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Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/02 Summer 2023 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 and there were few obvious gaps in their knowledge of learning outcomes from Modules 2, 4 and 6. There was, however, evidence that practical skills, in, e.g. Questions 5 and 17, had not been developed well in some candidates. Although many candidates were comfortable discussing variables, Questions 17 (a) (i) and 18 (c) (ii), that suggested many candidates still confuse the independent and dependent variable.

Candidates who took note of the command words were more likely to gain marks in Questions 17 (c), 20 (a) and 20 (c) (ii) and saved time when answering Question 18 (c) (ii). Candidates who carefully read the stem of the question, provided better answers to Questions 1, 8, 17 (c) and 18 (b).

The proportion of questions requiring mathematical skills remained at around 10%, as in all A Level Biology papers. Most candidates coped well with the questions in which a calculation was required, although many were let down by inappropriate rounding in Question 17 (b) (iii).

Candidates found both Level of Response (LoR) questions in the paper accessible, and many accessed Level 3 in Question 18 (c) (ii). However, centres are reminded that the answer to a question worth 6 marks should, on average be only twice as long as the 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 were pleased that candidates were indicating when an answer extended onto the additional answer space. It was also pleasing to see fewer candidates being unnecessarily supplied with additional sheets or answer booklets before they had used the additional answer 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.

Some of the traditional misconceptions were seen surrounding mutations. It was evident from Question 12 that many candidates believe that selective breeding causes mutations, from Question16 (c) that cloning causes mutations and from Question 19 (d) that antibiotics cause mutations. Questions 16 (b) (i), 17 (a) (iii), 17 (b) (iv) and 21 (b) revealed some misconceptions about plants and photosynthesis. There was also confusion about feeding relationships and migration patterns in Question 20.

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 • ignored command words • used general rather than precise terms or confused precise terms that have a different meaning.

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Section A overview

Candidates found most of the MCQs accessible, although some were challenging. 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. Question 9 was the lowest-scoring question but candidates also found the two questions about selective breeding, 12 and 13, challenging. Examiners noticed more examples than usual of candidates' thought processes on the paper, particularly in Question 4. 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 credited.

Question 1

1 Which option correctly describes a tissue?

A A group of cells performing similar functions

B A group of organs performing a specific function

C A group of similar cells performing a specific function

D A group of similar cells performing a variety of functions

Your answer ☐ **[1]**

A lot of candidates selected the correct answer **C**. There was a significant minority of candidates who incorrectly chose option A, perhaps not noticing the important plural distinction of the word 'functions'.

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Question 2

2 Bone marrow stem cells are a source of erythrocytes.

Which statement about bone marrow stem cells and their role in the production of erythrocytes is correct?

A Bone marrow stem cells are totipotent and can therefore differentiate into any type of cell.

B Erythrocytes are the only blood cell produced from bone marrow stem cells.

C Erythrocytes need to be replaced from bone marrow stem cells because erythrocytes are unable to undergo mitosis.

D In humans, differentiation of bone marrow stem cells into erythrocytes involves the synthesis of a haploid nucleus.

Your answer ☐ **[1]**

Two thirds of candidates gave the correct response, **C**. The most common incorrect responses were options **A** and **B.**

Question 3

3 Which option correctly describes the sequence of events during the cell cycle?

A Cytokinesis → interphase → G_1 → G_2 → S → mitosis

B Cytokinesis → mitosis → interphase

C G_2 → mitosis → cytokinesis → G_1 → S

D Mitosis → interphase → cytokinesis

Your answer ☐ **[1]**

Two thirds of candidates selected the correct response, **C**.

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Question 4

4 Scientists crossed two plants that were heterozygous for two different genes. Both plants had the same genotype, AaBb.

The genotypes and ratios of the offspring resulting from this cross were:

AABB AaBb aabb

1 : 2 : 1

Which option could explain these observations?

A Autosomal linkage

B Crossing over

C Epistasis

D Mutation

Your answer [ ] **[1]**

About half of candidates selected the correct response, **A**. The most common incorrect responses were **B** and **C.**

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Question 5

5 A student was observing and measuring cells using a light microscope.

Which option describes a method that would enable the student to accurately measure the length of a cell?

A View the cells using a calibrated eyepiece graticule and note the magnification of the eyepiece lens.

B View the cells using a calibrated eyepiece graticule and note the magnification of the objective lens.

C View the cells using a stage micrometer and note the magnification of the eyepiece lens.

D View the cells using a stage micrometer and note the magnification of the objective lens.

Your answer ☐ **[1]**

The responses in this question varied a lot. Around half of the candidates selected the correct option, **B.** This might be due to lack of practical experience.

Question 6

6 Which of the following describes, from lowest to highest, the resolution of images than can be achieved by different types of microscope?

A Light microscope → scanning electron microscope → transmission electron microscope

B Light microscope → transmission electron microscope → laser scanning confocal microscope

C Light microscope → transmission electron microscope → scanning electron microscope

D Scanning electron microscope → transmission electron microscope → light microscope

Your answer ☐ **[1]**

Just over half of the candidates selected the correct option; **A.** The most incorrect response was option **B**.

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Question 7

7 Lactose metabolism in *E. coli* is controlled by the *lac* operon.

Which of the structures associated with the *lac* operon contain nucleic acids?

1: the operator
2: the regulator gene
3: the structural gene product

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

Candidates answered **A** and **C** in equal measure, which possibly suggests that candidates did not realise that the structural gene product is a protein , which doesn't contain nucleic acids. The question was answered correctly (option **B**) by candidates who scored highly on other parts of the paper.

Question 8

8 Homeobox genes control body plan in eukaryotes.

Which of the statements about homeobox genes are correct?

1: they bind to transcription factors
2: they contain a highly conserved sequence of 180 base pairs
3: they regulate the expression of structural genes

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

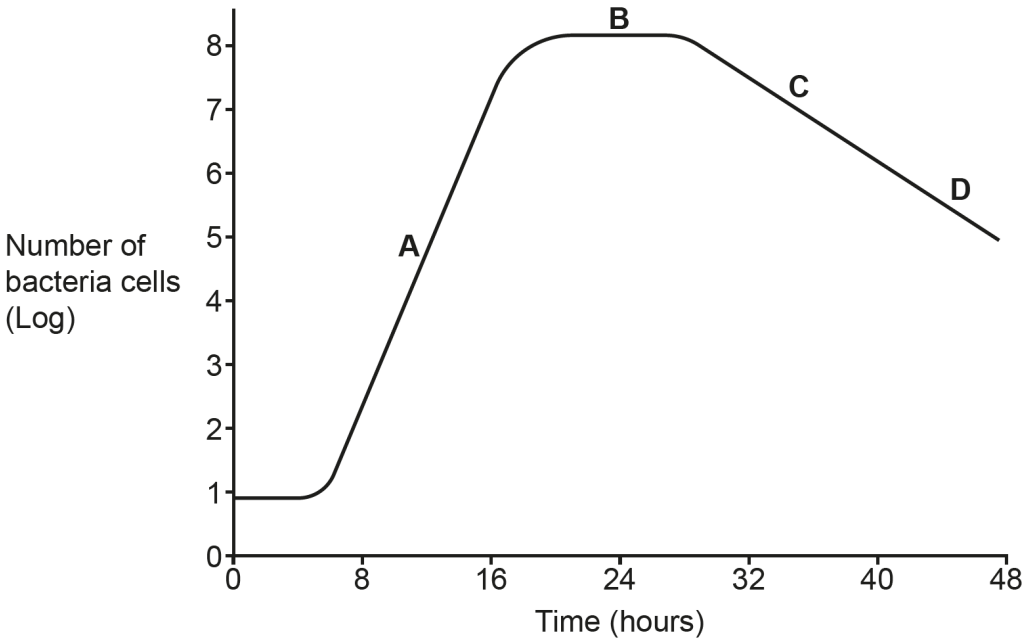
Your answer ☐ **[1]**

About half of the candidates selected the correct response, option **C**. A lot of candidates chose option **A**, perhaps this was due reading statement 1 without the 'bind to'.

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Question 9

9 The graph below shows the population of viable bacteria in a flask over 48 hours.



Which time, **A** to **D**, has the highest bacterial death rate?

Your answer [ ] **[1]**

This challenging question tested understanding of the logarithmic scale and the term 'rate'. Many candidates chose options **C** or **D**, presumably because they are in the death *phase.* The *incidence* of death (deaths as a proportion of bacterial population) would certainly be higher than at option **B**. However, 'death rate' implies 'deaths per minute/hour', which is higher at B because the population at B (which can be read from the y-axis) is about 12 times bigger than the population at C and around 500 times bigger than the population at D.

OCR support

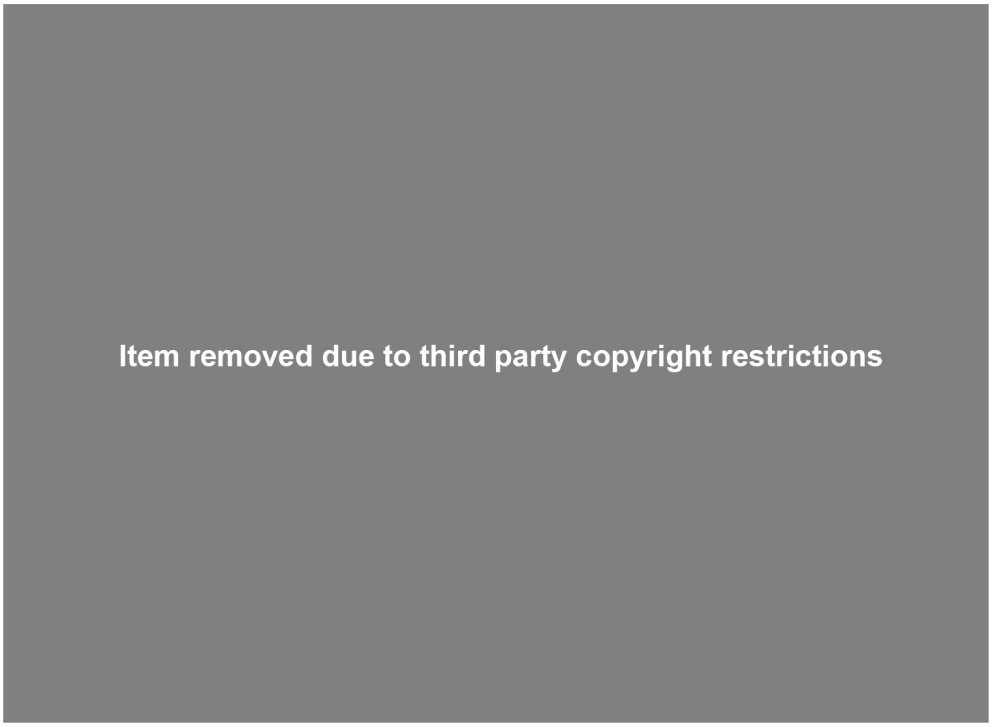
Help with logarithms and other mathematical skills can be found in the OCR Biology Maths Skills Handbook

Maths for Biology resources can also be useful to support students with mathematical skills via tutorials and quizzes.

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Question 10

The image below shows representations of the structures of four polysaccharides.



Use the image to answer questions **10** and **11**.

10 Which of the molecules contains the highest proportion of 1-6 glycosidic bonds?

A Amylopectin

B Amylose

C Cellulose

D Glycogen

Your answer ☐ **[1]**

Around 4 out of 5 candidates selected the correct response, option **D**, showing good understanding of glycosidic bonds and polysaccharides. Option **A** was the most common incorrect response.

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Question 11

11 Which of the molecules is **not** used for energy storage?

A Amylopectin

B Amylose

C Cellulose

D Glycogen

Your answer ☐ **[1]**

A very large proportion of candidates, selected the correct option for this question, **C**. Very few candidates chose options **A** or **B**.

Question 12

12 The modern pedigree dog breeds have been produced by many years of selective breeding.

Which option does **not** explain why genetic disorders are common in pedigree dogs?

A Characteristics that are desirable to humans can be associated with features that are harmful to dogs.

B Selective breeding increases the chance of an individual being homozygous for certain characteristics.

C Selective breeding increases the chance of mutations.

D Selective breeding is associated with inbreeding depression.

Your answer ☐ **[1]**

Very few candidates selected the correct answer for this question, option **C**. A range of incorrect responses were seen, highlighting a misconception on how mutations are caused.

Misconception

Mutations cannot be caused by selective breeding. Mutations occur randomly either due to random errors during DNA replication, exposure to mutagens or a viral infection.

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Question 13

13 What step could be taken to reduce the occurrence of genetic disorders in pedigree dogs?

A Breeding only with individuals that meet the official breed descriptions.

B Broadening the official descriptions of pedigree dog breeds.

C Increased use of somatic gene therapy.

D Regular cross-breeding with the wild ancestor of domestic dogs.

Your answer ☐ **[1]**

Candidates found this question challenging, with only around a quarter selecting the correct response, **B**. Option **D** and, to a lesser extent, option **A** were common incorrect responses. Option **A** would increase the occurrence of genetic disorders. Option **D** is also incorrect because the wild ancestor of dogs (and wolves) no longer exists.

Question 14

14 Organisms are named using the binomial system.

What is the correct way to represent the binomial name for domestic dogs?

A *Canis familiaris*

B Canis familiaris

C *canis familiaris*

D canis familiaris

Your answer ☐ **[1]**

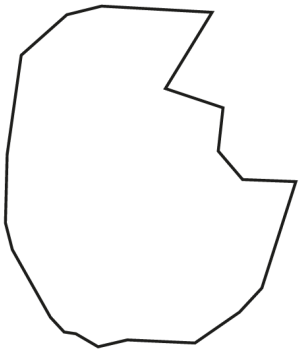
The vast majority of responses were correct, option **A**, The most common incorrect answers were C and B..

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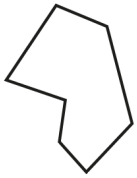
Question 15

15 The image below shows an enzyme and its substrate.

Enzyme



Substrate

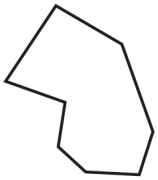


Which option represents a coenzyme for this enzyme?

A 

B 

C 

D 

Your answer ☐ **[1]**

A large majority of candidates correctly chose option **A**. Option **D** was seen regularly, suggesting uncertainty about the definition of coenzyme.

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Section B overview

Most candidates were able to display a good understanding of cloning, enzyme immobilization, the development of antibiotic resistance, and the structure of glucose. Many also demonstrated good planning, evaluation, and calculation skills. There were some clear gaps in knowledge and understanding relating to the enzyme-controlled practical, synthetic biology and the structure–function relationships of glucose.

Question 16 (a)

16 Many organisms undergo asexual reproduction by mitosis.

(a) State **two** other roles of mitosis in organisms.

1 .....

2 .....

[1]

This was expected to be a high-scoring question but only around half of candidates achieved the mark. Candidates who kept their answers simple and straightforward gained the mark but those who added unnecessary detail often included something that was incorrect and so the mark was not given. Many answers referred to the growth or repair of *cells* and so were not credited. Other commonly seen non creditworthy responses included 'cloning' (which was excluded by the word 'other' in the question) and 'differentiation'.

Question 16 (b) (i)

(b) Plants reproduce asexually by mitosis.

(i) Explain why mitosis, and not meiosis, is used for asexual reproduction in plants.

.....

.....

.....

.....

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

Around half of candidates gained the first marking point but many omitted the key word 'genetically'. Far fewer achieved the 2nd marking point and those that did often missed out on the first. Many answers spent time (and space) discussing the benefits of asexual reproduction in general, which this question did not ask for.

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Misconception

A large minority of candidates thought that plants were unable to produce gametes or carry out sexual reproduction.

OCR support

Our delivery guide on 'Cell division, cell diversity, cellular organisation' offers and overview of the key concepts and suggested a range of classroom activities to support with the topic.

Question 16 (b) (ii)

(ii) Bacteria reproduce asexually by a process called binary fission.

Suggest why bacteria are unable to reproduce asexually by mitosis.

.....

.....

.....

.....

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

Around half of candidates scored 1 mark, usually for marking point 2. Other alternative valid points were regularly awarded but the first marking point was rarer. Only a few candidates were aware of the distinction between the main loop of DNA and plasmids in prokaryotes. Some candidates thought bacteria did not contain DNA.

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Question 16 (c)*

(c)* Asexual reproduction is also known as cloning.

Many organisms can be artificially cloned for commercial purposes.

Discuss the arguments for **and** against artificial cloning in plants **and** animals.

.....

.....

.....

.....

.....

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

Most candidates were able to write competent and coherent answers to this level of response question and most achieved at least Level 2. All of the indicative points on the mark scheme were seen and many candidates offered other suggestions of similar quality. For example, the use of cloned animals in medical research to control a key variable.

Many advantages and disadvantages of cloning are generic, in that they can be applied to both plants and animals, e.g. lack of genetic variation and group susceptibility to a single disease. Such generic disadvantages were creditworthy and allowed candidates to access Level 1. If at least some kingdom-specific examples were included, a Level 2 was awarded. Level 3 required answers to include both positive and negative points that were specific to plants and others that were specific to animals.

Most candidates discussed disease susceptibility as a problem with cloning. This was awarded only if it was clear that the entire clone would have the same susceptibility to disease. Many candidates thought that cloning necessarily increased susceptibility to disease in general, which was not credited.

References to there being ethical issues with animal cloning were not credited without further high level qualification that was clearly related to cloning. Some candidates confused cloning with genetic engineering or/and selective breeding (or even with the production of mycoprotein). These points were not awarded and, if they made up a large proportion of the total answer, the upper 'communication' mark within a level was not awarded. The upper mark was also not awarded where there was ambiguity. For example, if it was not clear whether the candidate was discussing lack of genetic variation as a result of cloning or as a result of selective breeding. Descriptions of the processes involved in cloning were not awarded as they did not answer the question and, if they were lengthy, in some cases it resulted in loss of the communication mark.

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Exemplar 1

artificial cloning in plants is beneficial as if we obtain a plant of high quality we are able to clone it and produce a monoculture of high quality plants, ~~for example~~ artificial cloning only requires one parent plant / animal, meaning it could increase the population numbers of endangered species. however, artificial cloning is not beneficial as cloning plants produces a monoculture which decreases the genetic biodiversity of the species: it also opens up the risk of the whole monoculture dying from one disease as they are all identical. in animals it is considered unethical as by cloning we are interrupting nature's course and cloning has resulted in shorter lifespans of animals and certain diseases genetic biodiversity **[6]**

→ efficient production
→ more money made by factories/farmers.

Additional answer space if required.

decreases.

however in agriculture if animals such as cattle have high quality meat or high milk production, cloning them would be beneficial to the farmers and industry

This is a typical Level 2 response. While discussing plants, the candidate has mentioned some advantages of cloning (propagation of organisms with beneficial features and increasing the population of an endangered species) and has clearly addressed the problem of reduced genetic diversity and potential susceptibility to a single disease. However, all of these points could also apply to cloned animals, so the response did not achieve Level 3 as it did not include any plant-specific points. Towards the end of the main answer space, it mentions an animal-specific negative of cloning (potentially shortened lifespan). It also includes an animal-specific example of a beneficial feature (milk production) in the additional space.

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Question 16 (d)

(d) During meiosis, the independent assortment of chromosomes leads to the formation of genetically different gametes.

Gametes of the western clawed frog contain 10 chromosomes.

Calculate the number of genetically different gametes resulting from the independent assortment of chromosomes that would be produced by an individual frog.

Number of different gametes = ... **[2]**

Most candidates found this question very challenging, either because they did not know, or could not work out that the number of gamete combinations would be 2^n. Less than 1 in 5 candidates got this right but, of those that did, almost all achieved both marks. The most common incorrect response was '40'.

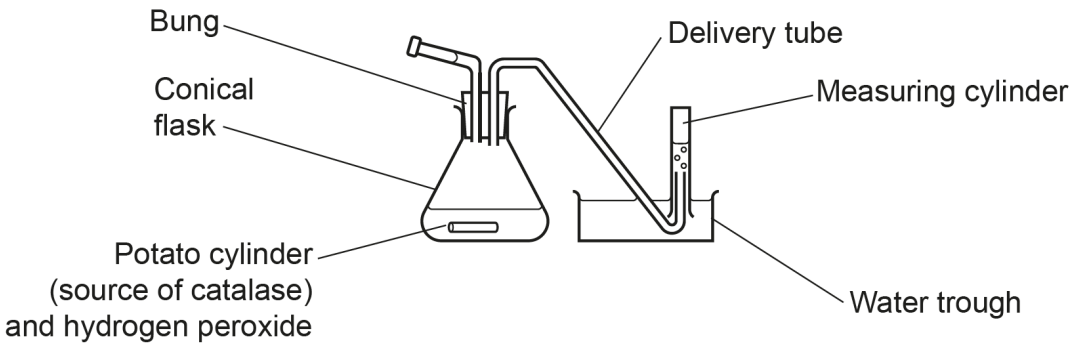
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Question 17 (a) (i)

17 Catalase is found in many tissues. It is an enzyme that breaks down hydrogen peroxide into oxygen and water.

Some students do an experiment to investigate the effect of hydrogen peroxide concentration on the rate of this reaction using the apparatus shown in **Fig. 17.1**.

Fig. 17.1



This is the method the students use.

1. Use a stock solution of 250 cm^3 of 20 a.u. hydrogen peroxide, to make solutions of 8 a.u. and 2 a.u.
2. Cut 15 cylinders of potato of equal diameter, using a cork borer, and use a ruler to ensure that each one is 5 cm long.
3. Set up the apparatus as shown in **Fig. 17.1**.
4. Record the starting position of the water in the measuring cylinder.
5. Place one cylinder of potato into the conical flask.
6. Pour 50 cm^3 of 2 a.u. hydrogen peroxide into the flask, immediately secure the bung and start the stopwatch.
7. Record the volume of gas given off every 30 s for 3 min.
8. Repeat steps 3 to 7 twice.
9. Repeat steps 3 to 8 using 8 a.u. and 20 a.u. hydrogen peroxide.

(a) (i) State the independent variable in this investigation.

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

Most candidates got this right. Some missed out by writing 'a.u.', 'conc.', or even 'amount', rather than 'concentration'. A small but significant minority cited 'volume of gas produced', suggesting that some candidates are unsure of the difference between the independent and dependent variable.

OCR support

Language of measurement resource is excellent guidance to help students with the correct use of scientific terminology.

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Question 17 (a) (ii)

(ii) Describe how a student could produce an 8 a.u. solution from a 20 a.u. stock solution.

.....

.....

.....

.....

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

This question differentiated well. Most recognised that water needed to be added and most of these correctly stated 'distilled' water. Many candidates found it difficult to suggest an appropriate ratio and suggested a serial dilution process involving more than one step, often struggling to conceive of a dilution factor other than 1 in 2, 1 in 10 or 1 in 100. Two-step dilution techniques (e.g. 50:50 dilution to achieve 10 a.u. then a second dilution to 8 a.u.) are not an accurate or appropriate way of making an 8 a.u. solution for use in an investigation.

Misconception

Many candidates were using the term 'serial dilution' and then suggesting a simple (often correct) proportional dilution, suggesting a misunderstanding to the term 'serial dilution'.

Assessment for learning

Giving candidates opportunities in lessons to practice a variety of dilution techniques, for example with blackcurrant cordial can be helpful.

OCR support

Help with generic practical techniques such as dilution can be found in the OCR Biology Practical Skills Handbook

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Question 17 (a) (iii)

(iii) Liver tissue contains a higher concentration of catalase than potato.

Suggest **two** reasons why the students chose potato rather than liver as a source of catalase.

1 .....

.....

2 .....

.....

[2]

Less than half of candidates achieved a mark here and less than 1 in 20 got both marks. The most common mark given was linked to potential ethical objections. Many candidates addressed the idea of surface area, e.g. by suggesting that it was easier to cut into shape, without using the term 'surface area', which is a key variable in rate of reaction investigations. A number of candidates noted that the question stem stated that liver has a higher catalase concentration than potatoes and would therefore produce a very rapid reaction. On this occasion, credit was given to candidates that suggested that this might be difficult to record accurate volumes. This was added in the Guidance column of the mark scheme as is not an ideal answer, since a simple adjustment (i.e., use a smaller mass of liver) would solve this problem. A few candidates suggested that, unlike potatoes, liver could not be bought in a shop, while a very small number of candidate thought that potato plants were not living organisms.

Question 17 (a) (iv)

(iv) The potato cylinders were cut to equal lengths.

Suggest a further precaution the students should have taken when preparing them, to ensure the investigation was valid.

.....

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

Around a quarter of answers scored a mark in this question. Many candidates stated that the potato pieces should be patted dry, suggesting confusion with an osmosis investigation. Suggestions that the potato pieces come from the same potato (or part thereof) were not credited on this occasion as extracting 15 x 5 cm cylinders from the same potato is not feasible.

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Question 17 (b) (i)

(b) Some of the students' results are shown in the tables below.

Results for 2 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	5	6	5	5.3	0.6
60	9	10	9	9.3	0.6
90	13	14	13	13.3	0.6
120	16	17	18	17.0	1.0
150	19	20	21	20.0	1.0
180	21	22	23	22.0	1.0

Results for 8 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	22	23	23	22.7	0.6
60	37	39	38	38.0	1.0
90	49	49	47	48.3	1.2
120	57	58	55	56.7	1.5
150	61	63	59	61.0	2.0
180	64	67	62	64.3	2.5

Results for 20 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	57	55	58	56.7	1.5
60	78	74	78	76.7	
90	89	73	88	83.3	9.0
120	95	79	93	89.0	8.7
150	97	81	95	91.0	8.7
180	97	83	96	92.0	7.8

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(i) Calculate the standard deviation for the 60 s result at 20 a.u. hydrogen peroxide.

Use the formula: $s = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$

Standard deviation = ... **[2]**

Most candidates scored both marks here. Where that was not achieved, a single mark was often given, either for the correct answer to too many decimal places (i.e., 2.31 – the answer needing to be consistent with the other numbers in the table) or for getting as far as 10.67. Less than 1 in 5 candidates scored 0 marks.

OCR support

We have a range of resources available to support you and your students on maths skills focused on statistics:

Maths for Biology resources

Include tutorials and student activities for all the statistical skills that candidates need to know for the course.

Statistics for Biologists

Guidance for teachers on the statistical skills that candidates need to have.

Mathematical skills Handbook

Provides guidance on the statistical skills and explains how they can be used within a biology context.

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Question 17 (b) (ii)

(ii) Use the standard deviations to discuss the repeatability of the students' results.

.....

.....

.....

.....

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

Around a third of candidates scored both of the marks available for this question. One common mistake was to omit the word 'repeatability' or to use it in absolute, rather than comparative, terms (e.g. 'the results are repeatable'). Some candidates merely defined the terms without reference to the numbers in the table.

OCR support

Support on Language of measurement can be found on Teach Cambridge.

Question 17 (b) (iii)

(iii) The students calculated the initial rate of reaction over the first 30 s.

Calculate the rate of reaction over the first 30 s for the result at 2 a.u. hydrogen peroxide.

Rate = ...

Unit = ...

[2]

Most candidates got both marks and 4 out of 5 achieved at least 1 mark. The second mark was often lost for incorrect units (e.g. 'secs' instead of 's' or 'cm^{-3} s^{-1}') or incorrect rounding ('0.176' was seen regularly).

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Question 17 (b) (iv)

(iv) When analysing the results, the students assumed that the volume of oxygen collected was the same as the volume of oxygen produced from breakdown of hydrogen peroxide.

Suggest **two** reasons why the value the students recorded for volume of oxygen collected might not accurately reflect the volume of oxygen produced.

1 .....

.....

2 .....

.....

[2]

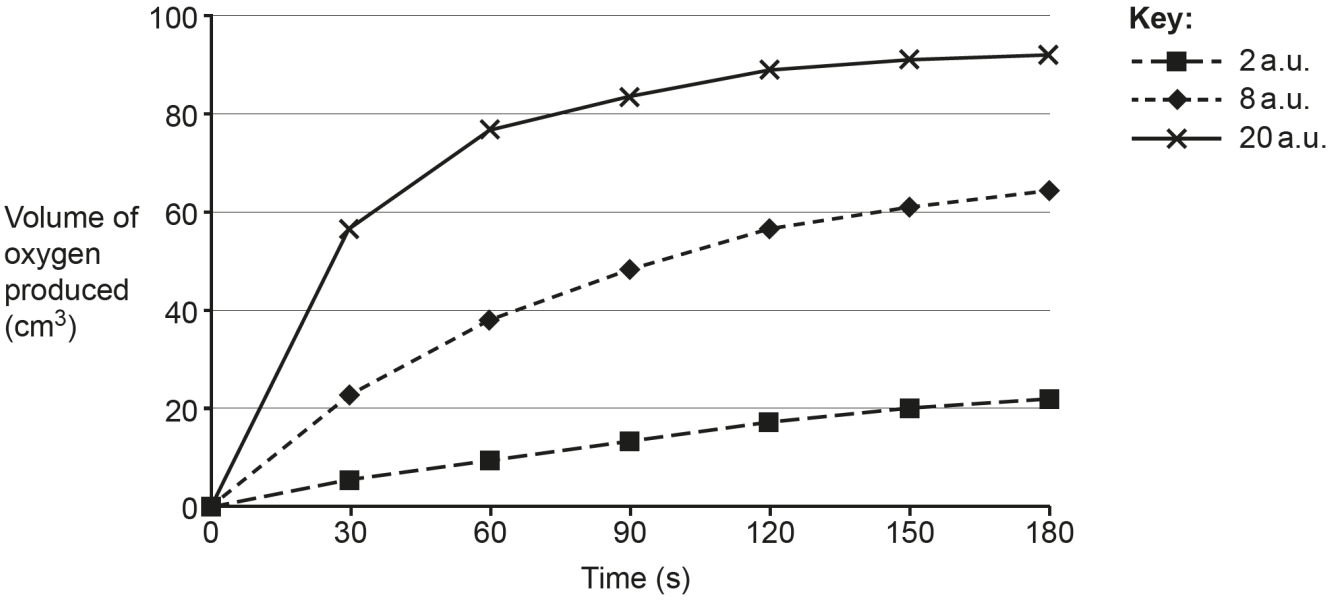
Most candidates achieved at least 1 mark here, usually for a version of one of the first 2 marking points. Some candidates offered human error as a suggestion, which was not credited. A number of candidates suggested that oxygen might have been produced by photosynthesising potato cells and in rare cases they mentioned that some of the oxygen might have been *used* in photosynthesis.

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Question 17 (c)

(c) **Fig. 17.2** shows a graph of the students' results.

Fig. 17.2



Explain the results for 20 a.u. hydrogen peroxide.

.....

.....

.....

.....

.....

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

Most candidates achieved at least 1 mark here, usually for the guidance version of marking point 2. Marking points 3 and 4 were frequently seen but many candidates did not use the key term 'rate' or alternative words, or 'concentration' when referring to substrate. The first marking point was attempted less often and sometimes it was not always achieved. The reason was because candidates did not link collisions to the idea of frequency. Many candidates attempted to explain the changes in terms of decreasing *enzyme* availability (and so could not get marking point 4). Some candidates assumed that the y-axis showed the rate of reaction and didn't gain any marks other than marking point 2. A significant minority of candidates answered in terms of the differences between the three concentrations, which meant that large parts of their answer were irrelevant to the question.

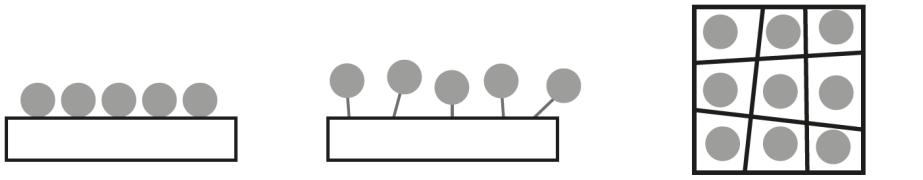
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Question 18 (a)

18 Immobilised enzymes are often used for industrial processes.

Fig. 18.1 shows three methods for immobilising enzymes.

Fig. 18.1



● = Enzyme molecule

(a) State **one** other method for immobilising enzymes.

.....

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

Around a third of candidates answered this question well, stating either membrane separation, encapsulation or a microcapsule. A number of candidates made slight adaptations to the list above, for instance, entrapment in beads and 'Ionic bonding' was seen frequently.

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Question 18 (b)

(b) One advantage of using immobilised enzymes is that the enzyme can be reused many times. However, the process of immobilisation can reduce the activity of enzymes.

With reference to **Fig. 18.1**, explain why the activity of immobilised enzymes might be lower than that of enzymes that are free in solution.

.....

.....

.....

.....

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

This question was low scoring but discriminated well. Candidates were asked to refer to Figure 18.1 and answers that were credited focused on reasons resulting from the processes of immobilisation illustrated in Fig. 18.1, not just the fact that the enzymes could not move. All marking points were seen but many responses were unable to gain credit for marking point 1 because they stated that the 'enzyme shape' or 'tertiary structure' would be changed, without mentioning the active site. Similarly, merely stating that enzyme surface area would be reduced, without reference to the active site, was not enough to be given marking point 2.

Question 18 (c) (i)

(c) Invertase is an enzyme that catalyses the following reaction:

sucrose ⟶ glucose + fructose.

Invertase is present in cells of baker's yeast, a type of fungus.

It is possible to immobilise invertase and it is also possible to immobilise yeast cells.

(i) Suggest **one** reason why using immobilised yeast might be more expensive than using immobilised invertase.

.....

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

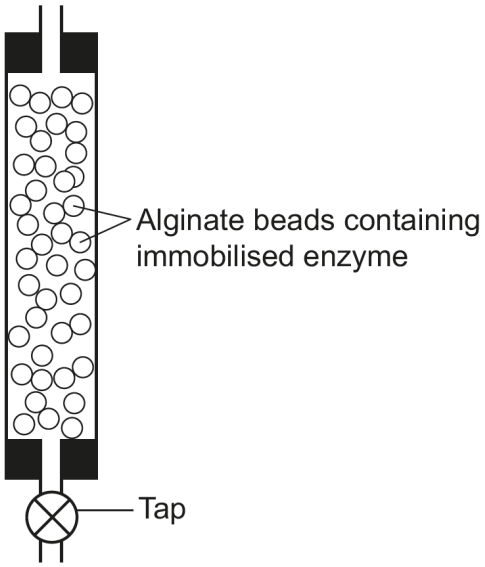
Around a quarter of candidates achieved this mark. Most incorrect answers referred to yeast being larger or difficult to immobilise. A few suggested that yeast was expensive because there was demand for it in the brewing and baking industries.

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Question 18 (c) (ii)

Investigations involving immobilised enzymes can be carried out using equipment like that shown in **Fig. 18.2**. A glass column with an outlet at the bottom is filled with alginate beads containing immobilised enzyme. The substrate can be added at the top and the product collected at the bottom.

Fig. 18.2



(ii)* A student wanted to compare the ability of immobilised invertase and immobilised yeast cells to hydrolyse sucrose.

The student had access to the following:

- sucrose solution
- alginate beads containing invertase
- alginate beads containing yeast cells
- glass columns such as the one shown in **Fig. 18.2**
- standard laboratory equipment and reagents.

Outline a valid method the student could use to compare the activity of immobilised invertase and immobilised yeast cells.

.....

.....

.....

.....

.....

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

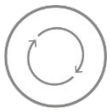
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This level of response question differentiated well and responses at all three levels were regularly seen. The command word was 'outline' so a good answer needed only the main steps of a method that was valid. The comparison was between the activity of immobilised invertase and immobilised yeast cells.

To access Level 3, a candidate needed to outline how they would change this independent variable, measure the dependent variable and keep control variables constant. Most candidates identified that the independent variable would require the setting up of two columns, each containing the different beads. Some candidates also had a third column with inert beads as a control. Fewer candidates were able to provide enough detail about measuring the dependent variable. Vague comments like 'measure the volume of product' or 'test the solution for sucrose', were common and not credited. Use Benedict's reagent was the most common creditworthy way to measure the end products. However, some candidates said that this would test for non-reducing sugar or that glucose and fructose were non-reducing sugars. Some candidates also correctly noted that a colorimeter would be the instrument to use but some candidates called it 'calorimeter' instead. When candidates opted to use a glucose test strip, they often did not add any further detail, thus limiting the level they could be given.

The majority of candidates were able to name several variables that should be controlled by keeping them constant. Some chose a suitable quantity for the variable and kept it the same for both tests. It was common to see the concentration and volume of sucrose being controlled or the number of beads added to each column. Common errors included controlling the enzyme concentration (as this was the independent variable) or using the ambiguous term 'amount' (as opposed to 'concentration' or 'volume'). Many candidates did not follow the command word, 'outline', and went into great detail about, e.g. what colour of filter to use in the colorimeter or what axes to use on the calibration curve, which took more time than was needed and often meant they could not be given the upper 'communication' mark within a given level. Some candidates added extra detail about, for example, statistical tests, which was not required under the directed focus of validity.

Assessment for learning

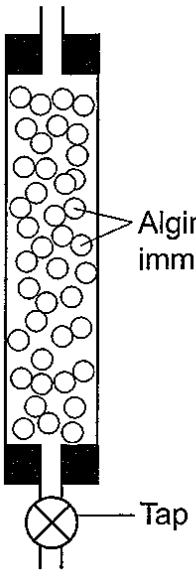


The use of the term 'amount' is ambiguous and it should be avoided especially when used to describe experimental designs. A more appropriate word should be 'concentration' or 'volume'.

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Exemplar 2

Fig. 18.2



IV - 2 glass columns
yeast invertase
DV: conc. of glucose (+ fructose) formed - Benedict's
↓
colorimetry
CV: no of beads added
volume of col
volume of Benedicts
Time in water bath
Use of cuvette

(ii)* A student wanted to compare the ability of immobilised invertase and immobilised yeast cells to hydrolyse sucrose.

The student had access to the following:

- sucrose solution
- ✓ alginate beads containing invertase
- ✓ alginate beads containing yeast cells
- ✓ glass columns such as the one shown in **Fig. 18.2**
- standard laboratory equipment and reagents.

Benedicts solution
→ glucose formed
↓
colorimetry
further comparison + quant

Outline a valid method the student could use to compare the activity of immobilised invertase and immobilised yeast cells.

Set up 2 glass columns. One column containing alginate beads with invertase and the other column containing alginate beads with yeast cells. Ensure that both columns contain the same or similar number of beads. Add the same and concentration volume of sucrose solution in both columns, for example 25-30cm³. Prepare a beaker at the bottom of the column

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to collect the products of glucose and fructose: wait for all product to be collected. use 2 separate boiling test tubes and transfer the products into the boiling tubes and label the tubes 'increase' and 'least'. Add the same volume of Benedict's [6]

Additional answer space if required.

solution (5cm^3) to the 2 boiling tube samples and place in a 90°C water bath for 5mins. To test further for the concentration of glucose and fructose produced, use a colorimeter to get quantitative results. Ensure the same volume is added to the cuvette. Record absorbance and plot a graph. Repeat at least 3 times to calculate mean average if colorimetry is done.

This response begins by concisely stating how to manipulate the independent variable. It then lists tree variables that need to be controlled. Enough detail about how to measure the dependent variable (Benedict's test and colorimeter) are included on the second page for it to achieve Level 3. Although there was some detail on the second page that went beyond what was required for an 'outline', and so was deemed 'irrelevant, the communication mark was awarded because the extra detail did not make up a disproportionately large part of the answer.

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Question 19 (a)

19 Animals are protected from infectious diseases by their immune system.

(a) Influenza is a viral disease that is common in winter months. It is transmitted when an uninfected person inhales droplets of moisture that an infected person has exhaled, often when coughing or sneezing.

Explain how mucous membranes make it more difficult for the influenza virus to enter the body.

.....

.....

.....

.....

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

Most candidates scored at least 1 mark here and around half achieved both marks. Each of the marking points was seen equally often. The first marking point was attempted more often but many candidates merely stated that the mucous membranes trapped the pathogen, without explicitly stating that it was the mucus, and so were not given the mark. A few referred to cilia as microvilli or pili.

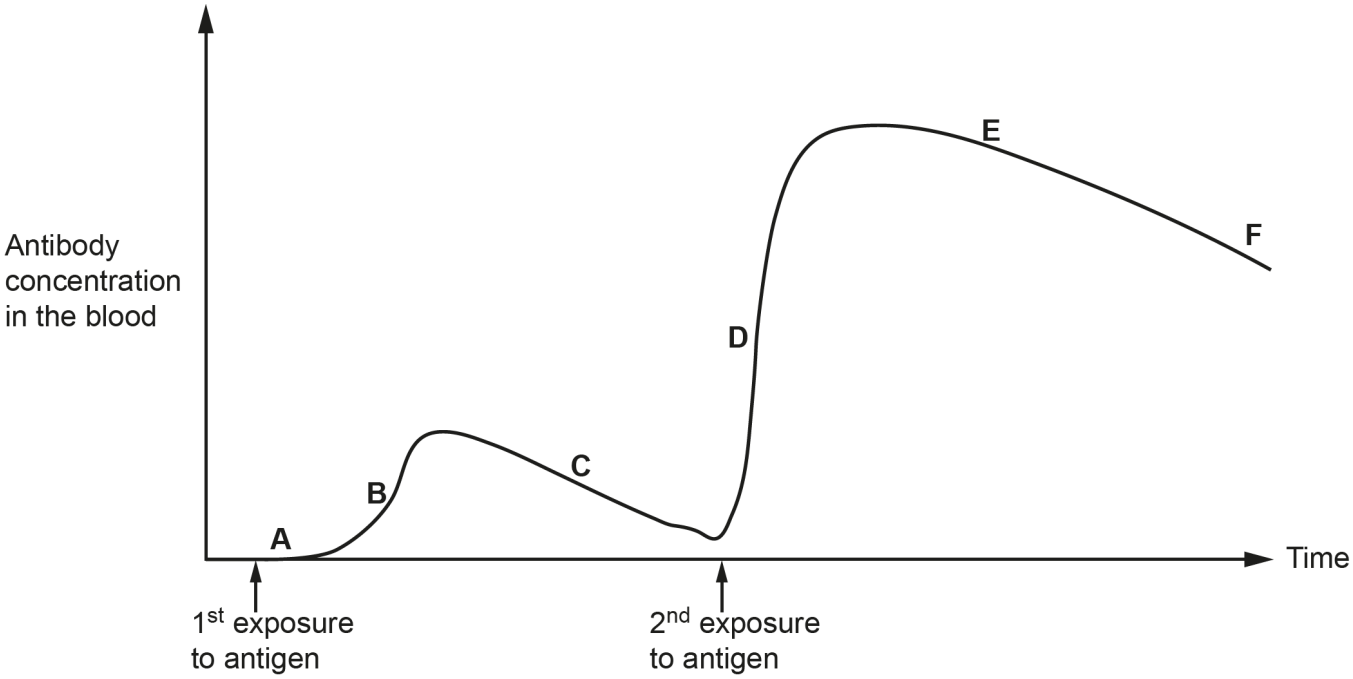
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Question 19 (b)

(b) Antigens on the surface of pathogens can provoke an immune response in a patient.

Fig. 19.1 shows the changes in antibody concentration in the blood of a patient.

Fig. 19.1



Different events during these immune responses have been represented as areas on the graph labelled with letters, **A** to **F**.

Complete the table with a letter or letters to indicate where on the graph the event is represented.

Event	Letter or letters
Antigen presentation	
Clonal expansion	
Clonal selection	
High T-helper cell activity	
Highest number of memory cells	

[5]

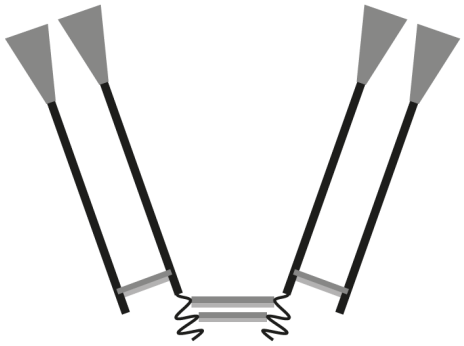
This was a challenging question that differentiated well between candidates. Most candidates scored 1 or 2 marks, usually for a combination of the first row and one other. Most candidates recognised that antigen presentation occurs after the first exposure to the antigen. Fewer realised that clonal selection also occurs at this point. Relatively few answers accounted for clonal expansion and high T-helper cell activity happening after both the first and second exposures to antigen. Many candidates assumed that the highest number of memory cells would be present at the end of the timeline and did not account for the decline in memory cells in the blood. A number of candidates answered with a single letter in each box, perhaps suggesting they had read the stem of the question carefully. Less than 1 in 20 scored all 5 marks.

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Question 19 (c) (ii)

(ii) **Fig. 19.2** shows the structure of a Fab fragment.

Fig. 19.2



Identify **two** similarities and **one** difference in structure between a Fab fragment and a whole antibody.

Similarity 1 .....

.....

Similarity 2 .....

.....

Difference .....

.....

[3]

This question differentiated well, although candidates found it challenging. Around half of the answers got a single mark for a similarity, most often for hinge region or disulfide bridge. Many candidates achieved the first marking point, while others did not because they did not state that there were two of variable regions/binding sites. The fourth marking point was less regularly seen but, when attempted, was usually achieved.

The difference mark was rarely scored. Most candidates who had the right idea stated that the F_{ab} fragment had *no* constant region (or *no* heavy chain). Very few candidates seemed to be aware that the constant region includes part of the upper 'arms' and those that did appeared to be centre-specific. Candidates that gained the difference mark rarely gained both of the other marks so all 3 marks were given to fewer than 1 in 20 responses.

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Question 19 (d)

(d) Infectious disease caused by pathogenic bacteria can be treated using antibiotics. The first antibiotics became widely available in the middle of the 20th Century.

Explain why many varieties of pathogenic bacteria are now resistant to a range of antibiotics.

.....

.....

.....

.....

.....

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

Most candidates scored at least 1 mark for this question, with around 1 in 10 scoring all 3 marks. Many candidates devoted their entire answer to a description of natural selection, gaining 1 mark only. The question asked candidates to explain why some bacteria are *now* resistant, not how this resistance evolved. So, without reference to overprescription, often at a low dose, the question was not fully answered. As natural selection was not the focus of the question, references to bacterial immunity to antibiotics was ignored. A few candidates described natural selection by suggesting that the antibiotic was causing mutations and were not credited.

Question 19 (e)

(e) Plants and microorganisms have traditionally been used as sources of new medicines.

Synthetic biology could play a major role in the development of new medicines.

Outline how synthetic biology can be used in the provision of new medicines.

.....

.....

.....

.....

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

Very few candidates gave a concise description of synthetic biology. Most answered in terms of personalised medicine or using computer modelling to synthesise and test drugs.

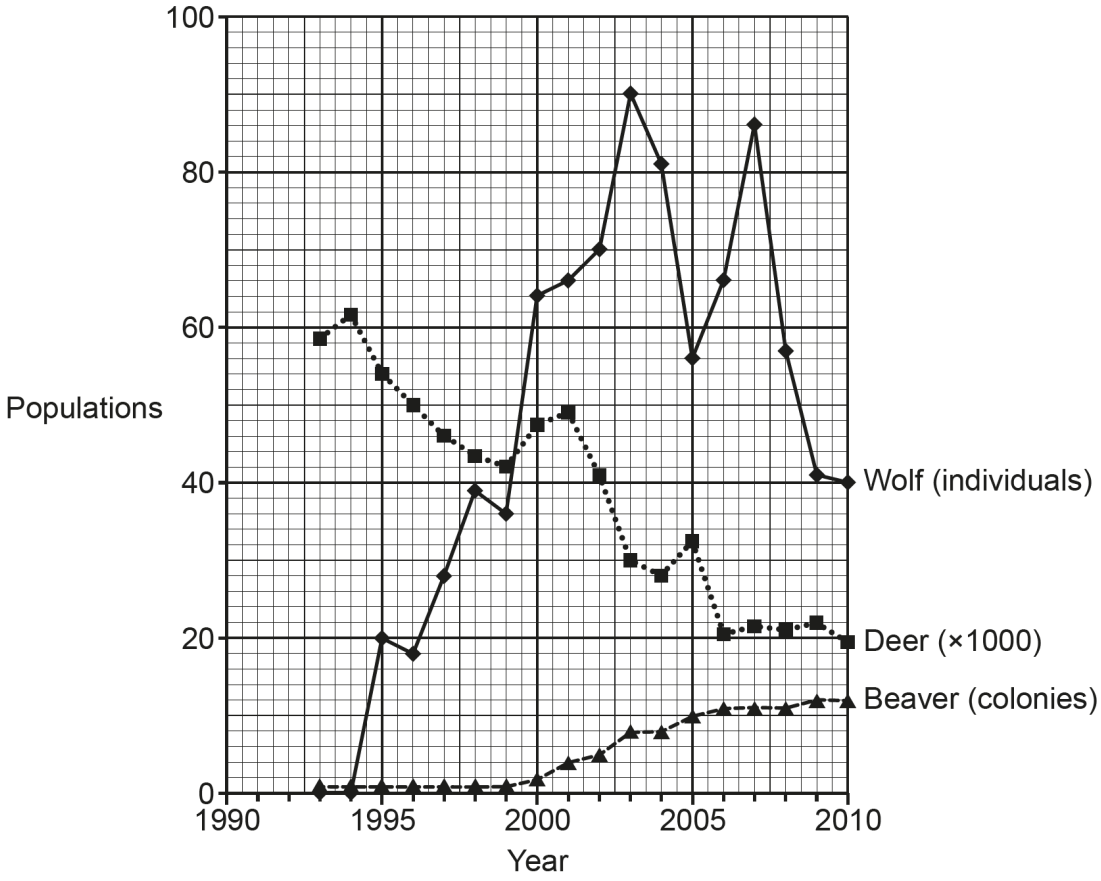
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Question 20 (a)

20 Grey wolves became extinct in an area of North America in the 1920s. In 1993 some grey wolves were reintroduced into the same area.

Grey wolves feed mainly on large herbivores, such as deer.

The graph shows the population of grey wolves and some other species since the reintroduction.



(a) Describe the changes in the deer population since 1993.

.....

.....

.....

.....

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

This question differentiated well between candidates and all marking points were regularly seen. Common responses that did not achieve marks included describing every micro-change in population on an almost year-by-year basis as opposed to giving the 'big picture' (in 6 lines for a total of 3 marks). Other common mistakes included the use of the term 'populations' as a unit of population or quoting the deer population as 20 (rather than 20 000), and explaining, rather than describing, the changes in deer population.

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Question 20 (b) (i)

(b) (i) Calculate the percentage increase in the wolf population between 1995 and 2003.

Percentage increase = ... **[2]**

Most candidates achieved both marks here but significant minorities offered either 450 (using the wolf population in 2003, rather than the increase) or 77.7 (dividing by the 2003 figure). Calculating percentage change is an important biological skill that is regularly tested in examinations and candidates would do well to make sure that they can do it.

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Question 20 (b) (ii)

(ii) Between 2003 and 2010 there were no significant changes in the climate of this area of North America and no disease outbreaks.

Suggest and explain **one** reason for the changes in the grey wolf population since 2003.

.....

.....

.....

.....

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

Although over half of responses gained both marks here, many wrote answers that were inappropriately long for a question worth only 2 marks, particularly as the question directed them to give only **one** explanation. Despite having been told that wolves feed on deer many candidates struggled to find non-obvious and often implausible explanations, such as the arrival of new predator of deer (or even wolves) or the wolf population having emigrated. Candidates were also told that deer are herbivores and wolves were introduced (by humans) so responses suggesting that wolves competed with deer (or badgers) for food or that humans had begun to hunt the wolves, were not credited.

Question 20 (c) (i)

(c) Beavers are mammals that live in water. They form colonies nesting under big mounds of wood set as islands in areas of water.

In 1993 there was one colony of beavers living in the area to which the wolves were reintroduced.

(i) Suggest why the population of beavers is measured in colonies rather than individual animals.

.....

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

Around a quarter of candidates scored this mark but too many offered generic responses, such as 'there being too many to count' without linking their answer to the context provided in the stem of the question.

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Question 20 (c) (ii)

(ii) Scientists have claimed that the reintroduction of the wolves has caused the beaver population to increase.

Evaluate the support given by the evidence in the graph for the scientists' claim.

.....

.....

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.....

.....

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

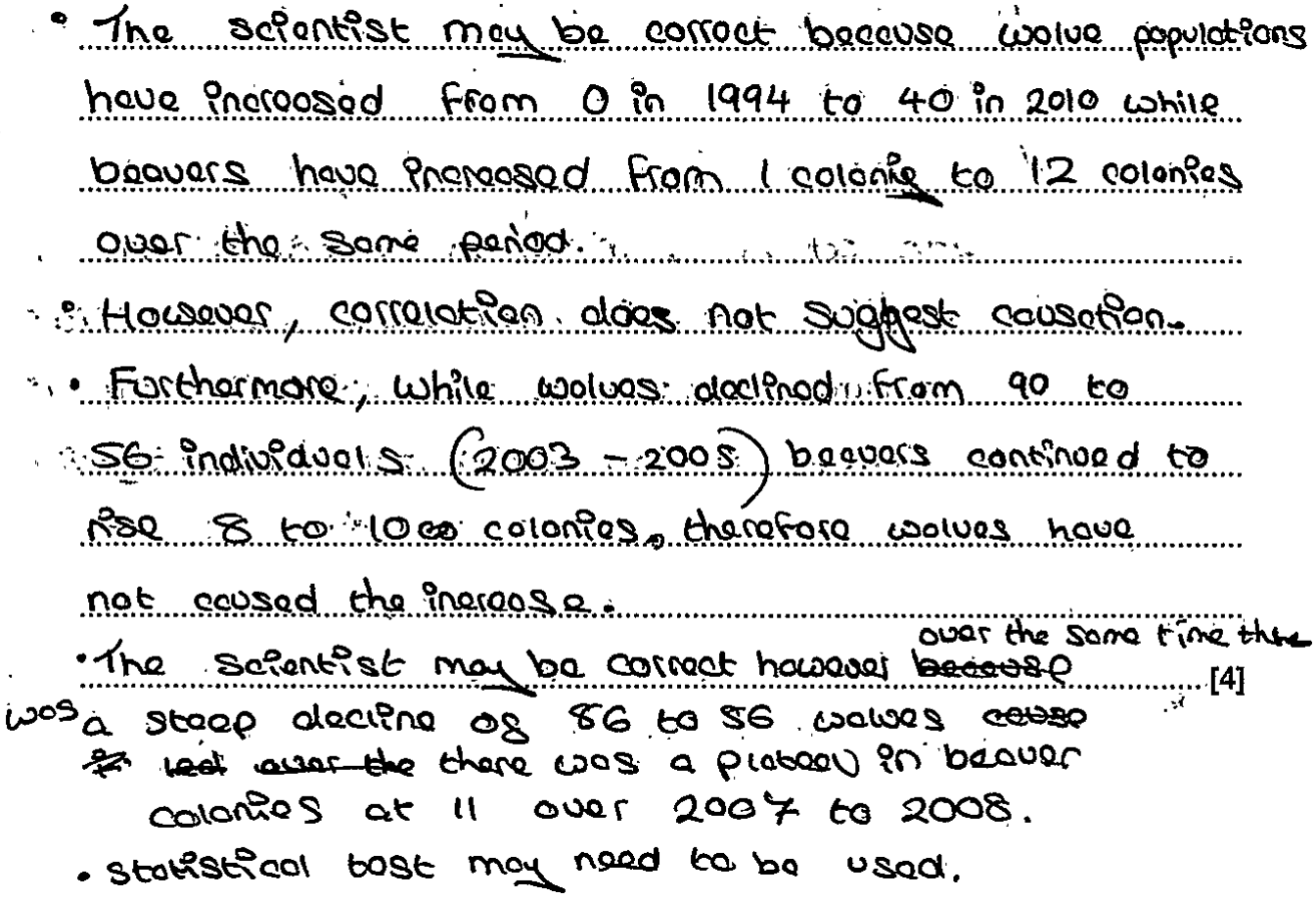
Many candidates knew how to present their answer in a clear format that demonstrated which pieces of evidence they thought supported the claim and which did not.

In support of the claim most candidates cited either a version of the first marking point or the extra guidance version of marking point 2. Very few combined these two points by stating that there was a lag between a rise in the wolf population and a subsequent rise in the beaver population. In fact, many candidates cited a delay between changes in the wolf and beaver population as evidence against the claim, an approach that could still lead to the award of marking point 4. Marking point 3 was seen on only a handful of occasions. Marking point 5 was only creditworthy when it was given in the correct context (i.e., when questioning a claim drawn from an apparent correlation). Marking point 6 was rarely given; when attempted, most responses either did not specify a plausible alternative cause or suggested an implausible biotic factor such as the arrival of a new predator.

A number of candidates attempted to explain the plausibility of the claim and were not credited.

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Exemplar 3



The response in line 1, has a clear statement with figures and achieves marking points 1 and 7. The 'However', in line 5 gives the correct context to the statement that follows (the candidate has been given the benefit of the doubt about the meaning of the word 'suggest') and marking point 5 has been given. The 3rd sentence is clearly in the same context (of not supporting the claim) and so has gained marking point 4.

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Question 20 (c) (iii)

(iii) Beavers build dams in the water using trees they have cut down. Deer damage trees while they are feeding. Wolves often hunt deer that are feeding near water.

The following explanation for the increase in beaver population has been suggested by scientists:

- The presence of wolves causes deer to avoid grazing close to water.
- This means that trees near water are not damaged.
- Beavers have a plentiful supply of trees with which to build dams.

Suggest **one** other piece of useful evidence that could be measured that would support the scientists' claim.

.....

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

A minority of answers achieved this mark, usually for a version of the first or third marking points. Many answers offered something imprecise (e.g. where the deer live) or difficult to measure (e.g. the health of the trees used to build the dams) and some offered explanations rather than evidence.

Question 20 (d) (i)

(d) Beavers are a species that was once native to Britain. The species became extinct in Britain about 400 years ago.

In 2009, a population of beavers was brought from Norway and released into the wild in Britain.

(i) Explain why the reintroduction of beavers to Britain is an example of conservation.

.....

.....

.....

.....

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

Most candidates knew what conservation was and achieved at least 1 mark. Many missed out on a second mark because they used the phrase 'maintain biodiversity', whereas, in the example given, biodiversity is clearly being *increased*.

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Question 20 (d) (ii)

(ii) Suggest a situation in which preservation of a habitat would be necessary.

.....

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

A large minority of candidates achieved this mark but many merely stated an area of the world, e.g. the Galapagos Islands, without further qualification.

Question 21 (a)

21 The element nitrogen is recycled within ecosystems.

(a) Complete the sentences using the most appropriate terms.

When animals die microorganisms convert nitrogen-containing molecules in the animals' bodies to ammonia in a process known as ..... . This ammonia is converted into nitrites and nitrates by ..... bacteria. The bacterium ..... converts ammonia to nitrites and the bacterium ..... converts nitrites to nitrates. Nitrates can be absorbed by plants and converted to ..... . Nitrogen gas is very unreactive but it can enter the nitrogen cycle by being converted to ammonia by ..... bacteria such as *Rhizobium*.

[6]

This question differentiated extremely well between candidates of differing abilities with less than 1 in 10 achieving full marks and slightly more scoring 0 marks. A large minority of candidates couldn't recall the correct bacterial genus and, often, incorrect names such as *Azotobacter*, were seen in place of the others. Candidates were given some leeway with spelling but answers that were clearly not phonetic equivalents of the correct answer were not credited; this included 'nitrogen-fixating'. A number of candidates wrote that a plant might convert absorbed nitrates to 'ammonia' and 'nitrogen', instead of 'proteins'.

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Question 21 (b)

(b) Use your knowledge of the nitrogen cycle to suggest **and** explain why plants do not grow well in soil with a low oxygen content.

.....

.....

.....

.....

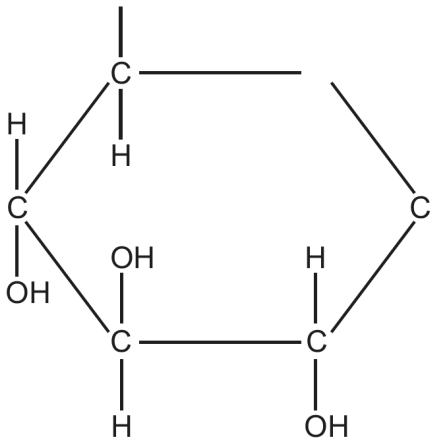
..... **[2]**

Almost half of candidates achieved 1 mark here, usually for describing reduced nitrification or nitrate availability. Only around 1 in 10 candidates realised that denitrification was the key to this question but those that did usually got both marks. Many candidates did not appreciate the significance of the reference to the nitrogen cycle and answered in terms of respiration. A significant number of responses stated that oxygen was needed for photosynthesis.

Question 21 (c) (i)

(c) *Rhizobium* forms nodules on the roots of certain plants. The *Rhizobium* receives a supply of glucose from the plant which the bacterium is able to use.

The diagram below shows an incomplete diagram of the structure of alpha glucose.



(i) Write **on the diagram** to show the complete structure of alpha glucose. **[3]**

This question differentiated well between candidates. Around two thirds got either the 'O' or the groups on 'C_1 ' correct and many candidates got both correct. A smaller proportion got the C_6 group correct but almost half achieved full marks. Some candidates, usually those who didn't perform well on the rest of the paper, achieved 0 marks.

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Question 21 (c) (ii)

(ii) Explain how the structure of glucose allows it to move from the plant to the bacterium.

.....

.....

.....

.....

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

This question was low demand but only half of the candidates scored one mark. Both marking points were seen but more common was the solubility idea. Candidates often stopped after explaining one feature and so the award of 2 marks was rare. Many candidates described the properties of glucose without linking this to the structure.

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