



NSW Education Standards Authority

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Centre Number

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Student Number

This sample HSC examination paper is designed to show one way the Biology 11–12 Syllabus (2025) could be examined. It reflects the layout of a formatted HSC examination paper.

Sample

HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions

- Reading time – 10 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- Write your Centre Number and Student Number at the top of this page

Total marks: 100

Section I – 20 marks (pages 3–15)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 80 marks (pages 16–41)

- Attempt Questions 21–36
- Allow about 2 hours and 25 minutes for this section

The first HSC examination for the Biology 11–12 Syllabus (2025) will be held in 2028. The structure of the Biology HSC examination is similar to the structure of past Biology HSC examinations. Where they are still relevant, past HSC questions have been used to illustrate different types of questions and how the syllabus can be examined.

The Biology HSC examination specifications can be found in the assessment information for the Biology 11–12 Syllabus (2025).

This sample examination provides examples of some types of questions that may be found in HSC examinations for the Biology 11–12 Syllabus (2025). Each question has been mapped to show how the question relates to syllabus outcomes and content.

Answers for the objective-response questions (Section I) and sample answers and marking guidelines for all other questions (Section II) are provided. The marking guidelines indicate the criteria for each mark.

In the examination, students will record their answers to Section I on a multiple-choice answer sheet and their answers to Section II in the spaces provided in the Section II Answer Booklet.

The sample questions, marking criteria, sample answers, answers could include and annotations provide teachers and students with guidance as to the types of questions to expect and how they may be marked. They are not meant to be prescriptive. Each year the structure of the examination may differ in the number and types of questions, or focus on different syllabus outcomes and content.

Note:

Comments in coloured boxes are annotations that provide information and guidance.

Section I

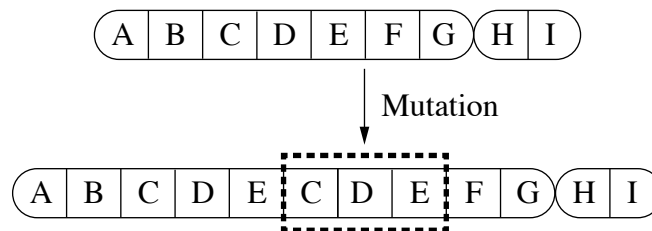
20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

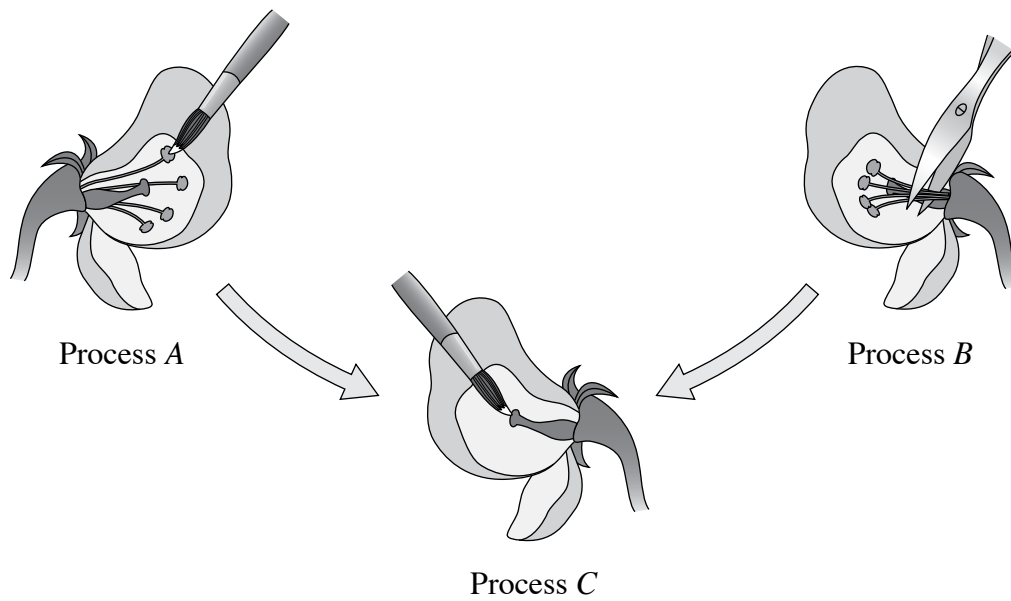
- 1** What happens when a keystone species is removed from an ecosystem?
- A. The food web becomes destabilised.
 - B. All species will eventually go extinct.
 - C. The ecosystem will increase in biodiversity.
 - D. Its ecological role will be filled by another species.
- 2** The science of analysing and interpreting large sets of biological data is called
- A. genomics.
 - B. bioinformatics.
 - C. biotechnology.
 - D. DNA profiling.
- 3** The image shows a chromosome that has undergone mutation. Each letter represents a gene.



What type of mutation has occurred?

- A. Deletion
- B. Duplication
- C. Inversion
- D. Substitution

- 4 The following diagram shows a summary of the process of artificial pollination.



Science Learning Hub – Pokapū Akoranga Pūtaiao,
The University of Waikato, Te Whare Wānanga o Waikato,
www.sciencelearn.org.nz

The purpose of Process *B* is to

- A. produce seeds.
 - B. collect the pollen.
 - C. fertilise the flower.
 - D. prevent self-pollination.
- 5 A farmer intends to artificially inseminate cows with semen from a bull which has been chosen based on characteristics of colour and muscle mass.

The farmer does not know that the bull is heterozygous for a rare recessive allele not previously present in the farmer's cow population.

The introduction of this recessive allele to the population of cows is an example of

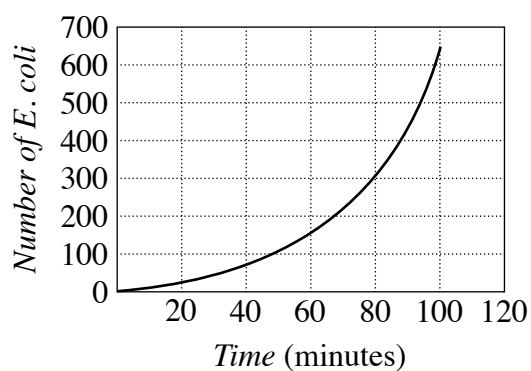
- A. gene flow.
- B. genetic drift.
- C. natural selection.
- D. selective breeding.

- 6 An experiment was conducted to investigate the rate of binary fission in *E. coli*. The results of the experiment are shown.

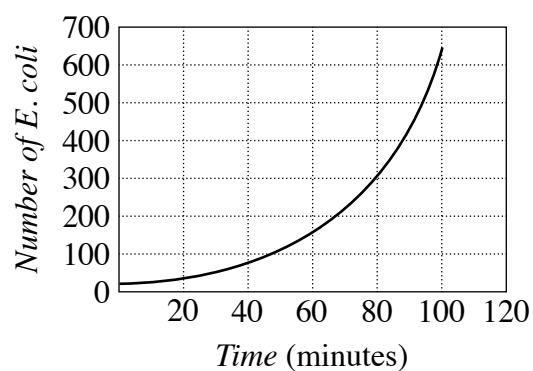
<i>Time (minutes)</i>	<i>Number of E. coli</i>
0	20
20	40
40	80
60	160
80	320
100	640

Which graph represents the data in the table?

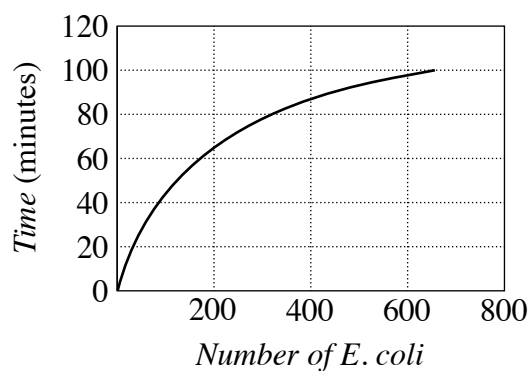
A.



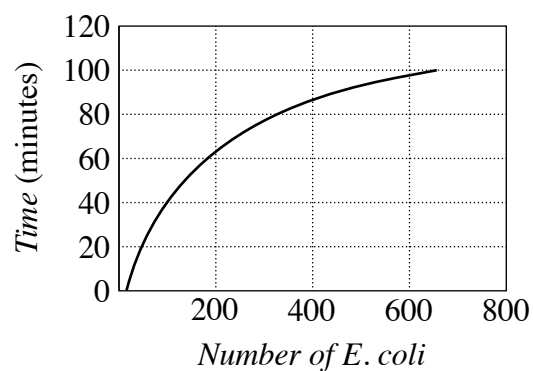
B.



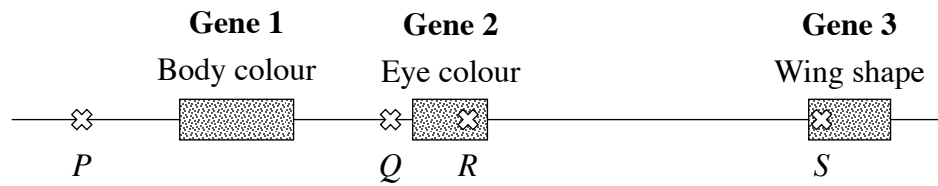
C.



D.



- 7 The diagram shows a section of a chromosome in an insect. It represents three genes amongst non-coding DNA. The crosses mark locations of four separate mutations.



Which location could produce a new allele for eye colour?

- A. P
 - B. Q
 - C. R
 - D. S
- 8 Female *Aedes aegypti* mosquitoes are vectors for the transmission of diseases.

It has been suggested that genetically modified (GM) male mosquitoes be released. These GM male mosquitoes do not bite humans, and mate with the wild female mosquitoes, only producing male offspring.

What would be an expected impact of this release?

- A. Mosquito numbers would increase.
- B. Mosquito numbers would decrease.
- C. Wild mosquito numbers would be unchanged, but the prevalence of the disease would decrease.
- D. Wild mosquito numbers would decrease but the incidence of the disease would remain the same.

- 9 Epidemiologists carried out a 10-year study to investigate the link between coffee consumption and high blood pressure. People were randomly selected to participate in the study. The subjects were split into two groups. The data is shown.

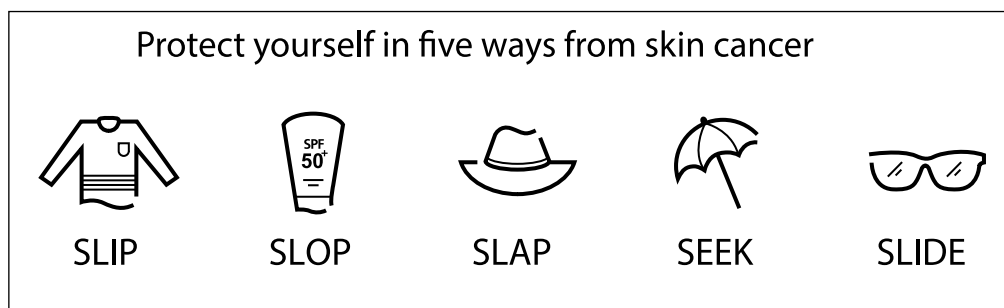
	<i>Coffee drinkers</i>	<i>Non-coffee drinkers</i>
Sample size	2355	2112
Diagnosed with high blood pressure	214	19

It was concluded that drinking coffee was a possible cause of high blood pressure.

Which of the following has negatively affected the validity of the study?

- A. A lack of a control group.
 - B. Only a small sample size was used.
 - C. Bias in the selection of participants.
 - D. The amount of coffee consumed is unknown.
- 10 A public education campaign was developed with the aim of lowering the incidence of skin cancer in the population.

The campaign was adopted Australia wide and is illustrated in the poster.

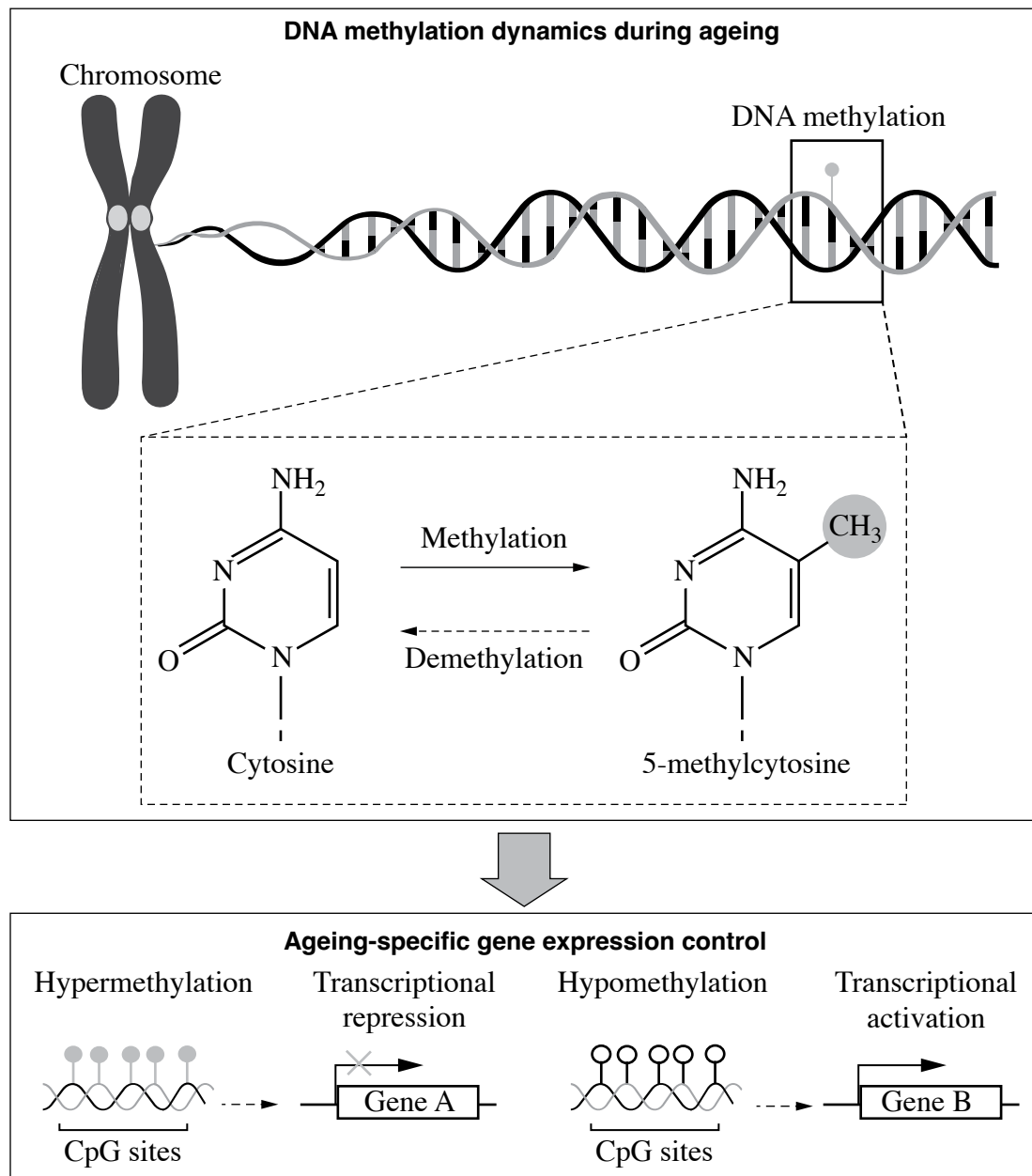


© Cancer Council VIC

Which of the following is the best method to measure the effectiveness of the campaign?

- A. Measuring exposure to the sun and skin cancer incidence
- B. Surveying beachgoers, asking if they remember the campaign
- C. Comparing skin cancer incidence before and after the campaign
- D. Counting the number of people on the beach wearing hats and sunglasses

- 11 Epigenetic changes have been shown to influence phenotype. The diagram shows methylation of DNA during ageing.

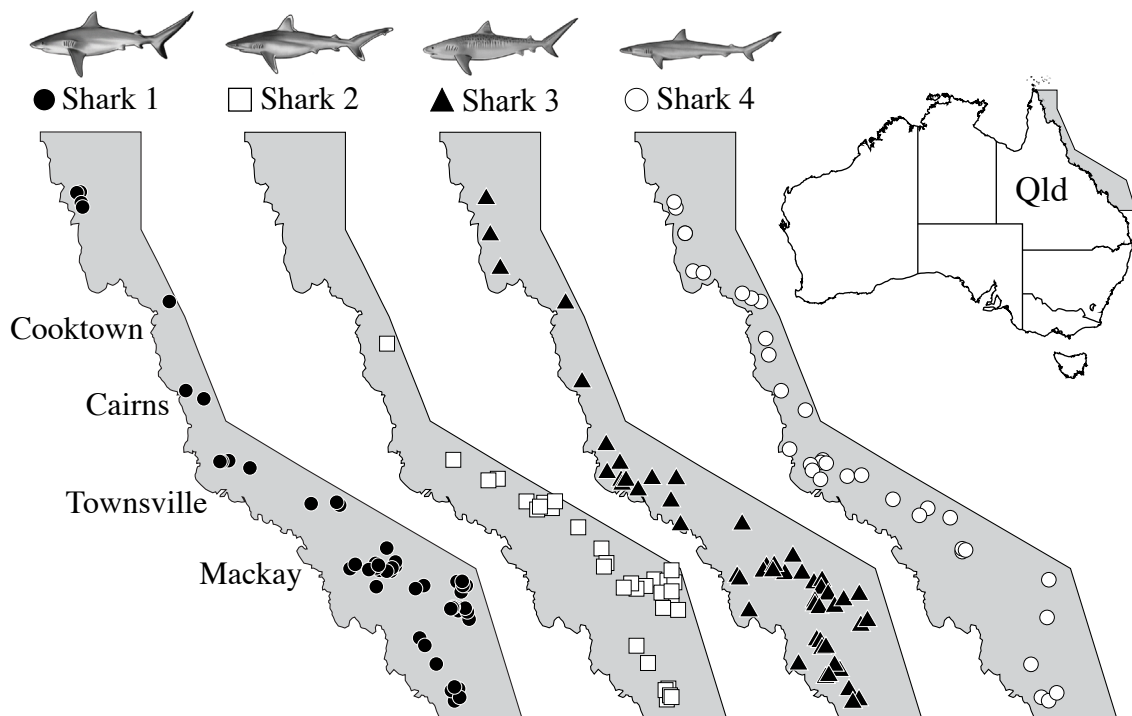


Adapted from Figure 4, Trends in Pharmacological Sciences: Emerging epigenetic insights into aging mechanisms and interventions by Zeming Wu, Weiqi Zhang, Jing Qu, Guang-Hui Liu, © 2024 Elsevier Ltd. All rights reserved.

Based on the diagram, what is the relationship between DNA methylation and gene expression?

- A. Methylation causes gene mutation but has no effect on gene expression.
- B. Methylation does not cause gene mutation and has no effect on gene expression.
- C. Hypermethylation activates gene expression, while hypomethylation inhibits gene expression.
- D. Hypermethylation inhibits gene expression, while hypomethylation activates gene expression.

- 12 Sharks are essential for maintaining the balance and health of coral reef ecosystems. The shapes in the diagram show positive sightings of four shark species along the Great Barrier Reef.

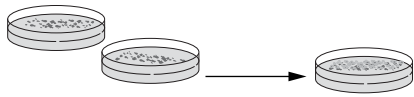
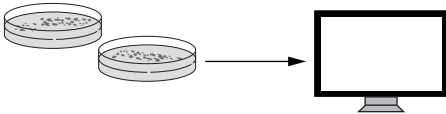
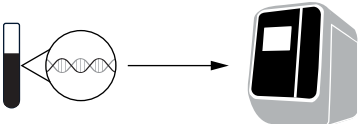
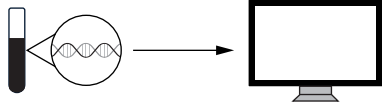


Adapted from Figure 1: Espinoza, Mario; Cappo, Mike; R. Heupel, Michelle; J. Tobin, Andrew; A. Simpfendorfer, Colin (2015). Map of the Great Barrier Reef Marine Park (Australia) showing the location of all baited remote underwater video stations sampling sites and the distribution of sightings for the most common sharks. PLOS ONE. Figure. <https://doi.org/10.1371/journal.pone.0106885.g001> <https://creativecommons.org/licenses/by/4.0/>

What does the variation in the distribution of different shark species along the Great Barrier Reef suggest about biodiversity in this ecosystem?

- A. The Great Barrier Reef has low biodiversity because one shark species dominates.
- B. Sharks are only found near major cities like Cairns and Townsville, showing the reef has low biodiversity.
- C. All shark species are evenly distributed throughout the entire reef without preference for specific areas.
- D. Different shark species occupy different areas, indicating a high level of species diversity and habitat specialisation.

- 13 The diagram shows a variety of techniques and typical timeframes for diagnosis of infectious diseases.

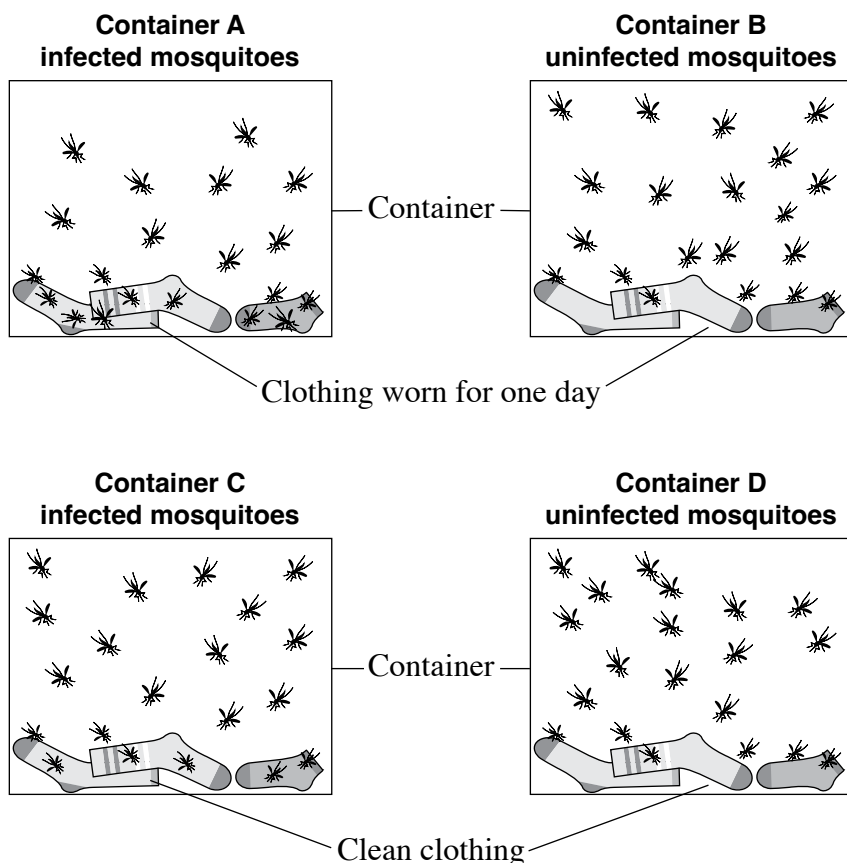
Test	Technique	Timeframe
1	 Culturing followed by biochemical testing	2 days
2	 Culturing followed by protein analysis	1 day
3	 DNA preparation followed by PCR analysis	8 hours
4	 Paper based nucleic acid testing	1 hour
5	 DNA preparation followed by sequencing	16 hours

Which two tests would be the most effective for diagnosing a life-threatening viral infection?

- A. 3 and 5
- B. 2 and 3
- C. 1 and 5
- D. 2 and 4

- 14 Malaria is an infectious disease which is spread to humans by infected mosquitoes.

Scientists conducted an experiment twice to determine if wearing clean clothing reduces transmission of malaria. They observed 20 mosquitoes for an hour in each of the four containers shown.



The results of the investigation showing the number of times mosquitoes landed on the clothing are provided.

<i>Trial</i>	<i>Container A</i>	<i>Container B</i>	<i>Container C</i>	<i>Container A</i>
1	15	7	12	5
2	19	5	9	3

Which of the following is a suitable conclusion for this investigation?

- A. Wearing clean clothing prevents the transmission of malaria.
- B. Clean clothing will protect against both infected and uninfected mosquitoes.
- C. Wearing the same clothing for one day may increase the transmission of malaria.
- D. Uninfected mosquitoes are just as likely as infected mosquitoes to land on clothing worn for one day.

- 15** The human *PRNP* gene codes for the prion protein. Misfolding of this protein may be the result of ingesting tissue that contains misfolded prion protein or a mutation. Accumulation of misfolded prion protein causes serious diseases such as Creutzfeldt-Jakob disease (CJD).

Which of the following statements best classifies CJD?

- A. It is both a genetic disease and an infectious disease.
 - B. It is a genetic disease only, since it is encoded by a gene.
 - C. It is not an infectious disease because the prion is non-cellular.
 - D. It is an infectious disease and the normal prion protein is the pathogen.
- 16** In a plant species, red flower colour (R) is dominant over white flower colour (r).

Two plants of known genotype for flower colour were crossed. A Punnett square was used to determine the proportion of genotypes expected in the offspring. Part of the Punnett square is shown.

		<i>Parent 1</i>	
<i>Parent 2</i>		RR	Rr
		RR	Rr

Which statement is true for the parents in this cross?

- A. Both parents were homozygous.
- B. Both parents were heterozygous.
- C. Both parents had flowers of the same colour.
- D. Parent 2 must have red flowers and Parent 1 must have white flowers.

- 17 Over 12 months, the prevalence of a non-infectious disease will increase in a population if
- A. the total population increases.
 - B. disease recovery time decreases.
 - C. the incidence rate of the disease decreases.
 - D. the survival time of individuals with the disease increases.
- 18 In humans, blood groups are produced by combinations of three alleles I^A , I^B and i .

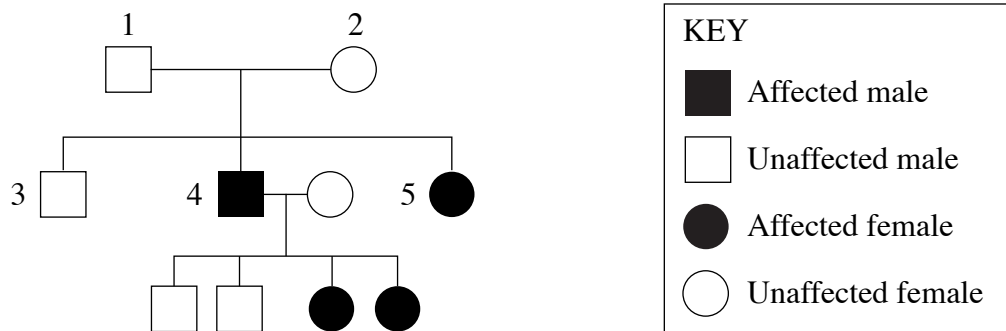
<i>Blood type</i>	<i>Genotype(s)</i>
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	$i i$

A mother has blood type O and her child has blood type A.

Which of the following includes all possible genotype(s) of the father?

- A. $I^A I^A$
- B. $I^A I^A$ or $I^A i$
- C. $I^A I^A$ or $I^A i$ or $I^A I^B$
- D. $I^A I^A$ or $I^A i$ or $I^A I^B$ or $i i$

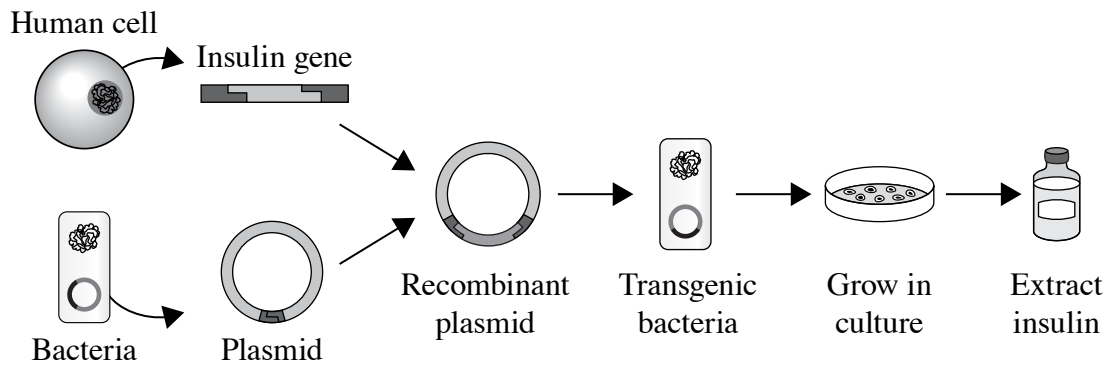
- 19 The occurrence of a genetic disease in a family resulting from the presence of a dominant allele is shown.



If the disease has arisen as a result of a mutation, which of the following is the most likely cause of the disease in this family?

- A. A somatic mutation in individuals 4 and 5
- B. A somatic mutation in individuals 1 and 2
- C. A germ-line mutation in individual 4
- D. A germ-line mutation in individual 2

- 20 The process of using recombinant DNA technology to produce human insulin is shown.



Adapted from Insulin Production via
Recombinant Gene Transfer diagram.
Reproduced by permission of Bio Ninja

Which of the following statements is correct regarding this process?

- A. The human genome was inserted into the bacterium.
- B. The insulin gene was inserted into the bacterial plasmid using restriction enzymes.
- C. The same restriction enzyme was used to cut out the insulin gene and cut the plasmid.
- D. PCR was used to copy the plasmid containing the insulin gene before being grown in culture.

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Centre Number

Biology

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Student Number

Section II Answer Booklet

80 marks**Attempt Questions 21–36****Allow about 2 hours and 25 minutes for this section**

Instructions

- Write your Centre Number and Student Number at the top of this page.
 - Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
 - Show all relevant working in questions involving calculations.
 - Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
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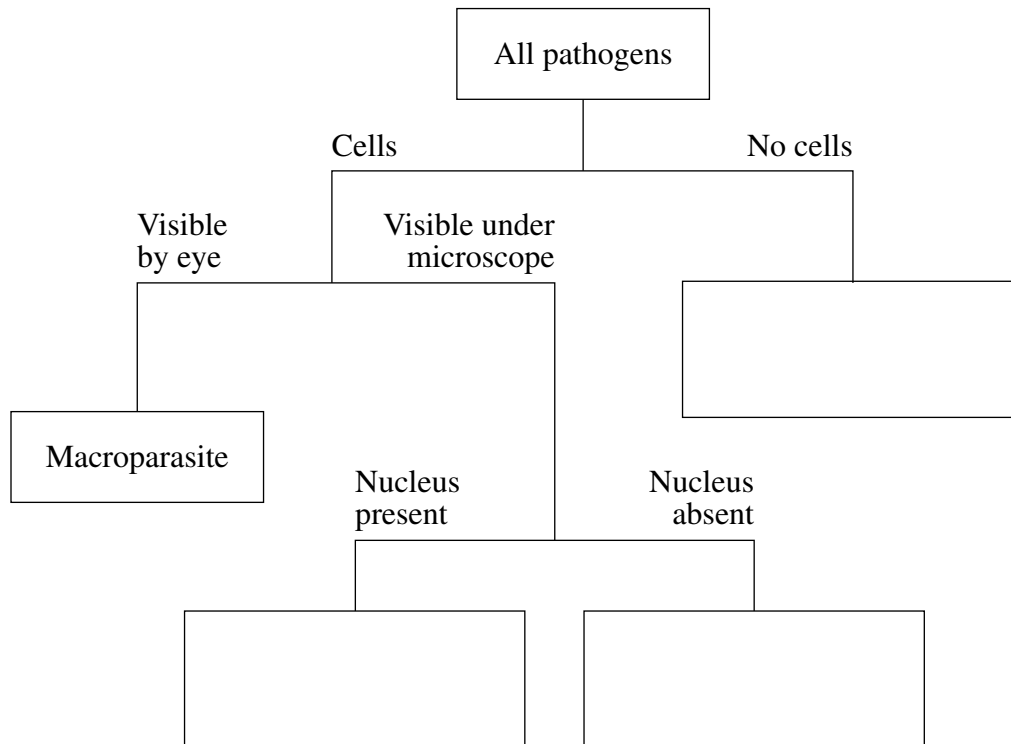
Please turn over

Question 21 (3 marks)

The following key can be used to classify some pathogens.

3

Complete each empty box with an appropriate pathogen.



Question 22 (2 marks)

Outline the use of an Aboriginal bush medicine in treating disease.

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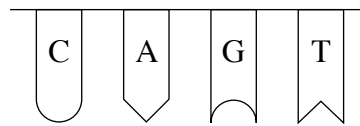
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Question 22 is an example of an item that requires students to demonstrate knowledge about Aboriginal Peoples' Knowledges and Practices.

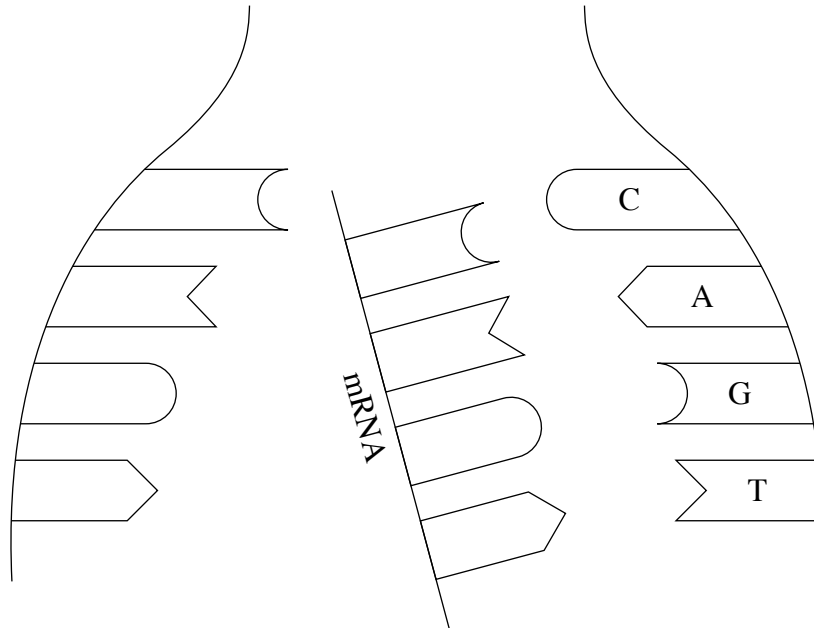
Question 23 (2 marks)

A section of a leading strand of DNA has a sequence of CAGT.

2



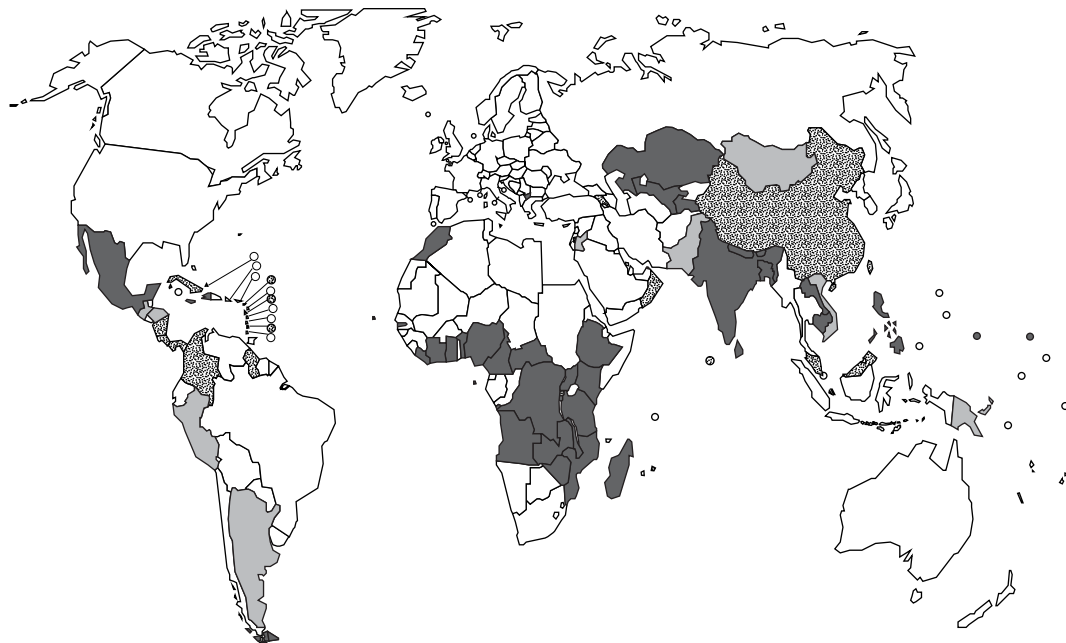
Complete the diagram by labelling the complementary mRNA strand.



Question 24 (3 marks)

Vitamin A deficiency can cause blindness. The map shows the prevalence of vitamin A deficiency in children under the age of 5.

3



KEY

None (<2%)

Moderate (≥10% – <20%)

Mild (≥2% – <10%)

Severe (≥20%)

Global prevalence of vitamin A deficiency in populations at risk 1995-2005:
WHO global database on vitamin A deficiency. World Health Organization
<https://iris.who.int/server/api/core/bitstreams/51f121fe-b2cd-40ea-8973-ffc7cee23382/content>
CC BY-NC-SA 3.0 IGO

Golden Rice is a genetically modified plant engineered to produce beta-carotene, which is converted to vitamin A in the body.

Using the data, explain the impact of adding Golden Rice to children's diets in areas with both high and low levels of vitamin A deficiency.

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Question 25 (3 marks)

Complete the table to show the differences between *somatic* and *germ-line mutations*.

3

	<i>Somatic mutation</i>	<i>Germ-line mutation</i>
Cell type		
Effect on offspring		
Example		

Question 26 (5 marks)

Honey has been used for thousands of years by humans to treat cuts, sores and burns. Recent studies have shown that honey has a very high level of methylglyoxal which is known to help fight infection.

5

A scientist wants to test the effectiveness of honey using agar plates.

Design a safe procedure that the scientist could use in a laboratory to investigate the effectiveness of honey as a pharmaceutical to inhibit bacterial growth.

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Question 27 (5 marks)

Cattle have been domesticated by humans for approximately 10 000 years. Many biotechnologies have been employed in the farming of cattle.

5

The table shows examples of the application of these biotechnologies.

<i>Biotechnology</i>	<i>Example</i>
Selective breeding	The offspring of highest milk producing female cows were retained and over time cows that produced more milk were bred, leading to dairy breeds.
Artificial insemination	An American bull holds the current record for artificial insemination. He produced 2.4 million units of semen and has sired cattle with high meat quality in 50 countries.
Transgenic organisms	The first transgenic cow produced human serum albumin (an important protein for human health) in its milk. The use of transgenic cattle is not widespread.

With reference to the table, evaluate the effect of biotechnologies on the biodiversity of cattle.

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Question 27 shows one way that an item could require the integration of knowledge from more than one syllabus focus area.

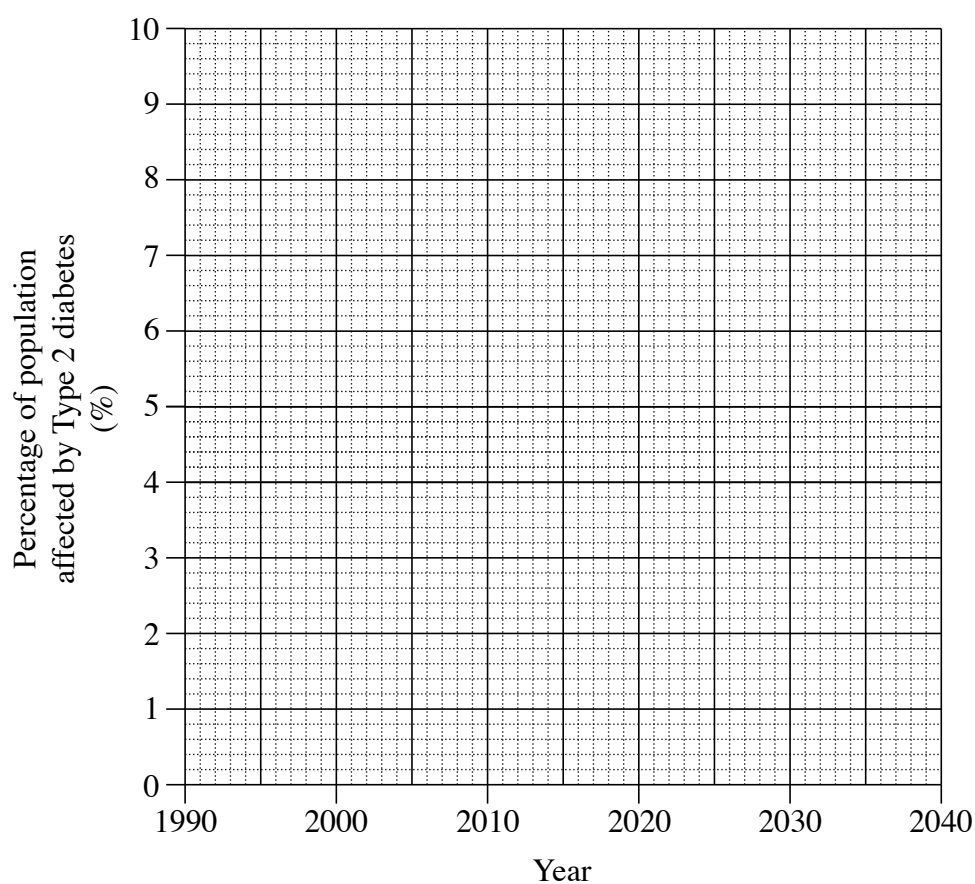
Question 28 (5 marks)

An epidemiological study was conducted to help model how many people will be affected by Type 2 diabetes globally in the future. Continuous data were collected from 1990 to 2020. From that data, the following data points were chosen to demonstrate the trend.

<i>Year</i>	<i>Percentage of population affected by Type 2 diabetes (%)</i>
1990	3.0
2000	4.0
2010	4.4
2020	5.4

- (a) Plot the data on the grid provided and include the line of best fit.

2



Question 28 continues on page 24

Question 28 (continued)

- (b) A prediction of the global population numbers suggests there will be about 9 billion people on the planet by 2040. **3**

Predict the number of people that will be affected by Type 2 diabetes in 2040.
Show working on your graph on the previous page and your calculations.

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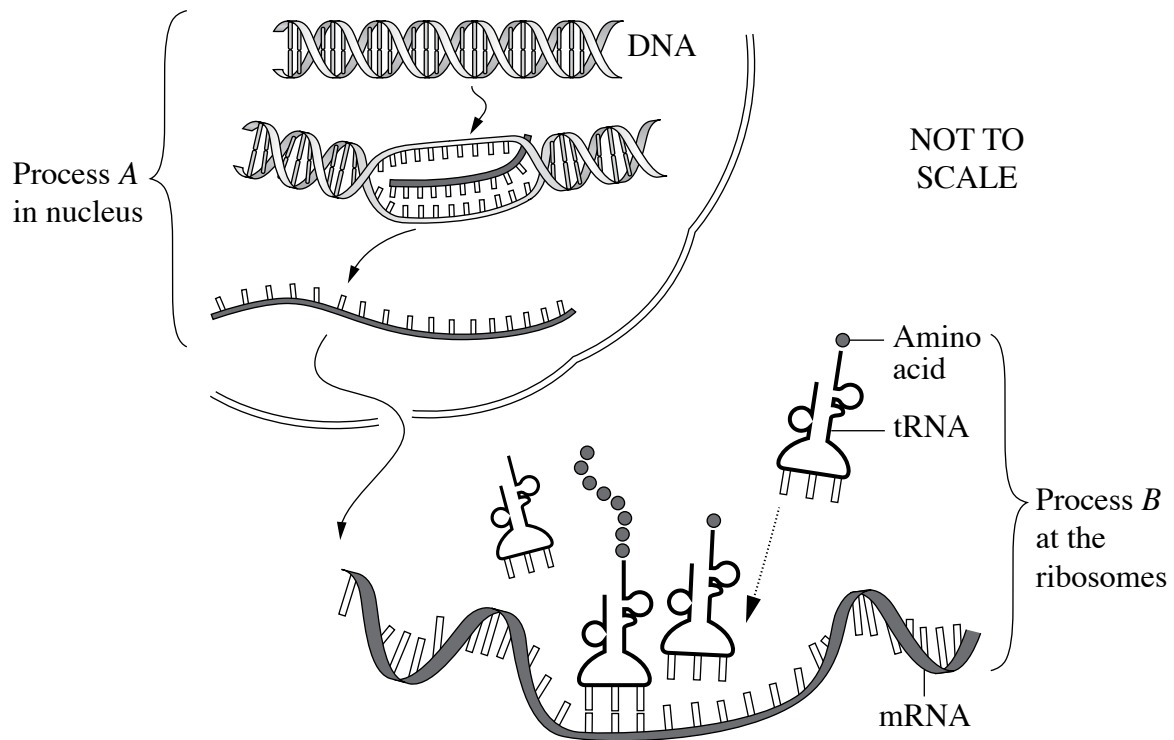
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End of Question 28

Please turn over

Question 29 (7 marks)

The diagram shows a simplified version of the process of polypeptide synthesis.



This file is licensed under the Creative Commons Attribution-ShareAlike 3.0 Unported license – <http://commons.wikimedia.org/wiki/File:MRNA-interaction.png>

(a) Identify Process A and Process B.

2

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Question 29 continues on page 26

Question 29 (continued)

- (b) Explain the roles of mRNA and tRNA in polypeptide synthesis.

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End of Question 29

Question 30 (5 marks)

Studies have shown that lung cancer can be linked to environmental causes.

5

In one historical study across 29 health districts in Japan, non-smoking married women aged 40 and above were followed up for 14 years (1966–79) and annual mortality rates for lung cancer were assessed according to the smoking habits of their husbands. They were compared to women who smoked.

The results are shown.

<i>Group</i>	<i>Number of women</i>	<i>Lung cancer mortality rate (per 100 000)</i>
Non-smoker women with non-smoker husbands	21 895	8.7
Non-smoker women with smoker husbands	69 645	15.5
Women who smoke	17 366	32.8

Evaluate the method used in this epidemiological study.

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Question 30 shows one way that an item could require the integration of knowledge from more than one syllabus content point.

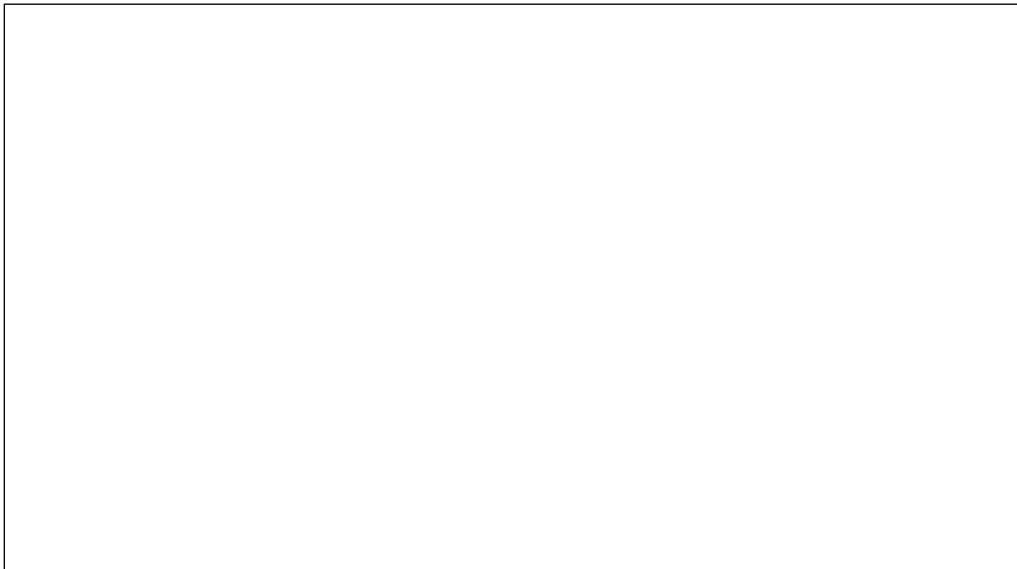
Question 31 (7 marks)

Cystic fibrosis is an inherited disorder that causes damage to the lungs, digestive system and other organs in the body. A person with cystic fibrosis will have two faulty recessive alleles for the cystic fibrosis gene (CFTR) on chromosome 7.

- (a) Two healthy parents, heterozygous for cystic fibrosis, have a child that does not have cystic fibrosis. They are planning to have a second child.

3

Using a Punnett square, determine the probability of their second child being born with the condition. Use '*B*' for the normal CFTR allele, and '*b*' for the faulty CFTR allele.



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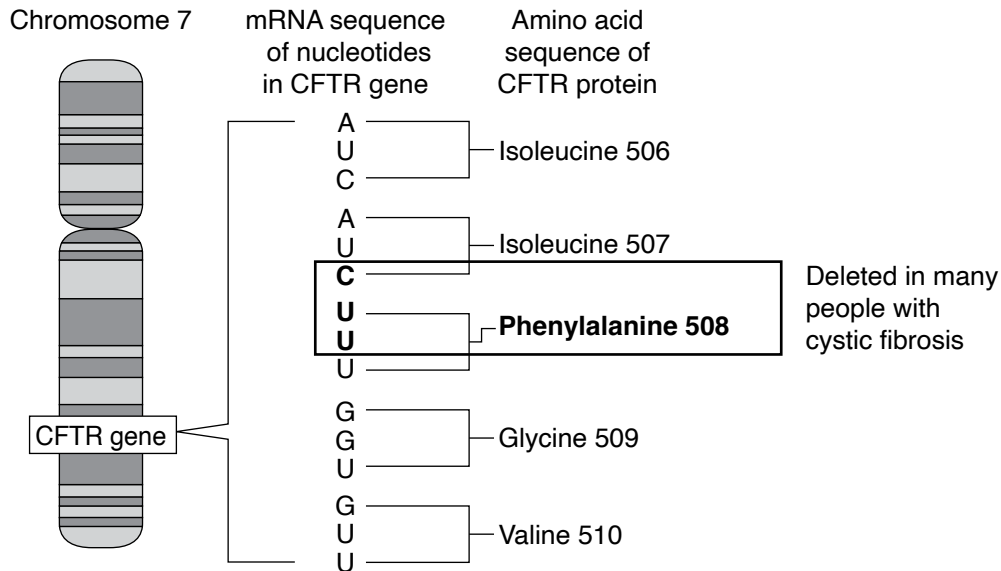
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Question 31 continues on page 29

Question 31 (continued)

The defect that creates the faulty CFTR allele is often caused by the deletion of three nucleotides. The following diagram illustrates a small section of the CFTR gene and the corresponding amino acid sequence of the CFTR protein.



Courtesy of Dr Francis S Collins/National Human Genome Research Institute

The following codon chart displays all the codons and the corresponding amino acids. The chart translates mRNA sequences into amino acids.

		Second base					
		U	C	A	G		
First base	U	UUU } Phenylalanine	UCU } Serine	UAU } Tyrosine	UGU } Cysteine	U	Third base
		UUC } Phenylalanine	UCC } Serine	UAC } Tyrosine	UGC } Cysteine	C	
		UUA } Leucine	UCA } Serine	UAA - STOP	UGA - STOP	A	
		UUG } Leucine	UCG } Serine	UAG - STOP	UGG - Tryptophan	G	
	C	CUU } Leucine	CCU } Proline	CAU } Histidine	CGU } Arginine	U	
		CUC } Leucine	CCC } Proline	CAC } Histidine	CGC } Arginine	C	
		CUA } Leucine	CCA } Proline	CAA } Glutamine	CGA } Arginine	A	
		CUG } Leucine	CCG } Proline	CAG } Glutamine	CGG } Arginine	G	
	A	AUU } Isoleucine	ACU } Threonine	AAU } Asparagine	AGU } Serine	U	
		AUC } Isoleucine	ACC } Threonine	AAC } Asparagine	AGC } Serine	C	
		AUA } Isoleucine	ACA } Threonine	AAA } Lysine	AGA } Arginine	A	
		AUG - Methionine	ACG } Threonine	AAG } Lysine	AGG } Arginine	G	
	G	GUU } Valine	GCU } Alanine	GAU } Aspartic acid	GGU } Glycine	U	
		GUC } Valine	GCC } Alanine	GAC } Aspartic acid	GGC } Glycine	C	
		GUA } Valine	GCA } Alanine	GAA } Glutamic acid	GGA } Glycine	A	
		GUG } Valine	GCG } Alanine	GAG } Glutamic acid	GGG } Glycine	G	

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Question 31 continues on page 30

Question 31 (continued)

- (b) Explain how the deletion of nucleotides in the CFTR gene removes only one amino acid. Include reference to the nucleotides that code for isoleucine and phenylalanine amino acids.

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End of Question 31

Please turn over

Question 32 (5 marks)

Using an example, discuss the ethical and legal implications of gene therapy in health care.

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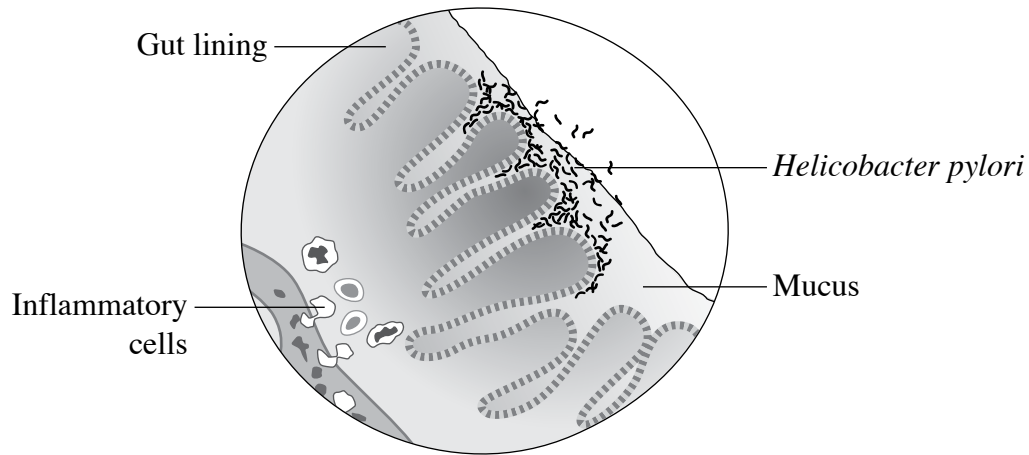
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Question 33 (7 marks)

Helicobacter pylori is a bacterium that invades the gut lining and can cause damage to the stomach as shown in the diagram.

7



© Guts UK Charity

With reference to innate and adaptive immunity, explain how the body responds after exposure to *Helicobacter pylori*.

[illegible]

Question 34 (7 marks)

Students tested the hypothesis that the number of eggs/young produced was greater in animals using external fertilisation than those using internal fertilisation. They obtained the following data from secondary sources.

<i>Mode of fertilisation</i>	<i>Species</i>	<i>Average number of young born or eggs laid in one reproductive cycle</i>	<i>Mean $\pm$ SD*</i>
Internal fertilisation	Red kangaroo	1	43 $\pm$ 55
	Bush rat	6	
	White tipped reef shark	6	
	Loggerhead turtle	126	
	Red bellied black snake	18	
	Guppy (fish)	100	
External fertilisation	Pouched frog	13	40 $\pm$ 32
	Loveridge's frog	20	
	Corroboree frog	25	
	Turtle frog	50	
	Clownfish	100	
	Siamese fighting fish	30	

*SD is standard deviation which gives a measure of the amount of variation in the data.

(a) What conclusion can be drawn from the data? Justify your answer.

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Question 34 continues on page 34

Question 34 (continued)

- (b) Compare the methods of fertilisation for creating genetic variation in the red kangaroo and the clownfish.

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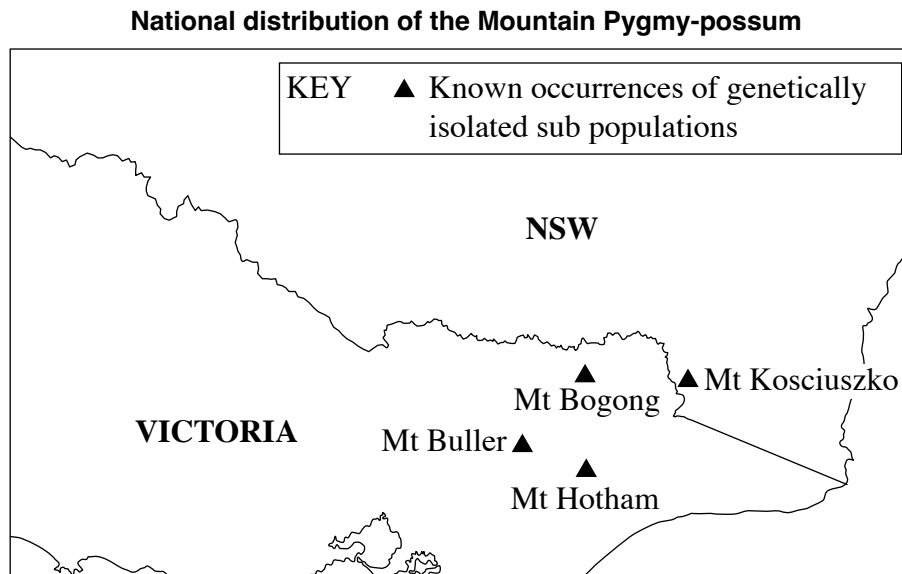
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End of Question 34

Question 35 (7 marks)

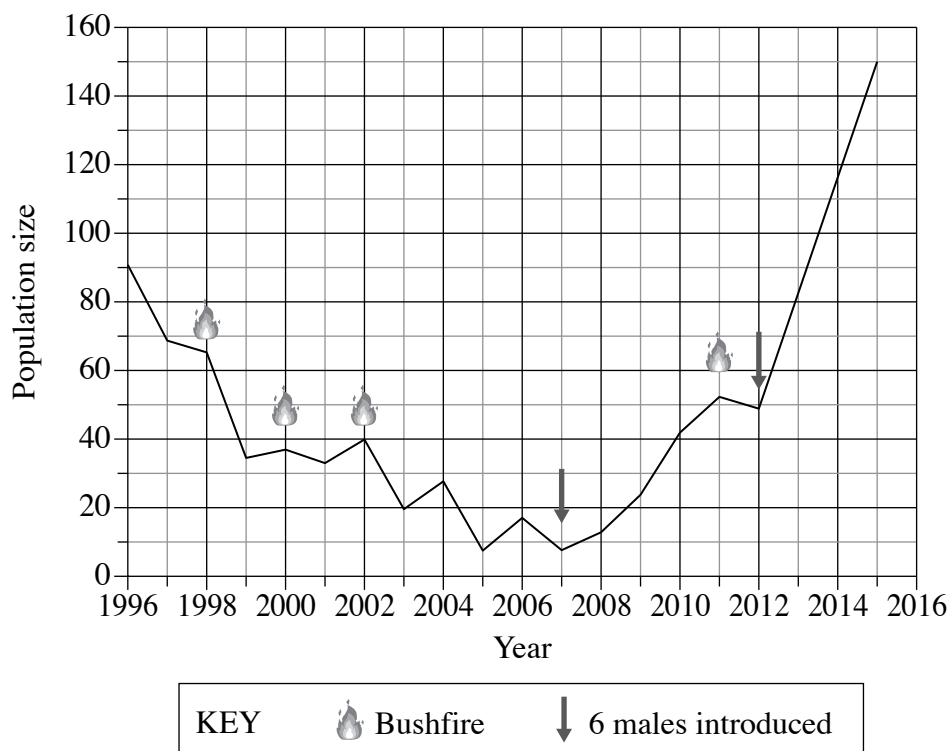
The Mountain Pygmy-possum (*Burramys parvus*) is restricted to four regions in Australia's alpine zone. The species is listed as critically endangered with less than 2000 adults remaining. The range of the Mountain Pygmy-possum has contracted due to a gradually warming climate.



Department of Environment, Land, Water and Planning. 2016.

'National Recovery Plan for the Mountain Pygmy-possum *Burramys parvus*' Australian Government, Canberra
© State of Victoria (Department of Energy, Environment and Climate Action)

Loss and degradation of these habitats have affected local populations. The graph shows changes in the Mt Buller population following recent bushfires and the introduction of male pygmy-possums from Mt Bogong.



Weeks, A.R., Heinze, D., Perrin, L. et al. 'Genetic rescue increases fitness and aids rapid recovery of an endangered marsupial population' Nature Communication 8, 1071 (2017).

<https://www.nature.com/articles/s41467-017-01182-3/figures/1>

Question 35 continues on page 36

Question 35 (continued)

Assess how bushfires and the introduction of males from other locations have affected the population size and gene pool of the Mt Buller pygmy-possum population.

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[illegible]

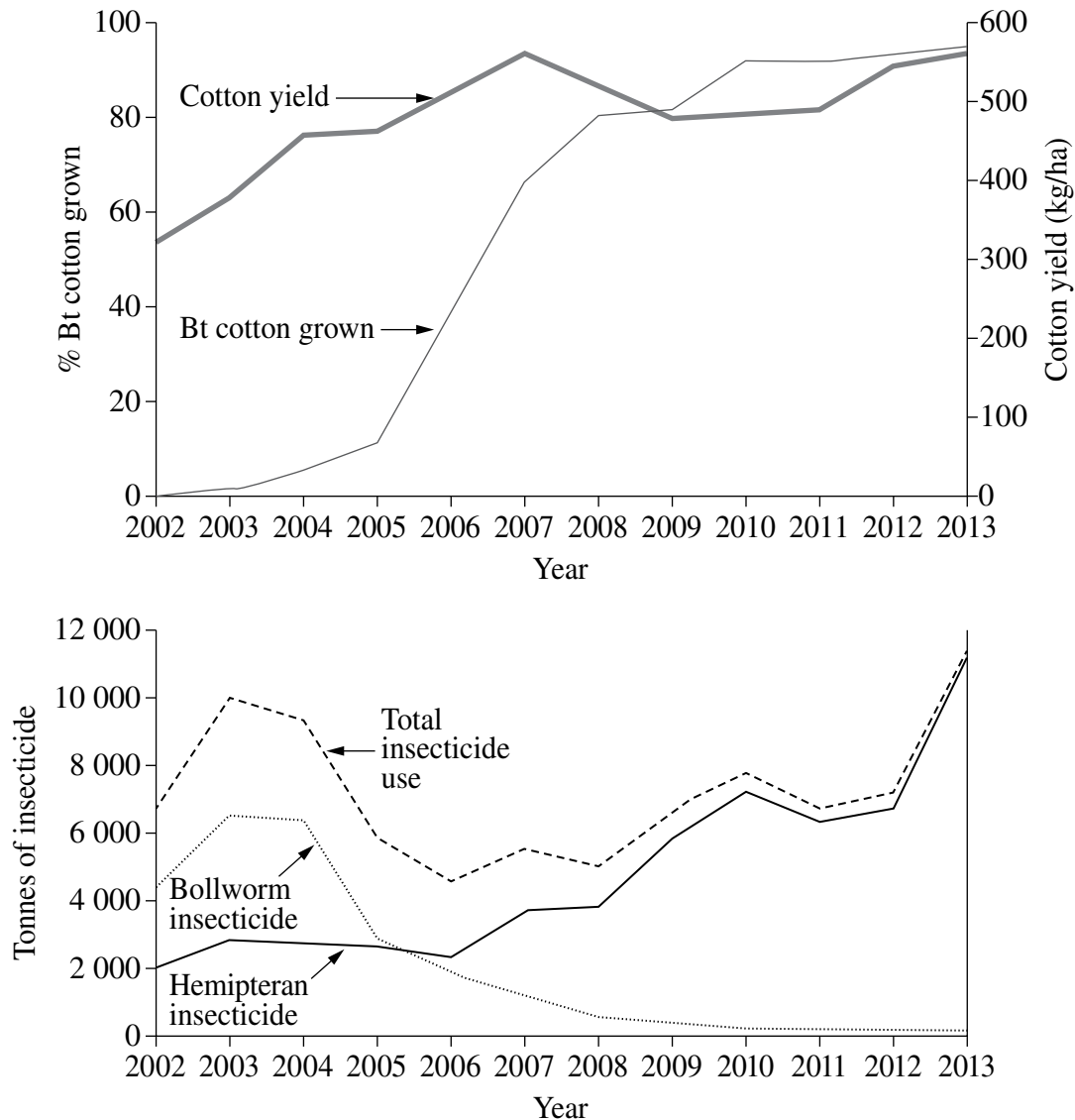
Question 35 shows one way an item could assess Working scientifically outcomes and content.

End of Question 35

Question 36 (7 marks)

Bt cotton has been genetically engineered to produce an insecticide that kills cotton bollworm. It was introduced to a cotton-producing nation in 2002.

The graphs show trends of national cotton yield, % Bt cotton grown, total insecticide use, insecticide use to control bollworms and insecticide use to control another insect pest (hemiptera) that also affects the cotton yield.



Adapted from 'The Failure of GMO Cotton in India' by Professor Andrew Paul Gutierrez, Independent Science News, September 9, 2020. Reproduced with permission by The Bioscience Resource Project.

- (a) Explain ONE reason why cotton yield changed between 2002 and 2013.

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Question 36 (continued)

- (b) To what extent do the data support the use of Bt cotton as a method of disease control in cotton?

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Section II extra writing space

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HSC Biology Sample Examination Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	A
2	B
3	B
4	D
5	A
6	B
7	C
8	B
9	D
10	C
11	D
12	D
13	A
14	C
15	A
16	C
17	D
18	C
19	D
20	C

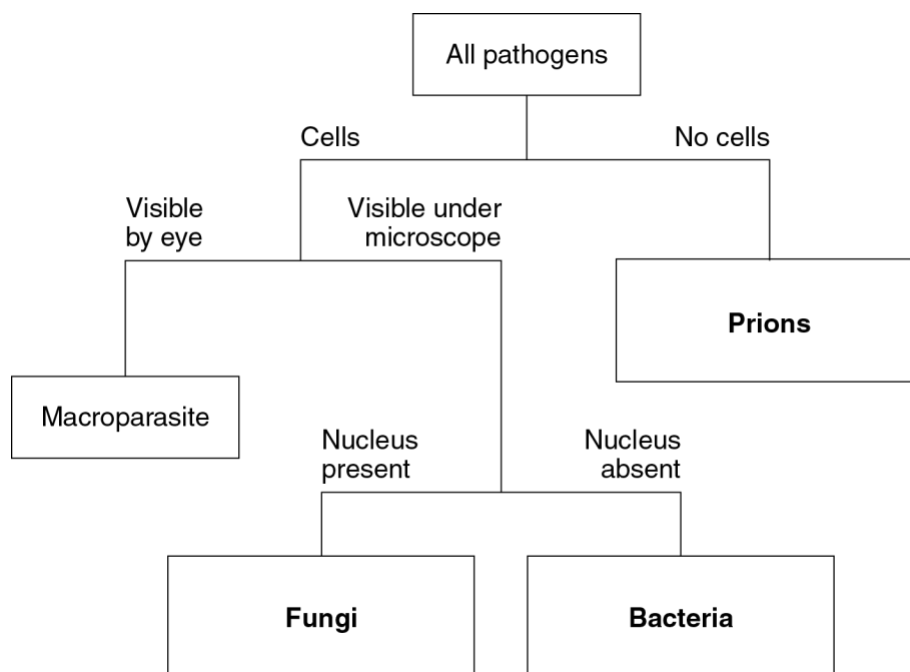
Section II

Sample answers are provided for each question in Section II. Sample answers show one way a student may answer a question and there may be alternative responses that are correct. Sample answers show one way maximum marks may be achieved for that question.

Question 21

Criteria	Marks
• Completes key with appropriate pathogens	3
• Completes some steps in the key correctly	2
• Provides some relevant information	1

Sample answer:



Question 22

Criteria	Marks
• Outlines the use of an Aboriginal bush medicine in treating disease	2
• Provides some relevant information	1

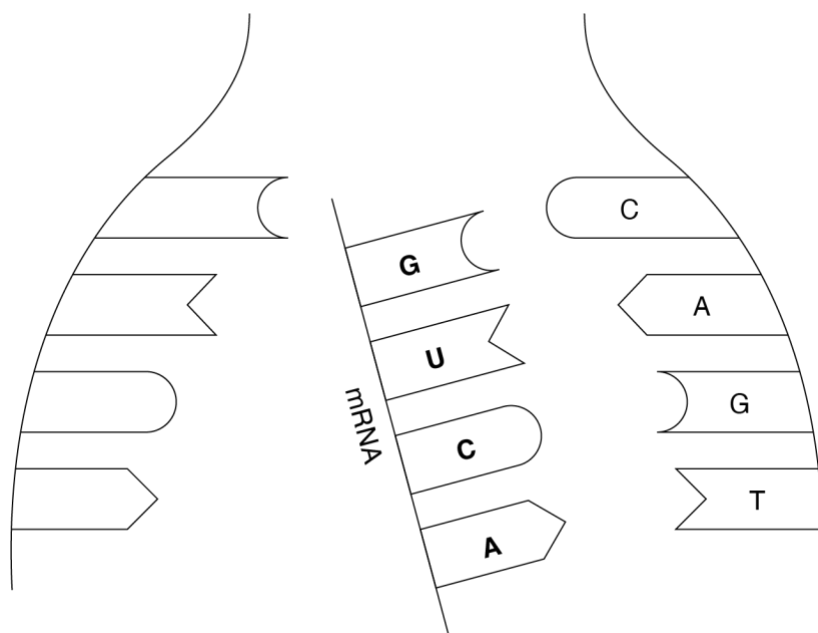
Sample answer:

Smokebush (*Conospermum* sp.) has been used traditionally by Aboriginal Peoples as medicine. It can be used to treat skin infections.

Question 23

Criteria	Marks
• Completes the diagram with the correct mRNA sequence	2
• Identifies uracil as a replacement for thymine for the mRNA sequence OR • Completes the diagram with the complementary DNA sequence	1

Sample answer:



Question 24

Criteria	Marks
• Uses data to explain the impact of adding Golden Rice to children's diets in areas with both high and low levels of vitamin A deficiency.	3
• Uses data to outline the impact of adding Golden Rice to children's diets in areas with both high and low levels of vitamin A deficiency	2
• Provides some relevant information	1

Sample answer:

Including Golden Rice in the diet of children in regions in Central Africa and India would be beneficial in the prevention of blindness, as these are regions with a higher percentage ($\geq 20\%$) of children with vitamin A deficiency. However, in Australia and Europe, it would be of limited benefit because there is no vitamin A deficiency.

Question 25

Criteria	Marks
• Completes table to show the differences between somatic and germ-line mutations	3
• Completes some parts of the table to show the differences between somatic and germ-line mutations	2
• Provides some relevant information	1

Sample answer:

	<i>Somatic mutation</i>	<i>Germ-line mutation</i>
<i>Cell type</i>	Body cells (not gametes)	Sex cells/gametes only
<i>Effect on offspring</i>	Not passed to offspring	May be passed to offspring
<i>Example</i>	Mutation in skin cell DNA leading to skin cancer	Mutation in sex cell leading to haemophilia

Question 26

Criteria	Marks
- Provides a logical procedure to test the effectiveness of honey as an inhibitor of bacterial growth - Provides independent variable, dependent variable, variables kept constant and the use of a control - Includes appropriate safety considerations - Includes repetition	5
- Provides a logical procedure to test the effectiveness of honey as an inhibitor of bacterial growth - Provides most of the features of a safe valid investigation such as - independent variable, dependent variable, variables kept constant and the use of control - includes repetition	4
- Provides a procedure to test the effectiveness of honey as an inhibitor of bacterial growth - Provides some features of a valid investigation	3
Provides some features of a relevant investigation	2
Provides some relevant information	1

Sample answer:

1. Select appropriate safety equipment including gloves and safety clothing.
2. Prepare three nutrient agar plates, using sterile techniques. Seal one plate and label as control.
3. Inoculate the remaining plates with bacteria to cover the agar surface.
4. Place a sterile paper disc soaked in distilled water in the middle of an agar plate. Seal and label as Water.
5. Place a sterile paper disc soaked in honey in the middle of an agar plate. Seal and label as Honey.
6. Incubate the plates at 25°C for 48 hours.
7. Remove from incubator but do not open any of the plates after incubation.
8. Observe the control plate to check for any contaminating bacteria.
9. For each agar plate, measure the zone of inhibition from edge to edge.
10. Repeat the experiment three more times and calculate an average.

Question 27

Criteria	Marks
• Demonstrates an extensive understanding of the biotechnologies applied to cattle with relevant references to the table • Makes an informed judgement of the effect of biotechnologies on the biodiversity of cattle	5
• Demonstrates a sound understanding of the biotechnologies applied to cattle with some references to the table • Makes a suitable judgement of the effect of biotechnologies on the biodiversity of cattle	4
• Demonstrates an understanding of the effect of biotechnologies on biodiversity of cattle	3
• Identifies an effect of a biotechnology	2
• Provides some relevant information	1

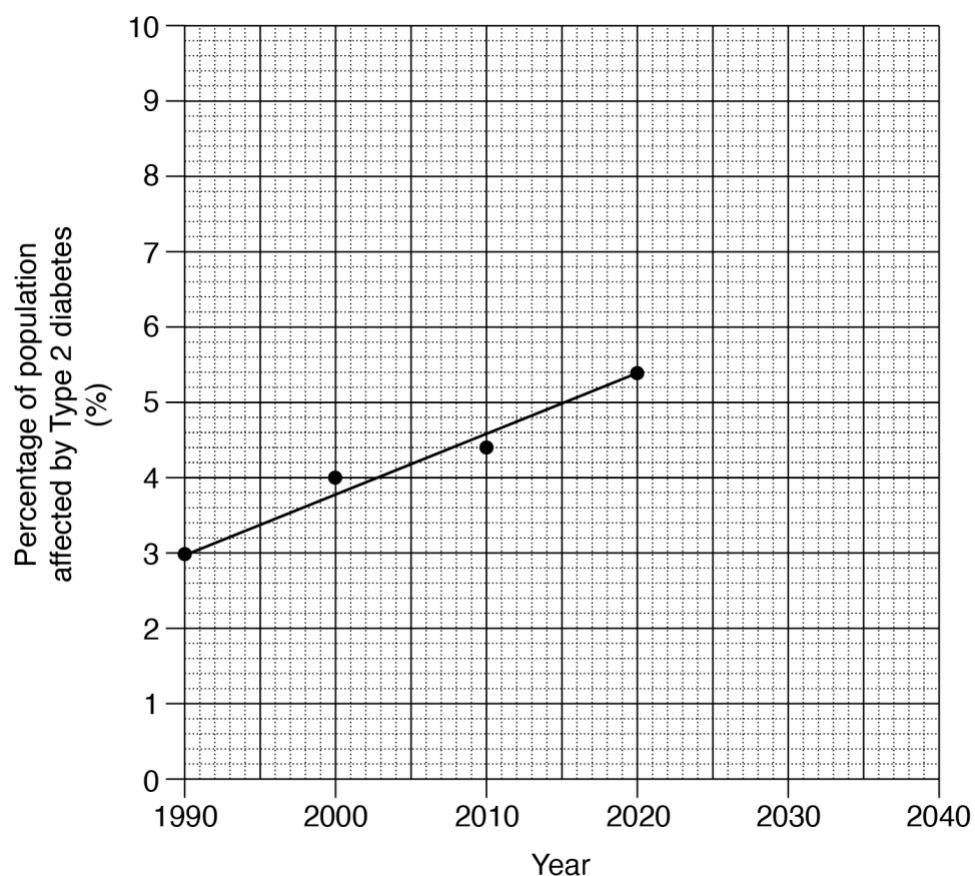
Sample answer:

Biotechnologies can increase, maintain and decrease biodiversity in cattle. Artificial insemination generally reduces biodiversity as one male can be used to sire many offspring. This reduces the number of bulls that pass on their genetics, reducing the biodiversity in the species. Selective breeding reduces biodiversity as only individuals with desired characteristics are allowed to breed and pass on their genes. Producing transgenic organisms may increase the genetic diversity in cattle by introducing genes not originally present, but as it is not widely used it is not currently having a large impact on biodiversity. These biotechnologies used in the farming of cattle have the overall effect of decreasing the biodiversity of cattle.

Question 28 (a)

Criteria	Marks
- All points plotted correctly - Appropriate line of best fit drawn	2
- Some points plotted correctly OR - Line of best fit attempted	1

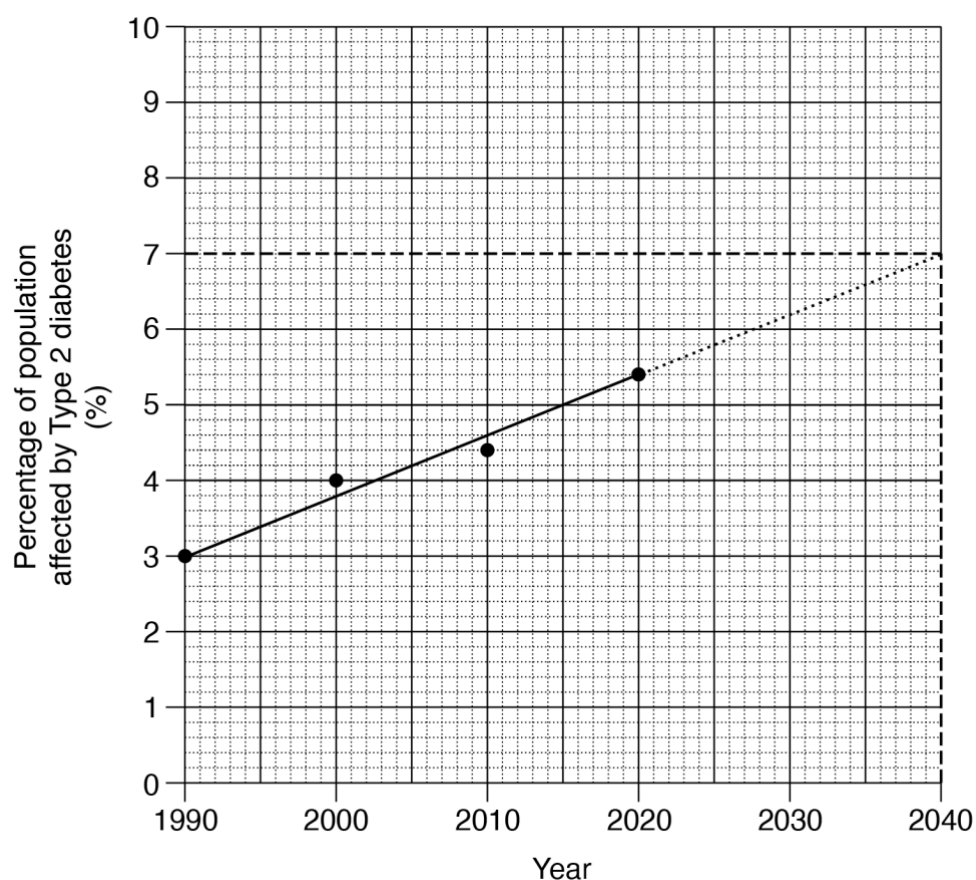
Sample answer:



Question 28 (b)

Criteria	Marks
- Extrapolates the line of best fit - States the percentage value from y-axis - Calculates the number of people with Type 2 diabetes in 2040 based on 9 billion people	3
Demonstrates some understanding of how to determine the number of people with Type 2 diabetes in 2040	2
Provides some relevant detail	1

Sample answer:



7% of the population

$$\frac{7}{100} \times 9 \text{ billion} = 0.63 \text{ billion or } 630 \text{ million}$$

Question 29 (a)

Criteria	Marks
• Identifies both processes	2
• Identifies one process	1

Sample answer:

Process A is transcription.

Process B is translation.

Question 29 (b)

Criteria	Marks
• Provides a thorough explanation of the roles of mRNA and tRNA in polypeptide synthesis	5
• Provides a sound explanation of the roles of mRNA and tRNA in polypeptide synthesis	4
• Demonstrates some understanding of the roles of mRNA and tRNA in polypeptide synthesis	3
• Demonstrates an understanding of mRNA or tRNA	2
• Provides some relevant information	1

Sample answer:

mRNA is synthesised from the DNA template in the nucleus. This mRNA carries the genetic instructions (codons) from the DNA in the nucleus to the ribosomes in the cytoplasm. Once the mRNA reaches the ribosome, polypeptide synthesis begins.

Each tRNA molecule has an anticodon that pairs with a complementary codon on the mRNA strand. The mRNA codons are read in sequence, and as each tRNA brings its specific amino acid to the ribosome, the correct polypeptide is assembled.

Question 30

Criteria	Marks
• Demonstrates a thorough understanding of the features of the methodology used • Provides an informed judgement	5
• Demonstrates a sound understanding of the features of the methodology used • Provides a suitable judgement	4
• Demonstrates some understanding of the features of the methodology used • Provides some judgement	3
• Provides relevant feature(s) of the methodology used	2
• Provides some relevant information	1

Sample answer:

The data from the observational cohort study shows that large numbers of women were grouped in three different categories based on their exposure to cigarette smoke. These women were from a number of locations and followed for 14 years. The categories of women assume that they spend similar periods of time with a smoker, and that each smoker smokes a similar amount. However, in reality, the time exposure and the volume of smoke they are exposed to may vary greatly. The study also does not account for any confounding factors, such as the women being exposed to other environmental contaminants or genetic or lifestyle factors that could affect their overall health.

The time period of 14 years is adequate for a valid study. To further improve the validity of the experiment, follow up over subsequent years would allow for more definitive data and morbidity should also be considered alongside mortality. In not accounting for the aforementioned variables, the accuracy and validity of the data is compromised, but the large cohort of women makes the method appear reliable.

Question 31 (a)

Criteria	Marks
- Provides the correct parental genotypes and suitable working with a Punnett square - Provides the correct probability of the second child having cystic fibrosis	3
- Provides the correct probability with some correct working OR - Provides the correct parental genotypes with suitable working	2
Provides some relevant information	1

Sample answer:

	<i>B</i>	<i>b</i>
<i>B</i>	<i>BB</i>	<i>Bb</i>
<i>b</i>	<i>Bb</i>	<i>bb</i>

There is a 25% chance of the second child having cystic fibrosis.

Question 31 (b)

Criteria	Marks
- Provides a thorough explanation of how the deletion removes only one amino acid - Refers to isoleucine, phenylalanine and the final amino acid sequence	4
- Provides a sound explanation of the deletion of one amino acid - Refers to appropriate amino acids or the effects of deletions	3
Demonstrates some understanding of how mRNA codes for amino acids or of the effects of deletions	2
Provides some relevant information	1

Sample answer:

A triplet of mRNA nucleotides codes for one amino acid, however, the three nucleotides that are removed span across two triplet codons – the codon for isoleucine and the codon for phenylalanine. Therefore, it would be expected that both amino acids are affected. However, isoleucine can be coded for by a number of different triplet nucleotide combinations. The correct coding is AUC, but after the deletion of the three nucleotides, the code left is AUU, which also codes for isoleucine. Thus, only the phenylalanine amino acid is removed.

Question 32

Criteria	Marks
Provides a detailed discussion of the ethical and legal implications of a named gene therapy	5
Provides a sound discussion of the ethical and legal implications of a named gene therapy	4
Provides some discussion of the ethical and/or legal implication(s) of a named gene therapy	3
Demonstrates some understanding of an ethical or a legal implication	2
Provides some relevant information	1

Sample answer:

Luxturna is a gene therapy approved in Australia for inherited retinal dystrophy caused by mutations in the RPE65 gene, leading to vision loss. Copies of the correct gene are injected under the retina to deliver the functional gene.

- Ethical implications:**

This therapy is expensive and not affordable for everyone restricting it to high income patients. Low income families would have to financially support others impacted by retinol dystrophy who may need to withdraw from employment due to blindness increasing their disadvantage further. Its success may lead to the development of other beneficial uses of gene therapy.

- Legal implications:**

Australia has well established approval procedures ensuring treatments are safe and effective for the patient. There are concerns about how the patient's data is stored, used and protected to avoid genetic discrimination in employment or insurance.

Question 33

Criteria	Marks
• Demonstrates an extensive understanding of the innate and adaptive immune response including phagocytosis, inflammatory response, stimulation and role of B and T cells • Relates body's responses to innate and adaptive immunity against <i>H. pylori</i>	7
• Demonstrates a thorough understanding of the innate and adaptive immune response including phagocytosis, inflammatory response, stimulation and role of B and T cells	5–6
• Demonstrates a sound understanding of the innate and adaptive immune response	3–4
• Demonstrates some understanding of the immune response	2
• Provides some relevant information	1

Sample answer:

Damaged cells cause chemicals to be released, causing inflammation. Dilation of blood vessels as a part of inflammatory response increases blood flow which facilitates movement of phagocytes including macrophages and neutrophils into the infected area.

Phagocytes process bacterial antigens and present them to the helper T-cells which triggers the adaptive immune response through release of cytokines. This results in activation of T and B cells.

Cytotoxic T-cells specific to *H. pylori* directly attack the bacteria while the memory T-cells stay in the system to induce a rapid secondary immune response. Suppressor T-cells help with the regulation of the immune response.

Plasma B-cells produce antibodies specific to *H. pylori* while memory B-cells remain in the system for secondary immune response. The antibodies can neutralise the antigens directly or tag it for destruction by phagocytes.

Both innate and adaptive immune responses work together to eliminate *H. pylori*. Innate response is rapid and provides immediate defence against *H. pylori* whereas adaptive response is slow but provides lifelong immunity through specific memory cells.

Question 34 (a)

Criteria	Marks
• Draws the correct conclusion from the data • Uses the data to provide justification for the validity of the conclusion	3
• Draws a relevant conclusion • Uses the data to provide a reason for the conclusion	2
• Provides some relevant information about the data	1

Sample answer:

Since there is little difference between the mean numbers of young/eggs produced in animals using the two modes of reproduction, and the variability of the data is large as shown by the standard deviations, the students could conclude that there is no difference between the number of young produced and the mode of fertilisation.

Question 34 (b)

Criteria	Marks
• Provides a detailed comparison of the external and internal fertilisation methods for creating genetic variation in the red kangaroo and clownfish	4
• Provides a comparison of the external and internal fertilisation methods for creating genetic variation in the red kangaroo and clownfish	3
• Provides a similarity and/or a difference in the way genetic variation can arise from both internal and external fertilisation	2
• Provides some relevant information	1

Sample answer:

External and internal fertilisation both facilitate variation through the combination of gametes from two parents.

In the clownfish, external fertilisation involves the mixing of many gametes from multiple individuals in an aquatic environment producing many offspring (100 for the clownfish). This potentially increases genetic variation in the population. On the other hand, in the red kangaroo internal fertilisation involves fewer gametes from a specific partner, which also leads to genetic variation but to a lesser extent.

External fertilisation is a less selective method where gametes are often released into the water with no mate choice, resulting in greater genetic variation within the offspring. On the other hand, internal fertilisation often involves mate selection, resulting in fewer genetic variations in the offspring.

Question 35

Criteria	Marks
• Demonstrates an extensive understanding of the relationships between bushfires and introducing males on the population size and gene pool of the Mt Buller pygmy possum population • Makes an informed judgement about factors affecting the Mt Buller pygmy possum population	7
• Demonstrates a sound understanding of the relationships between bushfires and introducing males on the population size and gene pool of the Mt Buller pygmy possum population • Makes a suitable judgement about factors affecting the Mt Buller pygmy possum population	5–6
• Demonstrates an understanding of the relationships between bushfires or introducing males on the population size and/or gene pool of the Mt Buller pygmy possum population	3–4
• Identifies the relationship between bushfires or introducing males on the population size or gene pool of the Mt Buller pygmy possum population	2
• Provides some relevant information	1

Sample answer:

The Mt Buller mountain pygmy possum population was reduced significantly after three bushfires (1998, 2000, and 2002) from approximately 70 individuals to 40. This was due to deaths and habitat destruction. The gene pool of the Mt Buller population was in turn reduced (fewer alleles present) with under 10 individuals left in 2005 (bottleneck effect). The continued decrease in population numbers from 2002 to 2007 indicates a lack of genetic diversity in the small population, making them vulnerable to change.

In 2007, 6 males with new alleles from Mt Bogong (a different location) were introduced into the Mt Buller population resulting in increased genetic diversity (gene flow). During the following 4 years, the population rose to over 50 individuals as the surviving females were able to breed with the new males.

The bushfire in 2011 caused only a few deaths. The subsequent introduction of a further 6 males in 2012 resulted in a big increase in the Mt Buller population (150 individuals by 2015).

This is evidence that the introduction of genetically different males into the remaining Mt Buller population has resulted in both increased numbers and greater genetic diversity. Increasing the gene pool improved the overall chances of survival for the Mt Buller mountain pygmy possum population.

Question 36 (a)

Criteria	Marks
• Provides cause and effect for the increase in cotton yield	2
• Provides some relevant information	1

Sample answer:

As the percentage of Bt cotton grown increased, so did the cotton yield. Bt cotton reduces insect attack, increasing yield.

Question 36 (b)

Criteria	Marks
• Demonstrates a thorough understanding of the links between the use of Bt cotton, insecticides, disease control and natural selection • Interprets inter-relationships between the use of genetically engineered crops and insecticides for disease control • Makes an informed judgement based on the data	5
• Demonstrates a sound understanding of the use of Bt cotton, insecticides, disease control and/or selective pressures • Provides a suitable judgement based on the data	4
• Demonstrates an understanding of the use of Bt cotton and disease control • Outlines the benefit(s) and limitation(s) of using Bt cotton for disease control • Supports answer with reference to the data	3
• Outlines a benefit or a limitation of the use of Bt cotton for disease control AND • Provides link(s) to the data	2
• Provides some relevant information	1

Sample answer:

The introduction of Bt cotton initially resulted in less insect damage and disease and a saving in application of insecticides.

As Bt cotton was introduced, the amount of insecticides applied to kill bollworm decreased, eventually to zero, suggesting that Bt cotton was effectively controlling disease due to bollworm. However, the data show that once most of the cotton crops grown were Bt cotton, insecticide use to kill hemiptera increased markedly to a higher level than before Bt cotton was introduced. These increased amounts of insecticides were needed to maintain high yields.

A conclusion that can be drawn is that Bt toxin killed bollworms but did not kill hemiptera. Removal of bollworms provided a survival advantage for hemiptera which became the dominant pest. Therefore, a new cause of disease in cotton was dominant and the benefit of Bt cotton for disease control was temporary.

This mapping grid shows how the Biology Sample HSC Examination allows for appropriate differentiation of student performance at each band on the performance scale. An examination committee uses a mapping grid to ensure the examination is appropriately mapped to the course's syllabus and performance standards.

HSC Biology

Sample Examination

Mapping Grid

An examination committee uses the 'targeted syllabus outcomes' column of the mapping grid to ensure there is a representative sample of a **range of syllabus outcomes** throughout the examination.

The 'targeted performance bands' column of the mapping grid shows how questions in this sample HSC examination are targeted to **levels of performance** that are described in the bands on the performance scale.

Section I

Question	Marks	Content	Targeted syllabus outcomes	Targeted performance bands
1	1	Biodiversity – Changing ecosystems	BI-12-03	2–3
2	1	Biotechnology – Modern biotechnologies	BI-12-04	2–3
3	1	Heredity – Genetic variants	BI-12-01, BI-12WS-04	2–3
4	1	Biotechnology – Biotechnology in agriculture and biodiversity	BI-12-04, BI-12WS-05	2–3
5	1	Biotechnology – Biotechnology in agriculture and biodiversity Biodiversity – Genetic diversity	BI-12-04	3–4
6	1	Biodiversity – Genetic diversity	BI-12-03, BI-12WS-04, BI-12WS-05	3–4
7	1	Heredity – Genetic variants	BI-12-01, BI-12WS-05	3–4
8	1	Biotechnology – Biotechnology in agriculture and biodiversity	BI-12-04	3–4
9	1	Diseases – Epidemiological studies	BI-12-02, BI-12WS-05	3–4
10	1	Diseases – Non-infectious diseases	BI-12-02, BI-12WS-04	3–4
11	1	Heredity – Polypeptide synthesis	BI-12-01, BI-12WS-05	4–5
12	1	Biodiversity – Sustainable ecosystems	BI-12-03, BI-12WS-05	4–5
13	1	Biotechnology – Biotechnology in human diseases	BI-12-04, BI-12WS-04	4–5

Question	Marks	Content	Targeted syllabus outcomes	Targeted performance bands
14	1	Diseases – Infectious diseases	BI-12-02, BI-12WS-05	4–5
15	1	Diseases – Infectious diseases	BI-12-02	4–5
16	1	Heredity – Inheritance patterns	BI-12-01, B1-12WS-06	4–5
17	1	Diseases – Epidemiological studies	BI-12-02	5–6
18	1	Heredity – Inheritance patterns	BI-12-01, BI-12WS-06	5–6
19	1	Heredity – Inheritance patterns	BI-12-01, BI-12WS-05	5–6
20	1	Biotechnology – Biotechnology in human diseases	BI-12-04, BI-12WS-04	5–6

Section II

Question	Marks	Content	Targeted syllabus outcomes	Targeted performance bands
21	3	Diseases – Infectious diseases	BI-12-02, BI-12WS-04	2–4
22	2	Diseases – Infectious diseases	BI-12-02	2–3
23	2	Heredity – Polypeptide synthesis	BI-12-01, BI-12WS-04	2–4
24	3	Biotechnology – Biotechnology in agriculture and biodiversity Diseases – Non-infectious diseases	BI-12-02, BI-12-04	2–4
25	3	Heredity – Genetic variants	BI-12-01	2–4
26	5	Diseases – Infectious diseases	BI-12-02, BI-12WS-02	2–6
27	5	Biotechnology – Modern biotechnologies Biotechnology – Biotechnology in agriculture and sustainability Biodiversity – Sustainable ecosystems	BI-12-03, BI-12-04 BI-12WS-05	2–6
28 (a)	2	Diseases – Epidemiological studies	BI-12-02, BI-12WS-04, BI-12WS-05	2–3
28 (b)	3	Diseases – Epidemiological studies	BI-12-02, BI-12WS-04 BI-12WS-05	3–5
29 (a)	2	Heredity – Polypeptide synthesis	BI-12-01, BI-12WS-04	2–4
29 (b)	5	Heredity – Polypeptide synthesis	BI-12-01, BI-12WS-04	2–6
30	5	Diseases – Epidemiological studies Diseases – Non-infectious diseases	BI-12-02, BI-12WS-05	2–6
31 (a)	3	Heredity – Inheritance patterns	BI-12-01, BI-12WS-05, BI-12WS-06	3–5

Question	Marks	Content	Targeted syllabus outcomes	Targeted performance bands
31 (b)	4	Heredity – Genetic variants	BI-12-01, BI-12WS-05, BI-12WS-06	3–6
32	5	Biotechnology – Biotechnology in human diseases	BI-12-04, BI-12WS-07	2–5
33	7	Diseases – Infectious diseases	BI-12-02, BI-12WS-04, BI-12WS-05	2–6
34 (a)	3	Biodiversity – Genetic diversity	BI-12-03, BI-12WS-05	4–6
34 (b)	4	Biodiversity – Genetic diversity	BI-12-03, BI-12WS-05	2–5
35	7	Biodiversity – Genetic diversity Biodiversity – Changing ecosystems	BI-12-03, BI-12WS-05, BI-12WS-07	2–6
36 (a)	2	Biotechnology – Modern biotechnologies	BI-12-04, BI-12WS-05, BI-12WS-07	3–4
36 (b)	5	Biotechnology – Modern biotechnologies	BI-12-04, BI-12WS-05, BI-12WS-07	3–6