H1

MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER | S | | | | |

INDEX NUMBER | | | | |

0123456789

BIOLOGY **8876/02**

Paper 2 Structured and Free-response Questions **For examination from 2026**

SPECIMEN PAPER **2 hours**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and index number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use an approved calculator.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

Singapore Examinations and Assessment Board

CAMBRIDGE International Education

[Turn over

Section A

Answer **all** the questions in this section.

1 **(a)** Eukaryotic DNA contains exons and introns.

(i) Describe **one** difference between exons and introns.

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..... [1]

(ii) Describe **one** similarity shared by exons and introns.

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..... [1]

(b) Figure 1.1 shows the structure of a pre-mRNA molecule formed from one gene. The pre-mRNA molecule consists of six sections, labelled **A**, **B**, **C**, **D**, **E** and **F**. Sections **A**, **C**, **D** and **F** can act as introns or exons. Sections **B** and **E** can act only as introns.

key

section of pre-mRNA molecule that can act only as an intron

section of pre-mRNA molecule that can act as an intron or as an exon

Figure 1.1

(i) Sketch the longest mRNA molecule that can be formed from the pre-mRNA molecule shown in Figure 1.1.

Label the drawing to identify the sections of the pre-mRNA molecule shown in Figure 1.1.

[1]

(ii) Explain how the mRNA molecule that you have sketched in **1(b)(i)** is formed from the pre-mRNA molecule shown in Figure 1.1.

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..... [2]

(iii) Determine the maximum number of different mRNA molecules that could be formed from the pre-mRNA molecule shown in Figure 1.1.

You can assume that the order of introns and exons will **not** change during processing of the pre-mRNA molecule.

space for working

number of different mRNA molecules = ... [1]

[Total: 6]

2 Lysosomes are important membrane-bound organelles within human cells.

They contain many different types of enzymes that hydrolyse lipids, nucleic acids, polysaccharides or proteins.

(a) Use a diagram to show how the bond between two amino acids in a protein is hydrolysed.

[4]

(b) Describe **two** functions of lysosomes that depend on their ability to hydrolyse a variety of biomolecules.

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..... [2]

[Total: 6]

3 **(a)** Two plants with round, hairy leaves were crossed. Both plants were heterozygous for one gene that controls leaf shape and for one gene controlling leaf hairiness. 560 offspring were produced from the cross.

The number of offspring with each of the four different leaf phenotypes observed is shown in Table 3.1.

Table 3.1

number of offspring	leaf phenotype
331	round, hairy
106	oval, hairy
91	round, smooth
32	oval, smooth

The expected phenotypic ratio for the cross between these two plants is:

9 round, hairy : 3 oval, hairy : 3 round, smooth : 1 oval, smooth.

(i) Using the information above, calculate the numbers of each leaf phenotype that would give a ratio of 9 : 3 : 3 : 1 for the number of offspring produced in this cross.

Show your working.

round, hairy = ...

oval, hairy = ...

round, smooth = ...

oval, smooth = ...

[2]

(ii) Suggest **two** different reasons why the actual numbers recorded in Table 3.1 are **not** the same as the expected numbers calculated in **3(a)(i)**.

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..... [2]

(b) A cross was carried out to determine the genotype of a plant with round, hairy leaves. The plant with round, hairy leaves was crossed with a plant that was homozygous recessive for the gene that controls leaf shape and the gene that controls leaf hairiness.

(i) State the name given to this type of cross

..... [1]

(ii) Using a genetic diagram, show the expected genotypes and phenotypes of the offspring from this cross if the plant with round, hairy leaves was heterozygous for the gene controlling leaf shape and homozygous for the gene controlling leaf hairiness.

Use the symbols **R** and **r** for the alleles for leaf shape and the symbols **H** and **h** for the alleles for leaf hairiness.

[3]

[Total: 8]

Turn over

4 *Staphylococcus aureus* is a common bacterium found on human skin. If it enters the body through a wound or after surgery, it can cause a serious infection.

There are many strains of *S. aureus*. Most of these strains were sensitive to penicillin when this antibiotic was first introduced in the 1940s. By the late 1950s, over 90% of *S. aureus* strains were resistant to penicillin. The antibiotic methicillin was then used to treat infection by *S. aureus*. Now there are at least 15 different strains of *S. aureus* that are resistant to methicillin. They are known as MRSA (methicillin-resistant *Staphylococcus aureus*).

Figure 4.1 shows the increase in antibiotic-resistant *S. aureus* infections in hospitals over this period of time.

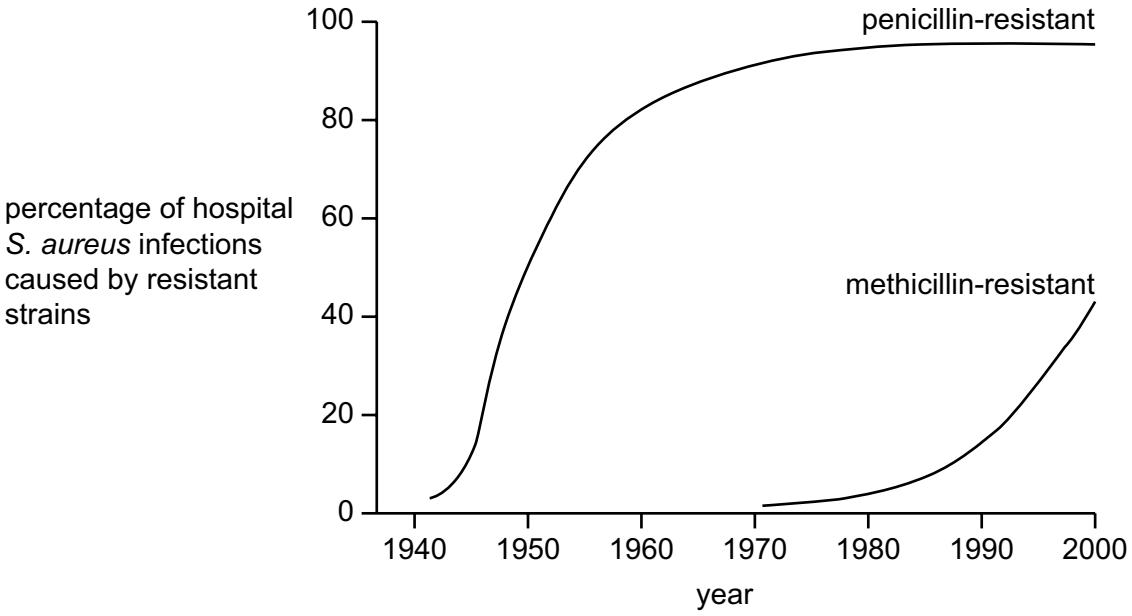

Figure 4.1

(a) Explain how 'at least 15 different strains of MRSA' could have evolved.

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..... [5]

(b) Table 4.1 shows, for a small country, the total number of deaths due to *S. aureus* each year from 1998 to 2005. The number of deaths due to methicillin-resistant *S. aureus* (MRSA) and non-methicillin-resistant *S. aureus* are also shown.

Table 4.1

year	A total number of deaths due to *S. aureus*	B number of deaths due to methicillin-resistant *S. aureus* (MRSA)	C number of deaths due to non-methicillin-resistant *S. aureus* (not MRSA)
1998	860	409	451
1999	964	480	484
2000	1142	666	476
2001	1204	731	473
2002	1215	794	421
2003	1416	968	448
2004	1599	1138	461
2005	2099	1649	450

(i) Describe **and** explain the trends shown by columns **A** and **B** in Table 4.1.

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..... [4]

(ii) Comment on the data shown in column **C** in Table 4.1.

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..... [2]

(iii) Table 4.2 shows the corresponding data for the same small country in 2009, 2010, 2011 and 2012.

Table 4.2

year	A total number of deaths due to *S. aureus*	B number of deaths due to methicillin-resistant *S. aureus* (MRSA)	C number of deaths due to non-methicillin-resistant *S. aureus* (not MRSA)
2009	1253	781	472
2010	961	485	476
2011	638	364	274
2012	557	292	265

Using the data in Table 4.2, calculate the percentage decrease in the number of deaths due to MRSA from 2009 to 2012.

Show your working and give your answer to **three** significant figures.

percentage decrease in number of deaths = ...
[2]

(iv) Suggest **one** reason to explain the change in the number of deaths due to infection with MRSA from 2009 to 2012.

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..... [1]

[Total: 14]

Turn over

5 Reef-building corals are marine invertebrates found in shallow, clear tropical seas. The corals secrete an exoskeleton of calcium carbonate that becomes the underlying structure of the coral reef.

Zooxanthellae are a group of unicellular, photosynthetic algae that live inside the cells of reef building corals. The relationship is beneficial to both the zooxanthellae and the coral.

(a) Evidence shows that the relationship between zooxanthellae and reef-building corals evolved when free-living algae invaded corals that did not contain algae.

(i) Corals that do **not** need zooxanthellae can live at a greater depth than reef-building corals.

Explain why.

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..... [2]

(ii) Suggest **one** way in which the zooxanthellae may benefit from their association with the corals.

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..... [1]

(b) Under conditions of environmental stress, the relationship between the reef-building corals and the zooxanthellae can break down. Loss of zooxanthellae and the subsequent whitening that occurs, shown in Figure 5.1, is known as coral bleaching. Coral bleaching can lead to the death of the coral.

Figure 5.1

(i) Suggest **one** reason why permanent loss of zooxanthellae can lead to death of the coral.

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..... [1]

(ii) One type of environmental stress that can cause coral bleaching is an increase in sea temperature.

Suggest why areas of sea with reef-building corals are particularly susceptible to increased temperature as a result of global climate change.

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..... [2]

(iii) The optimum temperature range for the survival of reef-building corals is 25 °C to 29 °C. As temperatures increase above the optimum, reef-building corals are increasingly stressed. However, coral bleaching may not occur until sea temperatures exceed 35 °C.

Explain why reef-building corals are affected by an increase in temperature above the optimum, even before coral bleaching occurs.

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..... [2]

(iv) In addition to an increase in sea temperature, climate change can also lead to increased rainfall.

Explain how an increase in rainfall can cause environmental stress to coral reefs.

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..... [3]

[Total: 11]

Section B

Answer **one** question in this section.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

Either

6 **(a)** Outline the roles of hydrogen bonds in biomolecules. [6]

(b) Discuss the suggestion that all living organisms on Earth depend on phosphate. [9]

[Total: 15]

Or

7 **(a)** Outline the roles of protein molecules in cell membranes. [6]

(b) The cell theory is based on a number of principles.

Discuss the extent, in humans, to which these principles can be accounted for by mitosis and the different types of stem cells.

You should consider individual humans **and** populations of humans from one generation to the next. [9]

[Total: 15]

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