 18 (c) (ii)

(ii) Identify **one** piece of evidence that does **not** support the conclusion that low genetic diversity contributed to the extinction of the thylacine.

.....

..... **[1]**

Most answers achieved this mark. Those that did not, often attempted to discuss the effects of hunting.

Question 19 (a) (i)

19 Vaccination can protect an individual from infectious disease.

Polio is a viral disease that usually affects children and can have lifelong effects.

(a) A vaccine against polio was introduced in 1956.

(i) Suggest the contents of the original anti-polio vaccine.

.....

.....

..... **[1]**

Most candidates were aware that the vaccine would contain a dead or weakened version of the polio pathogen but only those that responded to the contextual information in the question by stating that the polio pathogen was a virus were given a mark. Suggestions relating to DNA or RNA were not given because they were not consistent with the context of 1956.

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Question 19 (a) (ii)

(ii) B-lymphocytes and T-lymphocytes are involved in the immune response.

Describe the role of T-lymphocytes in the development of immunity to a virus such as polio.

.....

.....

.....

.....

.....

..... **[4]**

This question differentiated very well between candidates of differing abilities. Many candidates were aware that T-cells are involved in clonal selection and that they interact with APCs. However, many did not gain the 2nd marking point because they did not refer to receptors on the T-cells. It was relatively common to award marks for the release of interleukins and the stimulation of clonal expansion, or some detail thereof. It was also common for answers to discuss the role of T-memory cells in the secondary response, but use of the key term 'differentiate' was less frequent. Reference to stimulation of phagocytosis was seen less often and, although there were many attempts to describe the role of T-killer cells, most of these were not given because they suggested a direct action on the pathogen rather than via infected host cells.

Those responses that did not score well tended to be unclear about the distinction between T and B-lymphocytes.

Misconception

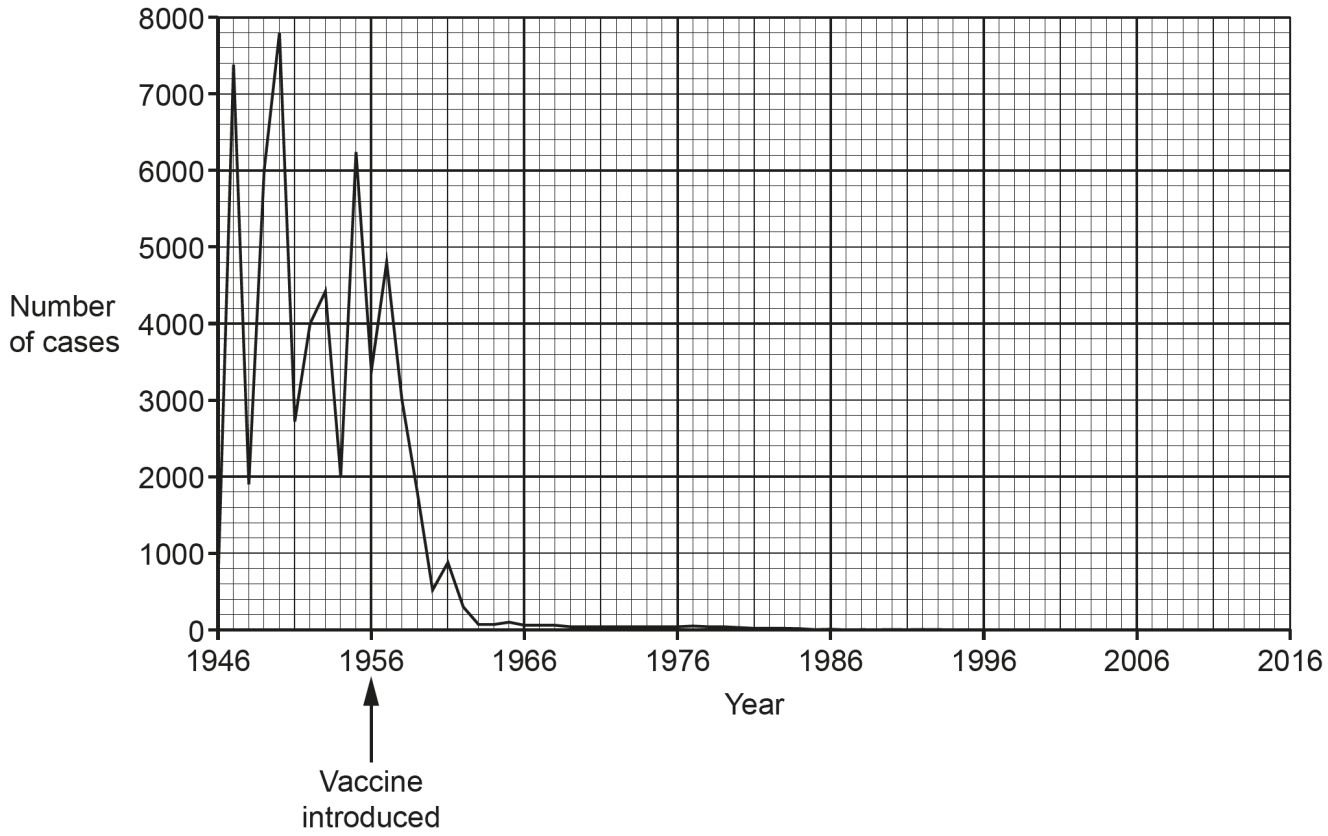


In the context of the humoral immune response, 'activate' and 'differentiate' are important key terms that candidates ought to be able to use correctly in their answers.

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Question 19 (b) (i)

(b) The graph shows the number of cases of polio in England and Wales between 1946 and 2016.



(i) Calculate the percentage decrease in cases between 1956 and 1960.

% decrease = ... **[2]**

Most candidates were able to correctly read the graph and calculate a percentage decrease. Answers given to more than 3 significant figures were given only one mark because that level of accuracy is not plausible given the graph they had been presented with. Candidates must understand that the lowest level of accuracy in the inputs of a calculation will determine the level of accuracy in the answer (M1.1).

Calculation:

Percentage change = ((no. of cases in 1960 – no. of cases in 1956) / no. of cases in 1956) x 100

Percentage change = ((3380 – 520) / 3380) x 100

Percentage change = 84.6% or 85%

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OCR support

The maths skills handbook offers further support on how to calculate percentage change and on the correct number of significant figures.

Additional support on all the maths skills can be found on 'Maths for Biology' resources on 'Teach Cambridge'.

Question 19 (b) (ii)

(ii) A student wants to use the calculation in part **(b)(i)** to support a conclusion about the effectiveness of the polio vaccination. Another student argues that it would be better to have used 1957 as a starting year for the calculation.

Suggest **two** reasons why 1957 might have been a better starting year for the calculation.

1 .....

.....

2 .....

.....

[2]

Perhaps helped by recent lived covid experience, many candidates were able to correctly suggest that more children would have been given the polio vaccine by 1957. However, answers that suggested that this would allow time for the vaccine to have an effect were not given. Fewer candidates suggested that the vaccine may not have been introduced until part-way through 1956. Many answers responded to the shape of the graph and suggested that starting in 1957 would allow a bigger change to be seen. Such responses are contrary to a key scientific principle and were not given.

Question 19 (b) (iii)

(iii) There were cases of polio in England and Wales in the 1980s.

The scale used on the graph is not sensitive enough to show changes in the number of cases during the 1980s.

Suggest **one** way in which the *y*-axis scale could be changed in order that changes in the 1950s and 1980s were both visible.

.....

..... **[1]**

Fewer than one in four candidates recognised the need for a logarithmic scale.

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Question 19 (b) (iv)

(iv) Between 90% and 95% of UK children are currently fully vaccinated against polio.

In 2022 some particles of polio virus were detected in sewage in London. As a result, an extra dose of the polio vaccine was offered to children in London. The vaccine was not offered to children across the whole country.

Suggest why the extra vaccine was offered to children in London only.

.....

.....

.....

.....

..... **[2]**

The best responses stated that vaccinating children outside London would be a waste of money as their risk of infection was low. However, only around 10% of responses achieved both marks. Many answers focused on ring vaccination preventing spread beyond London or stated that spread within London would be rapid because of a high population density, ignoring the important rationale of protecting those most at risk. Only a few candidates noted the high vaccination rates (of over 90%) in the UK, indicating that children outside of London were unlikely to need a further vaccination against polio.

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Question 20 (a) (i)

20 On a biology field trip, some students are studying an area of mixed woodland.

(a) Three tree species dominate the woodland: oak, ash and sycamore.

There are many small herbaceous plants in the woodland, but the students choose to collect data on only one: wood sorrel.

The students choose an oak tree, an ash tree and a sycamore tree and count every individual wood sorrel plant within a 3 m radius of each tree.

The results are shown in the table.

Species	**Wood sorrel population (total within 3 m radius)**					
Ash	44					
Oak	56					
Sycamore	20					

The null hypothesis of the students' investigation is that the species of tree would not affect the number of wood sorrel growing near it.

The students conclude that the conditions under oak trees are the most favourable of the three trees studied and that conditions under sycamore trees are the least favourable.

(i) Calculate the χ^2 value for the students' data.

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

You may use the empty columns in the table to help with your calculation.

χ^2 = ... **[3]**

Around half of candidates scored all 3 marks and many of those that didn't gain some credit for summing $(O\text{-}E)^2/E$, calculating the expected values, or both. Miscalculation of the expected values was the most common repeated error.

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OCR support

The maths skills handbook and the guidance on statistics for biologists offer further support on the use of statistical tests.

Additional support on all the maths skills can be found on 'Maths for Biology' resources on 'Teach Cambridge'.

Question 20 (a) (ii)

(ii) The critical value for χ^2 in this investigation at p = 0.05 is 5.991.

Discuss what can be concluded from the χ^2 calculation in part **(a)(i)**.

.....

.....

.....

.....

.....

..... **[3]**

This question differentiated well, and all marking points were regularly seen. Candidates seemed better at discussing statistical significance correctly than in previous years. There were, for example, fewer responses that ascribed significance to 'results' or 'data', rather than to a 'difference'. Candidates who had miscalculated the chi-squared value in part (i) were able to access all of the available marks.

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Question 20 (a) (iii)

(iii) The teacher suggested that, in order to have confidence in their results, the students should include data from more than one tree for each species.

The students collect all their results on the same day.

Identify **two** other variables the students should attempt to control when carrying out an investigation such as this.

1 .....

.....

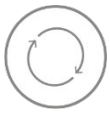
2 .....

.....

[2]

Unusually for a 'identify some control variables' question, the usual answers common to a range of laboratory-based investigations did not apply to this environmental context. Hence only a minority of candidates scored at all, and it was very rare to award both marks. Most commonly candidates gained a mark for suggesting that size (age, height or girth) of trees should be controlled as far as possible. References to density of surrounding trees and slope were seen but much less frequently. Although ensuring that the mineral or water content of the soil were controlled might well have been beneficial, such levels of control in a field study context are impractical. Time of day was a regular incorrect response but taking readings at different times of day would not realistically affect the number of small herbaceous plants growing under a tree.

Assessment for learning



Although time and resource constraints can make field trips difficult, experience of conducting a study such as this one in a site larger than school grounds is a useful way to learn about the issues involved in carrying out a scientific investigation in an environmental context.

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Question 20 (b) (i)*

(b) The teacher described the mixed woodland as a climax community that had resulted from succession.

Succession involves a series of changes in community over time, known as seres.

(i)* The first sere is the pioneer community. The final sere is the climax community.

The species that make up the pioneer and climax communities are different.

Compare the plant **and** animal species that make up the climax and the pioneer communities.

.....

.....

.....

.....

.....

..... **[6]**

The question asked candidates to compare plants and animals living in two communities. Lower-level answers tended to focus on very general statements about biodiversity and the size of individual organisms. High-scoring answers made direct comparisons along the lines of those suggested in the indicative points in the mark scheme – for example, "In a pioneer community, plants are able to withstand extreme environments, having, for example, xerophytic adaptations, whereas, in a climax community, plants lack such adaptations and require access to an ample supply of water." – and were able to keep their answers concise and within the writing space provided. Reference to all of the indicative points on the mark scheme were seen, along with other creditworthy ideas. Many answers focused entirely on the relative size of the organisms and the species richness of the two communities and so did not achieve higher than Level 2.

Many answers, appropriately, offered examples of pioneer and climax species. On this occasion candidates were not penalised for thinking that lichens (or indeed, algae) are plants, but not fungi and suggesting that bacteria were animals.

Answers that ignored the command word 'compare' and described the process of succession without making direct comparisons between pioneer and climax communities often wasted a lot of space and time discussing intermediate series and could not be given the upper 'communication' mark within a level.

OCR support

The Guide to Level of Response (LoR) questions supports students by providing guidance on how to answer the LoR questions with confidence.

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Exemplar 2

- Pioneer communities - little to no animal life due to harsh abiotic conditions. lichens and algae can survive initially. After lichens die and decompose to form a thin humus, smaller grasses and ferns can begin to grow. No trees. Little animal life, mostly decomposers. or large plants

- Climax communities - Thicker, nutrient rich soil means tall trees dominate by outcompeting for resources the plant life, with larger ferns and grasses also survive due to the less harsh abiotic conditions. Larger Variety of animal life can survive, from primary consumers such as deer or rabbits to secondary and tertiary consumers such as foxes, wolves, or bears.

This is a concise response that achieved full marks. It mentions few animals in pioneer community (implying species), pioneer plants being adapted to harsh conditions, and pioneer plants being small. (The candidate has been forgiven for thinking that lichens are plants.) With regard to the climax community, tall named plants that dominate and a larger variety of animals has been given. Some of the emboldened indicative points have been addressed so there is just enough here for Level 3. The way the candidate has presented their answer makes comparisons easy.

Question 20 (b) (ii)

(ii) Succession involves changes in the species that live in an area over time.

State **one** other change that takes place in the same area over the same time.

.....

..... **[1]**

Many candidates did not appreciate the significance of being asked for a change other than in the species that live there. Hence, frequently seen answers such as 'evolution' or 'speciation' were not given. Around a third of responses were given the mark.

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Question 20 (b) (iii)

(iii) Suggest what was present in the area that is now occupied by mixed woodland before the pioneer community arrived.

.....

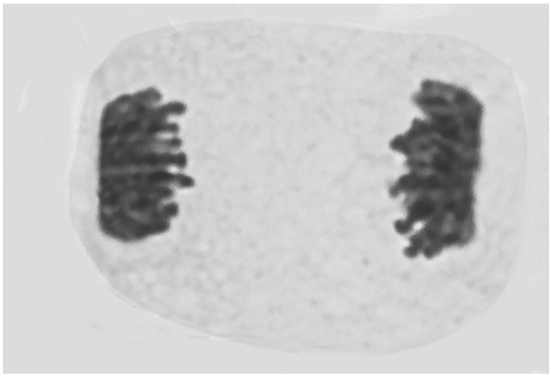
..... **[1]**

Most candidates got this correct; those that did not, tended not to have scored highly on part (i).

Question 21 (a) (i)

21 Certain changes occur throughout the life of a cell. These changes are known as the cell cycle.

(a) The image shows an onion cell undergoing mitosis.



(i) Name the stage of mitosis shown in the image.

..... **[1]**

The image shows two clear darkened areas at each pole where the chromosomes have begun to cluster, which happens just before the nuclear envelope is reformed, and individual chromosomes are no longer clearly identifiable. These are clearly signs that the cell is in telophase, but 'anaphase' was a much more common candidate response. If the cell were in anaphase, it would show the sister chromatids being separated or the chromosomes migrating towards each pole. The chromosomes would be clearly distinguishable in a 'V' shape.

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Question 21 (a) (ii)

(ii) Describe how the image would look different if the cell was in interphase.

.....

.....

.....

.....

..... **[2]**

Many candidates missed the thrust of this question which was about how the image would *look* different. Around a quarter of responses achieved a mark, usually for noting that the chromosomes would no longer be visible. Simply stating that the chromosomes would not be condensed does not describe how they look. Some candidates stated that the chromosomes would be in the nucleus, but few went on to describe its appearance – that a single nucleus would be visible or that there would be a single central area of dark staining. It was rare to see a description of the nuclear material not being as dark.

Question 21 (a) (iii)

(iii) The cell in the image is from the root of an onion.

State why root tissue is frequently chosen to study mitosis.

.....

..... **[1]**

Most responses had the right idea that the correct answer was about high levels of mitotic activity but many of those candidates were let down by a lack of precision in their answers. Many wrote 'it' is undergoing frequent mitosis and in this context 'it' would be the tissue and not the cells. It was essential that candidates presented mitosis only as a process occurring in a cell.

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Question 21 (b) (i)

(b) The stages of mitosis and meiosis are similar but not identical.

Prophase occurs in both mitosis and meiosis.

(i) At the beginning of mitosis and meiosis, the nuclear envelope disintegrates.

Identify **two** other similarities between prophase in mitosis and **prophase 1** of meiosis.

1 .....

.....

2 .....

.....

[2]

Most candidates gained some credit in this question, which differentiated well between candidates of differing abilities. The most common correct answers addressed either or both of the first two marking points.

Question 21 (b) (ii)

(ii) Identify **one** difference between prophase in mitosis and **prophase 2** of meiosis.

.....

.....

..... **[1]**

Although many had the right idea here only those candidates who could phrase their answers unambiguously using precise technical terms achieved the mark, and fewer than 1 in 10 did. Many responses stated, or implied, that crossing overtakes place in prophase 2 of meiosis and were not given.

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Question 21 (c)

(c) The cell cycle of an onion cell is estimated to be 15 h.

A root-tip squash from an onion contained 124 cells.

16 of the cells were undergoing mitosis.

Calculate the mean length of time each cell spent undergoing mitosis.

Give your answer in minutes to **3** significant figures.

Time spent undergoing mitosis = ... min **[2]**

Around half of candidates scored here. Although many struggled with principle of converting a proportion of cells to a proportion of time, the vast majority of candidates coped with the change of units.

Calculation:

16/124 = 0.129

15 hours = 900 minutes

0.129 x 900 minutes =116 min

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Question 21 (d)

(d) The cell cycle describes a series of events that occur during the life of a cell.

Complete the sentences by choosing the most appropriate terms.

During mitosis the ..... divides. This is followed immediately by ..... . Interphase contains three phases. Replication of DNA takes place during the ..... phase. Checkpoints occur during the cell cycle. The G_1 and G_2 checkpoints check for cell size and ..... . The second checkpoint occurs at the end of the ..... phase. If a cell does not satisfy the requirements of a checkpoint, it enters the ..... .

[6]

This question differentiated well between candidates, with most candidates gaining 2–3 marks. Many found the first gap difficult by not recognising that mitosis is nuclear division and not cell division. More recognised that cytokinesis is the step that follows mitosis. A good number of candidates also named the S, or synthesis, phase as the step where the replication of DNA takes place. Very few candidates were able to correctly identify an event that occurred in both G_1 and G_2 phases in addition to checking for cell size. DNA replication is checked for mutations (a common incorrect suggestion) after the S phase, so this does not occur in G_1. DNA is checked for damage or breaks in both G_1 and G_2. Many candidates knew that the second checkpoint was at the end of G_2. Even more knew that the phase a cell enters when the checkpoint is failed is G_0 or the resting phase (or state). A common incorrect response for the final gap was 'death phase'.

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Question 17 (b): Light micrograph of blood smear., © ALVIN TELSER / SCIENCE PHOTO LIBRARY.

Question 18: Photo of stuffed thylacine., © NATURAL HISTORY MUSEUM, LONDON / SCIENCE PHOTO LIBRARY.

Question 18 (c): Data upon which table 18.2 is based.

Question 21 (a): Light micrograph of cell. This image appeared on the insert for H420/02 June 2018., © STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY.

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