NSW GOVERNMENT

NSW Education Standards Authority

Centre Number

Student Number

2024 **HIGHER SCHOOL CERTIFICATE EXAMINATION**

Biology

General Instructions

- Reading time – 5 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 2–14)

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

Section II – 80 marks (pages 17–40)

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this section

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.

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1 Which of the following are non-cellular pathogens?

A. Bacteria

B. Fungi

C. Prions

D. Protozoa

2 Resin produced by spinifex grass has long been used by Aboriginal Peoples. Spinifex resin is currently used to produce medicinal creams.

What is this an example of?

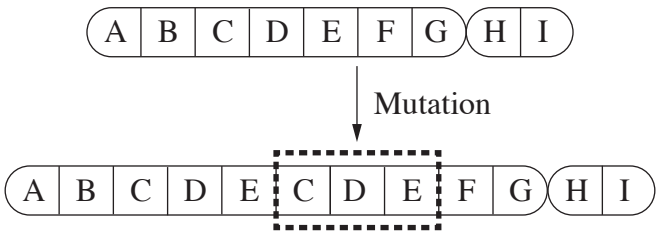
A. Biotechnology

B. Selective breeding

C. Artificial insemination

D. Genetically modified organisms

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

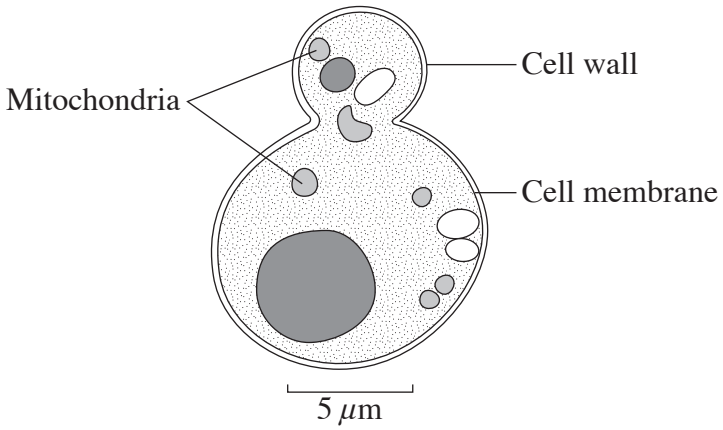
C. Inversion

D. Substitution

4 Which row of the table correctly identifies components of DNA?

	Phosphate	*Ribose*	*Deoxyribose*	*Uracil*	*Thymine*
A.	✓		✓	✓	
B.		✓		✓	✓
C.		✓	✓		✓
D.	✓		✓		✓

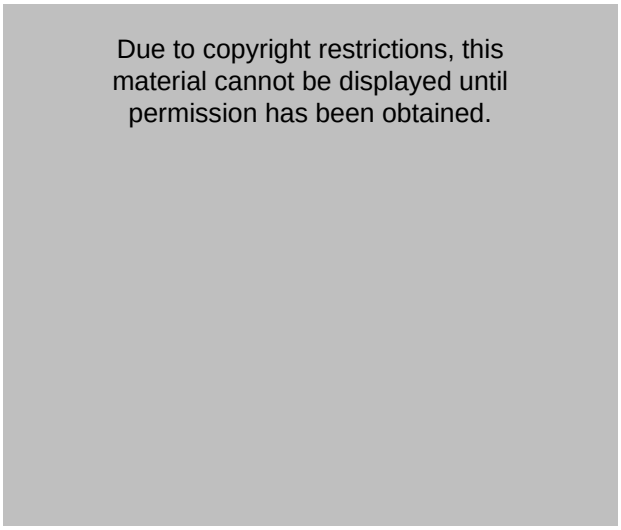
5 The diagram shows a cell reproducing.



Which row of the table correctly identifies the method of reproduction and the type of organism shown in the diagram?

	Method of reproduction	*Type of organism*
A.	Budding	Fungi
B.	Binary fission	Bacteria
C.	Production of spores	Plant
D.	Gamete production	Protist

6 The diagram shows the karyotypes of a body cell for a male and a female fruit fly.



How many chromosomes will the egg of a female fruit fly have?

A. 2

B. 4

C. 6

D. 8

7 How do stomata maintain water balance in plants?

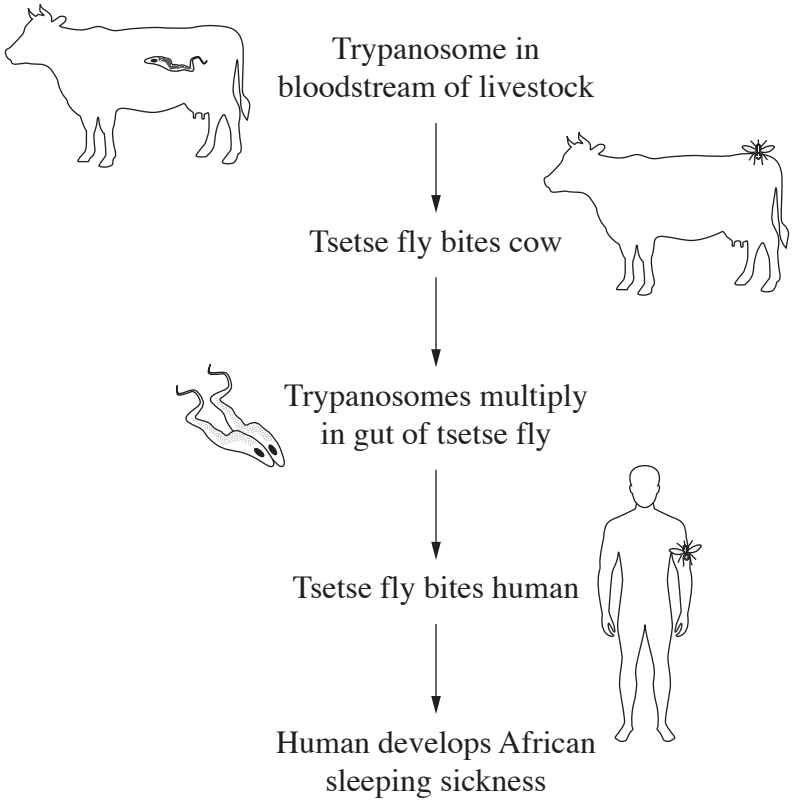
A. They close in hot weather to decrease transpiration.

B. They open in cold weather to decrease transpiration.

C. They open in hot weather to decrease evaporative cooling.

D. They close in cold weather to decrease evaporative cooling.

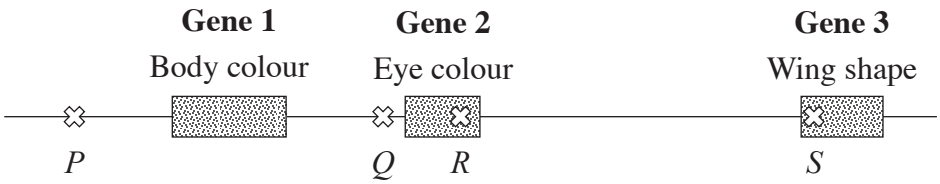
8 Trypanosomes (*Trypanosoma brucei*) are protozoans that cause African sleeping sickness in humans. The diagram shows the way that the disease is transmitted to humans.



Which row of the table identifies the pathogen, vector and method of disease transmission to humans?

	Pathogen	*Vector*	*Method of disease transmission*
A.	Trypanosomes	Tsetse fly	Direct
B.	Tsetse fly	Cow	Direct
C.	Trypanosomes	Tsetse fly	Indirect
D.	Tsetse fly	Cow	Indirect

9 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?

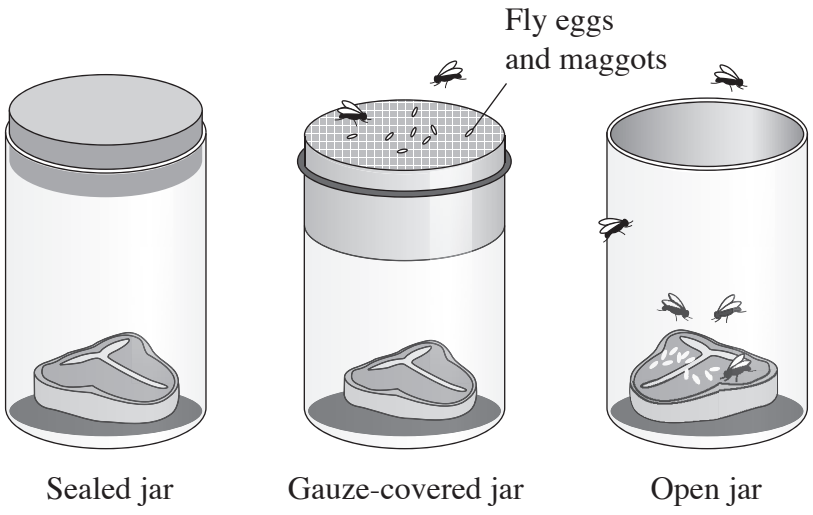
A. *P*

B. *Q*

C. *R*

D. *S*

10 Francesco Redi challenged the idea that maggots arose spontaneously from rotting meat. A modern version of his experiment was set up as shown.



Which of the following is correct for this experimental set up?

A. The sealed jar improves the validity of the experiment.

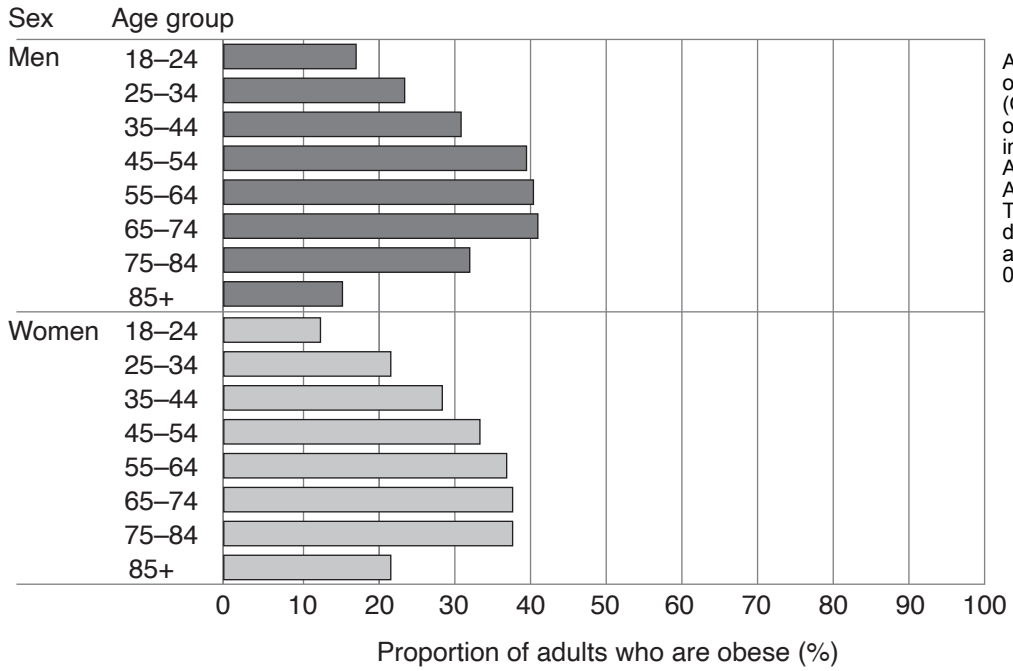
B. The independent variable is whether the meat spoils or not.

C. The use of three jars improves the reliability of the experiment.

D. The dependent variable is the use of different covers for the jars.

11 The data shows the proportion of adults living in Australia who are obese.

Proportion of adults who are obese by age group and sex, 2017–18



Australian Bureau of Statistics (Overweight and obesity, released in 2022) Source: ABS 2023c, ABS 2023d. See Data Tables S2 and S10 for data and footnotes., accessed 06 November 2024

Which of the following can be observed from the data?

A. The proportion of obese adults always increases with age.

B. There is a greater percentage of men who are obese than women in all age groups.

C. The proportion of women who are obese increases from 13% at 18–24 to 38% at 65–74.

D. The proportion of men who are obese increases from 18% at 18–24 to 35% at 45–54, then decreases to 23% at age 85 and over.

12 Robert Koch produced a set of criteria to establish whether a particular organism is the cause of a disease in an animal. The criteria are listed below but not in the correct order.

1. The microorganism must cause disease when introduced to a healthy experimental animal.
2. The microorganism must be extracted and isolated from the diseased animal and subsequently grown in culture.
3. The microorganism must be extracted from the diseased experimental animal and demonstrated to be the same microorganism that was isolated from the first diseased animal.
4. The microorganism must be found in the diseased animal, and not found in healthy animals.

Which of the following correctly shows the order of steps required to determine the cause of a particular disease in an animal?

A. 2, 3, 1, 4

B. 2, 4, 1, 3

C. 4, 2, 1, 3

D. 4, 3, 2, 1

13 Which of the following identifies plant responses to pathogens?

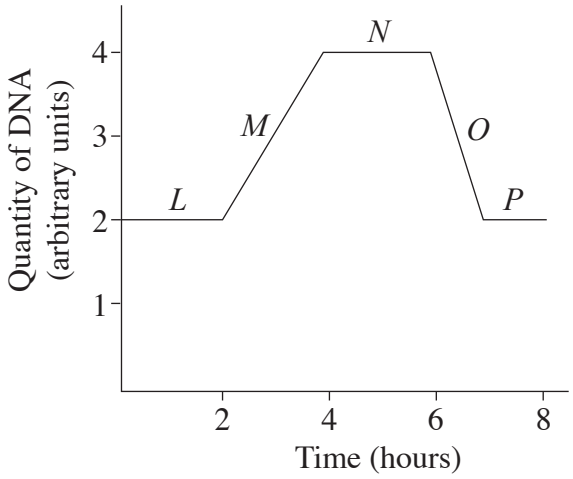
A. Increased phagocytosis and programmed cell death

B. Increased number of stomata and programmed cell death

C. Production of antihistamines and increased thickness of cell walls

D. Production of antimicrobial substances and increased thickness of cell walls

14 The graph shows the quantity of DNA in one mammalian cell over time.



Which of the statements about the cell's activity is correct?

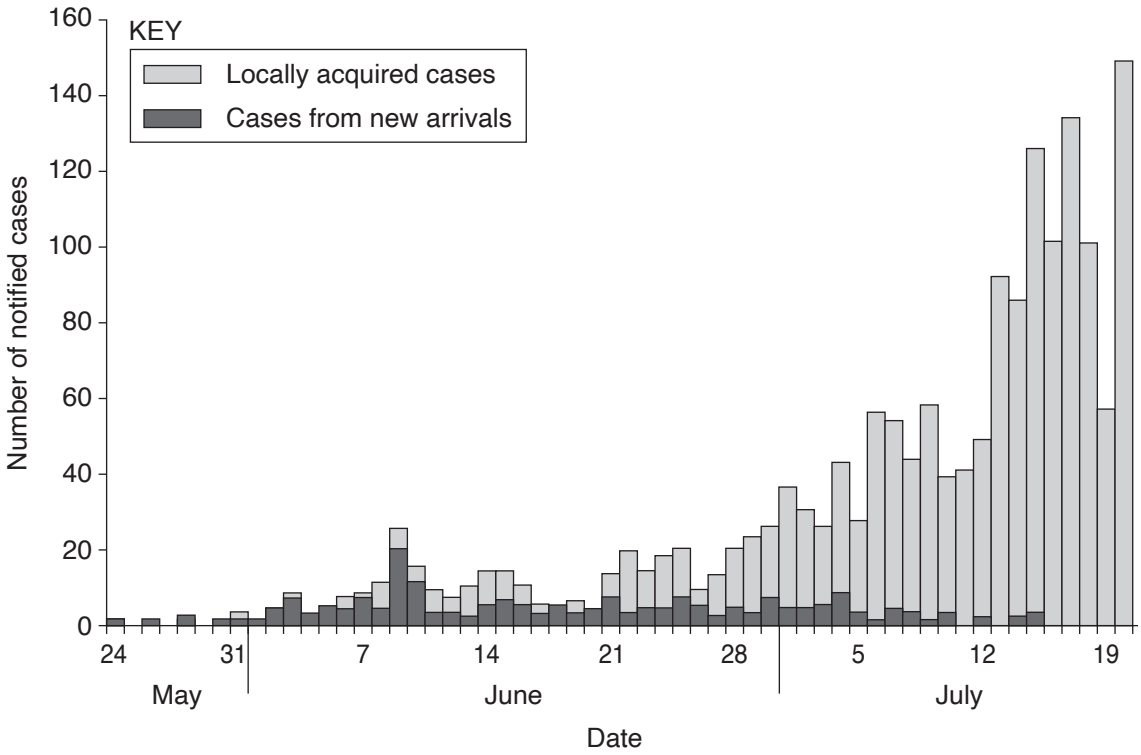
A. The cell is dividing during section *O*.

B. The cell is inactive for the first two hours.

C. The cell takes one hour to replicate its DNA.

D. The cell becomes diploid only during section *N*.

15 The graph shows the number of cases of Swine Flu (a viral respiratory illness) from May to July 2009 in Australia.

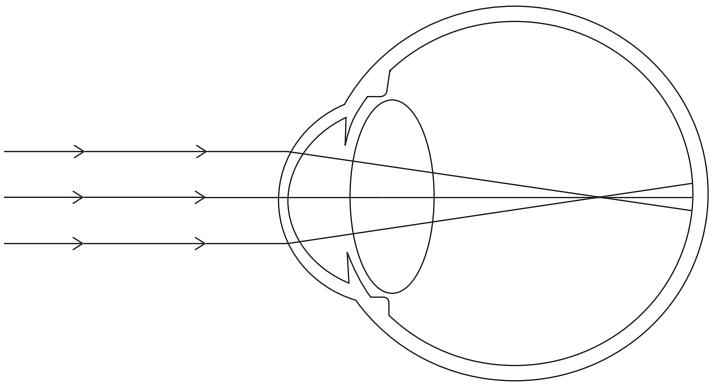


PLOS ONE (Pandemic (H1N1) 2009 Influenza Community Transmission Was Established in One Australian State When the Virus Was First Identified in North America)

What effective control measures could have been introduced between May and July to limit the spread of the disease in Australia?

	May–June	*July*
A.	Quarantine all people arriving in Australia	Encourage people to wear masks and wash hands regularly
B.	Issue antibiotics to overseas visitors	Isolate people with symptoms
C.	Encourage people to wear masks and wash hands regularly	Quarantine all people arriving in Australia
D.	Isolate people with symptoms	Vaccinate all people arriving in Australia

16 In a person with a particular visual disorder, light from a distant object focuses in front of the retina.



How can this disorder be corrected?

A. Laser surgery to reshape the retina

B. Use of a diverging lens in front of the eye

C. Use of a converging lens in front of the eye

D. Laser surgery to make the cornea more curved

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.

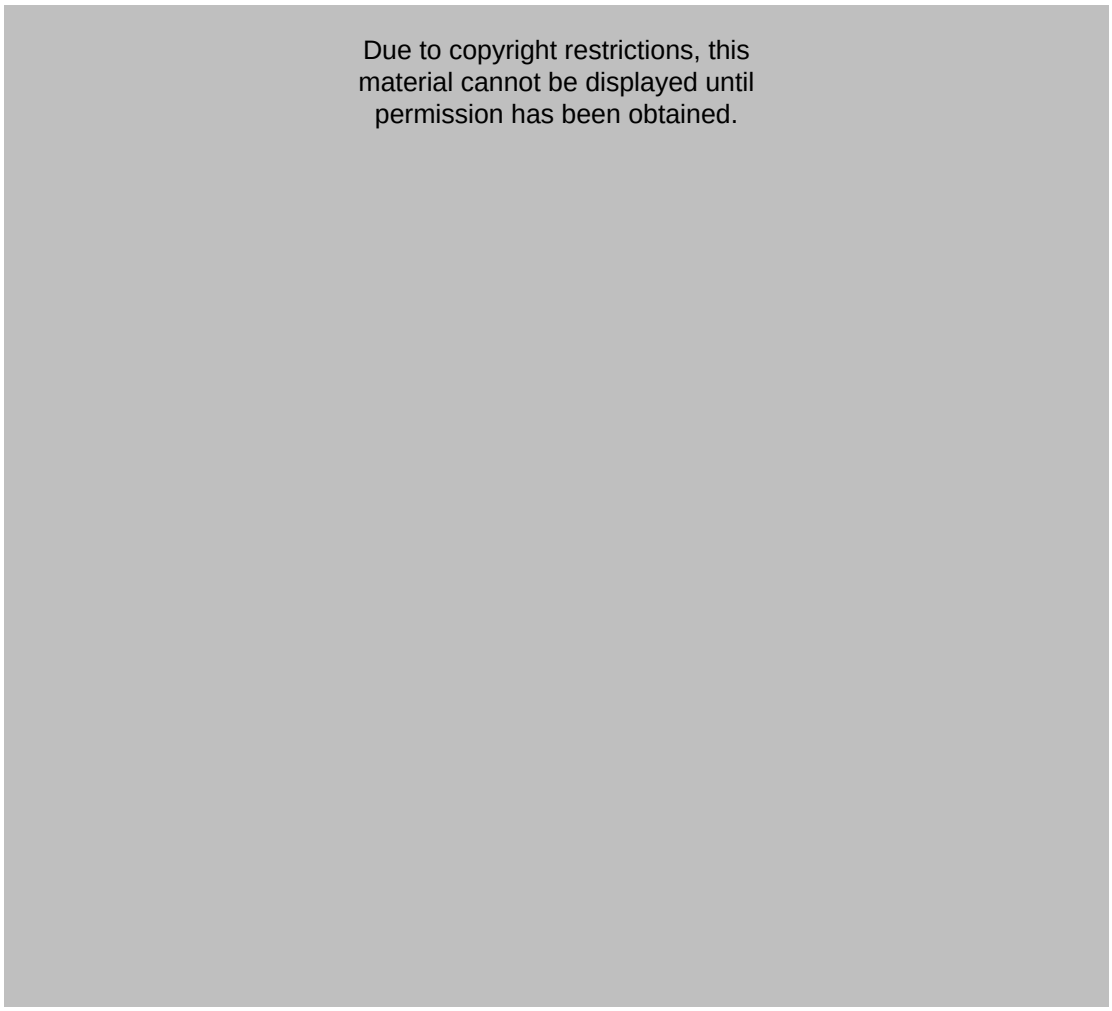
D. the survival time of individuals with the disease increases.

18 The following diagram models a population of glowworms in an isolated cave. The letters *B* and *b* represent the alleles for a gene in an individual.

Which row of the table correctly identifies the process and reason for the change in the gene pool?

	Process	*Reason*
A.	Gene flow	Change in frequency of the *b* allele due to a mutation
B.	Genetic drift	Change in frequency of the *b* allele due to random events
C.	Gene flow	Introduction of more *b* alleles due to new members moving into the population
D.	Genetic drift	Introduction of more *b* alleles due to this allele being more advantageous

19 The diagram represents some experimental steps used in the production of large amounts of human growth hormone.



What makes this technology successful?

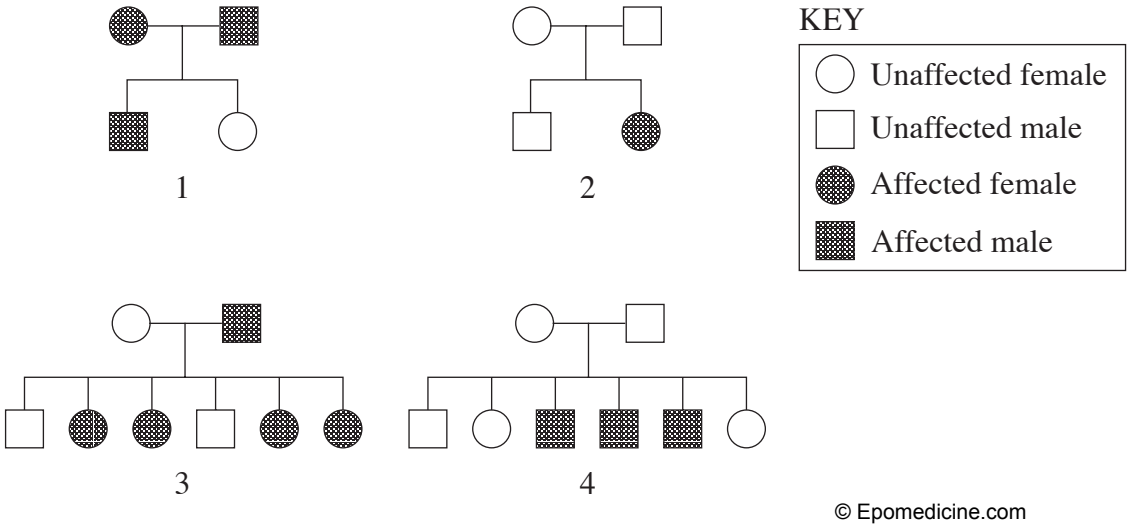
A. DNA ligase can cut human growth hormone genes from human cells.

B. Human growth hormone can cause *E. coli* to grow and mature rapidly.

C. Human plasmids containing the gene of interest can be inserted into bacteria.

D. Restriction enzymes can produce sticky ends on both bacterial and human DNA.

20 Analyse the following four pedigrees.



Which row in the table correctly identifies the pedigree with the type of inheritance?

	Autosomal dominant	*Sex-linked dominant*	*Autosomal recessive*	*Sex-linked recessive*
A.	2	1	3	4
B.	1	4	2	3
C.	1	3	2	4
D.	2	4	1	3

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2024 HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Student Number

Biology

Section II Answer Booklet

80 marks
Attempt Questions 21–35
Allow about 2 hours and 25 minutes for this section

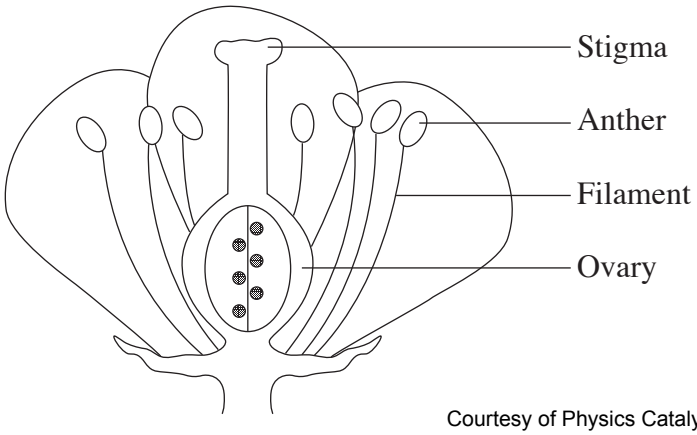
Instructions

- 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.

Please turn over

Question 21 (5 marks)

A diagram of the different parts of a flower is shown.



Courtesy of Physics Catalyst

(a) Identify the structures where pollen and ovules are located. **2**

Pollen .....

Ovules .....

(b) Complete the table to compare features of sexual and asexual reproduction. **3**

Feature	*Sexual*	*Asexual*
Genetic variability (yes/no)		
Number of parents required		
Example of an organism which uses this type of reproduction		

Question 22 (4 marks)

A student designed and conducted a practical investigation to test for the presence of microbes in water and food samples.

(a) Justify a safety precaution required to prevent infection when conducting the investigation. **2**

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(b) Explain how the student could ensure the reliability of the investigation. **2**

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Please turn over

Question 23 (2 marks)

Outline how ONE type of electromagnetic radiation can cause a germline mutation. **2**

Name of electromagnetic radiation: .....

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Question 24 (5 marks)

(a) Outline the cause of a disease due to environmental exposure. **2**

Name of disease: .....

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(b) Explain how an educational program or campaign can be used to decrease the incidence of a disease caused by environmental exposure. **3**

Name of disease: .....

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Please turn over

Question 25 (6 marks)

(a) One-Eyed Jack was a rescue dog that had been injured and lost an eye before his owner adopted him. One-Eyed Jack was cloned and the clone was born with two eyes. **2**

Explain why the cloned dog was born with two eyes.

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(b) Describe how animals like dogs can be cloned. **4**

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Question 26 (4 marks)

Describe a plant disease and its effect on agricultural production. **4**

Name of plant disease: .....

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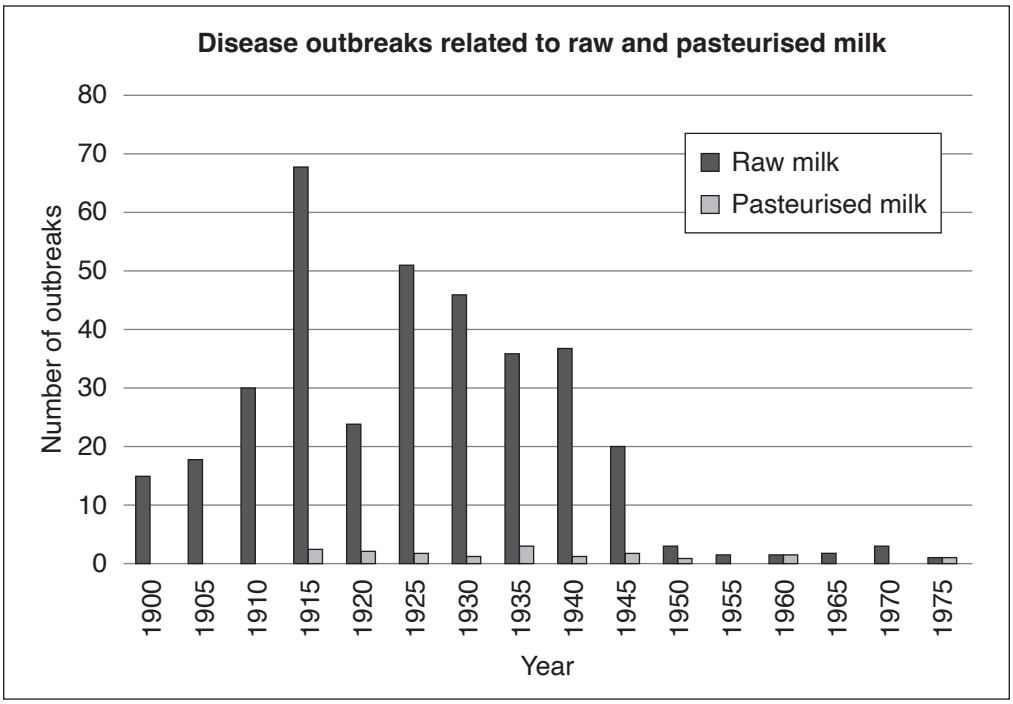
Question 27 (5 marks)

Milk pasteurisation (heating to approximately 70°C) was gradually introduced in America from the early 1900s. The graph shows the number of disease outbreaks in relation to raw (unpasteurised) and pasteurised milk in America from 1900–1975. **5**



Explain the trends observed in the graph. In your response, refer to the role of Pasteur's work in pasteurisation.

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Question 28 (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 '*R*' for the normal CFTR allele, and '*r*' for the faulty CFTR allele.

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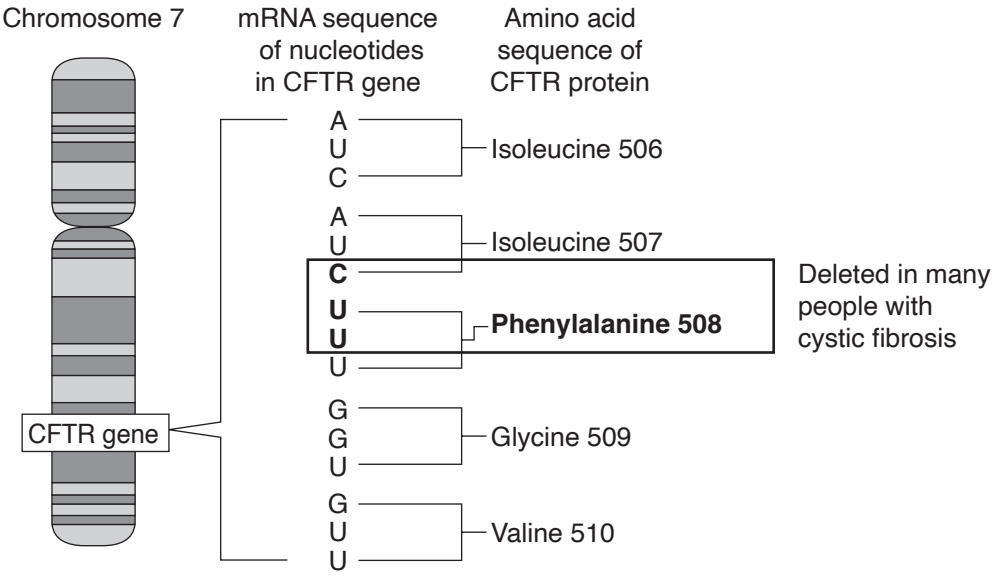
Question 28 continues on page 26

Question 28 (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

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

First base	Second base: U	Second base: C	Second base: A	Second base: G	Third base
U	UUU Phenylalanine	UCU Serine	UAU Tyrosine	UGU Cysteine	U
	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

Question 28 continues on page 27

Question 28 (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. **4**

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End of Question 28

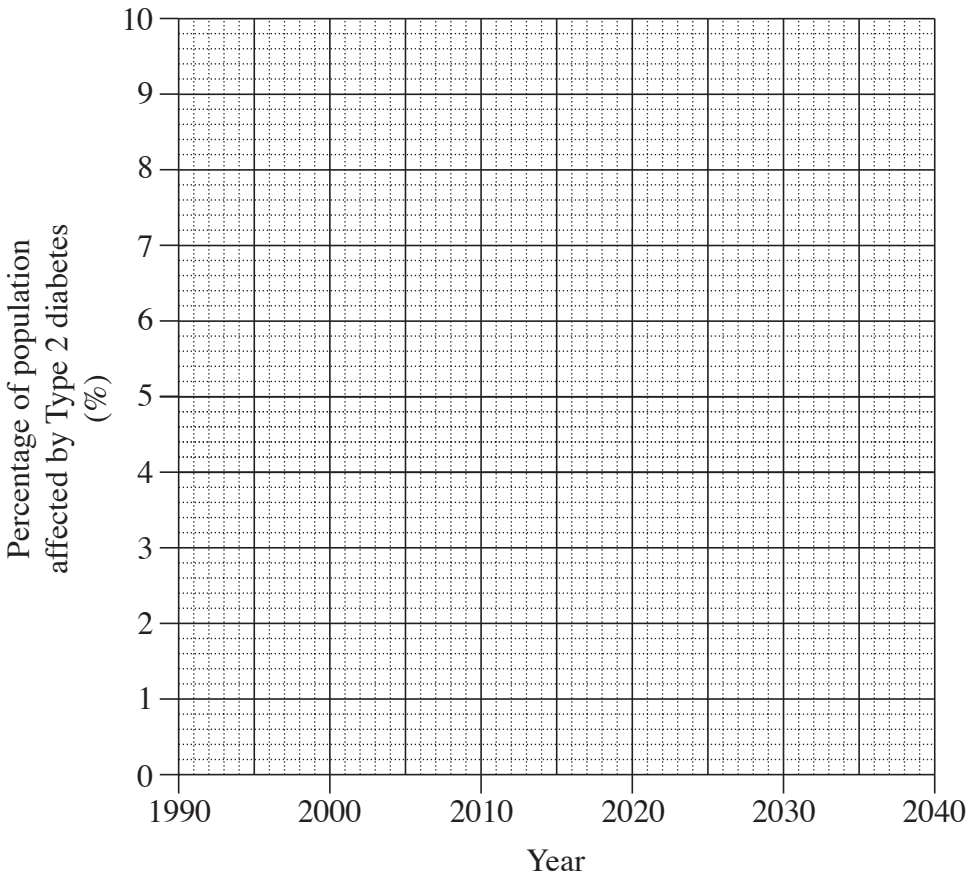
Please turn over

Question 29 (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.

Year	*Percentage of population affected by Type 2 diabetes* (%)
1990	3.1
2000	3.7
2010	4.3
2020	5.6

(a) Plot the data on the grid provided and include the line of best fit. **2**



Question 29 continues on page 29

Question 29 (continued)

(b) A prediction of the global population numbers suggests there will be about 9 billion (9 000 000 000) people on the planet by 2040. **3**

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

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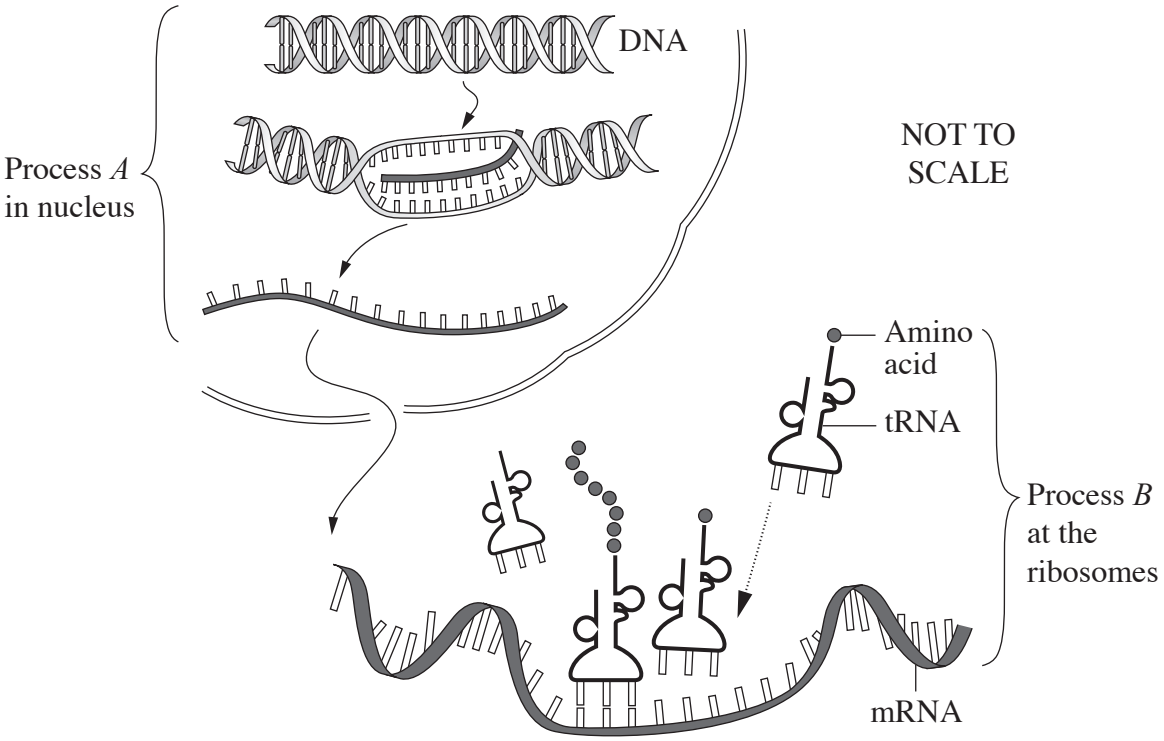
End of Question 29

Please turn over

Question 30 (8 marks)

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



(a) Compare Process *A* with DNA replication. **3**

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Question 30 continues on page 31

Question 30 (continued)

(b) Explain the importance of mRNA and tRNA in polypeptide synthesis. **5**

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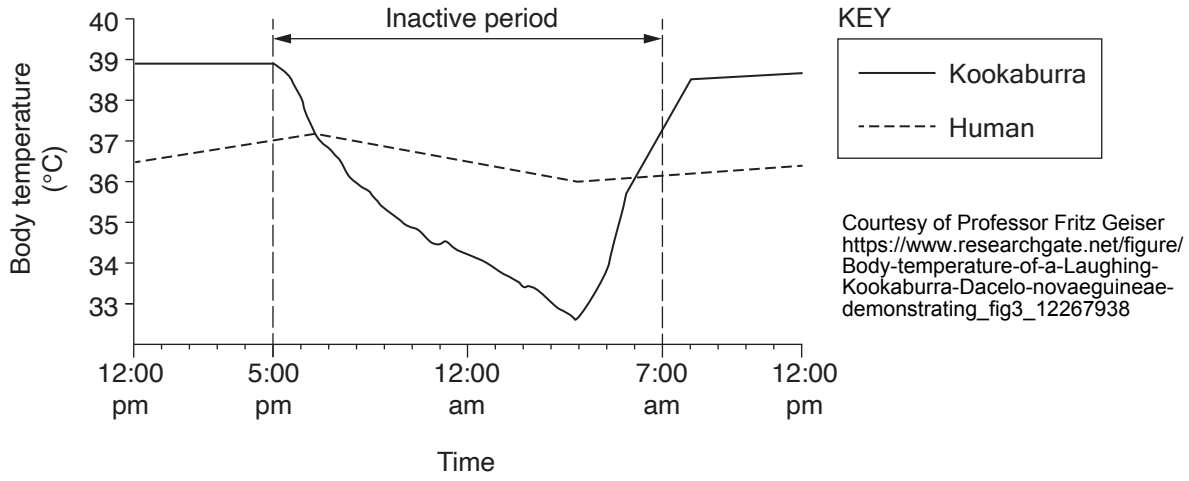
End of Question 30

Question 31 (6 marks)

A study monitored the changes in the body temperature of a kookaburra (an Australian bird) and a human over a 24-hour period. The results of the study are shown in the graph.



Courtesy of Professor Fritz Geiser
https://www.researchgate.net/figure/Body-temperature-of-a-Laughing-Kookaburra-Dacelo-novaeguineae-demonstrating_fig3_12267938

(a) At what time was the kookaburra's body temperature the lowest? **1**

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(b) Some endothermic organisms can display torpor (a significant decrease in physiological activity). **3**

With reference to the graph, explain whether the human or the kookaburra was displaying torpor and if so, state the time this occurred.

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(c) Outline an adaptation that may lead to an increase in the kookaburra's body temperature during the inactive period. **2**

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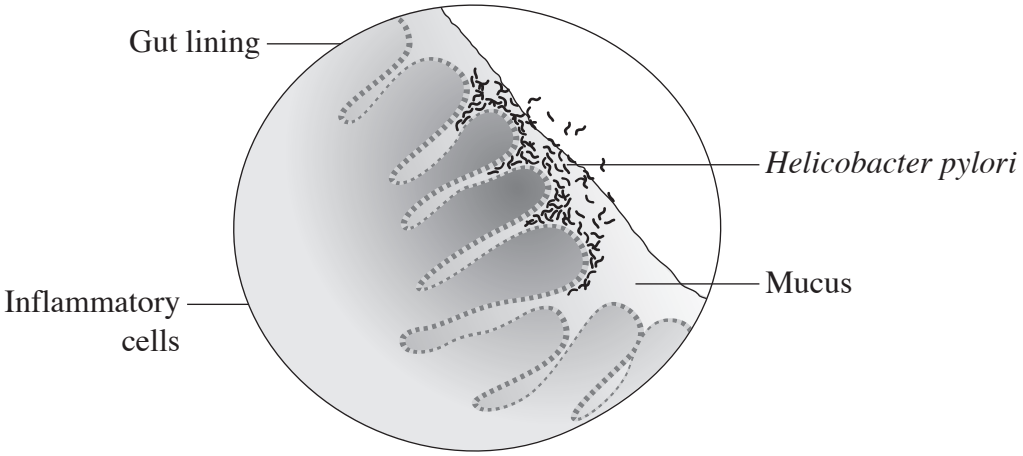
Question 32 (7 marks)

Helicobacter pylori is a bacterium that invades the gut lining and can cause damage to the stomach as shown in the diagram. **7**



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

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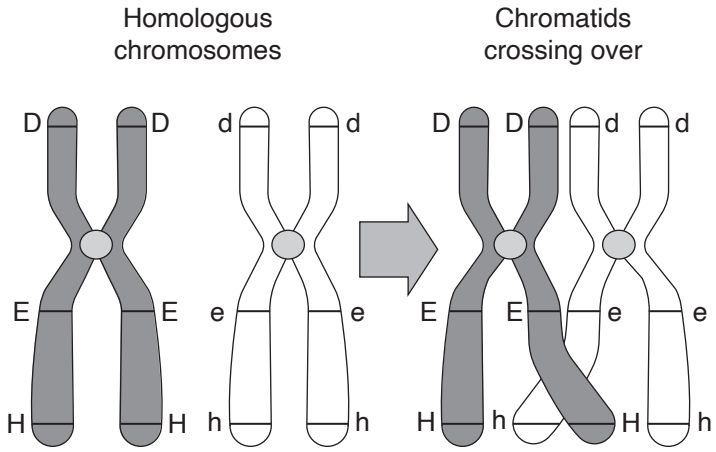
Question 33 (4 marks)

Female Jack Jumper ants (*Myrmecia pilosula*) have a single pair of chromosomes. During meiosis, crossing over occurs. The diagram shows the crossing over and the position of three genes on the chromosomes.



(a) Outline the significance of crossing over for the Jack Jumper ants. **2**

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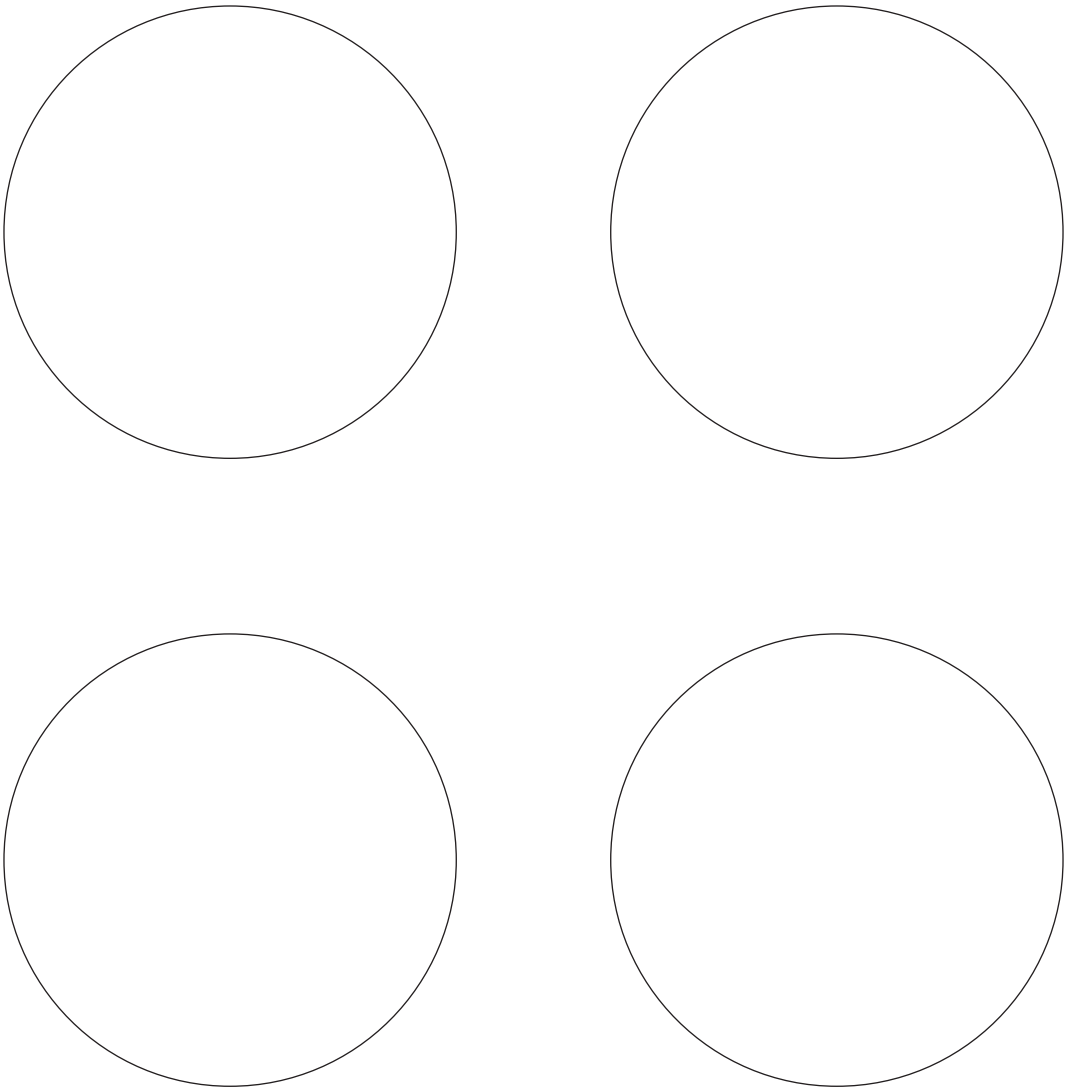
Question 33 continues on page 35

Question 33 (continued)

(b) Draw the chromosomes of the four possible gametes after crossing over for the Jack Jumper ants occurs. Include the alleles for each gene. **2**



End of Question 33

Question 34 (7 marks)

Discuss the ethical implications and impacts on society of the use of TWO biotechnologies. **7**

Question 35 (5 marks)

The graph shows the results of a survey conducted to determine if children changed their method of communication after cochlear implantation. **5**

With reference to the data, describe how cochlear implants work, and how they affect communication in children.

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