



NSW Education Standards Authority

2022 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

**Total marks:
100**

Section I – 20 marks (pages 2–11)

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

Section II – 80 marks (pages 13–36)

- Attempt Questions 21–32
- 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.

1 A healthy person in a hot environment measures their body temperature to be 38.0°C.

Which of the following might occur in this person?

- A. Shivering
- B. Vasodilation
- C. Goosebumps
- D. Pale appearance

2 Some desert mammals can obtain their water from breaking down stored body fat.

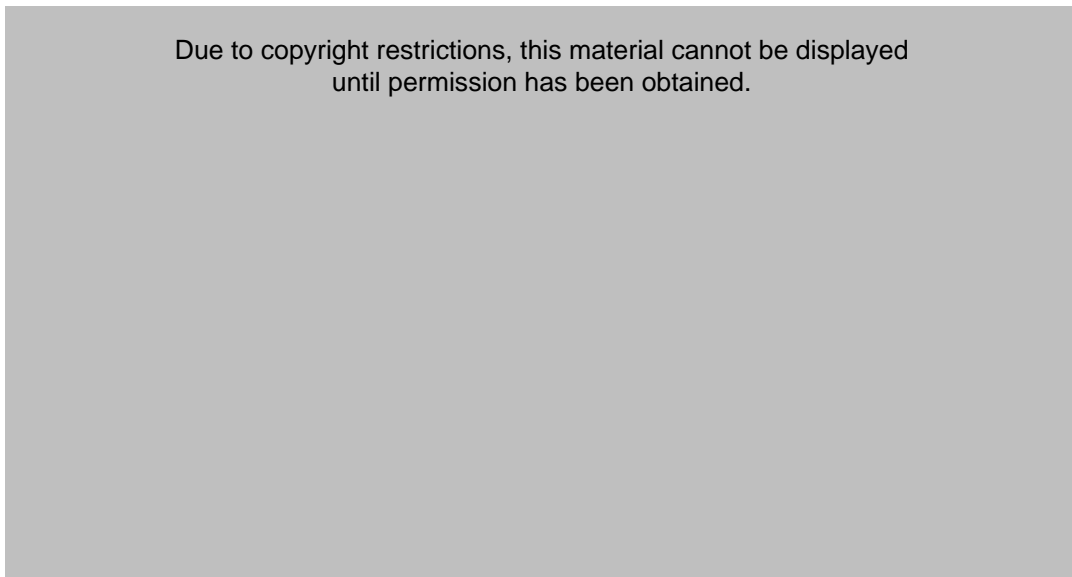
What type of adaptation is this?

- A. Behavioural
- B. Environmental
- C. Physiological
- D. Structural

3 What type of protein is formed in response to a pathogen?

- A. Antibody
- B. Antigen
- C. Antihistamine
- D. Antiseptic

- 4 The diagram shows the response to an injury in a human.



What is the response shown?

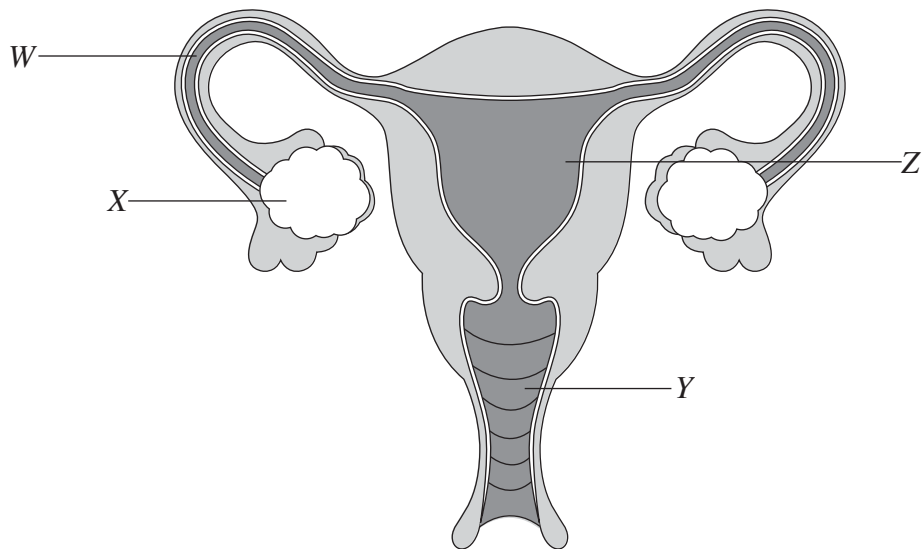
- A. Infection
 - B. Inflammation
 - C. Phagocytosis
 - D. Vasoconstriction
- 5 Data for incidence of notifiable infectious diseases in Australia are shown in the table.

<i>Disease</i>	<i>Percent of all cases of infectious disease notified for 2019</i>
Influenza	53
Sexually transmitted infections	25
Gastrointestinal diseases	10
Vaccine preventable diseases excluding influenza	9
Other	3

Which type of graph should be chosen to best represent these data?

- A. A column graph because percentages are continuous.
- B. A column graph because diseases are categorical.
- C. A line graph because percentages are continuous.
- D. A line graph because diseases are categorical.

- 6 A diagram of the human female reproductive system is shown.



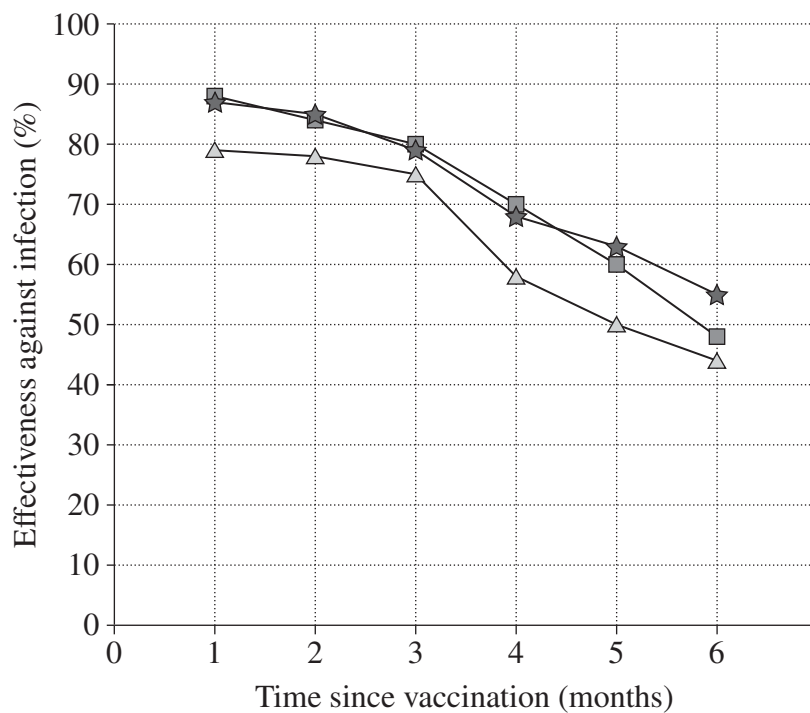
Where does implantation normally occur?

- A. W
 - B. X
 - C. Y
 - D. Z
- 7 Animal cloning involves inserting the nucleus from a somatic cell of one animal into the
- A. plasmid of a bacterium.
 - B. uterus of a surrogate animal.
 - C. fertilised egg from another animal.
 - D. enucleated egg from another animal.
- 8 In mice, muscle cells contain 40 chromosomes.

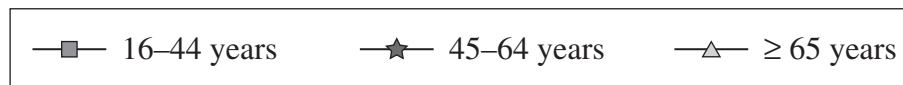
Which of the following is a correct statement about mouse cells?

- A. The gametes contain 20 pairs of chromosomes.
- B. The somatic cells contain 20 pairs of chromosomes.
- C. The cells produced by meiosis contain 40 chromosomes.
- D. The cells produced by mitosis contain 40 pairs of chromosomes.

- 9 A new vaccine against an infectious disease was developed. The effectiveness of the vaccine in preventing infection in humans was plotted over time in three different age groups.



KEY



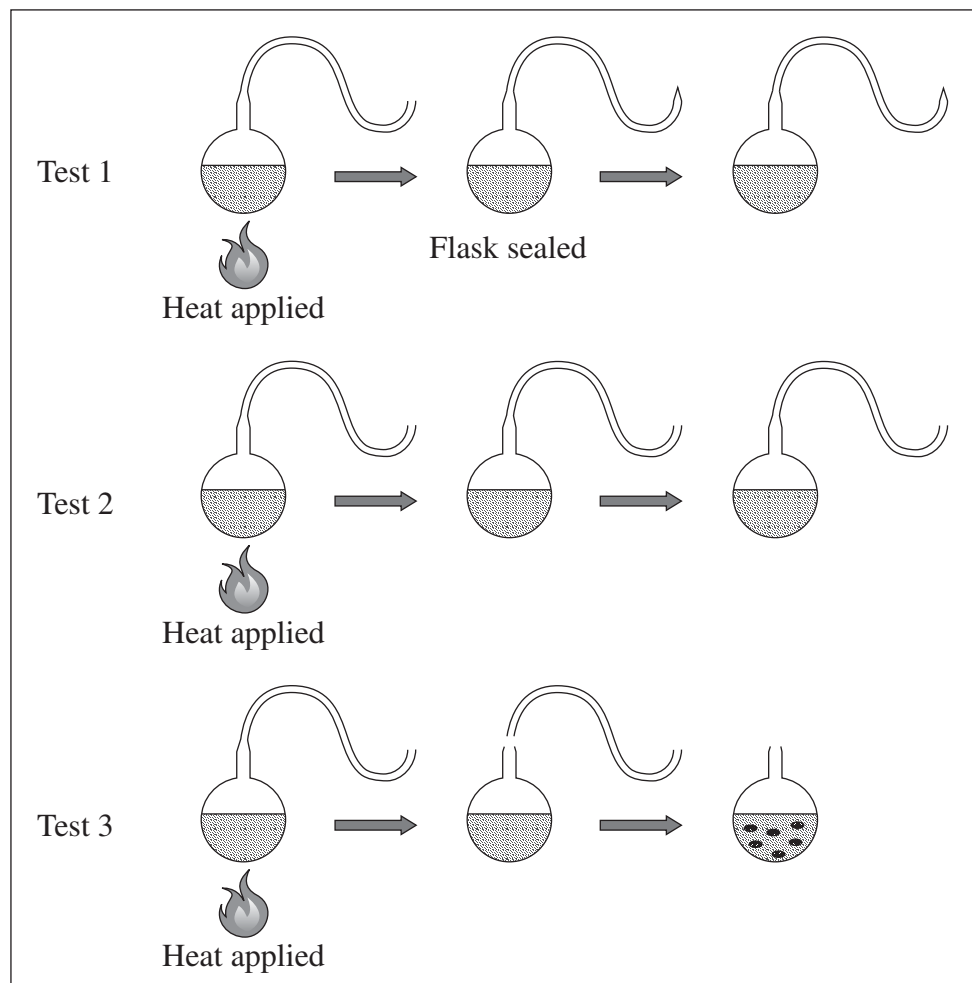
Courtesy of Dr Sara Y Tartof

Which of the following is a valid conclusion that can be drawn from the data in the graph?

- A. The vaccine is ineffective after six months.
- B. The younger the person the more effective the vaccine.
- C. The younger the person, the faster the immunity to infection declines.
- D. The vaccine offers more protection to younger people than those over 65.

Refer to the following information to answer Questions 10–11.

Pasteur used swan neck flasks to conduct experiments on microbial contamination of broth. One of Pasteur's investigations is shown.



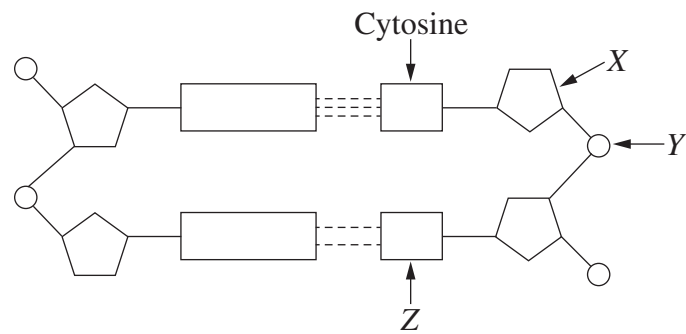
10 Which of the following was the independent variable in this investigation?

- A. The air
- B. The flask
- C. The broth
- D. The microbes

11 What is the best explanation for Pasteur's results?

- A. Cells arise from existing cells
- B. Heating prevents broth spoiling
- C. Gases in the air cause broth to spoil
- D. Cells arise by spontaneous generation

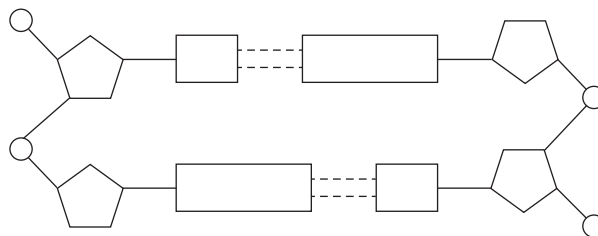
- 12 The following diagram represents a short section of DNA.



What are the components labelled X, Y and Z?

	X	Y	Z
A.	Deoxyribose sugar	Phosphate	Thymine
B.	Deoxyribose sugar	Phosphate	Guanine
C.	Phosphate	Deoxyribose sugar	Guanine
D.	Phosphate	Deoxyribose sugar	Thymine

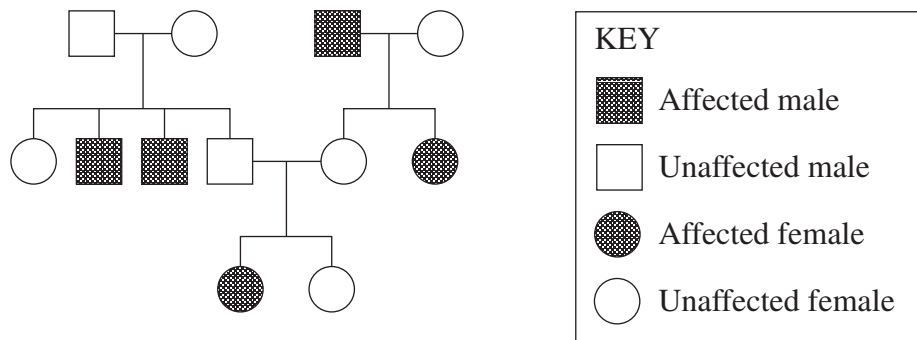
- 13 The section of DNA shown in Question 12 came into contact with a mutagen, resulting in a change in the cytosine. The effect on the DNA after several replication cycles is shown.



The mutagen has resulted in

- A. a frame-shift mutation.
- B. an increase in cytosine.
- C. a change in one base pair.
- D. a change in one nucleotide.

- 14 An inherited characteristic in a family is mapped in the pedigree shown.



Inheritance of this characteristic is

- A. autosomal recessive.
 - B. sex-linked recessive.
 - C. autosomal dominant.
 - D. sex-linked dominant.
- 15 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 punnet square was used to determine the proportion of genotypes expected in the offspring. Part of the punnet square is shown.

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

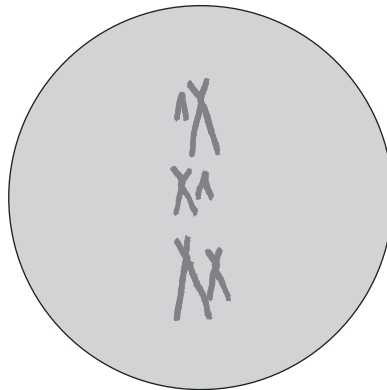
Which statement is true for the parents in this cross?

- 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.

16 What is the significance of mutations in non-coding DNA?

- A. They do not alter nucleotides.
- B. They do not affect phenotype.
- C. They may affect gene expression.
- D. They may alter amino acid codons.

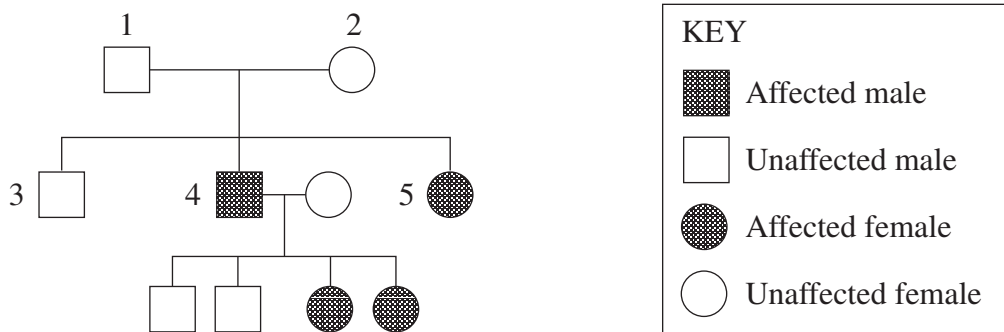
17 A student constructed a model of the phases of meiosis in an organism with six chromosomes in its somatic cells. One of the early phases is shown.



Which of the following identifies an error in the model?

- A. Chromosomes are not lined up single file on the metaphase plate.
- B. Chromosomes of matching size and structure are not paired.
- C. There are no homologous chromosomes.
- D. There are too many chromosomes.

- 18 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?

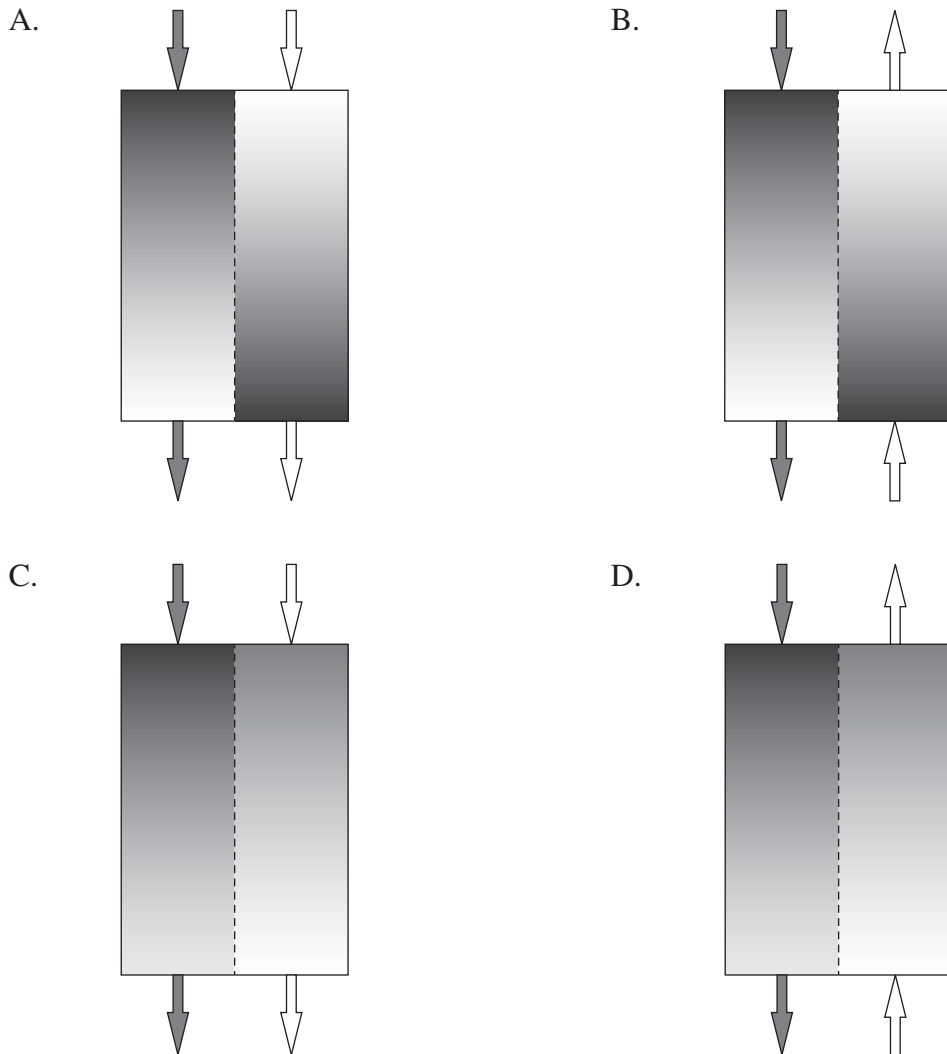
- A. A germ-line mutation in individual 2
 - B. A germ-line mutation in individual 4
 - C. A somatic mutation in individuals 1 and 2
 - D. A somatic mutation in individuals 4 and 5
- 19 A person with short-sighted vision (myopia) was incorrectly given a pair of spectacles with convex lenses.

Which row of the table demonstrates what happens?

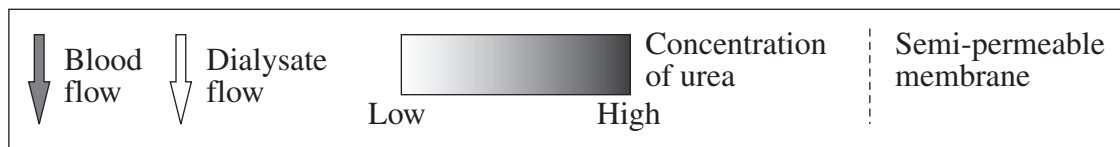
	<i>Without spectacles</i>		<i>With spectacles</i>		
	Distant object	Eye	Distant object	Lens	Eye
A.					
B.					
C.					
D.					

20 Renal dialysis involves passing blood from a patient past a dialysate solution in order to remove waste such as urea from the blood.

Which diagram correctly shows possible concentrations of urea and the direction of flow of both solutions in a dialysis machine?



KEY



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Centre Number

Biology

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Student Number

Section II Answer Booklet

80 marks

Attempt Questions 21–32

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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Question 21 (5 marks)

- (a) Outline ONE way that a pathogen can pass from person to person. 2

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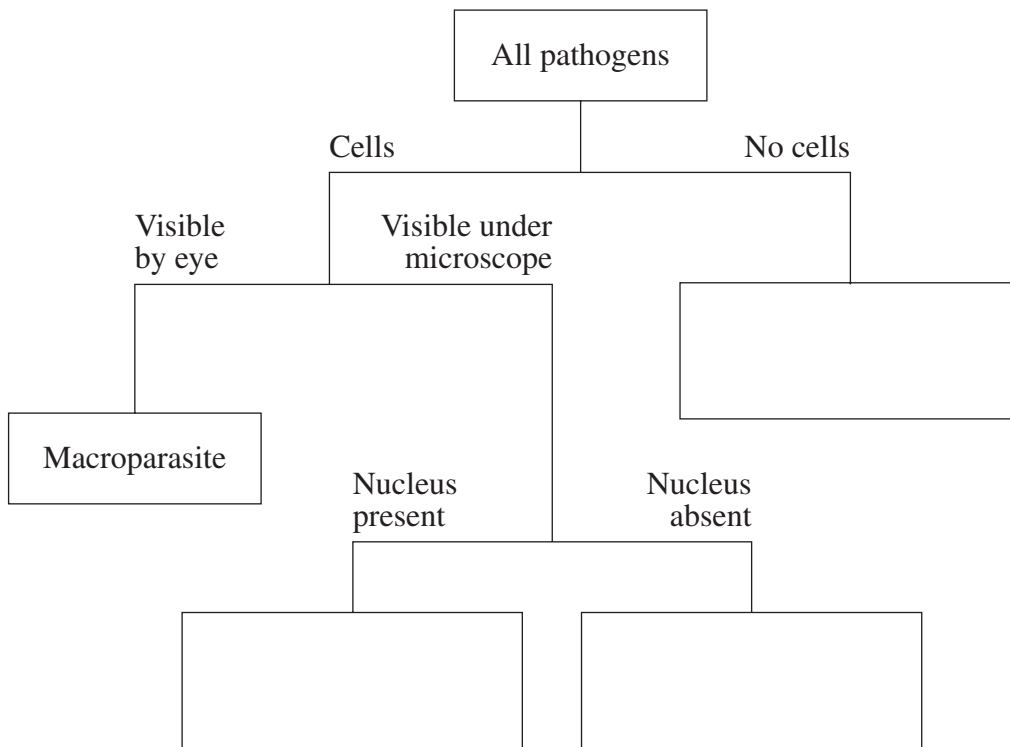
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- (b) The following key can be used to classify some pathogens. 3

Complete each empty box with an appropriate pathogen.



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Question 22 (3 marks)

Eggplant fruit comes in three colours: dark purple, white and violet. A genetic cross between the dark purple and white eggplants will always result in the violet phenotype.

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What phenotypic ratio would you expect to see when two violet offspring are crossed?
Show your working.



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Question 23 (4 marks)

- (a) Outline the process of artificial pollination. **2**

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- (b) Explain a possible outcome of the use of artificial pollination on subsequent populations. **2**

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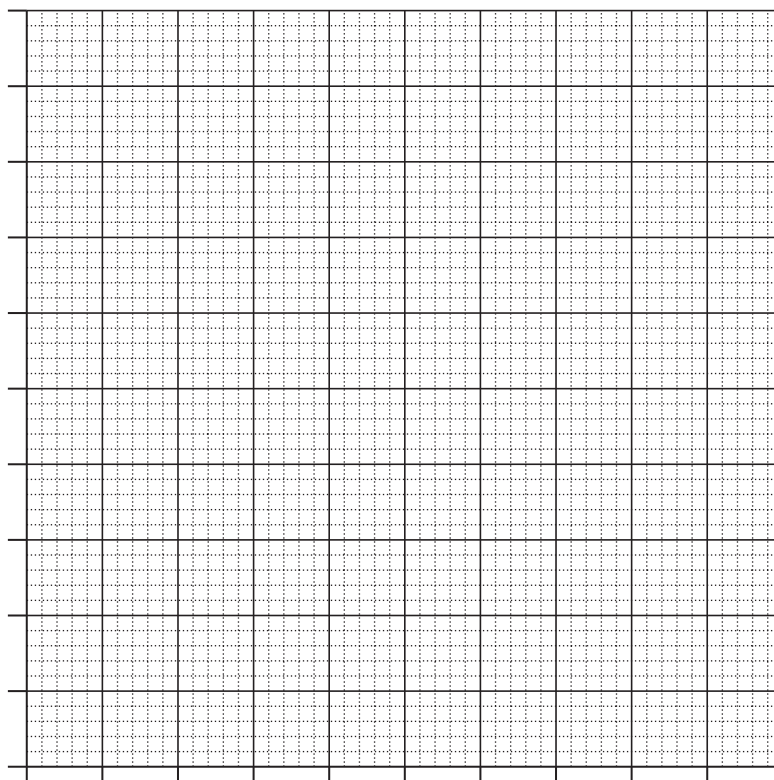
Question 24 (8 marks)

Birth defects in humans can be caused by chromosomal abnormalities.

<i>Maternal age</i> (years)	<i>Prevalence of chromosomal abnormalities</i> (per 1000 births)
20	1.5
30	3
35	8
40	22
45	38

- (a) Draw a suitable graph of the data provided in the table. Include a suitable line of best fit.

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Question 24 continues on page 19

Question 24 (continued)

- (b) Outline the trend shown in the data. 2

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- (c) Explain the cause of a type of chromosomal mutation. 3

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Question 26 (5 marks)

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Jelly Bush honey has been used by Aboriginal Peoples to treat cuts, sores and burns. Recent studies have shown that Jelly Bush honey has a very high level of methylglyoxal which is known to help fight infection.

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

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

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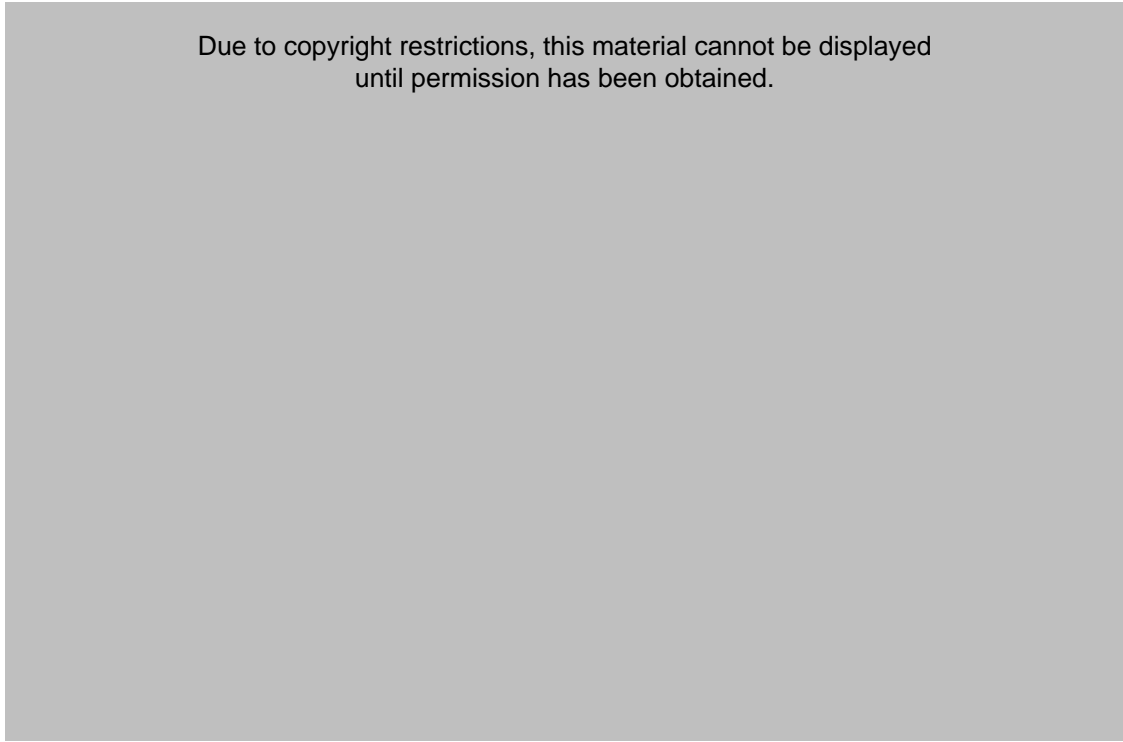
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Question 27 (6 marks)

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The incidence of cervical cancer in the Australian population is shown in the graph from 1985–2015. Public health campaigns commenced during this period to reduce the incidence of cervical cancer. This included a national screening program to detect pre-cancerous cells and a vaccination program against human papillomavirus (HPV) which causes most cervical cancers.



Evaluate the success of these campaigns in reducing the incidence of cervical cancer in Australian women. Include reference to the data in your answer.

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Question 27 continues on page 23

Question 27 (continued)

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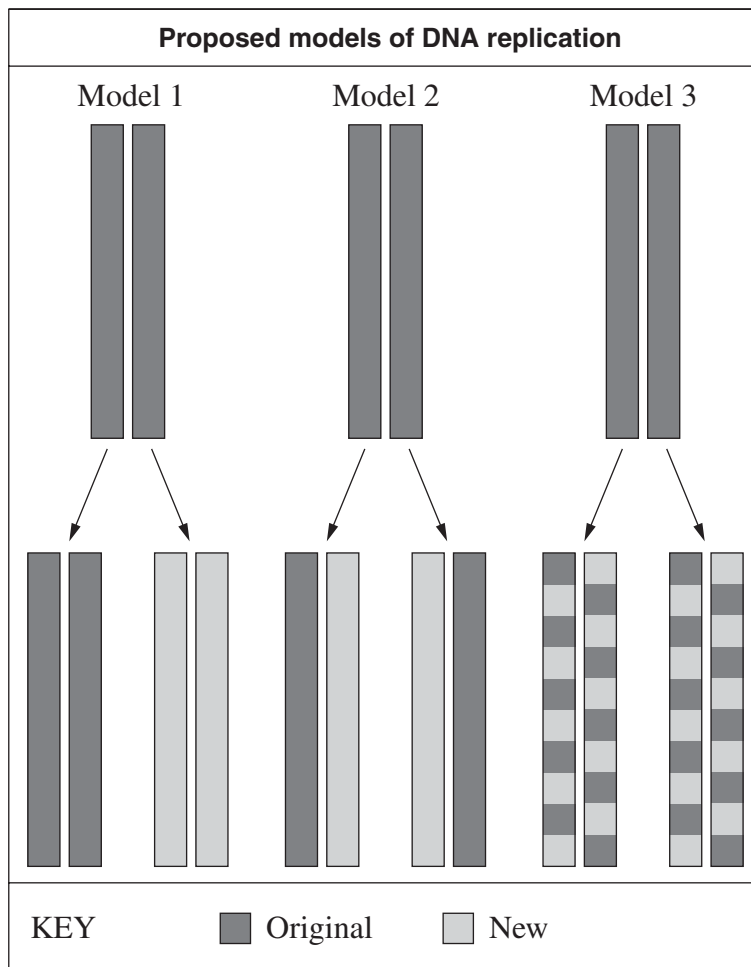
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Question 28 (7 marks)

Soon after the discovery of the structure of DNA, scientists began investigating how DNA replicated. Three models were proposed.



OpenStax/Rice University.
Adapted from Figure 14.12 The three suggested models of DNA replication.
<https://openstax.org/books/biology/pages/14-3-basics-of-dna-replication>
Permitted under Creative Commons Attribution 4.0 International Licence.

(a) Identify which of the models above is currently accepted.

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Question 28 continues on page 25

Question 28 (continued)

(b) Describe the process of DNA replication.

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(c) Outline the ways in which the DNA of prokaryotes and eukaryotes differ.

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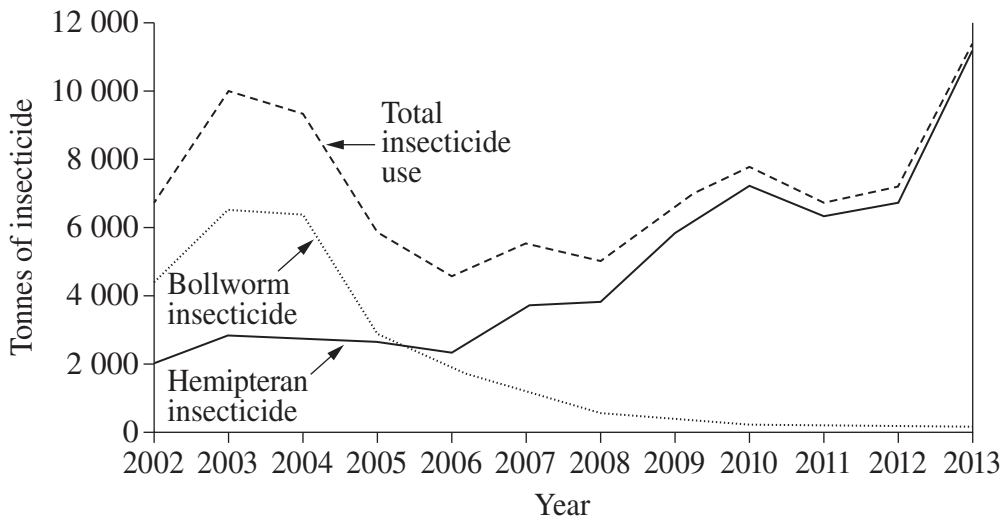
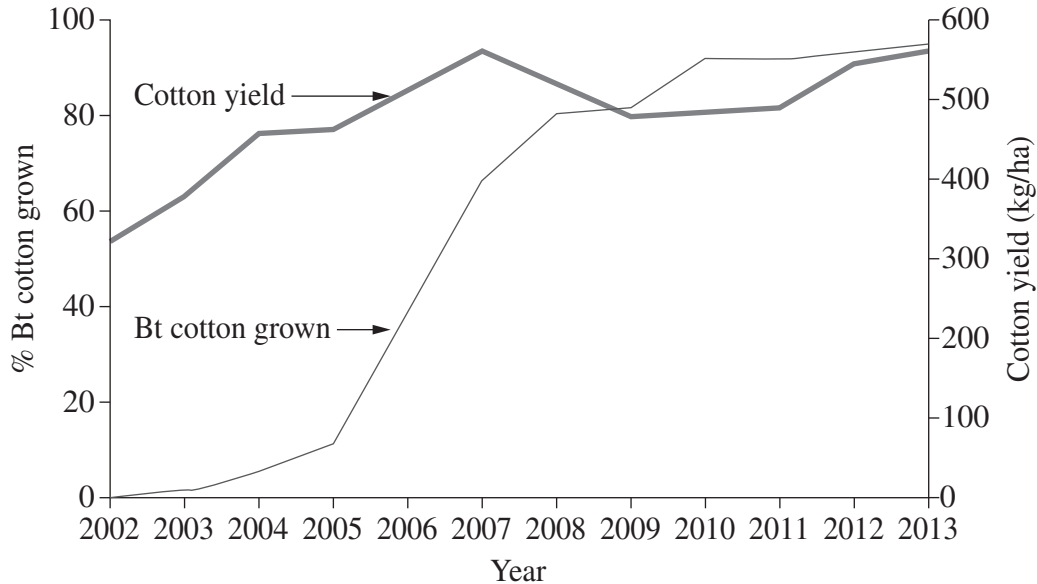
End of Question 28

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Question 29 (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).



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 29 continues on page 27

Question 29 (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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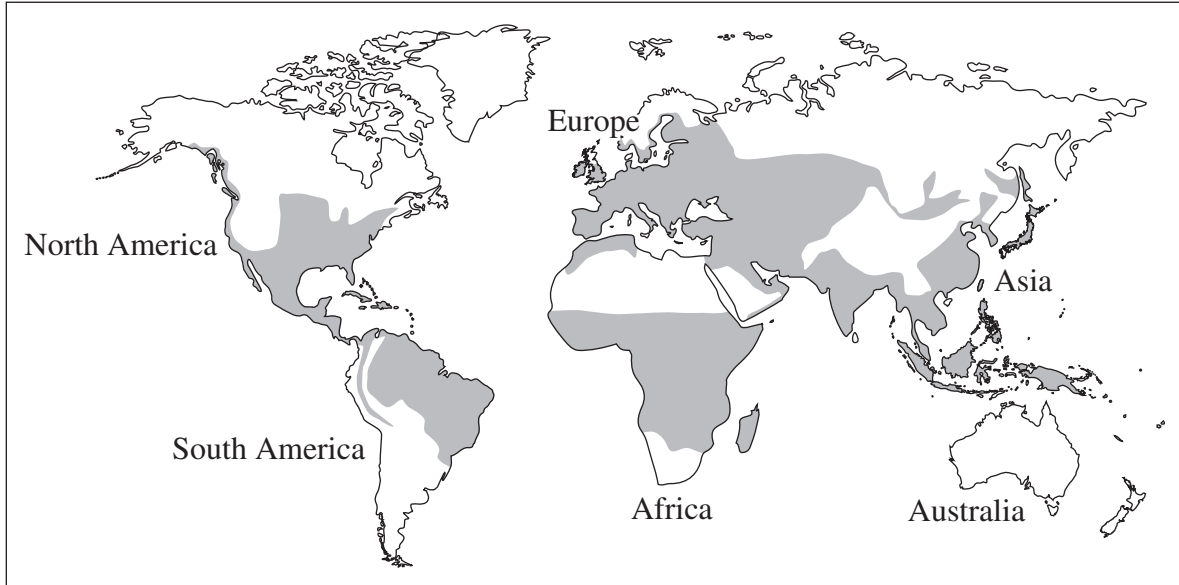
Question 30 (7 marks)

Malaria is a disease transmitted by a mosquito vector. There has been no effective vaccine developed.

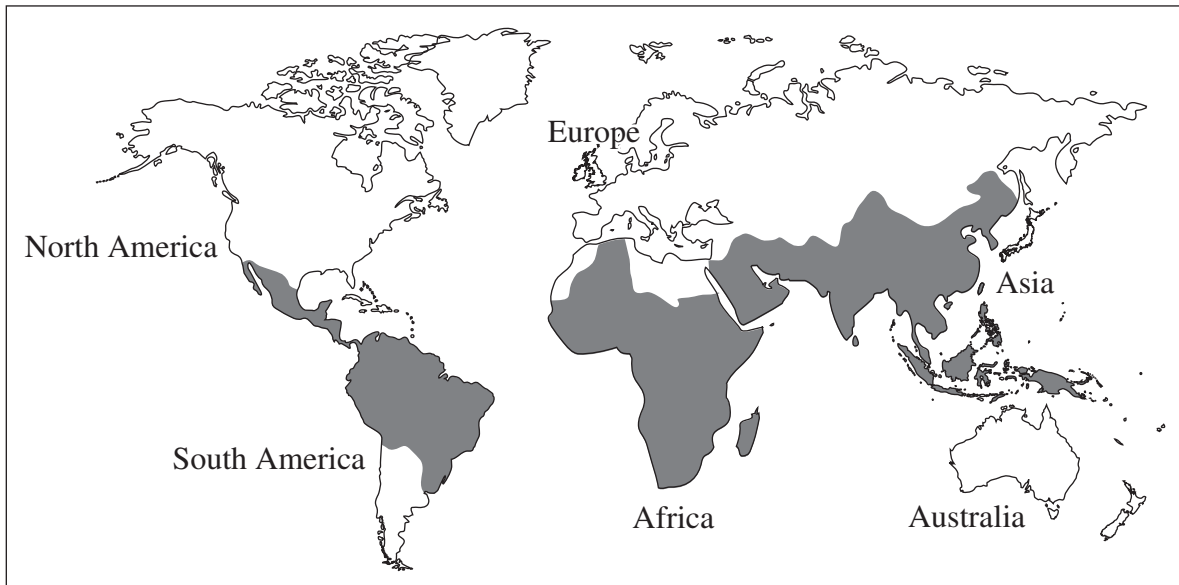
7

Refer to the maps below to answer Question 30.

Map 1 Global distribution of the malaria-transmitting mosquito



Map 2 Global distribution of malaria cases



The World Malaria Report 2010
World Health Organization
<https://www.who.int/publications/i/item/9789241564106>
CC BY-NC-SA 3.0 IGO

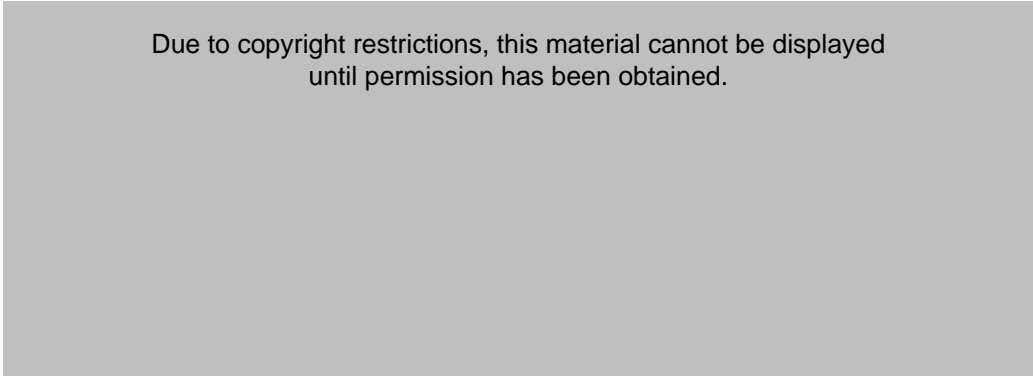
Question 30 continues on page 29

Question 31 (15 marks)

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

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.



- (a) (i) Evaluate the method used in this epidemiological study.

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Question 31 (continued)

(ii) Justify conclusions that could be drawn from the results of the study. **3**

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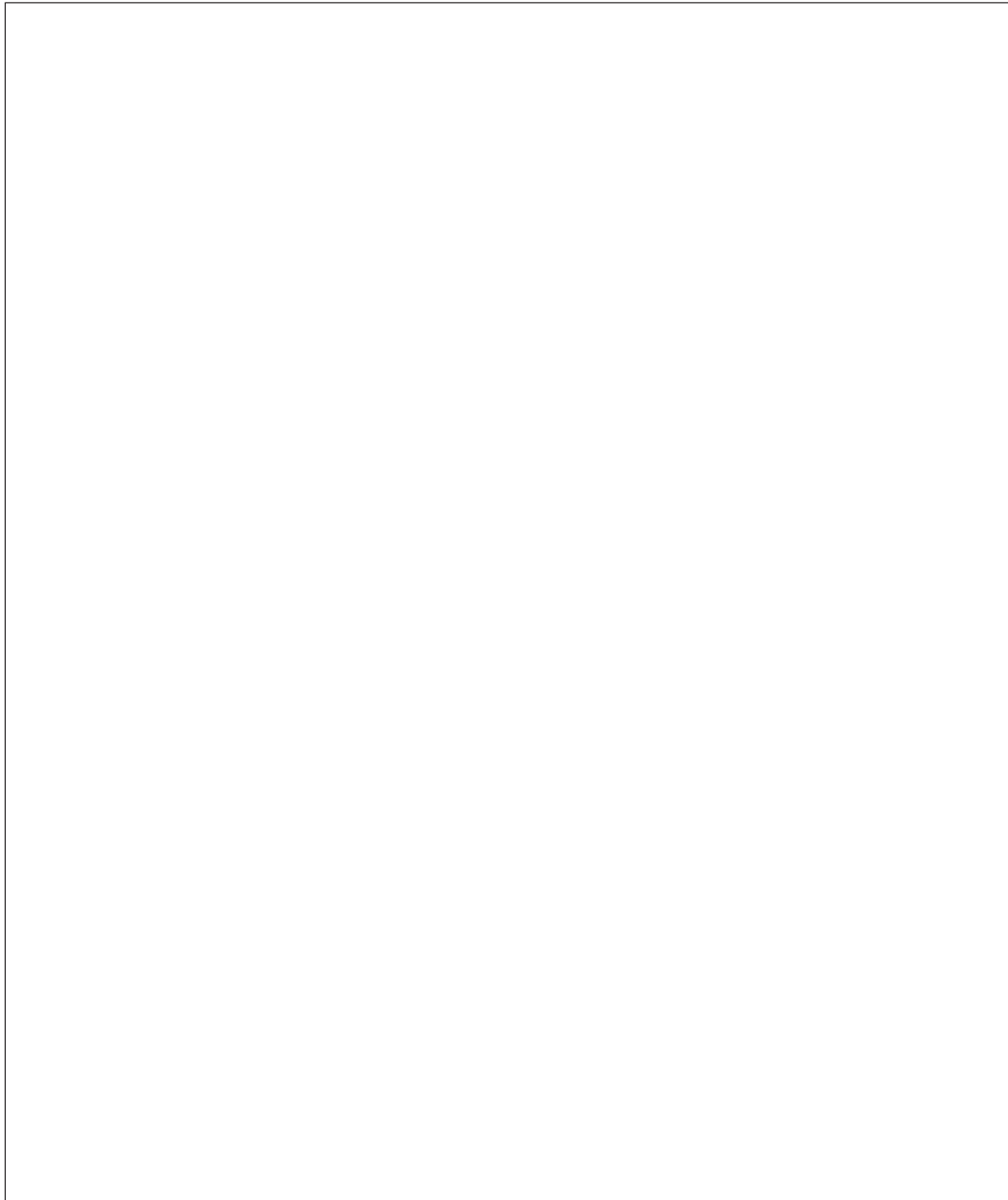
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Question 31 continues on page 32

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Question 31 (continued)

- (b) Lung cancer can be linked to genetic causes. One of the genes frequently studied in lung cancer tissue is the Epidermal Growth Factor Receptor (EGFR) gene. It codes for EGFR protein, which is composed of one polypeptide chain.
- (i) Construct a flow chart to outline the synthesis of the EGFR protein from the EGFR gene. 4



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Question 31 continues on page 33

Question 31 (continued)

The structure of the EGFR protein includes a receptor and an enzyme component. The function of the protein is to help the cell to regulate cell division.

EGFR mutations are present in about 32% of cases of Non-Small Cell Lung Cancer (the most common type of lung cancer).

- (ii) Explain how a mutation in the EGFR gene could result in changes in protein structure and function to increase the risk of lung cancer.

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Question 32 (7 marks)

Researchers have identified a gene that determines the inflammatory response of lung cells to infection with a virus. An allele of this gene is associated with increased inflammation and increased chance of death from the virus.

7

The table shows the percentage presence of the allele in people with different ancestries.

<i>Ancestry</i>	<i>Percentage of population with the allele</i>
South Asian	60.3
European	15.1
African	2.4
East Asian	1.8

Explain how mutation, natural selection, genetic drift and gene flow could have led to these differences in the gene pools of populations with differing ancestry.

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Question 32 continues on page 35

Question 32 (continued)

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Section II extra writing space

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