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Examiners' report

BIOLOGY A

H420
For first teaching in 2015

H420/02 Summer 2018 series

Version 1

Contents

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. 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 can be downloaded from OCR.

Paper H420/02 series overview

Many candidates found this paper challenging and certainly the most challenging of the three in the current series; however, it differentiated well between the more able candidates. There was no evidence of candidates running out of time.

Candidates scored well on questions 1, 2, 7, 9, 13, 16(a)(i), 19(c)(ii), 20(a)(iv), 20(c)(i), 21(b) and 22(d).

Candidates generally wrote more concise answers to the Level of Response (LoR) questions this year and fewer used the additional pages available, particularly on question 18. Although using the extra space is entirely valid, 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 onto additional pages often struggle to retain enough coherence to achieve the upper mark within a given level. A number of candidates answered both LoR questions with little or any use of key terms; this was a particular problem in 19ci. Using key terms correctly can be a very effective way of communicating science clearly and concisely and is likely to be helpful, if not essential, in LoR (and other) questions.

The LoRs also highlighted an issue that was common to many other questions. Many responses used fundamental key biological terms or ideas incorrectly, perhaps because candidates are unsure of their meaning. However, examiners inferred that, on many occasions, candidates may well have understood the term but did not take enough care to use it correctly. For example,

- misuse of *optimum* in 19(c)(i)
- confusion of *base* and *amino acid* in 21(a) and 21(b)(iii)
- conflation of *gene* and *allele* in 18, 20(b)(i), 20(b)(iii) and 20(c)(ii)
- misuse of *species* in 18
- misunderstanding of *genetic drift* in 20b(iii) and also 7 and 20(c)(ii)

On a number of questions, for example 20(b) and 20(c)(iii), some candidates appeared to repeat what they knew about a topic rather than answering the question that was asked. Related to this is the issue of context. In the 2017 report for this paper the importance of applying knowledge in unfamiliar contexts was highlighted but many candidates found this difficult on this paper, particularly in 21(c)(ii), 21d and 20(c)(ii). A large number of the questions on the paper tested learning outcomes from AS topics and there was evidence that candidates struggled to display a full grasp of topics learned in year 10, particularly if they were in the context of a Module 6 topic.

The proportion of questions requiring mathematical skill remained at around 10%, as in all A Level Biology papers. Many candidates coped well with the maths skills questions, but some are still omitting units and it is worth reminding candidates to check that their answer makes sense by estimating at least the order of magnitude of the expected answer. Centres can find additional help with maths skills in the OCR Maths Skills Handbook.

Although the answer spaces provided on the paper are meant to suggest an appropriate length of answer, many candidates find it necessary, perfectly reasonably, to continue their answer beyond the space provided. Examiners were pleased that candidates were indicating when an answer extended onto the additional answer space. However, it was again noted that some centres are unnecessarily supplying additional sheets or answer booklets before candidates have 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. It is also essential that such answers are numbered correctly with the full question number, e.g. '20(c)(ii)', not just '(ii)'.

Section A overview

Marks credited for multiple choice questions ranged from 3/15 to 15/15. If it was not clear which letter was the intended answer, either because more than one letter was given or because the letter was written ambiguously, no mark was credited. Where candidates had changed their mind and clearly indicated this on the paper, credit was given where appropriate.

Question 1

1 Which of the following best describes a microscope with *high resolution*?

A The microscope can distinguish structures that are very close together.

B The microscope can view structures that are very small.

C The microscope is capable of high magnification.

D The microscope has an in-built eyepiece graticule.

Your answer ☐ **[1]**

The vast majority of candidates answered this straightforward definition question correctly.

Question 2

2 The image below shows a tardigrade, *Echiniscus granulatus*, viewed from the underneath. The magnification is × 110.

How long is the tardigrade in real life?

A 115 µm

B 1.14×10^{-5} m

C 8.64×10^{-4} m

D 0.116 mm

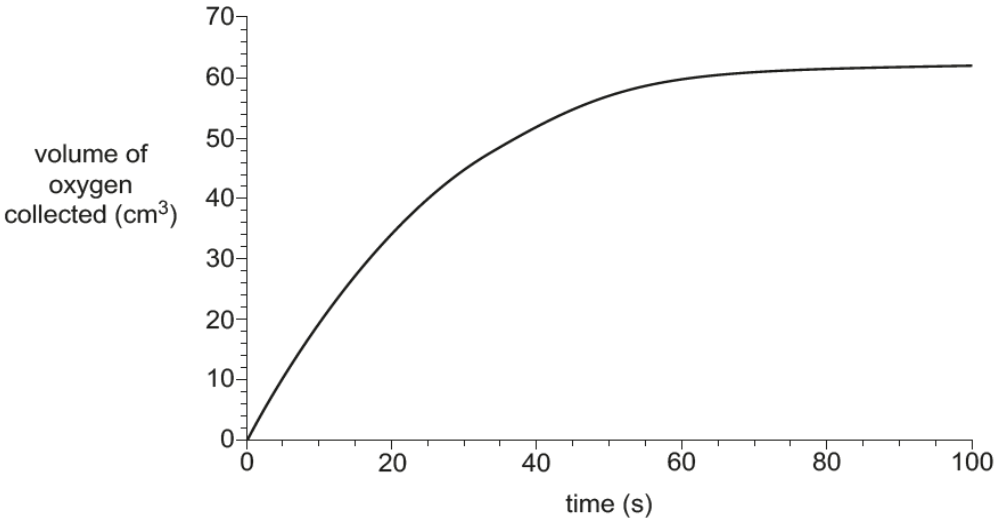
Your answer ☐ **[1]**

Most candidates were able to correctly calculate the real length of the tardigrade and there was often evidence of working shown.

Question 3

3 Celery contains the enzyme catalase, which breaks down hydrogen peroxide into oxygen and water.

A student added liquidised celery to a solution of hydrogen peroxide and collected the oxygen given off by the reaction. The results are shown in the graph below.



Which of the following shows the rate of reaction **at** 30s?

A $0.85\,cm^3\,s^{-1}$

B $1.00\,cm^3\,s^{-1}$

C $1.15\,cm^3\,s^{-1}$

D $1.50\,cm^3\,s^{-1}$

Your answer ☐ **[1]**

Most candidates incorrectly answered D, measuring the rate **over** the first 30 s. Those who drew a tangent **at** 30 s correctly answered A.

Question 4

4 Which of the following processes involves the formation of ester bonds?

1 synthesis of polynucleotides

2 synthesis of triglycerides

3 synthesis of polypeptides

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

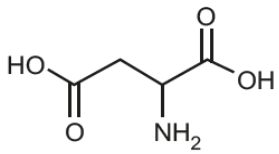
Your answer ☐ **[1]**

Most candidates got this right. Some thought polypeptides contained ester bonds and some were perhaps unaware either that phosphodi**ester** bonds contain esters, or that they are present in polynucleotides.

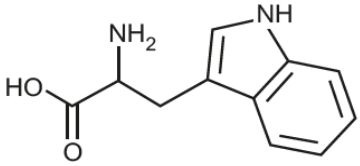
Question 5

5 Which of the following could **not** be an amino acid?

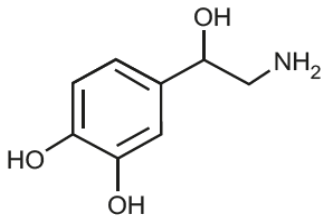
A



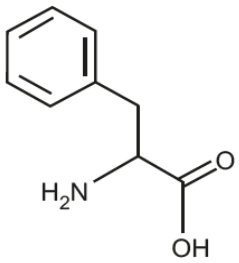
B



C



D



Your answer ☐ **[1]**

Most candidates were able to correctly spot that C did not have a terminal -COOH group.

Question 6

6 Lipids are a diverse group of chemicals that are neither polar nor charged and hence are insoluble in water. The ___(1)___ nature of the heads of phospholipids allows them to form membranes. ___(2)___ also contain fatty acids and form part of the membrane. Lipids can be used for energy storage in the form of ___(3)___. Some hormones are also lipids and they are similar in structure to ___(4)___.

Which row shows the correct sequence of missing words?

	1	2	3	4
A	hydrophilic	glycolipids	triglycerides	cholesterol molecules
B	hydrophilic	triglycerides	cholesterol molecules	glycolipids
C	hydrophobic	cholesterol molecules	triglycerides	bile
D	hydrophilic	cholesterol molecules	triglycerides	glycolipids

Your answer ☐ **[1]**

The most common answer was the correct one, but many candidates answered D, which suggests a misunderstanding about the structure of cholesterol.

Question 7

7 Which of the following statements about antibiotic resistance is correct?

A All antibiotics cause mutations in bacterial DNA.

B Antibiotic resistance in bacteria is evidence to support Darwin's theory of evolution by natural selection.

C The development of antibiotic resistance in bacteria is an example of genetic drift.

D The development of antibiotic resistance in bacteria is an example of stabilising selection.

Your answer ☐ **[1]**

Most responses were correct. The most common misconception was that antibiotic resistance is an example of genetic drift.

Question 8

8 Which of the following antibodies increase(s) the phagocytosis of pathogens?

1 opsonins

2 agglutinins

3 anti-toxins

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

This was correctly answered by most.

Question 9

9 Which of the following describes an autoimmune disease?

A a disease in which an individual's own body cells are antigenic

B a disease in which a pathogen attacks cells of the immune system

C a disease that prevents production of antibodies

D a disease to which an individual has developed immunity

Your answer ☐ **[1]**

This was correctly answered on most scripts but a sizeable minority put B.

Question 10

10 During which stage of the cell cycle does semi-conservative DNA replication take place?

A first growth phase

B prophase

C second growth phase

D synthesis phase

Your answer ☐ **[1]**

Most candidates were able to answer this correctly.

Question 11

11 The cell cycle includes a number of checkpoints.

Which of the following statements about the cell cycle is correct?

A If damaged DNA is detected at a checkpoint apoptosis is triggered.

B If damaged DNA is detected at the G_2 checkpoint the cell cycle is halted and the cell tries to repair the damage.

C If a mistake is detected at a checkpoint the cycle reverts to an earlier checkpoint and is repeated.

D The G_1 checkpoint checks for mistakes in DNA replication.

Your answer ☐ **[1]**

Although on the same topic as Q10, fewer candidates were clear about what happens if damaged DNA is detected and A was a common incorrect response.

Question 12

12 Turtle doves, *Streptopelia turtur*, were once common in farmland in the UK but their numbers have recently been in decline.

Farmers can claim money from the UK government if they farm in ways that encourage the survival of species such as the turtle dove.

Which of the following agreements is/are relevant to the example described above?

1 The Convention on International Trade in Endangered Species (CITES)

2 The Rio Convention on Biological Diversity (CBD)

3 The Countryside Stewardship Scheme (CSS)

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

Most responses were correct but many candidates thought that CITES was involved, possibly due to the reference to endangered species, without recognising the international focus of CITES.

Question 13

13 Bacteria are used in many areas of biotechnology.

In which of the following processes, **A** to **D**, do bacteria **not** play an active role?

A bioinformatics

B bioremediation

C cheese-making

D manufacturing human insulin

Your answer ☐ **[1]**

Three quarters of candidates got this right.

Question 14

14 Mycoprotein is a food produced using the fungus *Fusarium venenatum*.

Which statement about mycoprotein is correct?

A production of protein is slower than in animals and plants

B production is dependent on seasons

C waste products can be used as a substrate

D there are no ethical issues associated with production

Your answer ☐ **[1]**

Around half of responses were correct. A common misconception was to think that there were **no** ethical issues associated with the production of mycoprotein.

Question 15

15 Which of the following statements about ecosystems is **not** true?

A An ecosystem is affected by biotic and abiotic factors.

B An ecosystem is all of the organisms and habitats in a large area.

C An ecosystem is dynamic.

D There is a flow of biomass between trophic levels in an ecosystem.

Your answer ☐ **[1]**

Most responses were correct. There was evidence that some candidates expected to see the term 'energy' rather than 'biomass' and so opted for D. However, 'biomass' is the term used in the specification and so the statement associated with D was true.

Section B overview

Many candidates coped well with the calculation questions but there were some questions in which candidates struggled to apply their knowledge to the context of the question.

Question 16(a)(i)

16 Fig. 16, **on the insert**, shows 6 onion cells at various stages of mitosis.

(a) (i) Name the stage of mitosis shown in cell **A**.

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

Almost all candidates got this right. A few wrote prophase or anaphase.

Question 16(a)(ii)

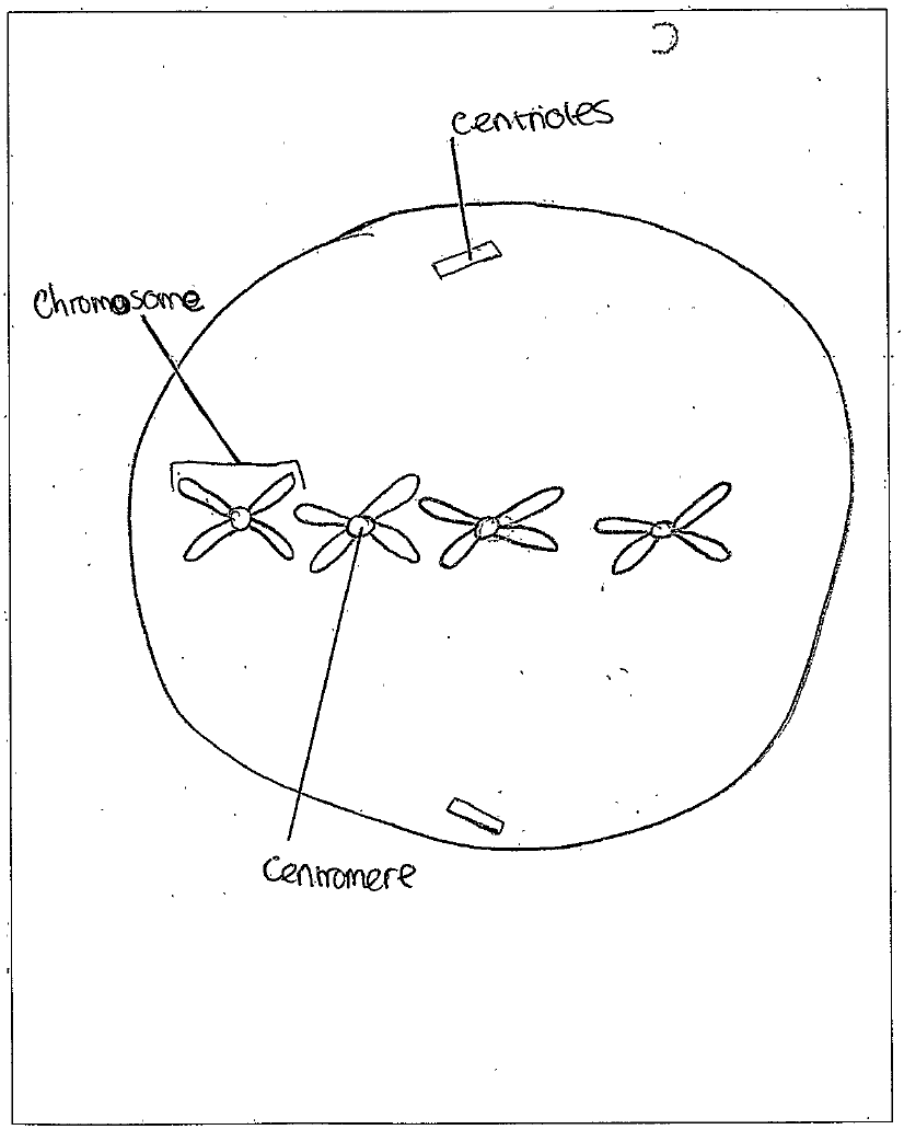
(ii) In the space provided below draw cell **A**. Label your drawing to show visible features.

[4]

The quality of diagrams was very variable. Less than 1 in 5 candidates achieved full marks.

Although most diagrams were large enough, many candidates drew a generic textbook-style image of metaphase with no attempt to draw the chromosomes visible on the insert. Chromosomes were too often drawn as single lines and candidates often added in structures that they could not see but assumed to be there, e.g. spindle fibres and centrioles. Structures were usually labelled correctly but many candidates did not use a ruler or used label lines with an arrowhead. Many candidates omitted to label the cytoplasm. Very few responses mentioned colour in the annotations and those that did had often achieved the other 4 marks anyway.

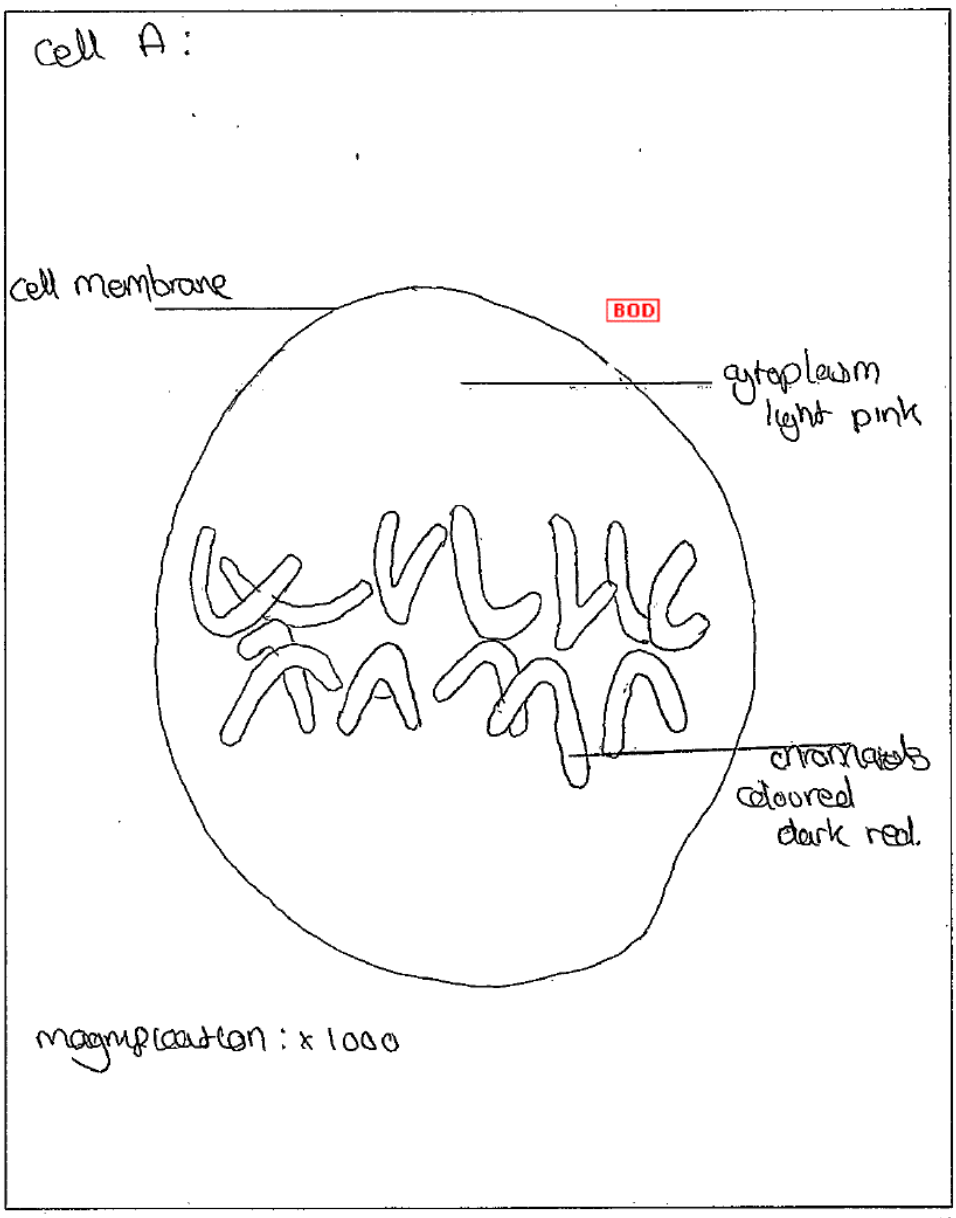
Exemplar 1



[4]

The candidate has drawn textbook-style chromosomes at metaphase rather than attempting to copy the image provided so marking point 1 has not been credited. A careless error in the membrane near the top of the diagram has meant that the second marking point has also not been given. The 1 mark credited was for drawing ruled label lines.

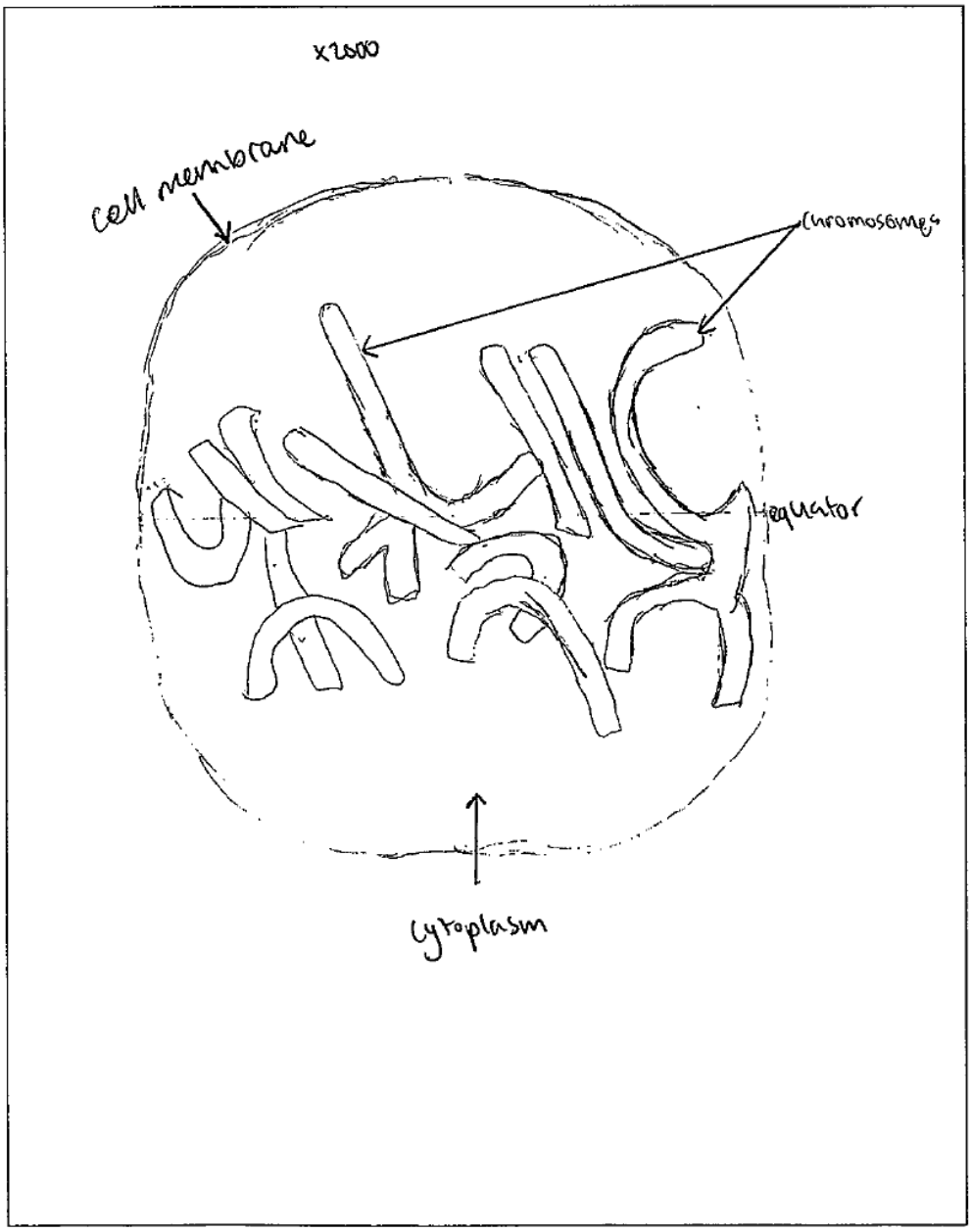
Exemplar 2



[4]

This response achieves 5 marking points and full marks.

Exemplar 3



[4]

This response achieves marking points 1 and 4. Marking point 2 has not been credited because the lines are not clear and continuous and marking point 3 has not been credited because the label lines have arrowheads.

Question 16(b)(i)

(b) (i) The volume of cell **A** is $5.4 \times 10^4 \mu m^3$.

Assume that cell **B** is spherical.

Calculate the volume of cell **B**.

Use the formula: volume of sphere = $\frac{4}{3}\pi r^3$

Give your answer in standard form in μm^3.

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

Around half of candidates could apply the scaling formula correctly and most did answer in standard form. However, many candidates appeared to struggle with converting units, or measuring using the correct units, and answered with incorrect and implausible orders of magnitude. Many candidates did not appear to realise that their answer should be quite close to the size of cell A, which was given.

Question 16(b)(ii)

(ii) State the type of microscope that was used to view these images. Justify your answer.

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

Most candidates were aware that it was a light microscope and then achieved 1 or 2 marks, usually for reference to magnification or colour. A number of uncredited responses mentioned the cells being alive, which was not obvious from the image, or the 2D nature of the image, which is not an exclusive feature of light microscopes. A number of candidates incorrectly identified the electron microscope as the source of images and a small minority suggested laser scanning confocal microscopes.

Question 16(b)(iii)

(iii) Mitosis is involved in growth and repair of tissues.

State **two** other roles of mitosis in multicellular organisms.

1 .....

2 .....

[1]

This question required candidates to bring together their learning from different areas of the specification. Many candidates were able to give asexual reproduction as a response but most struggled to find a second example. Body plan and clonal expansion were the most common additional creditworthy responses.

Question 17(a)(i)

17 Penguins are flightless birds that eat fish. Most species of penguin live near the coast of Antarctica or on the many islands that surround Antarctica.

Fig. 17 shows the populations of three penguin species on an island off the coast of Antarctica.

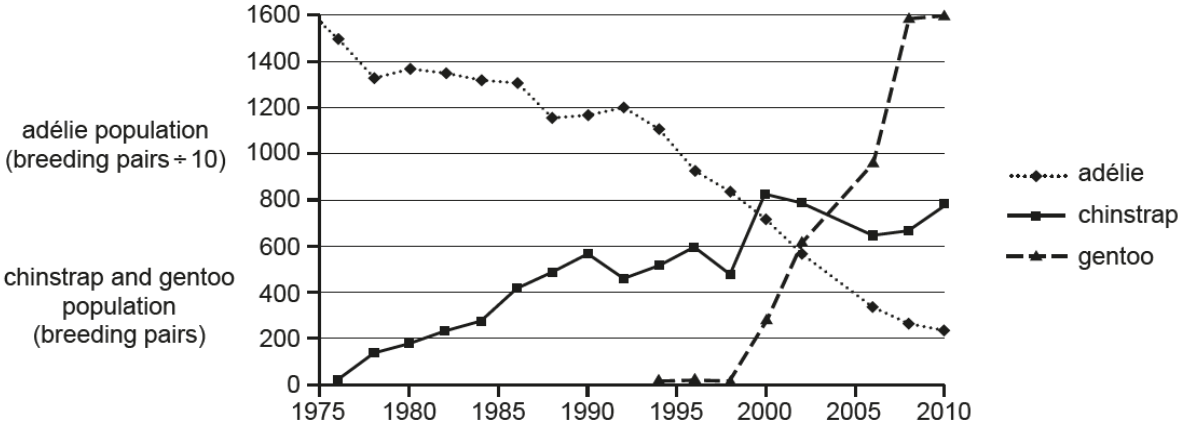

Fig. 17

(a) (i) Before 1975 the only penguin species on the island was the adélie penguin. Chinstrap penguins were first recorded on the island in 1976.

The changes in the chinstrap penguin population are not directly related to abiotic factors.

Suggest explanations for the changes in the population of **chinstrap** penguins between 1976 and 2010.

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

Most candidates achieved 2 out of the 3 available marks with a smaller number achieving all 3. Marking points 3 and 4 were commonly credited, 5 and 6 less so, 1 and 2 rarely. The question tested the skill of interpreting and explaining graphs. Candidates who did not make it clear which part of the graph their explanation referred to did not receive any credit. Thus, for example, 'there was plenty of food available' might hint at an explanation for the first part of the graph but unless this was explicitly linked to the increase in chinstrap numbers no mark was credited. A large number of candidates were content to offer an explanation for only the increase in chinstrap population and so did not access the final two marking points.

Question 17(a)(ii)

(ii) Calculate the mean annual decrease in the **adélie** penguin population between **1988** and **2010**.

Show your working. Give your answer to **three significant figures**.

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

This calculation proved problematic for many candidates. Many found the y-axis difficult to interpret and very few attempted to give units. A good proportion of responses gave answers as a percentage decrease rather than the mean annual decrease as asked for.

Question 17(b)(i)

(b) Adélie penguins need a habitat that contains sea-ice. Gentoo and chinstrap penguins can survive without access to sea ice.

Scientists have claimed that the population changes in the three penguin species on the island suggests that the Antarctic temperature is increasing.

(i) Discuss whether the information in Fig. 17 supports the scientists' claim.

You should refer to the data in Fig. 17 in your answer.

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

This AO3 question tested the candidates' ability to assess whether a claim was supported by evidence presented and, as such, answers that did not mention whether or not the evidence supported the claim were unable to gain marks. However, 2 marks were commonly credited, usually for good descriptions of supporting evidence with figures. When discussing whether evidence supports a claim, candidates are expected to consider both sides of the argument, but most responses did not address reasons why the claim might not be supported. Those that did often did not suggest a plausible reason that would be consistent with the evidence presented – merely stating, 'there could be other factors'. A few were able to clearly express the idea that correlation does not imply causation.

When asked to discuss whether evidence supports a claim, or to evaluate the support given by evidence to a claim, candidates are advised to consider reasons that support and reasons that do not support the given claim.

Exemplar 4

You should refer to the data in Fig. n your answer.

The information supports the claim as from 1992 to 2010 the population size of adélie penguins is decreasing which suggest that the temp in antarica is increasing as ice is melting and the penguins are dying. The population however decreases by 930 breeding pairs ÷ 10 however for chinstrap and gentoo penguins there population as a whole increases by 370 and 1680 breeding pairs respectively. This is because these penguins are not reliant on sea ice so when temp increases and ice melts, their population size doesn't change. [3]

This typical response achieves two marks easily for explaining how the evidence supports the claim but fails to address why the evidence might not support the claim.

Exemplar 5

adeli dec. other inc

You should refer to the data in Fig. 17 in your answer.

On one hand

Yes the data supports the scientists claim. He states that adelie penguins need a habitat containing ice and with climate change, temperatures increase melting the sea-ice. As a result, the population of adelie penguins is reducing eg in 1955, the population was 1300 (breeding pairs) but in 2010 this had decreased dramatically to around 240. a total decrease of 1378 00000's. In addition, the both the chinstrap and gentoo species have continued to increase. They are not affected by sea-ice however. Nonetheless, this decrease in adelie could be as a result of another factor not climate change eg parasitism. The adelie species might not be resistant to a pathogen which both the other penguin species are. [3]

left factor other than ice.

This response addresses both sides of the argument and achieves full marks.

Exemplar 6

Both the chinstrap and gentoo population increase whereas when the adelie population decreases due to less competition. Although overall the adelie population decreases it still fluctuates. For example, in 1978 it increases from 1360 to 1380 but then at in 1988 it decreases again to 1150 showing another factor could be affecting the population

[3]

This response correctly mentions an increase in chinstrap and gentoo and a decrease in Adélie penguins but it does not link these statements to supporting the claim.

Question 17(b)(ii)

(ii) Scientists working in the local area monitored water temperatures and populations of other water animals around the island between 1976 and 2010.

Suggest **two** further pieces of evidence that the scientists might have found to support their claim.

1 .....

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2 .....

.....

[2]

This AO3 question was generally low scoring. Most candidates stated the type of evidence that might be available but, as the question asked for evidence that would *support* such a claim, plausible answers had to be in the context of a *change* from previous levels. Hence, 'extent of sea ice' did not get a mark but 'reduced sea ice' did. Many candidates repeated information given in the stem about water temperature or water animals, not recognising the significance of 'further' in the question.

Question 18*

18* For centuries, artificial selection has been used to improve the quality of crop plants used for human consumption.

Explain, with reference to selective breeding, why it is important to maintain viable wild populations of crop plant species.

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

Most candidates gave answers that indicated they had a good understanding of the problems associated with selective breeding, i.e. that selection of desired characteristics results in reduced genetic diversity. Most were then able to exemplify the consequences of a reduced gene pool in terms of susceptibility to the same disease. Fewer candidates were able to show that they understood that the existence of a wild variety of the same species could alleviate this problem. Only occasionally did responses include discussion of potential environmental changes that may happen in the future, to which the resource of alleles in the wild population of plants may provide a solution.

It was noted by examiners that, when discussing selective breeding, many candidates displayed a fundamental misunderstanding of a lot of related biology. Commonly seen errors included: conflating genes with alleles, referring to resistance as immunity, suggesting that selective breeding caused mutations, conflating genetic diversity and biodiversity and misuse of 'species' to mean 'variety'. Such responses often meant that the upper mark within a level could not be credited and sometimes limited the level that the response was able to access.

Many answers included a lot of irrelevant material about ethics, aesthetics and medicinal drugs and were therefore unable to access the upper mark within a level.

Question 19(a)

19 Two students investigated the growth of bacteria at different temperatures.

Three flasks containing identical solutions of nutrient broth were used.

- Flask 1: inoculated with 1 cm^3 of broth containing the bacterium *Bacillus subtilis* and incubated at 20 °C.
- Flask 2: inoculated with 1 cm^3 of broth containing *B. subtilis* and incubated at 30 °C.
- Flask 3: inoculated with 1 cm^3 of broth containing no bacteria and incubated at 30 °C.

Aseptic techniques were used throughout.

At set times over the next 3 days the students removed samples from each flask and measured the number of viable bacteria present.

(a) State one further variable the students should have controlled in their investigation in order to produce **valid** results.

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

Most candidates were aware that conditions ought to be as similar as possible and around half achieved a mark by stating one of marking points 2 to 5. As usual in these questions, the vague word 'amount' did not achieve any credit. Irrelevant responses such as 'size of flask' and 'light' were seen but received no credit. Some candidates described a control sample and gained no credit.

Question 19(b)(i)

(b) The students used the following procedure to determine the number of viable bacteria in each flask at a given time.

From each flask, 0.1 cm^3 was removed and mixed with 9.9 cm^3 of sterile water in a test tube. This was labelled **Tube A**. A serial dilution then proceeded, as shown in Table 19.1.

Tube	Contents	
B	1 cm^3 of Tube A mixture	9 cm^3 of sterile water
C	1 cm^3 of Tube B mixture	9 cm^3 of sterile water
D	1 cm^3 of Tube C mixture	9 cm^3 of sterile water
E	1 cm^3 of Tube D mixture	9 cm^3 of sterile water
F	1 cm^3 of Tube E mixture	9 cm^3 of sterile water

Table 19.1

From each tube, A–F, 0.1 cm^3 of mixture was cultured on nutrient agar for 24 hours at 30 °C.

The results from Flask 2 after 7 hours of incubation are shown in Fig. 19.

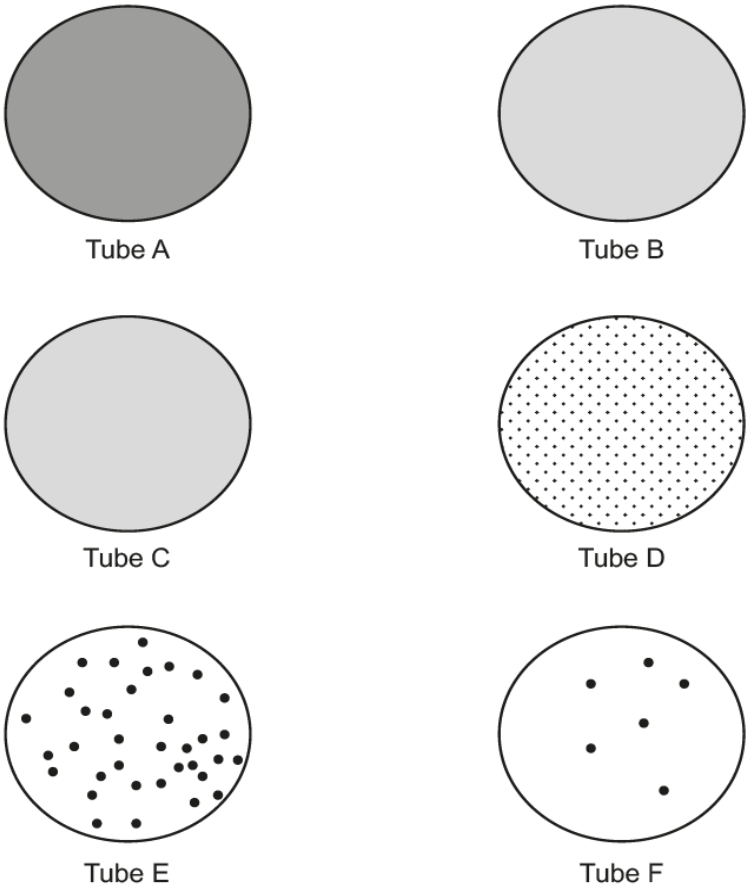

Fig. 19

The students used Tube F to calculate the number of viable bacteria present in the original sample.

(i) Use Tube F to calculate the number of viable bacteria present in the original 0.1 cm^3 sample from Flask 2 after 7 hours of incubation.

Give your answer in standard form.

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

Less than 20% of responses achieved both marks. Candidates fell into one of two similarly-sized groups: those who clearly knew how to calculate number of bacteria and were either correct or out by a factor of 10 or 100, and those who did not know how to approach the calculation at all. Some candidates ignored the instruction to write the answer in standard form and so were limited to 1 mark.

Question 19(b)(ii)

(ii) The students disagreed about which tube's result to use as a starting point for their calculation.

Discuss whether the petri dish resulting from Tube F was the most appropriate for them to use.

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

Most candidates gained at least 1 mark but it was rare for a response to achieve all 3. Many candidates thought that F was the most appropriate and this limited their score to 1 mark. Candidates who discussed reasons why F might not have been the best tube often achieved a mark for discussing diluting error or marking point 3 in some form. However, many such candidates seemed reluctant to clearly state that E would have been the best tube to use. Marking point 2 was rarely credited because few candidates used the word 'colonies'. A significant minority of candidates seemed to think that E would be inappropriate because someone might make a mistake when counting; such responses were not credited. Candidates are advised that answers to practical questions that cite avoidable human error are not likely to attract marks.

Exemplar 7

It was the most appropriate to use because it had to smallest and most clear amount of bacteria which decreases the chances of human error, it was also easier to check and recalculate from tube F due to the small bacteria population present, less time consuming and more appropriate. [3]

This is an example of a response that suggests that human counting error is the main concern when selecting which tube to use and hence achieves no marks. Typically, this type of response often achieved marking point 6 but this one does not explicitly state that the colonies in tube F are countable, hence the omission mark, so no marks were credited.

Question 19(c)(i)*

(c) The processed results from the students' investigation are shown in Table 19.2.

Time after incubation started (hours)	Number of viable bacteria present in Flask 1 at 20 °C	Number of viable bacteria present in Flask 2 at 30 °C
0	7.0×10^2	7.1×10^2
2	6.8×10^2	7.4×10^2
4	4.7×10^4	2.5×10^6
8	6.5×10^7	9.2×10^{10}
12	2.4×10^9	1.8×10^{11}
18	7.8×10^{10}	1.8×10^{11}
24	9.2×10^{10}	5.5×10^8
36	8.6×10^{10}	4.2×10^4
48	6.0×10^9	6.7×10^2
60	5.7×10^7	5.2×10^2
72	1.3×10^5	3.1×10^2

Table 19.2

(i)* Using the information in Table 19.2, compare and explain the patterns of growth seen at 20 °C and at 30 °C.

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

Some candidates achieved Level 3 for this question but Level 1 was the most commonly credited. In order to achieve Level 3 a response needed to make clear comparative statements about both curves and to explain the reasons for differences between the two temperatures using key A Level terminology.

Most candidates compared the curves but responses that were credited lower level marks often displayed a sequential, narrative style which could not really be considered a comparison. Equally, many candidates did not even attempt to *explain* differences as so were limited to Level 1.

Descriptions of phases provided an opportunity for candidates to display their ability to use technical terms but a sizeable minority of candidates did not take this opportunity, often referring to a 'growth in numbers', without reference to the term 'lag phase', for example. While some, usually Level 3 responses, did offer relevant explanations at an appropriate standard, many responses merely explained the phases of a bacterial growth curve, without reference to the data provided in the question. Some attempts at explanation did not raise the level of an answer because of basic errors when discussing enzymes.

Enzyme action is frequently assessed in biology examinations. With reference to common errors, candidates are reminded of the following: the term 'optimum temperature' applies to enzymes, not bacteria; it is reasonable to describe enzymes or molecules as having 'more kinetic energy' but not bacteria; and the death phase of a growth curve does not cause, nor is a result of, denaturation of bacterial enzymes.

Exemplar 8

At The pattern of growth at 20°C was slower at a slower rate and produced fewer bacteria at its holding carrying capacity.
The lower bacteria reproduced faster at 30°C due to it being closer to their optimum growth conditions, resulting in a shorter lag phase and faster log phase, reaching their carrying capacity 12 hours faster than at 20°C. This was due to metabolic reactions happening at a faster rate due to conditions being optimum for enzyme activity resulting in more successful collisions for reactions. So the bacteria could reproduce faster at 30°C. However the decline phase in the bacteria at 30°C began sooner than at 20°C (around 24 hours) due to the population growing faster. So nutrients running out faster, thus leading to greater competition, thus resulting in the production of more toxic secondary metabolites at 30°C, resulting in a greater decline rate. [6]

L2

The main differences between the two temperatures are described using key terms and there are multiple explanations for the differences between the temperatures. The response is coherent, relevant and uses A Level scientific terminology.

Question 19(c)(ii)

(ii) No bacteria were detected at any time in the flask that was inoculated with nutrient broth that did not contain bacteria.

Explain the purpose of this flask.

.....

.....

.....

.....

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

Most could establish it was a control, although some confused this control with a control variable or control group. Many were able to link this to the idea of checking for unintended bacterial growth. The context should have clearly signalled the idea of contamination so, on this occasion, responses that gave generic answers about comparisons were not credited.

Question 19(c)(iii)

(iii) The teacher told the students they should not investigate the growth of bacteria at 35 °C.

Suggest why the teacher told them not to grow bacteria at 35 °C.

.....

.....

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

About a third of candidates achieved this mark. Incorrect responses often referred to enzymes denaturing (which is unlikely at 35°C) or rapid uncontrollable growth.

Question 19(c)(iv)

(iv) The teacher also suggested that the students should have carried out the investigation using three flasks at each temperature.

Explain how this suggestion would have improved the students' investigation.

.....

.....

.....

.....

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

Correct use of the term 'repeatable' and appropriate use of 'accurate' were able to gain credit as part of a correct explanation; in the context of this question, 'valid' was not relevant. Help with the correct use of the language of measurement is available in the OCR Practical Skills Handbook. Most responses achieved one mark, usually for reference to the idea of repeatability. All marking points were credited, but marking point 2 was by far the most frequently credited.

It is worth reminding centres that discarding results purely on the basis of their being different from the mean is a very questionable practice. Anomalous results should only be excluded if there is a clear explanation for why they occurred. If not, while they might trigger further replicates or affect the outcome of a statistical test, they ought to be included in any calculated means. Replicates will, however, minimise the impact of any outlying data on those means.

Question 20(a)(i)

20 The cheetah, *Acinonyx jubatus*, is a member of the cat family, Felidae.

Cheetahs display less intraspecific variation than other members of the family Felidae.

Fig. 20.1 shows the mean body length of a population of cheetahs from southern Africa.

The error bars on Fig. 20.1 show the standard deviation of mean body length.

Fig. 20.1

(a) (i) At between 2.5 and 4 years old, the mean length of female cheetahs is less than that of males.

Calculate how much shorter than males female cheetahs are.

Show your working. Express your answer as a percentage to **two significant figures**.

Answer ..... % **[2]**

Most candidates scored on this question, either getting the full 2 marks for 4.7 or getting one mark for 4.8 or 4.9 as a result of dividing by the female length rather than the male. The majority of candidates answered to 2 significant figures as instructed.

Question 20(a)(ii)

(ii) Using only Fig. 20.1 and your answer to **(i)**, what can be concluded about the **significance** of the difference between the length of male and female cheetahs aged between 2.5 and 4 years?

Explain your answer.

.....

.....

.....

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

Less than 1% of candidates gave the full correct answer, i.e. that, without performing a statistical test, nothing can be concluded. However, around a third of responses gained 1 mark by stating that the difference was probably not significant because the error bars overlapped. Although not strictly true, this approach is obviously being taught by centres.

Many responses included phrases like 'low significance' or 'not very significant'. These largely meaningless terms gained no credit. Candidates are advised to stick with the absolute term: the difference is or is not significant. A number of candidates confused the percentage difference in height (4.7%) with the 5% probability used to determine significance and gained no marks.

Question 20(a)(iii)

(iii) A student looked at Fig. 20.1 and wrote:

"The longest male cheetah that was measured was 1.52 m long".

Explain whether the information in Fig. 20.1 supports the student's answer.

.....

.....

.....

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

Around half of responses stated, correctly, that the information did not support the candidate's answer and a majority of these gained a mark. A minority, however, believed that the reason the candidate's answer was not supported was that the mean length was that of the longest cheetah. The other half of responses incorrectly stated that the information did support the candidate's answer, usually because they interpreted the error bars as range bars.

Question 20(a)(iv)

(iv) State the likely causes of variation in body length in cheetahs.

.....

.....

.....

.....

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

About half of responses achieved 2 marks. However, many wrote unnecessarily long explanations. The command word 'state' ought to have directed candidates to answer quickly with short, direct, statements. On this occasion a three-word answer 'genes and environment' easily achieved both marks. Many candidates missed the significance of the context of the question, i.e. that body length displays continuous variation and that any contribution from genes is likely to be minimal in the relatively genetically homogenous cheetah population; hence, answers that focussed on genetic variation alone achieved no credit. Responses that did not answer the question, such as lengthy discussions of the potential advantage of longer body length in males, received no credit.

Question 20(b)(i)

(b) The population of cheetahs has been declining for the past 100 years and is estimated to be between 6000 and 7000.

Within the remaining cheetah population, intraspecific genetic diversity is very low.

One isolated population of cheetahs in Iran has fewer than 100 individuals.

(i) State one way in which genetic diversity can be measured.

.....

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

Less than 1 in 4 responses achieved this relatively straightforward AO1 mark.. Some candidates appeared to miss the significance of 'genetic' and suggested various sampling techniques or Simpson's index of diversity. Others appeared to attach little significance to 'diversity' and described DNA sequencing techniques or the Hardy-Weinberg principle.

Question 20(b)(ii)

(ii) It is thought that the modern cheetah population has low genetic diversity because the population, relatively recently, experienced a genetic bottleneck.

Explain why a genetic bottleneck can lead to low genetic diversity.

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.....

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

This was a relatively low scoring question. Most responses did not address the question that was asked but rather attempted to explain what a genetic bottleneck was or to discuss the consequences of low genetic diversity. Those candidates that did address the question usually achieved 1 mark, often for referencing the loss of alleles when the population crashed. However, some such responses did not achieve this mark because of imprecise references to reductions in allele frequency, rather than number of alleles or because of conflation of 'genes' with 'alleles'. Fewer candidates discussed the idea that the modern population were all descended from the diminished original. Some responses hinted that candidates thought the genetic bottleneck had occurred within the last 100 years, perhaps misunderstanding the significance of 'relatively recently' in terms of the existence of the species.

Question 20(b)(iii)

(iii) Scientists are concerned about genetic drift in the remaining cheetah populations.

Explain why genetic drift is likely to be of particular concern in the population of 100 cheetahs in Iran.

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.....

.....

.....

.....

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

Genetic drift seems to be poorly understood on the part of candidates. Many responses appeared to confuse genetic drift with speciation or inbreeding depression; others discussed the decreased likelihood of meeting another cheetah. Around a quarter of responses achieved 1 mark and very few scored both. Some of the candidates that appeared to know what genetic drift was went no further than stating that genetic drift affects small populations, which added little or nothing to the information given in the question.

Question 20(c)(i)

(c) Madagascar is a large island off the coast of Africa that once formed part of the mainland.

The fossa, *Cryptoprocta ferox* is the top predator on Madagascar.

The fossa shares many physical similarities with cats but it is not a member of the family Felidae. It is related to the mongoose.

The mongoose is a much smaller mammal that lives on the African mainland.

Fig. 20.2 shows a fossa and a mongoose.

Fig. 20.2

(i) The mongoose is a smaller mammal and also has proportionally longer fur. State **one** other difference, **visible in Fig. 20.2**, between a fossa and a mongoose.

.....

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

The vast majority of candidates achieved this mark. Some were even able to correctly refer to proportional sizes. Those few responses that did not gain a mark tended to refer to differences not visible in the figure or vague differences in body shape.

Question 20(c)(ii)

(ii) When the island of Madagascar became separated from the African continent, there were no members of the cat family, Felidae, on the island.

Outline how a fossa could have evolved from a much smaller, mongoose-like ancestor.

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

This question differentiated well between candidates of differing abilities and two marks were most commonly scored. The best responses outlined the natural selection of cat-like features using technical terms. Many responses were not credited marks because they did not use the term 'alleles' correctly. Some conflated 'alleles' with 'genes' while others merely referred to traits, characteristics or features. Answers that ignored the context completely struggled to gain full marks as generic references to selection pressures or survival of the best adapted were not credited without a link to the Madagascar/fossa-like context. A minority of responses did not address the question, which the evolution of the fossa, and devoted their entire answer to issues of speciation, gaining little credit. Use of the A Level key term, 'directional selection', was rare.

Exemplar 9

There was a random mutation of a gene, producing an advantageous characteristic, when a selection pressure was applied, the animals that showed the advantageous characteristic survived, reproduced and passed its advantageous characteristics onto the next generation; over time the allel frequency of the characteristic increases leading to a formation of a new species

[4]

This response ignores the context of the question and simply discusses natural selection in generic terms. One mark has been credited for discussing mutations but, although the response alludes to marking points 2 and 4, as these are context-dependent, the marks have not been given.

Exemplar 10

Population isolated and under different environmental selection pressures. Gene mutation in an individual which cause them to be larger is considered an advantageous characteristic (move faster to catch food etc) so they are more likely to survive and pass on allele to offspring, overtime the allele frequency changes so that fossa are evolved [4]

This response achieves full marks for the following marking points: 2 – recognising the context of an environment different from the African mainland, 3, 4 – recognising the context of a vacant large predator niche, and 5.

Question 20(c)(iii)

(iii) Islands, such as Madagascar, often have species that are different from those on the nearest land mass because they are reproductively isolated.

State **three** other conditions that must be present in order for speciation to occur.

1 .....

2 .....

3 .....

[3]

This question was poorly answered with many candidates failing to appreciate the significance of 'other' in the question and, hence, listing methods of reproductive isolation. Mutation and different environmental conditions were the most commonly seen correct answers but references to natural selection and time were rare.

Question 21(a)

21 Fred Sanger developed an effective DNA sequencing technique in 1977.

(a) Define the term *DNA sequencing*.

.....

.....

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

About half of responses were credited the mark for this straightforward definition. Candidates who used the irrelevant term 'base pairs', or who suggested that DNA was made of amino acids, received no credit. Some responses misinterpreted the question and attempted to describe the process of DNA sequencing. Occasionally, these responses included an accidental definition and gained a mark.

Question 21(b)

(b) The speed at which DNA can be sequenced has been increasing rapidly since the introduction of DNA sequencing.

The length of DNA that can be sequenced in a given time is measured in base pairs or kilobase pairs.

In 1980, the speed at which DNA could be sequenced by a single machine was approximately 500 **base pairs** per hour. In 2016 that speed had increased to approximately 50 million **kilobase pairs** per hour.

Calculate how many times faster the speed of DNA sequencing is in 2016 compared with 1980.

Answer ..... times faster **[2]**

Candidates performed better on this than on other calculations and many answered in standard form. It is noteworthy that answers presented in standard form, although not required, were less likely to be accidentally out by a factor of 10.

Question 21(c)(i)

(c) One technique that has allowed the speed of DNA sequencing to increase has been the development of nanopores.

Fig. 21 shows how nanopores can be used to sequence DNA.

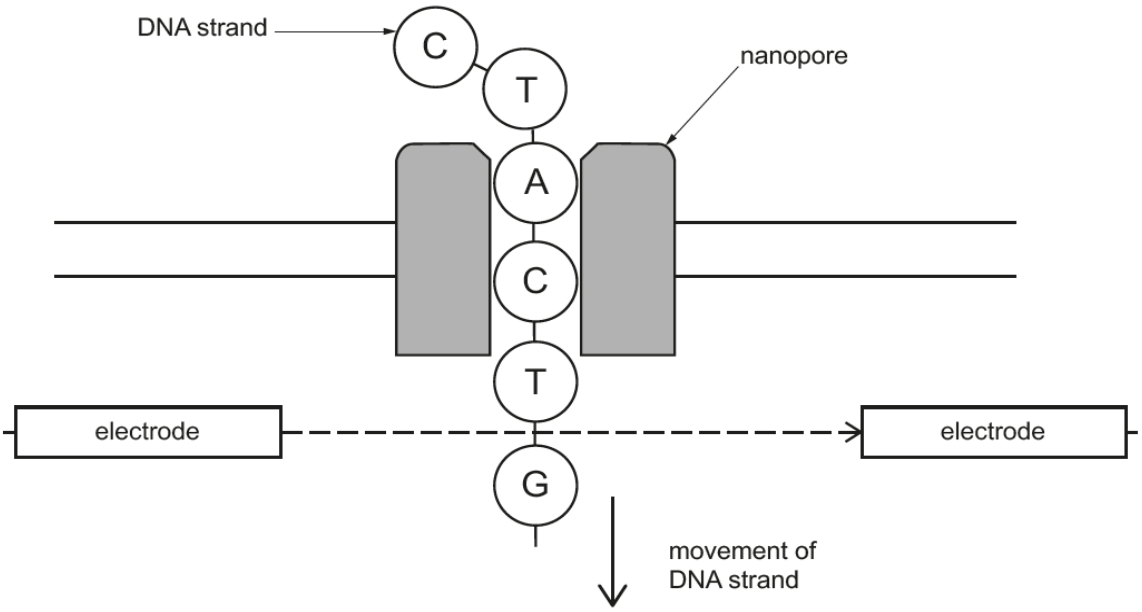


Fig. 21

(i) State one development, other than nanopore technology, that has led to an increase in the speed at which DNA can be sequenced.

.....

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

A correct answer was seen only in about a quarter of responses; of those, pyrosequencing was the most common, although all others were seen occasionally. Common incorrect responses included 'PCR', 'electrophoresis' and 'use a computer'.

Question 21(c)(ii)

(ii) Part of Fig. 21 is labelled **G**.

Use the table below to identify two differences between the part labelled **G** and the structure of a molecule of ATP.

	G	Molecule of ATP
Difference 1	....	....
Difference 2	....	....

[2]

This AO2 question had very few candidates achieve full marks. A majority of candidates gained 1 mark but less than a third scored both. Many candidates were confused by the context: some answers suggested that candidates thought G was DNA. Many candidates thought that G was guanine. Such responses could gain the first two marking points but tended not to as the third marking point was the one most commonly attempted. The final marking point was never seen. Only a small minority of responses did not write comparative structural aspects in the same row. Those who, for example, wrote 'guanosine' next to '3 phosphates' in the same row could not be credited.

Question 21(c)(iii)

(iii) Explain how DNA sequencing allows the sequence of amino acids in a polypeptide to be predicted.

.....

.....

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

Surprisingly few responses scored marks here. Those that did were most likely to be credited a mark for the idea that 3 bases represents the code for one amino acid. Linking the base sequence to the amino acid sequence was less common. Many responses gave detailed descriptions about DNA sequencing and appeared to be answering the question 'Describe DNA sequencing'. Candidates are reminded to read the question carefully. Of those candidates who had read the question carefully, many confused bases with amino acids.

Question 21(d)

(d) DNA sequencing can be used to determine the genome of an entire organism.

The first organism to have its entire genome sequenced was a virus.

Ebola is a virus that caused the death of over 11 000 people in West Africa between 2014 and 2016. The DNA of ebola virus has a rapid rate of mutation.

Since the first outbreak in 2014 scientists have been working to develop an effective vaccination against ebola.

Other scientists have developed a portable nanopore sequencing technique that could be used to sequence rapidly the entire ebola genome.

Outline how DNA sequencing and bioinformatics could be used to increase the effectiveness of a vaccination programme against ebola.

sequencing .....

.....

.....

.....

bioinformatics .....

.....

.....

.....

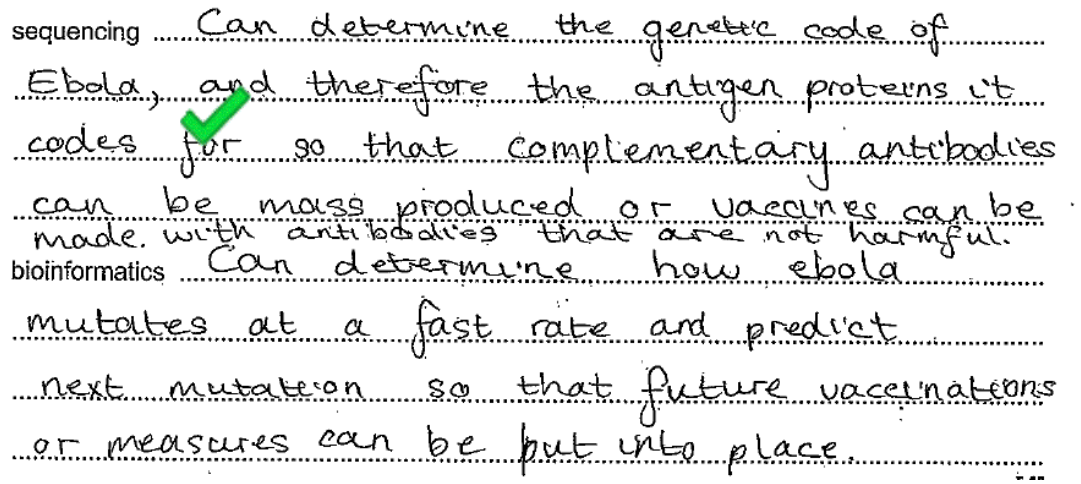
[4]

This was a very low scoring question. Although, all-in-all, it was quite a difficult question, candidates seemed to lack preparation in two areas:

1) The question mixed Module 6 topics – DNA sequencing and bioinformatics, with a Module 4 topic – vaccinations. Candidates seemed a little more comfortable with DNA sequencing but, unless they remembered and understood how vaccinations work, it was difficult to achieve many marks. It was not uncommon to see marking point 2 but candidates then often suggested that the vaccine would contain an antibody or that it was a drug that somehow affected the functioning of the virus.

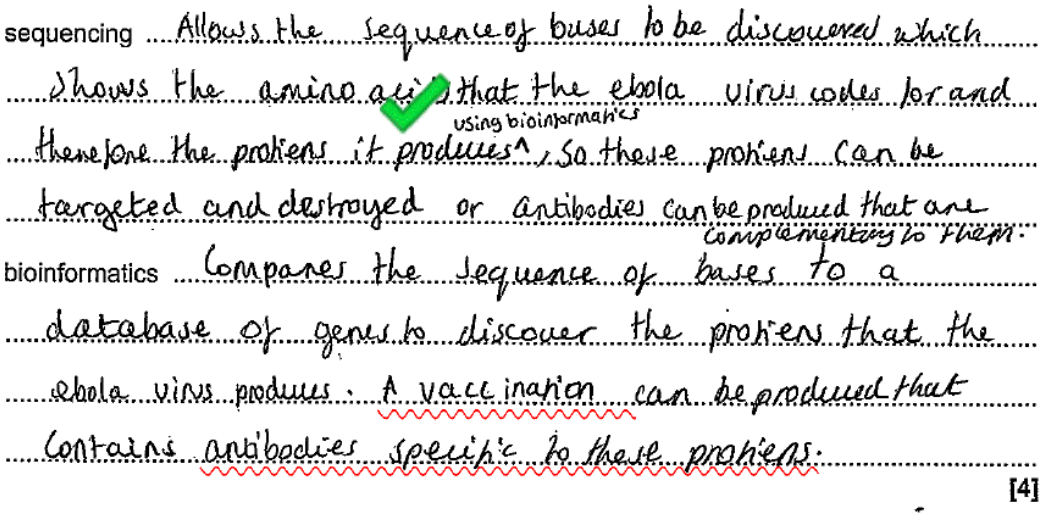
2) Bioinformatics is a new topic on the specification and was very poorly understood by candidates. The vaccination-related marking points in the lower half of the mark scheme were occasionally given, most often marking point 9, but the exclusively bioinformatics points, 4,5 and 6, were almost never seen.

Exemplar 11



This response achieves the regularly credited marking point 2 but misses out on marking point 3 as the response implies that vaccinations contain antibodies.

Exemplar 12

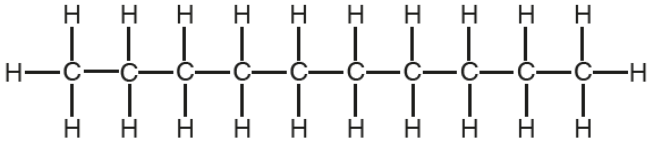


This response also achieves marking point 2 but misses out on marking point 3 as the response implies that vaccinations are drugs that directly target the biochemistry of the virus or, again, contain antibodies.

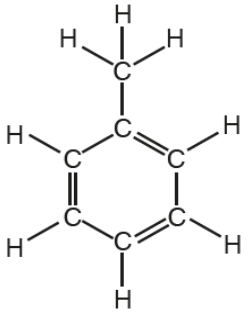
Question 22(a)

22 Crude oil contains hydrocarbons. Three hydrocarbons commonly present in crude oil are shown in Fig. 22.

W



X



Y

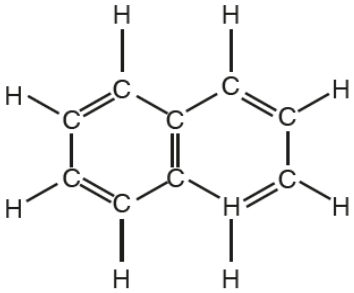


Fig. 22

(a) Compound **W** shows some structural similarities with fatty acids.

State one structural difference between compound **W** and a saturated fatty acid.

.....

.....

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

Fewer than half of responses gained this very straightforward mark. A large number of incorrect responses suggested double bonds, ester bonds or glycerol as being present in (saturated) fatty acids. A few partially correct, but not creditworthy, answers mentioned oxygen molecules, or just oxygen.

Question 22(b)(i)

(b) Crude oil is often spilled from ships into the sea causing great damage to wildlife. The chemicals in crude oil are harmful to many species and do not break down quickly in the environment.

Some bacteria can break down the hydrocarbons in crude oil. These bacteria have been used by conservationists at sites where oil has been spilled.

(i) The rate of hydrocarbon breakdown by bacteria can be increased by spraying the oil with detergent. Detergents break up oil into droplets, thereby increasing their surface area.

- Student A concluded that the detergent speeded up the rate of hydrocarbon breakdown **only** because it increased the surface area of hydrocarbon upon which the bacteria could grow.
- Student B concluded that the detergents **also** increased the growth of the bacterial population by an alternative mechanism.

Use the information in Fig. 22 and your knowledge of bacterial growth requirements to provide support for student B's conclusion.

.....

.....

.....

.....

.....

.....

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

This high demand, stretch and challenge, question tested AO3 and AO2 skills and most candidates found it very challenging. The question directed candidates to Fig 22 and reminded them about bacterial growth requirements. As the structures in Fig 22 contain only C and H, candidates might have figured out that other elements would be needed to facilitate bacterial growth. However, less than 20% of candidates gained any marks and less than 1% scored all 3. A range of reasonable, but non-creditworthy, answers were seen but many answers appeared to be attempting to support Student A's conclusion.

Question 22(b)(ii)

(ii) Suggest **one** piece of evidence that would further support student B's conclusion.

.....

.....

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

Less than 1 in 50 candidates scored a mark on this challenging question. A high number of candidates missed it out.

Question 22(c)

(c) Bacteria that are able to digest and metabolise the hydrocarbons in crude oil are more common in areas, such as around the coast of Alaska and the Gulf of Mexico, where oil spillages are common.

Suggest an explanation for this observation.

.....

.....

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

This was also a challenging contextual question for candidates to achieve a mark in as responses had to offer something not already included in the question. Many candidates did not appreciate from the context that there would not always be oil present in the area, merely that oil spills happened with some regularity, hence answers like 'they can gain nutrition from the oil' were not credited without further explanation.

Question 22(d)

(d) Listed below are three approaches, A, B and C, that can be taken to maintain biodiversity:

A	*ex situ* conservation
B	*in situ* conservation
C	preservation

For each of the statements below, indicate whether it could be consistent with *in situ* conservation, *ex situ* conservation or preservation by inserting the correct **letter or letters** in the table.

	Approach
organisms are **not** removed from their natural habitat	
human intervention is happening	

[2]

Most candidates achieved 1 mark and almost half got both. A number only put 1 letter in each box, despite the emboldened instruction. All three letters appeared often in the lower box, suggesting a misunderstanding about preservation on the part of some candidates.

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Section A, Q2

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Section B, Q20, Fig. 20.1

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