OCR
Oxford Cambridge and RSA

H

Monday 15 November 2021 – Morning

GCSE (9–1) Biology B
(Twenty First Century Science)

J257/03 Breadth in biology (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
• a ruler (cm/mm)

You can use:
• an HB pencil
• a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number [ ][ ][ ][ ][ ]   Candidate number [ ][ ][ ][ ]

First name(s) _____

Last name _____

INSTRUCTIONS
• Use black ink. You can use an HB pencil, but only for graphs and diagrams.
• Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
• Answer **all** the questions.
• Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
• The total mark for this paper is **90**.
• The marks for each question are shown in brackets **[ ]**.
• This document has **24** pages.

ADVICE
• Read each question carefully before you start your answer.

Turn over

2

Answer **all** the questions.

1 (a) Plants and animals use small organic molecules to make larger organic molecules.

Draw lines to connect the small organic molecules with the large organic molecules that they are used to make.

Small organic molecules   **Large organic molecules**

| Amino acids |

| Fatty acids |

| Glycerol |

| Sugar |

| Fats |

| Long-chain carbohydrates |

| Proteins |

[2]

(b) Plants obtain important substances from their environment.

Which list of elements must plants obtain from the environment?

Tick (✓) **one** box.

Carbon, hydrogen, and oxygen ☐

Carbon, hydrogen, nitrogen, and oxygen ☐

Nitrogen and carbon ☐

Only carbon ☐

[1]

2 Tay-Sachs disease is an inherited disease caused by a recessive allele.

The symptoms of the disease start when a child is 3–6 months old. The disease is usually fatal.

Charlie and Eve decide they want to have a child. They do not have the disease, but they are concerned that they may be carriers of this disease and will pass it on to their child.

(a) Describe how Charlie and Eve could find out if they are carriers.

....

....

.... **[2]**

(b) Charlie and Eve find out they both have the genotype **Tt**.

What word is used to describe this genotype?

.... **[1]**

(c) Charlie and Eve still want to have a child.

Complete the Punnett square to find out the probability of their child having Tay-Sachs disease.

Probability of child having Tay-Sachs disease = ... **[3]**

(d) Charlie and Eve decide that they do not want to risk their child inheriting Tay-Sachs disease.

Suggest **two** ways in which they can have a child that does not have the disease.

1. ....

....

2. ....

....
[2]

Turn over

3 The diagram shows a pyramid of biomass for the following food chain.

Food chain

Tree ⟶ Insect ⟶ Sparrow ⟶ Kestrel

Pyramid of biomass   **Dry weight (g/m²)**

Bar	Dry weight (g/m²)
D	1.5
C	11
B	37
A	809
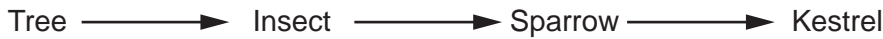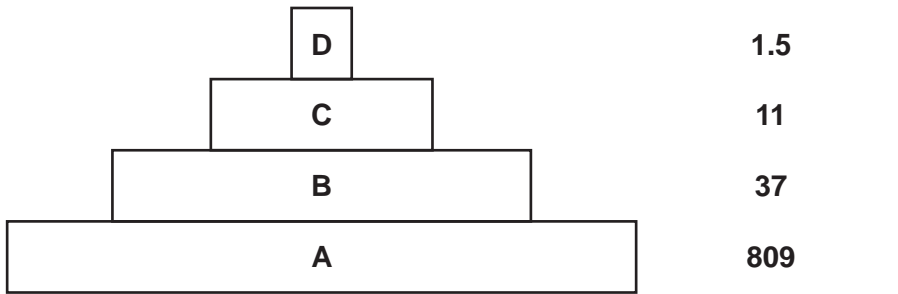
(a) Which organism in the food chain would you place in **bar A** of the pyramid of biomass?

.... **[1]**

(b) Describe the general change in biomass that occurs between the trophic levels shown in the pyramid **and** give **two** reasons for this change.

....

....

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....

....

.... **[3]**

(c) The percentage efficiency of the biomass transfer between trophic levels can be calculated using the efficiency equation:

$$\text{Percentage efficiency} = \frac{\text{average biomass in higher trophic level (g/m}^2\text{)}}{\text{average biomass in lower trophic level (g/m}^2\text{)}} \times 100\%$$

Calculate the percentage efficiency of the biomass transfer between trophic levels 2 and 3.

Give your answer to **1** significant figure.

Efficiency = ... % **[3]**

4 This question is about hormones in plants and animals.

Select the correct word from the list to match each statement.

You can use each word once, more than once, or not at all.

ADH   **adrenalin**   **auxin**   **ethene**   **FSH**   **gibberellin**

LH   **oestrogen**   **progesterone**   **thyroxine**

(a) A plant hormone responsible for the ripening of fruits.   .... **[1]**

(b) A plant hormone responsible for gravitropism in roots.   .... **[1]**

(c) A human hormone that is responsible for ovulation.   .... **[1]**

(d) A human hormone that increases the permeability of the kidney tubule.   .... **[1]**

(e) A human hormone that regulates growth and chemical reactions in cells.   .... **[1]**

(f) A human hormone used in the contraceptive pill to prevent ovulation.   .... **[1]**

Turn over

5 DNA is found in both eukaryotic cells and prokaryotic cells.

(a) Explain the difference in how DNA is stored in these two types of cells.

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....

....

.... **[2]**

(b) (i) Describe the structure of DNA.

....

....

....

....

....

.... **[3]**

(ii) A student talks about DNA with their friend.

The student tells their friend that all features in a person's phenotype are controlled by single genes in their DNA.

Give **one** reason why the student is wrong.

....

.... **[1]**

7

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Turn over

6 Flystrike is a condition that affects sheep in the UK and New Zealand.

Blowflies are attracted to the smell of urine on the fleece (wool) around the sheep's backside, as shown in the diagram. They lay their eggs and when the eggs hatch, maggots are released. The maggots bury deep into the sheep's flesh and feed on it as a food source.

Fleece

Blowflies lay eggs where there is urine on the sheep's fleece
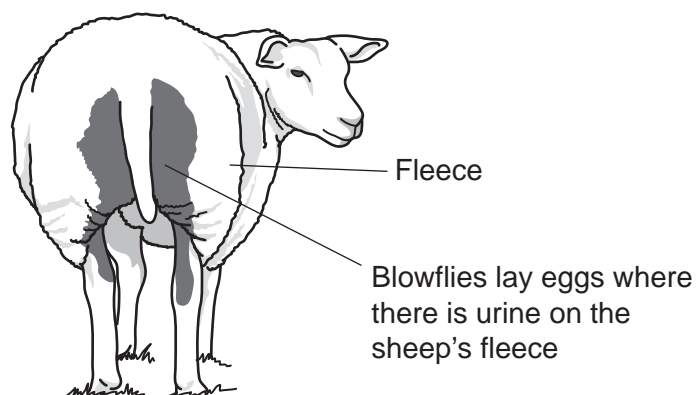
Sheep that are most at risk have long fleece.

(a) Scientists in New Zealand selectively breed sheep to prevent this problem.

Table 6.1 gives information on different breeds of sheep and their features.

Breed of sheep	Features of the breed
Cheviot	Bare heads and legs
Downs	Produce good meat
East Friesian	Bare backside
English Leicester	Long flowing heavy fleece
Merino	Produce good wool

Table 6.1

9

(i) Select two breeds of sheep from **Table 6.1** that the scientists could use in the selective breeding programme to prevent flystrike, **and** give **one** reason for your selection.

Breeds of sheep:

1 ....

2 ....

Reason ....

....
[2]

(ii) Describe how the scientists would use selective breeding to produce sheep that are less likely to get flystrike.

....

....

....

.... **[2]**

(b) Sheep and other species produce milk. Milk contains protein, sugar and fat.

Table 6.2 shows the percentage of sugar found in the milk from some mammals.

Species	Percentage of sugar in milk (%)
Donkey	6.9
Rabbit	1.8
Sheep	4.6

Table 6.2

(i) Describe how Benedict's reagent could be used to show that the amount of sugar in the milk of different species varies, and how the results would support the data in **Table 6.2**.

....

....

....

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.... **[3]**

(ii) Name the reagent that would test for the presence of protein.

.... **[1]**

Turn over

7 The picture shows an animal called a Tasmanian devil. These animals are only found on an island off the coast of Australia.

The table shows data for the estimated population of Tasmanian devils from 1995 to 2008.

Year	Estimated population of Tasmanian devils
1995	140 000
2004	104 000
2006	84 000
2007	68 000
2008	52 000

(a) (i) Plot a bar chart to represent the data shown in the table.
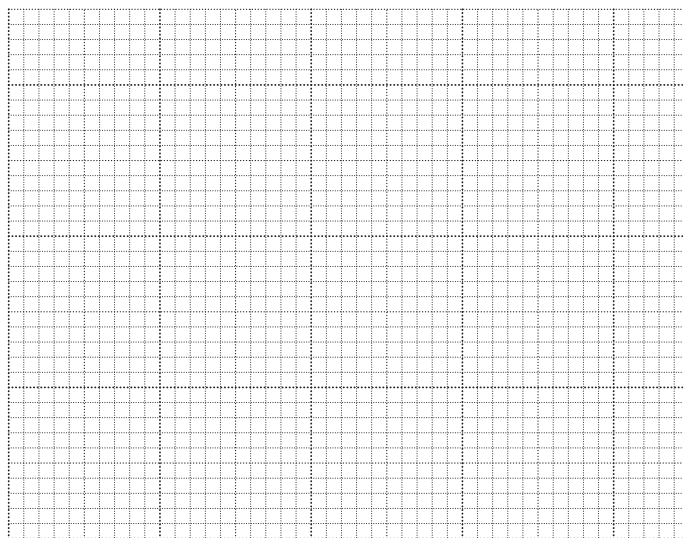
[3]

(ii) Calculate the percentage decrease in the estimated population of Tasmanian devils between 1995 and 2008.

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

Percentage decrease = ... % **[3]**

(b) The decrease in population is because of a disease called Devil Facial Tumour disease.

Devil Facial Tumour is a form of cancer. It is spread from one Tasmanian devil to another when they bite each other.

How is the Devil Facial Tumour cancer different from cancers found in humans?

....

....

....

.... **[2]**

(c) Scientists have discovered six disease-resistant Tasmanian devils in the population.

Initially scientists did not know if this resistance was hereditary.

Suggest how the scientists could investigate whether the resistance could be inherited.

....

....

....

.... **[2]**

Turn over

PMT

12

8 The Colorado potato beetle feeds on potato crops.

Farmers can use different chemical compounds to kill the beetle. The beetle has developed resistance to these chemicals over time.

The graph shows the cumulative number of chemicals that Colorado potato beetles have become resistant to, from 1955 to 2003.

(a) Explain why farmers are worried about the effect that Colorado potato beetles may have on potato crops in the future.

Use data from the graph to support your answer.

....

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....

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....

.... **[3]**

(b) Using insecticides is one method of controlling insect pests.

Suggest **one** alternative method that could be used to control insect pests.

....

.... **[1]**

(c) The evolution of new pests is one example of a biological threat to food security.

Identify **two** additional threats to food security.

1 ....

2 ....

[2]

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9 (a) Explain **two** ways in which white blood cells defend against disease.
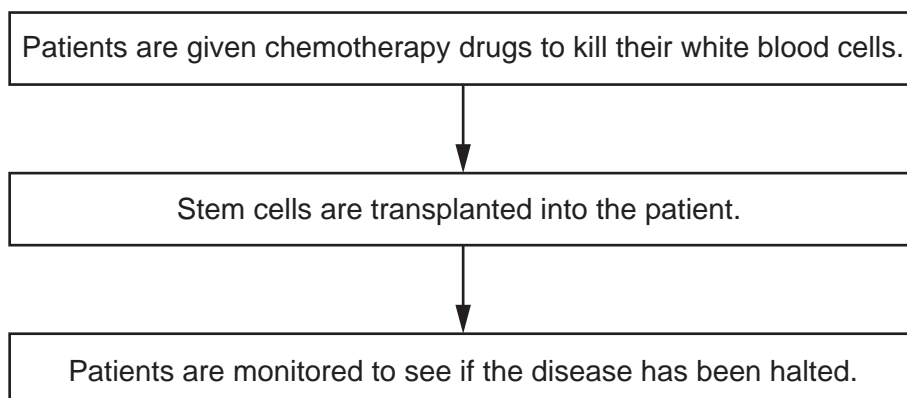
1. ....

....

2. ....

....
[2]

(b) Multiple sclerosis is a disease which causes the fatty sheath surrounding neurons to break down.

What is the role of the fatty sheath?

....

.... **[1]**

(c) Multiple sclerosis is an autoimmune disease. This means the body's immune system attacks healthy body cells.

A new treatment has been trialled which scientists hope will stop the progression of the disease. The flow chart in **Fig. 9.1** shows the procedure followed.
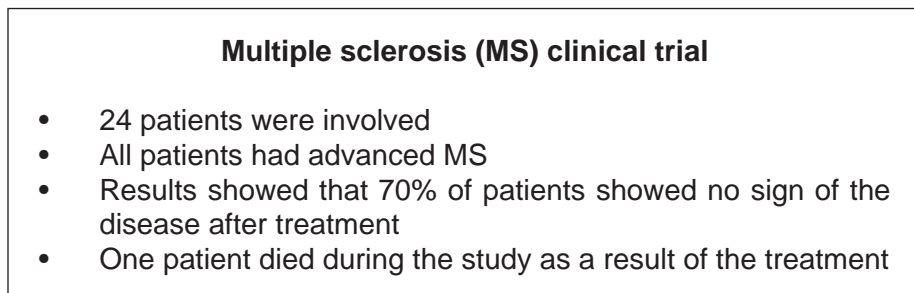
Patients are given chemotherapy drugs to kill their white blood cells.

↓

Stem cells are transplanted into the patient.

↓

Patients are monitored to see if the disease has been halted.

Fig. 9.1

Suggest why stem cells were given to the patient **after** chemotherapy.

....

....

....

.... **[2]**

(d) Information about the clinical trial is given in **Fig. 9.2**.

Multiple sclerosis (MS) clinical trial

- 24 patients were involved
- All patients had advanced MS
- Results showed that 70% of patients showed no sign of the disease after treatment
- One patient died during the study as a result of the treatment

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Fig. 9.2

This was the first clinical trial of this treatment and it was not known what effects the treatment would have.

Suggest why the patients still chose to take part in the trial, even though there were risks.

....

.... **[1]**

(e) The results of this study were published in a peer reviewed journal.

Why would this give other scientists confidence in the findings?

....

.... **[1]**

(f) 24 patients took part in this study. Only half of the patients were reassessed after 3 years.

Why is this a concern?

....

.... **[1]**

10 Reactions catalysed by enzymes are affected by temperature changes.

(a) Describe how body temperature affects the rate of reactions catalysed by enzymes.
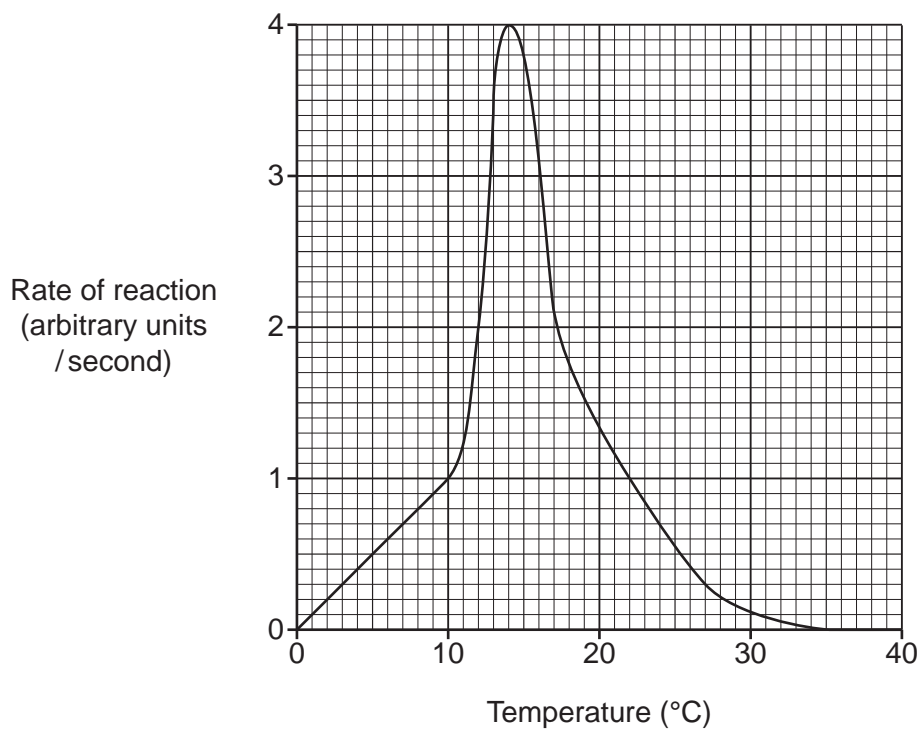
....

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.... **[3]**

(b) The graph shows the effect of temperature on the rate of reaction for the enzyme catalase.

The table shows the optimum temperature for catalase in three different organisms.

Organism	Optimum temperature for catalase (°C)
E. coli bacterium	22
Potato	35
Toad	15

Which organism from the table was used to produce the data shown in the graph?

Explain your answer.

....

....

....

.... **[2]**

11   Gonorrhoea is a sexually transmitted disease.

The number of recorded cases in England from 2008 to 2015 is shown in the table.

Year	Number of recorded cases in England
2008	14 985
2009	16 141
2010	16 839
2011	21 090
2012	26 909
2013	31 172
2014	37 172
2015	41 380

(a) Describe the trend shown by the data **and** suggest **one** possible reason for this trend.

....

....

....

....

....

.... **[3]**

(b) A group of students discuss the treatments available for gonorrhoea.

Gonorrhoea is becoming resistant to the drugs that are available.

Amaya

97% of countries have reported resistance to the drug ciprofloxacin.

81% of countries have reported resistance to the drug azithromycin.

Both drugs were used regularly to treat gonorrhoea.

Layla

There are only three new drugs currently in development.

James

Suggest why scientists are concerned about gonorrhoea.

Use information from the students' discussion to support your answer.

....

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.... **[2]**

(c) The drugs currently in development are being tested in clinical trials. They are being tested on healthy people and on people with the disease.

Explain why the drugs are being tested on both groups of people.

....

....

....

.... **[2]**

Turn over

12 Insulin and glucagon are two hormones involved in the control of blood sugar in humans.

(a) The statements explain how insulin and glucagon work together to control blood sugar.

Complete the table by deciding if each statement explains the role of insulin, glucagon or both.

Tick (✓) **one** box for each statement.

Statement	Both insulin and glucagon	Only insulin	Only glucagon
Decreases the amount of blood glucose			
Increases the amount of blood glucose			
Increases the rate of glucose uptake by cells			
Produced by the pancreas			
Stimulates the conversion of glucose to glycogen			
Stimulates the conversion of glycogen to glucose			

[3]

PMT

(b) A student is looking at some pancreas cells using a microscope. They draw one of the cells.
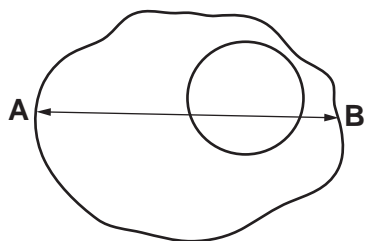
(i) The actual size of this cell from points **A** to **B** is 80 μm.

Calculate the magnification used to produce this drawing.

Use the equation: magnification = $\dfrac{\text{measured size}}{\text{actual size}}$

Magnification = × .... **[2]**

(ii) The magnification of a light microscope is 1.5×10^3.

The magnification of an electron microscope is 5×10^5.

Calculate the difference in magnification.

Give your answer in **standard form**.

Difference in magnification = ... **[3]**

Turn over

13 This question is about photosynthesis.

   (a) Write the balanced symbol equation for photosynthesis.

   .... + ... $\rightarrow$ .... + ...

<div align="right">**[2]**</div>

   (b) A student investigates the effect of light intensity on the rate of photosynthesis.

   They set up a test tube containing pond weed in water at different distances from a lamp.

   Their results are shown in the table.

Distance of lamp from pond weed (cm)	Number of bubbles produced in 1 minute
10	122
15	54
20	31
25	18
30	13

   The student writes down the relationship between light intensity and the distance, d, of the pond weed from the lamp.

   light intensity $\alpha \dfrac{1}{d^2}$

   Explain why the rate of photosynthesis was lower at 20cm than at 10cm.

   Use the inverse square law and data from the table to support your answer.

   ....

   ....

   ....

   .... **[2]**

(c) The graph shows how different factors affect the rate of photosynthesis.
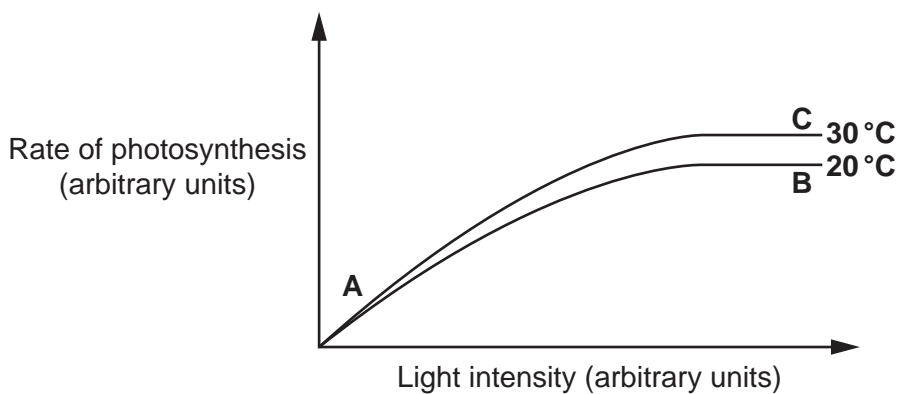
Which factors are limiting the rate of photosynthesis at points **A**, **B** and **C**?

Explain your answers.

Limiting factor at point **A** ....

Limiting factor at point **B** ....

Limiting factor at point **C** ....

A ....

....

B ....

....

C ....

....

[4]

END OF QUESTION PAPER

24

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).