



GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE BIOLOGY B

J257 For first teaching in 2016

J257/04 Summer 2023 series



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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 4 series overview

J257/04, Depth in Biology, is the second of two higher tier examination units for the Twenty First Century Science Biology B GCSE.

The paper assessed content from across the specification and allowed candidates to demonstrate their depth of understanding of specific aspects of the content. As well as short answer response questions there were also structured questions, calculations and questions based on practical skills. This paper also had two extended response questions each with a total of 6 marks.

The assessment of quantitative skills has to include at least 10% GCSE mathematical skills. This was spread throughout the paper and although most tasks were well done, it did highlight an area that candidates were less aware of this year (see individual parts for detail, and see section 5d/5e of the specification for details of the skills required). In addition, candidates should be encouraged to show all of their working as marks can be given in some circumstances for errors carried forward.

Many candidates appeared to have been well prepared for the examination, attempting the majority of questions. However, some candidates seemed to have problems with certain aspects of questions relating to practical skills which are detailed in the next section.

Most candidates used the space provided for their responses; however, some extended their answers to other parts of the paper. Where candidates were not able to limit their responses to the provided space and used the additional examination sheets, it should be stressed to them that it is very important to clearly show the question numbers. There was, however, an improvement in this area.

It should also be emphasised to candidates that ray diagrams (Question 5 (d) (i) and (ii)) should be drawn with a ruler and not freehand as was seen on a considerable number of responses.

This cohort has experienced less disruption to their learning due to the pandemic than last year's cohort. The extent to which this will have affected each candidate will be different and will depend on the quantity and quality of provision during lockdown as well as the duration of time each candidate was out of school. The exposure that candidates had to practical activities will also be different and may have been limited to observing demonstrations especially while still in formative situations in Key Stage 3.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:	
 answered the mathematical questions well referred to all instructions in the level of response questions 	 were unaware of how to recognise order of magnitude demonstrated a lack of knowledge of 	
 were aware of all processes involved in protein synthesis 	ideas such as respiration and photosynthesis	
 demonstrated a good understanding of	 did not refer to all instructions in the level	
practical skills	of response questions	
 demonstrated good knowledge of sex-	 demonstrated a lack of understanding	
linked inheritance	between types 1 and 2 diabetes	
 demonstrated good knowledge of	 demonstrated that they had limited	
communicable diseases	understanding of practical skills	

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
 engaged fully with the questions, read them thoroughly and gave more detailed responses, answering in specific rather than generic terms 	 were unable to complete Punnett squares involving sex-linked alleles demonstrated limited knowledge of the structure and function of the human eye.
 used scientific terminology carefully and accurately, especially terminology associated with genes and inheritance in particular with protein synthesis. 	

Question 1 (a)

1 A scientist cuts a thin slice from a plant stem, as shown in Fig. 1.1.

The slice of stem contains three different tissues.

Fig. 1.1



(a) Draw lines to connect the description of each tissue with its correct name.

One has been done for you.



Candidates performed well, with the majority aware of the role of the tissues concerned.

[1]

Question 1 (b) (i)

(b) The scientist places the slice of stem on a microscope slide and adds a cover slip.

The scientist uses the light microscope in Fig. 1.2 to look at the slice of stem on the slide.

Fig. 1.2



 Statements A to E describe steps the scientist uses to look at the slide under the microscope.

They are not in the correct order.

- A Place the slide on the stage.
- B Look into the eyepiece lens.
- C Use the coarse focus control to move the objective lens down towards the stage.
- **D** Use the fine focus control to move the objective lens until the image is as clear as possible.
- E Use the coarse focus control to move the objective lens upwards until the image is clear.

Write the letters in the boxes to describe the correct order of the steps.

One has been done for you.



Most candidates understood the basics of microscope activity. Less than half were able to complete the correct sequence.

Question 1 (b) (ii)

(ii) Suggest two ways the scientist can work safely when using the microscope.



This was not successfully answered, with most candidates giving responses relating to general safety in the laboratory and not ones specifically to do with using a microscope.

Question 1 (c) (i)

(c) Fig. 1.3 shows part of the slice of stem. One of the cells is dividing by mitosis.

Fig. 1.3



(i) The chromosomes in the labelled dividing cell are clearly visible and appear dark.

Describe what the scientist added to the slide to make the chromosomes clearly visible.

.....[1]

Most candidates gave the correct response of a stain or dye or a named one. However, there was a minority of candidates who were unaware of this and gave responses such as 'indicator'.

Question 1 (c) (ii)

(ii) To get the image in Fig. 1.3 the scientist used an eyepiece lens with a magnification of ×10, and an objective lens with a magnification of ×40.

Describe how to calculate the total magnification.

.....[1]

This was reasonably well answered, although many gave responses suggesting that the two magnifications should be added together and others that it involved image size.

Question 1 (d) (i)

(d) One of the dividing cells in Fig. 1.3 has a width of $10 \,\mu m$.

(i) What is $10\,\mu m$ to the nearest order of magnitude?

Put a (ring) around the correct option.

10⁰ µ m	10 ¹ μm	10² μm	10 ³ µm	[1]

The majority of candidates knew the correct answer. However, this aspect of mathematical skills is an area that would suggest a lack of knowledge as some candidates appeared to find this challenging.

Question 1 (d) (ii)

(ii) In the dividing cell, a single chromosome has a width of $0.01 \,\mu m$.

How many orders of magnitude larger is the cell than the single chromosome?

Put a (ring) around the correct option.

3	30	100	1000	[1]

This was not answered successfully, exemplifying the above comment on lack of knowledge on orders of magnitude.

OCR support

The <u>Maths skills handbook</u> and accompanying <u>Mathematical skills check in</u> are useful to use with students to familiarise them with particular maths skills. The check in tasks also encourage candidates to RAG rate themselves, which can help guide revision or areas for further support in class.

Question 2 (a)

- 2 Plant cells in the leaf of a tree contain chloroplasts and mitochondria.
 - (a) Complete the sentences about the processes that take place in chloroplasts and mitochondria.

Use words from the list.

cellular respiration	meiosis	photosynthesis	transpiration
In the chloroplasts, glucose is	s made by		
The glucose is used in the mi	tochondria in		

Candidates were very aware of these processes and gave the correct responses in both cases.

Question 2 (b)

(b) The process of cellular respiration takes place continuously in plant cells.

Explain why it has to take place continuously.

......[1]

There was some confusion here between respiration and photosynthesis and there are many candidates using incorrect statements such as producing, making or creating energy.

Question 2 (c)*

(c)* There are two trees growing next to a building.

- Tree A is growing on the sunny side of the building.
- Tree B is growing on the shadier side of the building.
- Tree A has grown larger than tree B.

The map shows the positions of the trees and the building. It also shows the movement of the Sun from sunrise to sunset each day.



The two trees are the same species and were planted as seeds at the same time.

Explain why tree A has grown larger than tree B.

[6]

Clear statements about light intensity and rate of photosynthesis were often missing. Many candidates used incorrect terms such as 'Tree A sees the sun more' or 'has more contact with the sun'. Candidates also quite often used absolute statements such as 'Tree A gets light and B doesn't' and 'Tree B can only photosynthesise at sunrise and sunset'. This together with irrelevant statements about auxins and phototropism, and no information about respiration and the effect of temperature limited many candidates to Level 2.

Question 3 (a)

- 3 Pathogens cause communicable diseases.
 - (a) Complete Table 3.1 by explaining how the spread of each communicable disease can be reduced or stopped.

Table 3.1

Communicable disease	Infects	How the spread of the disease can be reduced or stopped
Crown gall	Plants	
Influenza	Humans	

```
[2]
```

Perhaps because of the recent experiences of Covid, the influenza mark was gained by most candidates. Many candidates were unable to adequately give a suitable method of control for crown gall disease, despite it being the example of a plant bacterial disease in the specification.

Question 3 (b)

(b) Ash dieback and tobacco mosaic disease are communicable diseases in plants.

Complete Table 3.2 by describing these plant diseases.

Table 3.2

Disease	Pathogen that causes the disease	Spread by
Ash dieback		
Tobacco mosaic		Contaminated seeds

[2]

This question required three correct responses for 2 marks or two correct responses for 1 mark. Unfortunately, specific plant pathogens appear to be an area where responses were less successful.

Question 3 (c) (i)

- (c) A farmer is growing cherry trees. The farmer notices that some of the trees have lumps on their trunks caused by crown gall disease.
 - (i) The farmer counts the lumps on five trees. Table 3.3 shows the results.

Table 3.3

Tree	Number of crown gall lumps
1	10
2	6
3	11
4	5
5	8

Calculate the mean number of lumps per tree.

Mean = lumps [1]

This was a fairly simple calculation of a mean and the majority of candidates gained the mark.

Question 3 (c) (ii)

(ii) There are 200 trees on the farm.80 of the trees have crown gall disease.

Calculate the probability that any individual tree on the farm has crown gall disease.

Probability =[1]

Likewise, the calculation for probability scored very highly.

Question 4 (a)

4 Fig. 4.1 is a diagram of the human eye. Some of the structures of the eye have been labelled.

Fig. 4.1



(a) Draw lines to connect each structure with its correct function.



Knowledge of eye structure and function was good with the majority of candidates correctly linking all structures to the function.

[2]

Question 4 (b)

(b) Fig. 4.2 shows four ray diagrams.

```
Fig. 4.2
```



Which ray diagram explains how the lens of the eye focuses light so that we can see a nearby object?

Tick (✓) one box.

Ray diagram A

- Ray diagram B
- Ray diagram C

Ray diagram D

	1
_	1

Again, the majority of candidates were aware that the image is focused on the retina.

Question 4 (c)

(c) Nina has cataracts in her eyes.

Explain why Nina can only read if she uses a bright light.

Misconception



Many candidates thought that cataracts were caused by the cornea becoming cloudy.

Question 4 (d) (i)

- (d) Tom is shortsighted.
 - (i) Complete the ray diagram in Fig. 4.3 to show why Tom cannot see a distant object clearly.

Fig. 4.3



A number of candidates were let down by the quality of their drawings with less than straight lines, often completed without a ruler. In addition, a number of responses showed the lines stopping before the retina.

[1]

Question 4 (d) (ii)

(ii) Tom tries on a pair of glasses.

Complete the ray diagram in **Fig. 4.4** to show how a lens in a pair of glasses allows Tom to see the distant object clearly.

Fig. 4.4



Once again this was not answered successfully. The effect of the concave lens was not well understood.

Question 5 (a)

- 5 The blood transports substances around the human body.
 - (a) Complete the table to describe the transport of three substances around the human body.

Substance	Where it is absorbed into the blood	What it is used for in cells
Glucose	Digestive system	
		Aerobic cellular respiration
	Digestive system	As a solvent for chemical reactions, and to maintain the volume of the cytoplasm

[3]

Most candidates scored 2 or 3 marks here, the most common mistake being not knowing that water was the solvent in the third mark point.

Question 5 (b)

(b) Carbon dioxide and urea are waste products made by cells.

Describe where in the body these waste products are removed from the blood.

Carbon dioxide	
Urea	[41]
	[1]

Misconception

Many candidates thought that the bladder was responsible for removing urea from the blood.

Question 5 (c)

(c) The blood transports sugar and hormones that control the blood sugar level.

Complete the sentences to explain how hormones control blood sugar level.

Use words from the list.

ADH auxin FSH glucagon insu	in
-----------------------------	----

To reduce the blood sugar level when it is too high, a hormone called

..... is released.

To increase the blood sugar level when it is too low, a hormone called

..... is released.

Most candidates knew that insulin and glucagon were the correct hormones. However, there were a number who got them the wrong way round.

Question 5 (d) (i)

(d) People living with diabetes cannot control their blood sugar level properly without treatment or lifestyle changes.

Doctors hope to treat type 1 diabetes by injecting embryonic stem cells into the patient's pancreas.

(i) Explain how injecting embryonic stem cells into the pancreas could help to treat type 1 diabetes.

Many candidates scored a mark for recognising that because stem cells are unspecialised they can become any type of cell. However, many candidates did not score on the second mark as they stated that the stem cells can 'become insulin'.

Exemplar 1

en cells are unspecialised cells which can all Angeromythat they con becare cells a[2]

This response clearly states that stem cells are unspecialised and that they can differentiate into cells capable of producing insulin. The candidate was awarded both marks.

Question 5 (d) (ii)

(ii) Discuss **one** benefit, **one** risk and **one** ethical issue with using embryonic stem cells to treat type **1** diabetes.

Mark point one, a benefit of using embryonic stem cells, was rarely given. General statements such as 'diabetes would be cured' were insufficient.

Likewise in mark point three, general statements that did not give specific ethical dilemmas such as 'Playing god' did not gain credit.

Question 5 (d) (iii)

(iii) People with type 2 diabetes have asked if they can also have the stem cell treatment.

Explain why other treatments may be better for people with type 2 diabetes.

This question was not answered successfully, with mark points one and two rarely given. These required using knowledge about the cause and control of type 2 diabetes to gain credit. Candidates often gave very vague statements about making lifestyle changes without giving suitable examples such as increased exercise, avoiding high-sugar foods, etc. for mark point three.

Exemplar 2

Other treatments such as changing your lifestile may be better, given that it is cheaper, has less ethical issues and can help to combat other illnesses. Changing lifestyle may include diehing and doing more exercise. Furthermore type 2 diabetes can occur when cells stop [3] responding to insulin, so treating their pancieus woudn't actually help to heat the disease.

* such as coronary heart disease.

All three mark points credited in this example.

Question 6 (a) (i)

6 Fungi are a type of organism that live in soil. They are eukaryotic.

- (a) Fungi use their genome to make proteins, like humans.
 - (i) Describe what the fungi's genome is and where it is stored.

A number of candidates misunderstood the term 'eukaryotic' and stated that the genetic material would be found in the cytoplasm or in a plasmid.

Question 6 (a) (ii)

(ii) Explain how the genome is used to make proteins.

Few candidates were able to give a fully coherent account of protein synthesis. Relevant terms such as coding, mRNA, nucleotides and amino acids were well known but not always used in the correct context.

Exemplar 3

This example gives a clear commentary of the whole process of protein synthesis and was awarded full marks.

Question 6 (b)

(b) Fungi release digestive enzymes into the soil.

Explain why these enzymes are helpful to organisms other than the fungi.

Misconception

Many candidates thought that the fungal enzymes could be taken up by other organisms from the soil to aid their own reactions.

Question 6 (c) (i)

(c) A scientist collects soil samples from three different sites. The soil samples contain an enzyme released by fungi.

The scientist tests the enzyme from each soil sample by:

- adding the enzyme to its substrate in 10 solutions, each with a different pH
- measuring the rate of reaction.
- (i) The scientist plans to control the temperature of the solutions by leaving them in the same room.

Describe a better way to control the temperature of each solution.

A significant number of candidates were unfamiliar with a water bath for control of temperature in experiments and thought that a thermometer could be used to control temperature.

Question 6 (c) (ii)

•

- (ii) The scientist makes sure that:
 - the same type of enzyme is taken from each soil sample
 - the same concentration of enzyme is used in each solution
 - the same substrate is used in each solution.

Describe **one other** factor that could affect the rate of the enzyme reaction **and** how this factor could be controlled.

Very few candidates could identify that substrate concentration as the factor to be controlled. Even fewer were then able to say that you would need the same mass in the same volume of solution to control this factor.

Question 6 (d)

The results of the tests are shown in the graphs.



(d) What was the optimum pH for the enzyme from sample A?

Optimum pH =

Most candidates were able to interpret the graph to gain credit here.

Question 6 (e) (i)

(e) (i) What was the maximum rate of reaction for the enzyme from sample B?

Maximum rate of reaction = arbitrary units

[1]

Likewise, most candidates performed well at this skill.

Question 6 (e) (ii)

(ii) Describe and explain the general trend in the results for the enzyme from sample B.

The description part of the question was well answered with the majority of candidates being given 2 marks. The explanation aspect was less successful, with very few candidates able to state that the results were due to changes in the shape of the active site of the enzyme.

[1]

Question 6 (f)

(f) The scientist thinks a mutation must have happened in the fungi in the soil in sample C.

Describe how this mutation could have caused the results for sample C.

[3]

A significant number of candidates suggested that the fungus found itself in acidic conditions so was able to mutate to produce an enzyme with an optimum pH of 4. Candidates often referred to the mutation as a change in the substrate or the enzyme rather than in the DNA.

Question 6 (g)

(g) The scientist concludes that the enzyme works best in alkaline soil.

Give evidence for and against the scientist's conclusion.

Candidates were often given the first mark point for evidence for the scientist's conclusion, recognising that two of the enzymes worked best in alkaline conditions. However, for the second point as well as stating that enzyme C worked best in acid conditions, the rate of reaction for that enzyme was much higher than A and B was also required.

Question 7 (a)

7 Elephants live in the wild in Mozambique, Africa.



Some elephants inherit an allele that causes them to never develop tusks. This no-tusks allele is the result of a mutation.

(a) Mutations to alleles happen quite often.

Explain why mutations often have no observable effects.

[3]

There was some confusion about the terms 'genotype' and 'phenotype', and a number of candidates wrote about mutations 'becoming dominant' or 'developing over generations'. This is another example of candidates being aware of the scientific terms but not using them in the correct context.

Question 7 (b)

(b) Elephants in Mozambique are hunted by humans. The humans kill the elephants so they can sell their valuable tusks.

Scientists recorded data on the Mozambique elephant population over several generations.

	Total number of elephants	Percentage of total number of elephants with the no-tusks allele (%)
Start of study	2542	18.5
End of study	242	50.9

Calculate the percentage **decrease** in the total number of elephants from the start of the study to the end.

Give your answer to 1 decimal place.

Percentage decrease =% [3]

This was well answered, with the majority of candidates gaining 3 marks. Some candidates made arithmetic errors in their calculations or did not give their answer to one decimal place but were credited with some marks.

Question 7 (c)*

(c)* The scientists found that the no-tusks allele was more common in each new generation of the elephants.

Explain the scientists' finding.

[6]

The majority of candidates were credited with at least Level 2 marks. For a number of candidates, the lack of use of technical terms such as selection, advantage, proportion and frequency and no consideration of survival aspects restricted the level given.

Question 7 (d) (i)

- (d) Elephants have sex chromosomes just like humans.
 - Female elephants have the genotype X X.
 - Male elephants have the genotype X Y.

Scientists have discovered that:

- The no-tusks allele, T, is dominant.
- The allele for normal tusks, t, is recessive.
- The alleles are found on the X chromosome. This means an X chromosome can be either X^T or X^t .
- All elephants that have the genotype X^T Y die before they are born.
- (i) What is the phenotype of an elephant that has the genotype X^T X^t?

.....[1]

A minority of candidates recognised that as well as being 'tuskless', the elephant was also a female. A common error was referring to it as being 'heterozygous' as this refers to the genotype and not phenotype.

Question 7 (d) (ii)

(ii) Explain why no female elephants are born homozygous for the no-tusks allele.

A common error here was referring to the allele as a gene.

Question 7 (d) (iii)

(iii) A female elephant that is heterozygous for the no-tusks allele has a baby.

Complete the Punnett square to show the possible genotypes of the baby.



Many candidates seemed unfamiliar with solving genetics problems involving sex-linkage and constructed their Punnett square with T and t rather than X^t, etc.

Question 7 (d) (iv)

(iv) A scientist concludes that this female elephant is likely to have twice as many female offspring as male offspring.

Explain why the scientist is correct.

Candidates found it difficult to express their thoughts adequately. Those that used the data from their correctly drawn Punnett square tended to be credited with marks.

Question 7 (e)

(e) Predict what is likely to happen to the population of elephants in Mozambique if the hunting continues.

Most candidates picked up on the idea that the population would eventually become extinct but did not state that it was due to a lack of males.

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Question 7 (b): Data from Campbell-Staton et al., Science 374, 483-487 (2021)

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