OCR
Oxford Cambridge and RSA

Monday 9 June 2025 – Morning

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

J257/04 Depth 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

H

* J 2 5 7 0 4 *

* 1 8 9 2 5 3 5 0 1 5 *

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

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

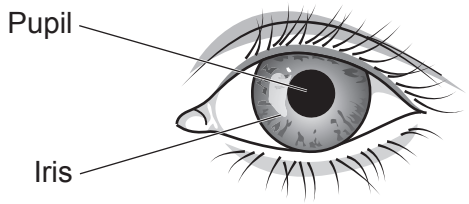
Last name _____

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 **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

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

1 The pupil is part of the human eye.



A student investigates the effect of changing the light level on pupil diameter.

The student uses a lamp with adjustable brightness, measured in lumens.
The maximum brightness of the lamp is 1200 lumens (100%).

Table 1.1 shows the data the student records.

Table 1.1

Light level (%)	Light brightness (lumens)	Distance between lamp and eye (m)	Pupil diameter (mm)
80		1.5	4
40	480	1.5	6
20	240	1.5	8

(a) Complete **Table 1.2** to identify the variables in the investigation.

Put **one** tick (✓) in each row to show whether the variable is the **dependent variable**, the **independent variable** or **neither**.

Table 1.2

	Dependent variable	Independent variable	Neither
Distance between lamp and eye (m)			
Light brightness (lumens)			
Pupil diameter (mm)			

[2]

(b) Suggest **one** other variable **not** included in **Table 1.2** that should be controlled.

.....

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

(c) Calculate the number of lumens equivalent to a light level of 80%.

Use the data in **Table 1.1**.

Number of lumens equivalent to a light level of 80% = ... lumens **[2]**

(d) The student measures the pupil diameter by holding a ruler against the person's eye.

Suggest a safer way to measure the pupil diameter.

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

(e) The student predicts that if a light brightness of 1200 lumens is tested, the pupil diameter will be approximately 2 mm.

Explain why the student is **correct**.

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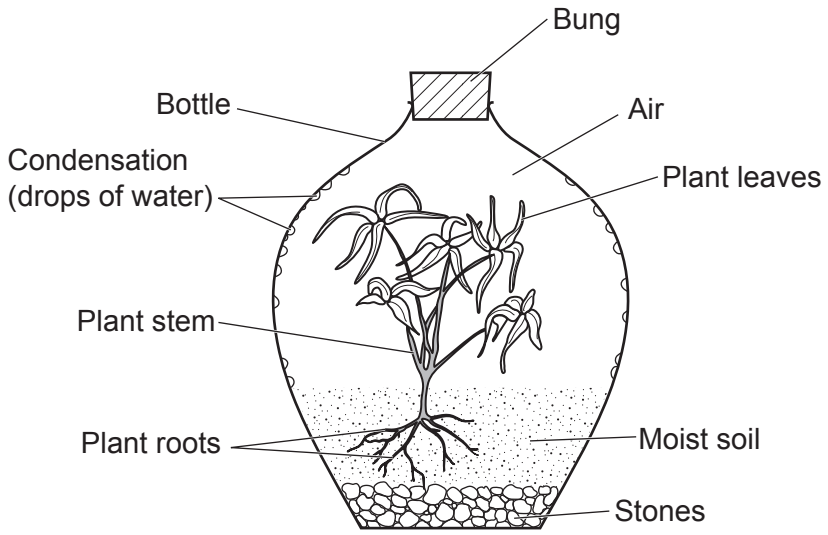
..... **[3]**

2 The diagram shows a living plant growing in a bottle garden.

The bottle garden is a small but complete ecosystem.



(a) Which part of the bottle garden ecosystem is **biotic**?

Tick (✓) **one** box.

Condensation ☐

Plant ☐

Soil water ☐

Stones ☐

[1]

(b) Explain why the air in the bottle is an **abiotic** part of the ecosystem.

.....

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

(c) The bottle allows light to pass through it.

Explain why this is essential for the plant to survive.

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

(d)* A bung is used to seal the bottle closed.

The plant stays alive even though the bottle is kept sealed for years and no extra water is added.

Explain:
- why the plant needs water
- how the plant gets enough water even though the bottle is kept sealed.

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

3

(a) Complete the table to explain how the human heart and blood vessels are adapted to their functions.

Use words from the list.

One has been done for you.

Artery	**Capillary**	**Heart**	**Vein**

	Adaptation
.....	Has valves **and** chambers.
.....	Has valves but **not** chambers.
Artery	Thick muscular wall.
.....	Wall is just one cell thick.

[1]

(b) Draw lines to connect each **part** of the blood to the **adaptation** that allows that part to carry out its function.

Part	**Adaptation**
Plasma	Large surface area for rapid absorption of oxygen.
Platelets	Receptors that recognise antigens.
Red blood cells	Acts as a solvent.
White blood cells	Stick together to seal wounds.

[2]

(c) Suggest what could happen to a person with a low number of white blood cells.

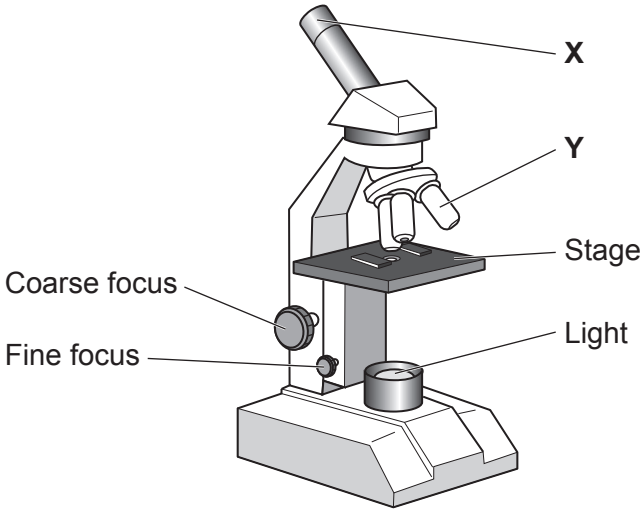
.....

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

4 A student uses a light microscope to observe stomata on the surface of a piece of plant leaf.

(a) **Fig. 4.1** shows a light microscope.

Fig. 4.1



Identify parts **X** and **Y**.

Part **X** .....

Part **Y** .....

[2]

(b) Statements **A** to **D** describe steps for setting up the microscope to view a piece of leaf on a slide.

The statements are **not** in the correct order.

A Place the slide on the stage.

B Turn the coarse focus to bring the specimen of leaf into view.

C Turn the fine focus until the image is sharp and clear.

D Turn part **Y** to select the magnification.

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

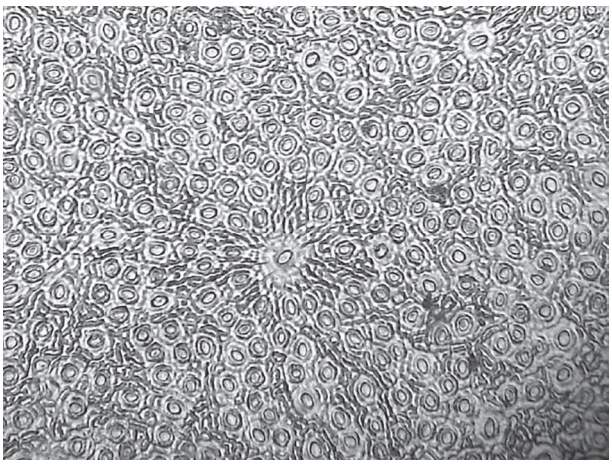
The first step has been done for you.

A			

[2]

(c) **Fig. 4.2** shows what the student observes.

Fig. 4.2



Width of image: 60 mm

Actual width of the piece of leaf: 1.5 mm

Length of image: 80 mm

Actual length of the piece of leaf: 2 mm

(i) Calculate the magnification of the image shown in **Fig. 4.2**.

Use the equation: magnification = $\frac{\text{image length (mm)}}{\text{actual length (mm)}}$

Magnification = ... × **[1]**

(ii) The student counts 243 stomata in **Fig. 4.2**.

The stomatal density is the number of stomata per mm^2 of **leaf**.

Calculate the stomatal density of the piece of leaf in **Fig. 4.2**.

Stomatal density = ... stomata per mm^2 **[3]**

(iii) Describe how the student could produce an **estimate** of the total number of stomata on one side of the leaf.

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

(iv) Suggest **one** benefit of producing an estimate of the total number of stomata rather than counting all of them.

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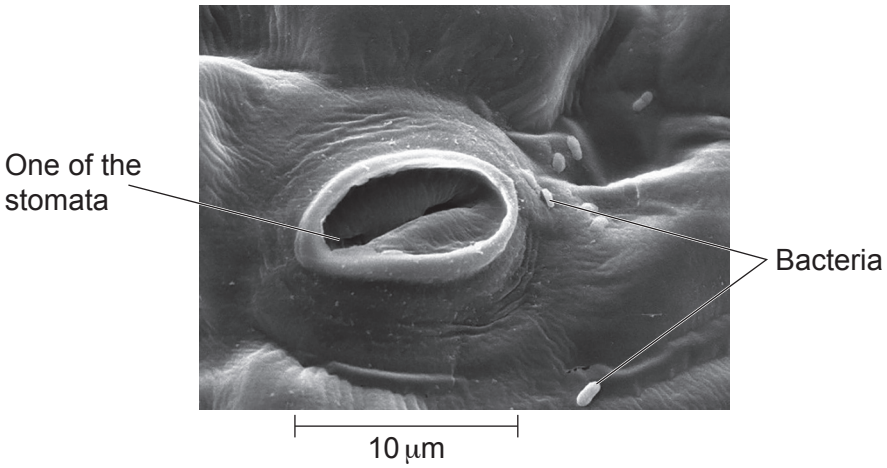
..... **[1]**

(d) A light microscope is **not** powerful enough to observe the structure of stomata in detail.

Fig. 4.3 shows a detailed image of one of the stomata, produced using a different type of microscope.

Fig. 4.3



(i) Suggest which type of microscope was used to produce the image in **Fig. 4.3**.

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

(ii) Explain why this type of microscope can show the structure of stomata in great detail.

.....

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

(iii) The length of one of the stomata is 10 μm, which is 1×10^{-2} mm.

Which of these is the same as 1×10^{-2} mm?

Tick (✓) **one** box.

0.001 mm ☐

0.01 mm ☐

10.00 mm ☐

100 mm ☐

[1]

(e) Light causes stomata to open.

Explain why it is an advantage for the plant that its stomata open in the light.

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

(f) Suggest **one** advantage to the plant that its stomata close when it gets dark, rather than staying open all night.

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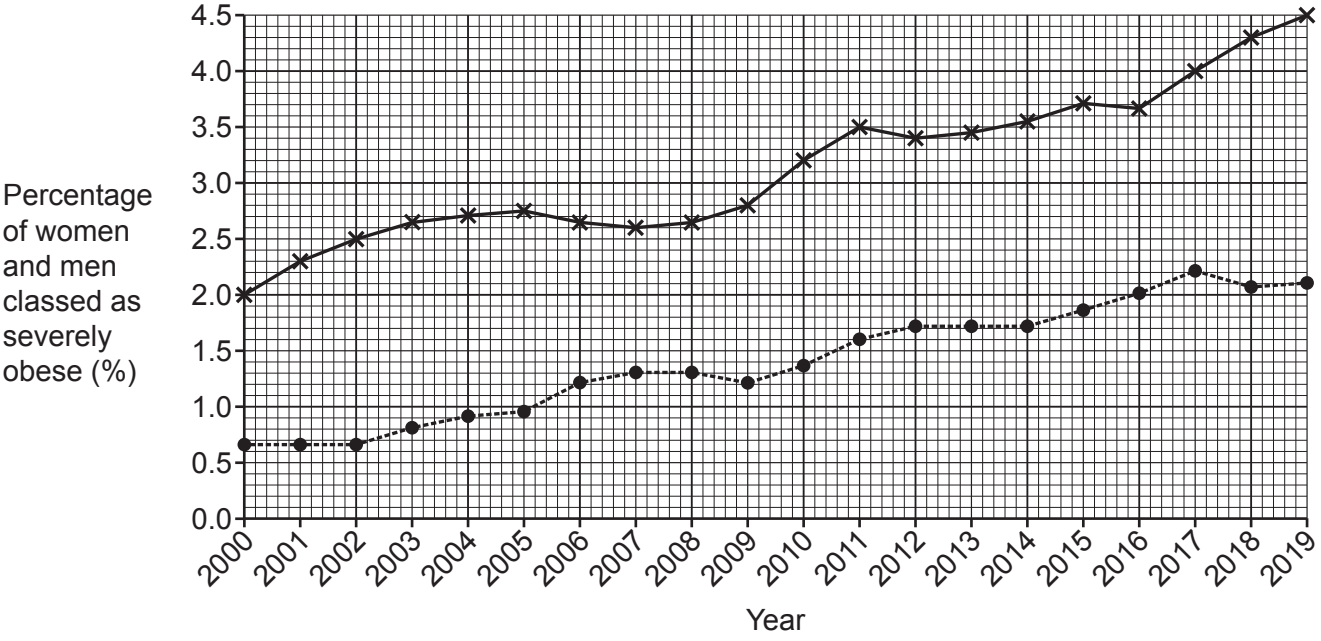
..... **[1]**

5 The graph shows the percentages of women and men in the UK who were classed as severely obese each year between 2000 and 2019.

Key:

—×— Women

---●--- Men



(a) What was the highest recorded percentage of **men** classed as severely obese between 2000 and 2019 **and** in which year did it occur?

Percentage = ... %

Year = ...

[1]

(b) Calculate the average annual increase in the percentage of **women** classed as severely obese between 2000 and 2019.

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

Average annual increase in percentage = ... % per year **[2]**

(c) One conclusion that can be made from the graph is that the general trend was an increase in severe obesity levels for both women and men.

State **one other** conclusion about a general trend that is shown in the graph.

.....

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

(d) Predict the general trend in the number of people in the UK with **cardiovascular disease** (CVD) between 2000 and 2019.

Explain how the graph supports your prediction.

Prediction .....

.....

Explanation .....

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[2]

(e) It was **not** possible to collect data from every woman and man in the UK every year between 2000 and 2019.

The data shown in the graph are estimates.

Suggest how good estimates have been produced.

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

6 Crown gall disease affects many species of plants in the UK.

(a) What type of pathogen causes crown gall disease?

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

(b) The cell walls of plant cells help defend the plant against pathogens.

State **one other** plant defence against pathogens.

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

(c) Crown gall disease kills plants because it damages phloem and xylem tissue.

Complete the table to show what is transported in each type of tissue.

Put **one or more** ticks (✓) in each row.

	Nitrate ions	**Sugars**	**Water**
Phloem			
Xylem			

[2]

(d) Conifer trees have a genetic variant that makes them resistant to crown gall disease.

Scientists hope to transfer this genetic variant from conifer trees into some apple trees.

Explain how natural selection would increase the number of apple trees with the genetic variant over time.

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

7 A famous sycamore tree grew in a gap between two hills in the North of England.

The tree was cut down without permission in 2023, leaving just the tree stump at the bottom.

The tree stump is still alive, and the tree is regrowing from cells in the stump.

(a) Which cells in the tree stump can turn into all the other cells and tissues needed by the regrowing tree?

Tick (✓) **one** box.

Meristem cells ☐

Phloem cells ☐

Root hair cells ☐

Xylem cells ☐

[1]

(b) Explain how these cells can make all the other cells and tissues needed by the regrowing tree.

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

(c)* A student learns that the tree is regrowing from the living stump and says:

'I think the regrown tree will be identical to the original one.'

Explain why the student is only partly correct that the regrown tree will be identical to the original tree.

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

8 Pea plants produce peas that are round or wrinkled.

A pea plant's alleles control which type of peas it produces.

A pea plant with one or two **R** alleles produces **round** peas.

A pea plant with two **r** alleles produces **wrinkled** peas.

(a) Draw lines to connect each **example** to its correct **description**.

Example	Description
	Dominant allele
	Dominant phenotype
R	
	Heterozygous genotype
Rr	
	Homozygous dominant genotype
rr	
	Homozygous recessive genotype
Wrinkled peas	
	Recessive allele
	Recessive phenotype

[4]

(b) Gregor Mendel investigated the inheritance of round and wrinkled peas in the 1860s.

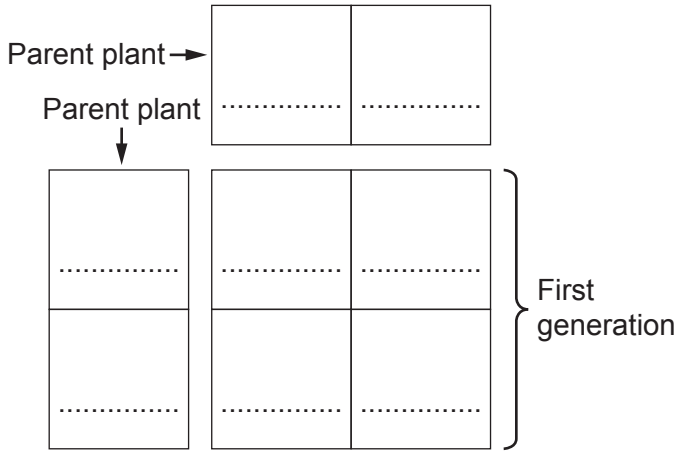
Here are the steps Mendel took in one experiment:

Step 1: Mendel bred one **RR** parent plant with one **rr** parent plant.
This produced the 'first generation' of offspring plants.

Step 2: Mendel then bred two of the first-generation plants.
This produced the 'second generation' of offspring plants.

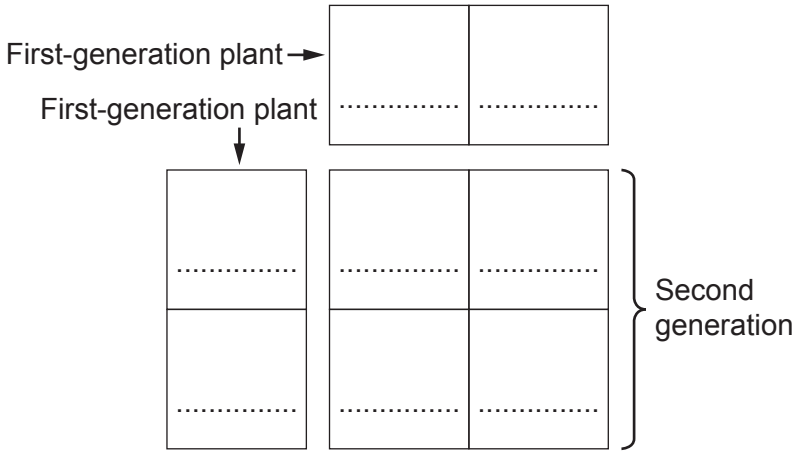
Complete the **two** Punnett squares **and** find:
- the **probability** of a first-generation plant producing wrinkled peas
- the **ratio** of round pea plants to wrinkled pea plants in the second generation.

Step 1



Probability of a first-generation plant producing wrinkled peas = ...

Step 2



Ratio of round pea plants to wrinkled pea plants in second generation = ... : .....

[4]

(c) Almost 130 years later, scientists Alison Smith and Cathie Martin discovered where the alleles for round and wrinkled peas are located in pea plant DNA.

(i) They discovered that the **R** allele is used to make an enzyme called SBE1.

Complete the sentences to explain how this happens.

Use words from the list.

amino acids	**chloroplasts**	**DNA**
mRNA	**plasmids**	**ribosomes**

Copies of the allele are made from ..... .

The copies travel to structures called ..... in the cytoplasm.

The sequence of bases tells these structures how to join ..... together to make the enzyme.

[3]

(ii) The **R** and **r** alleles have different sequences of bases.

Describe how the scientists could have worked out where the **R** allele is located in the genome of pea plants.

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

(iii) The scientists also discovered that:
- the **r** allele has an extra section of DNA inserted into it
- the version of the SBE1 enzyme made from the **r** allele does **not** work.

Suggest how the extra section of DNA in the **r** allele could lead to the SBE1 enzyme **not** working.

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

9 Over recent years there has been increased rainfall in Kenya's Rift Valley. This is affecting biodiversity in the valley.

Increased rainfall can be caused by climate change.

(a) Suggest how climate change can **reduce** biodiversity.

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

(b) **Table 9.1** shows data about two lakes in Kenya's Rift Valley.

Table 9.1

	Year		
	2010	**2014**	**2020**
Surface area of Lake A (km^2)	159.49	221.77	268.06
Surface area of Lake B (km^2)	34.79	40.50	43.25
Distance between the two lakes (km)	20	17	13

Local environmental workers claim the two lakes may soon join.

Evaluate this claim.

Use the data in **Table 9.1**.

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

(c) **Table 9.2** shows additional data about the same two lakes in Kenya's Rift Valley.

Table 9.2

	Lake A	**Lake B**
Lake type	Freshwater	Saltwater
Salt concentration (mg / L)	8	100 000
Organisms living in the lake	Producers: microalgae Primary consumers: fish Secondary consumers: birds Tertiary consumers: crocodiles	Producers: cyanobacteria

(i) Explain why the crocodiles in Lake A would become endangered if the microalgae died out.

Use information from **Table 9.2**.

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

(ii) Microalgae are single-cellular organisms.

Scientists predict the microalgae will die out if the two lakes join.

Explain why the scientists have made this prediction.

Use information from **Table 9.2**.

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.