BOARD OF STUDIES
NEW SOUTH WALES

2010

HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your Centre Number and Student Number at the top of pages 9, 13, 15, 17, 19 and 23

Total marks – 100

Section I Pages 2–26

75 marks

This section has two parts, Part A and Part B

Part A – 20 marks

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

Part B – 55 marks

- Attempt Questions 21–30
- Allow about 1 hour and 40 minutes for this part

Section II Pages 27–37

25 marks

- Attempt ONE question from Questions 31–35
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 20 marks
Attempt Questions 1–20
Allow about 35 minutes for this part

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

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1 Which of the following provides evidence that supports the theory of evolution?

(A) Clones

(B) Punnet squares

(C) The fossil record

(D) The DNA double helix

2 Which method did Rosalind Franklin use during her investigations of the structure of DNA?

(A) Protein sequencing

(B) Monohybrid crosses

(C) Computer modelling

(D) X-ray crystallography

3 Cilia prevent the entry of pathogens into the human body by

(A) providing a protective body covering.

(B) producing secretions toxic to pathogens.

(C) moving trapped pathogens to the mouth.

(D) increasing circulation of blood to the infected area.

4 Which of the following correctly compares the urine of marine and freshwater fish?

(A) Similar volumes of urine are produced by freshwater and marine fish.

(B) Smaller volumes of urine are produced by freshwater fish than marine fish.

(C) The urine produced by freshwater fish is less concentrated than that of marine fish.

(D) The urine produced by both freshwater and marine fish is similar in concentration.

5 The gamete plays an important role in sexual reproduction because it carries

(A) genetic information from both parents.

(B) half the genetic information of the parent.

(C) all of the genetic information of the parent.

(D) double the genetic information of the parent.

6 An increase or decrease in the salt concentration in interstitial fluids triggers a response so that the concentration returns to a set value.

What is this mechanism called?

(A) Diffusion

(B) Homeostasis

(C) Enantiostasis

(D) Positive feedback

7 Koch contributed to an understanding of disease by developing

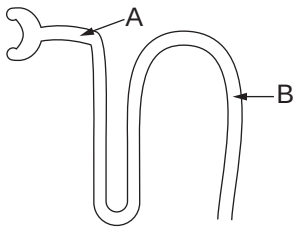
(A) a method to link a particular pathogen to the cause of a disease.

(B) an experiment that disproved the theory of spontaneous generation.

(C) a method of killing microbes by heating and thus preventing decay.

(D) an immunisation program based on a knowledge of immune responses.

8

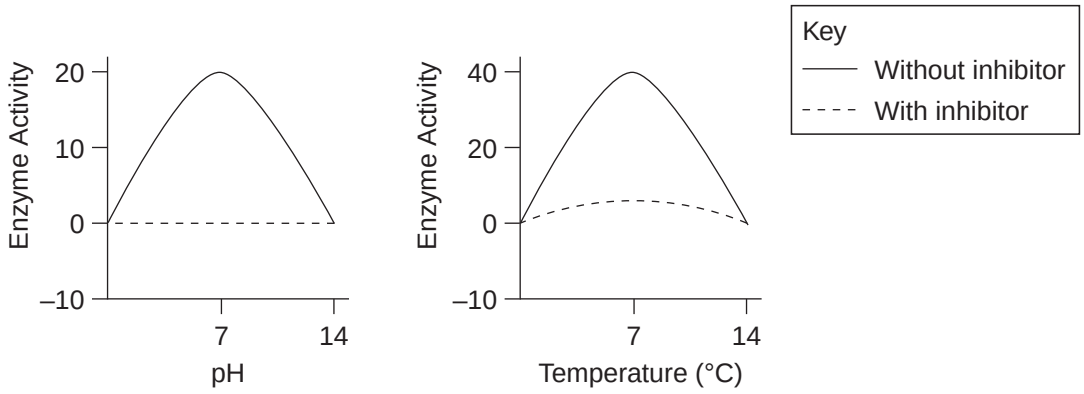


A diagram of a nephron

What happens to the concentrations of glucose, urea and protein as fluid moves from A to B in the nephron?

	Glucose Concentration	*Urea Concentration*	*Protein Concentration*
(A)	Unchanged	Decreases	Decreases
(B)	Unchanged	Decreases	Increases
(C)	Decreases	Increases	Increases
(D)	Decreases	Increases	Unchanged

9 Experiments were carried out to show the effects of pH and temperature on enzyme activity. The experiments also tested the effects of a chemical called an inhibitor. The results are shown in the graphs.



The best conclusion that can be drawn from these results is that the inhibitor affects

(A) pH.

(B) temperature.

(C) enzyme activity.

(D) enzyme concentration.

10 An experiment was conducted to test the effect of dissolved carbon dioxide (CO_2) on the pH of water. It was found that the pH of water decreased as CO_2 was added.

How do these findings relate to the acidity of blood as it circulates in the body?

(A) Blood in the veins of muscles becomes less acidic.

(B) Blood in the arteries of muscles becomes less acidic.

(C) Blood in the capillaries of the brain becomes less acidic.

(D) Blood in the capillaries of the lungs becomes less acidic.

11 How can widespread use of artificial insemination alter the genetic composition of a population?

(A) It results in many genetically identical individuals.

(B) It makes certain alleles more common in a population.

(C) It decreases the number of chromosomes in some individuals.

(D) It ensures that only the genetic composition of the males is altered.

12 How are lipids transported in mammalian blood?

(A) They are attached to proteins.

(B) They are dissolved in the blood.

(C) They are part of the membrane of red blood cells.

(D) They are attached to haemoglobin in red blood cells.

13 Which of the following shows DNA replication in the correct order?

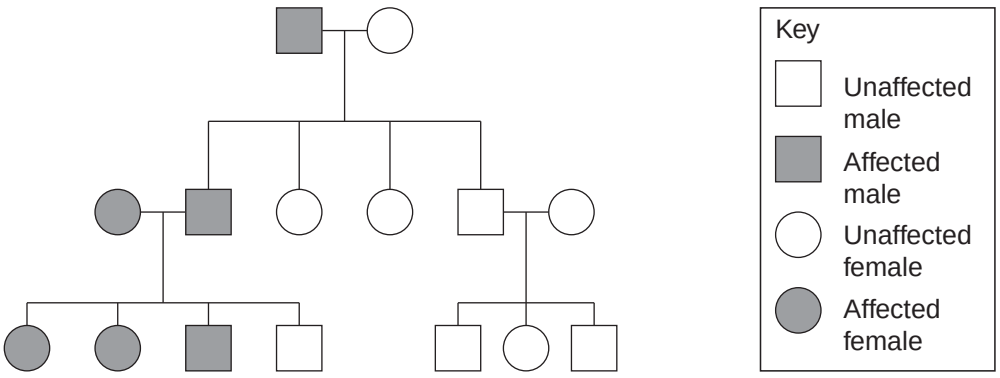
(A) Two DNA double helices ➔ strands separate ➔ matching bases pair up ➔ DNA double helix

(B) DNA double helix ➔ strands separate ➔ matching bases pair up ➔ two DNA double helices

(C) Strands separate ➔ two DNA double helices ➔ matching bases pair up ➔ DNA double helix

(D) DNA double helix ➔ strands separate ➔ two DNA double helices ➔ matching bases pair up

14 A pedigree is shown.



What type of inheritance is shown in the pedigree?

(A) Sex-linked recessive

(B) Sex-linked dominant

(C) Non sex-linked recessive

(D) Non sex-linked dominant

15 A rainforest vine grows up a tree to reach the top. Near the ground, the leaves are small and oval. At the top, the leaves are large and round.

This change in leaf size is an example of

(A) variation in a species.

(B) a commensal relationship.

(C) a co-dominant gene relationship.

(D) environment affecting phenotype.

16 The following events occur after DNA is subjected to radiation. The events are listed in no specific order.

P: Change in protein structure
Q: Change in polypeptide sequence
R: Change in cell activity
S: Mutation

What is the correct sequence of steps?

(A) S, P, Q, R

(B) S, Q, P, R

(C) R, Q, S, P

(D) R, S, Q, P

17 What feature of prions distinguishes them from all other types of pathogens?

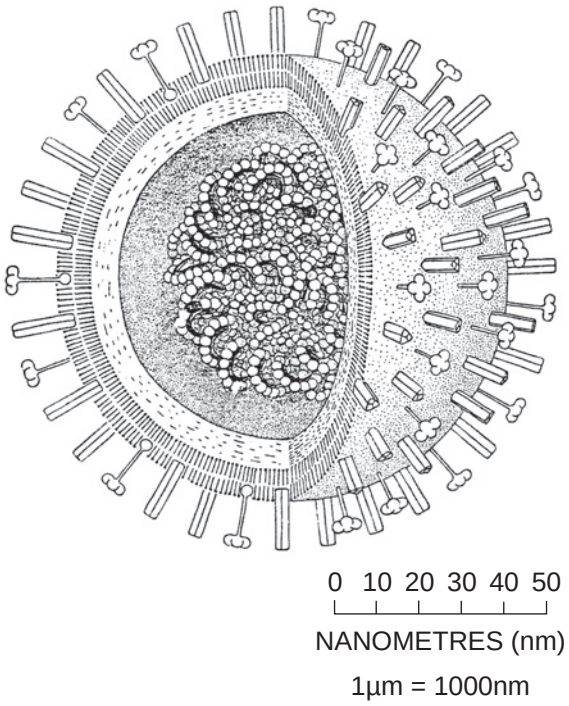
(A) Prions are not cells.

(B) Prions do not contain DNA.

(C) Prions do not contain nucleic acids.

(D) Prions cannot reproduce outside a host cell.

18 A model of a virus is shown.



"The epidermiology of Influenza" by Martin M. Kaplan and Robert G. Webster, reproduced by permission of Donald Garber, Executor of the Estate of Bunji Tagawa

What is the approximate diameter of this virus?

(A) 13 cm

(B) 13 nm

(C) 130 µm

(D) 0.130 µm

19 Which of the following observations helped develop a model for the transmission of malaria?

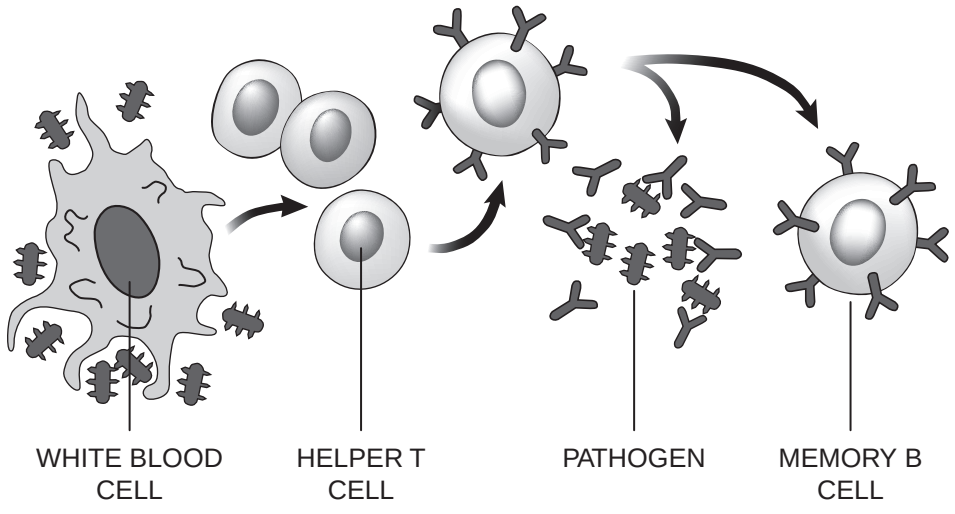
(A) Immunisation against the pathogen prevented transmission of malaria.

(B) Use of antibiotics decreased the incidence of malaria in the community.

(C) After transmission, B cells in the infected individual produced antibodies against malaria.

(D) After swamps were drained there was a major decline in the numbers of individuals catching malaria.

20 The diagram illustrates an immune response.



With kind permission of McGraw-Hill Ryerson, Canada

Below is a list of statements, each describing a step in the immune response.

1. Antibodies are produced to immobilise the pathogens.
2. B cell is activated by a helper T cell.
3. Helper T cells are activated by the white blood cell.
4. Memory B cell is ready to respond to further infections.

What is the correct sequence of events?

(A) 2, 3, 1, 4

(B) 2, 3, 4, 1

(C) 3, 2, 1, 4

(D) 3, 4, 2, 1

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Centre Number

Student Number

Section I (continued)

Part B – 55 marks
Attempt Questions 21–30
Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Question 21 (2 marks)

Gregor Mendel and Thomas Morgan both used breeding experiments to deduce fundamental principles of genetics.

Complete the four blank boxes in the table. **2**

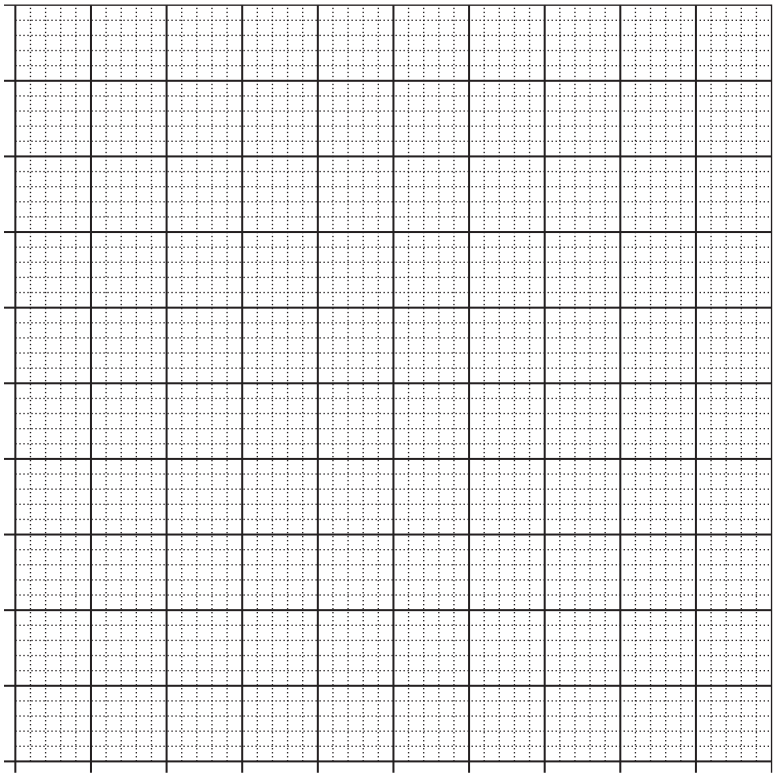
	Mendel's Monohybrid Cross	Morgan's Fruit Fly Experiments
First Cross Parents Phenotype	tall × short	red eyed female × white eyed male
First Cross (F_1) Parents Genotype		$X^R X^R \times X^r Y$
First Cross Punnet Square	t t T Tt Tt T Tt Tt	
F_1 Phenotype		

Question 22 (6 marks)

The following data were recorded about the effectiveness of antimalarial drugs for treating malaria.

	Effectiveness of drug (%)	
Year	*Mefloquinine*	*Quinine*
1976	100	90
1978	100	85
1980	100	80
1984	100	72
1988	90	64
1992	70	58

(a) Graph the data on the grid. **3**



Question 22 continues on page 11

(b) Use these data to explain the impact of human processes on biodiversity. **3**

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End of Question 22

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Section I – Part B (continued)

Question 23 (7 marks)

(a) Use an example to explain why hybridisation within a species is carried out. **2**

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(b) Use an example of a named transgenic species to discuss the social and environmental impact of this technology. **5**

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Question 24 (5 marks)

Design an experiment that tests the effect of opening a window on the blood oxygen saturation level of the people in a room. **5**

Independent variable	.....
Control	.....
Variables to be kept constant and justification for keeping each constant.	Variable 1: ..... Justification: ....
	Variable 2: ..... Justification: ....
Technology used to measure oxygen saturation in blood	.....

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Centre Number

Student Number

Section I – Part B (continued)

Question 25 (5 marks)

(a) Justify your choice of equipment or resources to perform a first-hand investigation to draw a longitudinal section of xylem tissue. **2**

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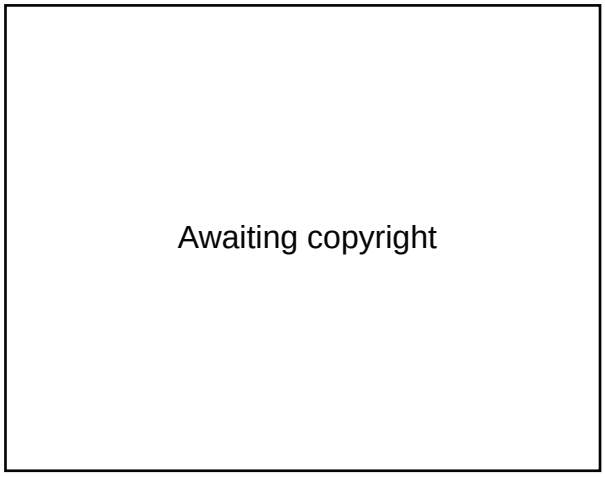
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(b) Draw a diagram of a longitudinal section of xylem tissue and label ONE characteristic feature. **3**

Question 26 (5 marks)

An epidemiological study of lung cancer, cigarettes and death rates produced the following data.



Using these data alone, you are asked to report on the likelihood of reducing lung cancer by increasing the price of cigarettes. Present your evaluation including limitations of the information provided. **5**

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Question 27 (3 marks)

(a) Outline examples of effective quarantine regulations in Australia that protect animal and plant health. Give one example for each.

(i) animal health **1**

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(ii) plant health **1**

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(b) Using one of your examples, explain why this method is effective. **1**

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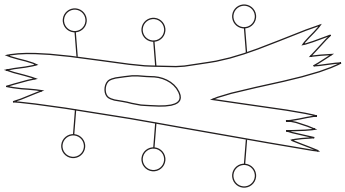
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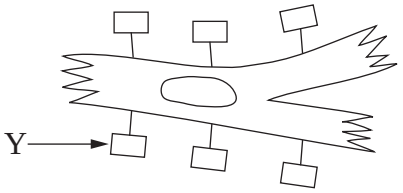
Question 28 (8 marks)

Organ transplants may trigger an immune response which can lead to organ rejection.

The diagram below represents a model of two heart cells, one from a transplant recipient and one from a donor.



Recipient heart cell



Donor heart cell

(a) What does Y represent? **1**

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(b) Assess the effectiveness of the model in explaining the cause of organ rejection in a transplant recipient. **3**

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(c) Name and outline the role of TWO types of T lymphocytes in organ rejection. **4**

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Question 29 (7 marks)

Question 29 continues on page 20

Question 29 (7 marks)

You have been asked to write a report on the responses of plants to temperature change.

You find three sources of information.

Awaiting copyright

Question 29 continues on page 21

Question 29 (continued)

(a) From these articles, identify two responses of plants to temperature change. **2**

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(b) Evaluate the relevance of the information to your report, and the reliability of each of the sources given. **5**

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End of Question 29

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Question 30 (7 marks)

Question 30 continues on page 24

Question 30 (7 marks)

Geological and biological history of New Zealand

Event	*Time*
Australia and New Zealand separated	85–65 million years ago
New Zealand drifted east and subsided, its land mostly under seawater (most fossils are marine)	85–22 million years ago
Mammals became abundant worldwide	60 million years ago
Earliest migratory bird fossils	55 million years ago
New land created by volcanoes in New Zealand	22 million years ago to present
Many new, unique species of birds appear in the fossil record	20 million years ago to present
Islands completely devoid of mammals. Birds occupied niches that were usually occupied by mammals	700 years ago

Use this information and other relevant knowledge to demonstrate how the practice of biology has led to the validation of current theories of evolution. **7**

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Question 30 continues on page 25

Question 30 (continued)

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End of Question 30

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Biology

Section II

25 marks
Attempt ONE question from Questions 31–35
Allow about 45 minutes for this section

Answer parts (a)–(c) of the question in a writing booklet. Answer parts (d)–(e) of the question in a SEPARATE writing booklet. Extra writing booklets are available.

		Pages
Question 31	Communication	28–29
Question 32	Biotechnology	30–31
Question 33	Genetics: The Code Broken?	32–33
Question 34	The Human Story	34–35
Question 35	Biochemistry	36–37

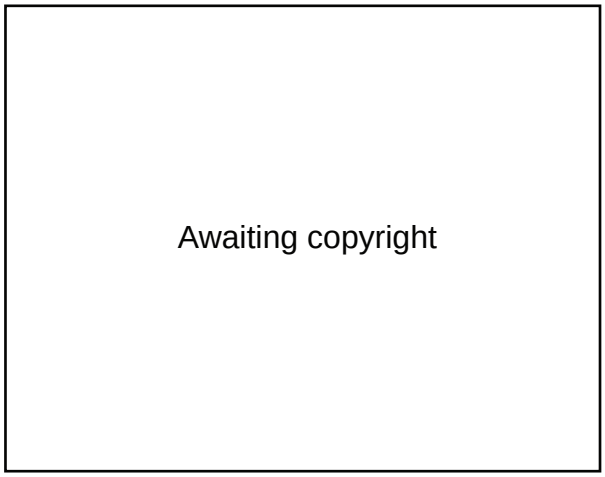
Question 31 — Communication (25 marks)

Answer parts (a)–(c) in a writing booklet.

(a) Construct a table to identify the structures used by insects, fish and mammals to detect vibrations. **3**

(b) The vocal folds are different when a person sings a high pitched note and a low pitched note. Draw TWO labeled diagrams to illustrate this difference. **4**

(c) On the cross-section of the eye and the graph, corresponding retina locations are indicated according to their angle from the fovea.



(i) What label should be given to the line Y? **1**

(ii) Explain why the structure of cones varies depending on their location in the retina. **2**

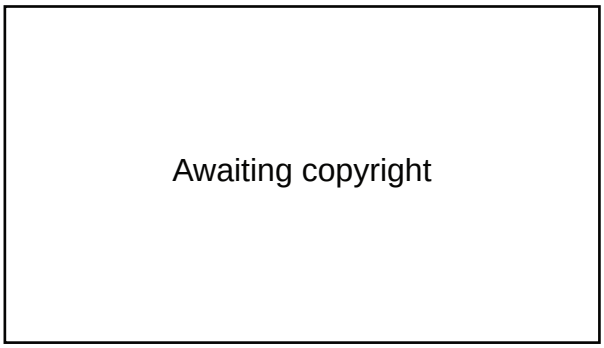
(iii) Outline the role of rhodopsin in rods. **2**

Question 31 continues on page 29

Answer parts (d)–(e) in a SEPARATE writing booklet.

(d) In your course, you did a first-hand investigation on a mammalian brain similar to the one shown.

The brain shown is from a mammal that was brought into a vet surgery after surviving a fall. Brain testing showed no action potentials occurring in region X.



(i) Explain TWO possible causes for the lack of action potentials in region X. **4**

(ii) Outline how this condition could change the behaviour of the mammal. **2**

(e) The following article was found in a newspaper.

Movie experience just gets better and better –
3D movies, 3D glasses and surround sound systems

In a 3D movie, two different images are projected onto the same screen. 3D glasses are worn by the audience to ensure that one image is seen by one eye and the other image is seen by the other eye.

Surround sound systems allow sounds to be produced in different areas of a cinema so that members of the audience feel like they are at the centre of the action that is displayed on the screen.

These new technologies use our knowledge of depth perception, sound shadows and how sights and sounds are received, transmitted and then interpreted by the brain to improve our movie experience.

Evaluate how our understanding of the eye and the ear has led to the development of technologies such as those above. **7**

End of Question 31

Question 32 — Biotechnology (25 marks)

Answer parts (a)–(c) in a writing booklet.

(a) Construct a table to identify an industrial fermentation process, the microorganism used, and a product of the process. **3**

(b) Draw a flowchart showing the sequence of events that results in the formation of recombinant DNA. **4**

(c) A farmer raised some animals. Offspring from each generation were chosen for crosses for the next generation. The farmer collected data which are shown in the table.

Generation number	*Breeding males*	*No. of offspring*	*No. of early deaths*	*Number of male animals surviving to breeding age*
1	non-brown	53	27	2 non-brown 8 brown
2	brown	45	12	3 non-brown 15 brown
3	brown	62	10	1 non-brown 27 brown

(i) Outline the form of biotechnology used by the farmer. **1**

(ii) Using the farmer's data, assess the effectiveness of this use of biotechnology. **4**

Question 32 continues on page 31

Answer parts (d)–(e) in a SEPARATE writing booklet.

(d) Fire and Mello discovered a cellular process now known as RNA interference. In this process, small nucleotides bind to specific mRNA sequences causing their destruction. This discovery is revolutionising molecular therapeutics for devastating diseases.

(i) Explain how protein synthesis is affected by RNA interference. **2**

(ii) Describe the roles of DNA and RNA in an application of biotechnology. **4**

(e) Assess how the development of new biotechnologies has led to ethical and social issues. **7**

End of Question 32

Question 33 — Genetics: The Code Broken? (25 marks)

Answer parts (a)–(c) in a writing booklet.

(a) Construct a table to identify how each of the following mutations affects chromosome number in an organism: **3**

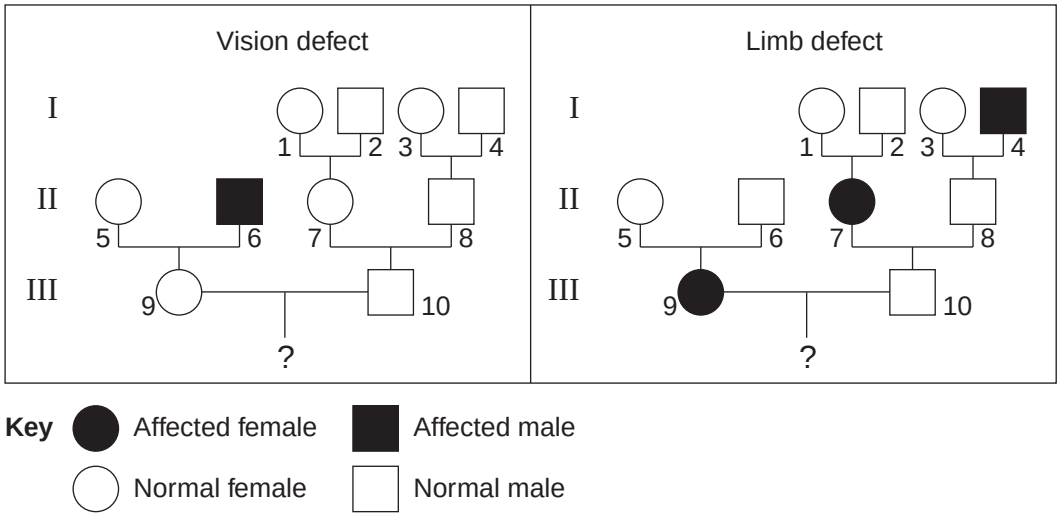
Trisomy, Polyploidy, Base Substitution.

(b) A somatic cell has a diploid number of 4. **4**

Draw diagrams that show the similarities and differences between the chromosomes in:

- this diploid cell and
- a haploid cell which could result from meiotic division of this cell.

(c) The pedigrees show the inheritance of two genetic disorders in the same family. Person 8 is not a carrier of the vision defect.



(i) Predict whether genes for each of these defects are dominant or recessive. **1**

(ii) Individuals 9 and 10 have requested genetic counselling. **4**

Predict the possible ratios of the phenotypes of their children if the genes were linked. Predict the ratios if they were not linked. Show working.

Question 33 continues on page 33

Answer parts (d)–(e) in a SEPARATE writing booklet.

(d) (i) Explain how data can be collected and analysed to identify the relative position of linked genes. **3**

(ii) Give THREE reasons why the human genome project could not be achieved by studying linkage maps. **3**

(e)

New Artifical Life Form Produced!

Recently, knowledge of gene cloning and gene cascades has been used to produce a whole artificial chromosome. This chromosome was inserted into a bacterium and resulted in surviving, reproducing bacteria.

Evaluate how our understanding of gene cloning and gene cascades has led to the development of new applications for technologies such as the one shown above. **7**

End of Question 33

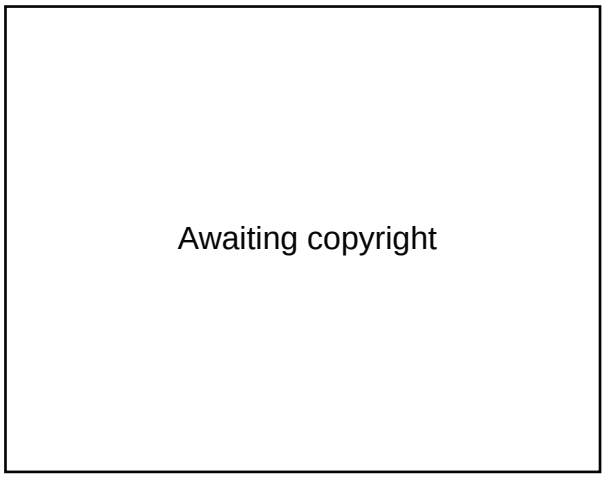
Question 34 — The Human Story (25 marks)

Answer parts (a)–(c) in a writing booklet.

(a) Construct a table to identify a feature of humans which classifies them as chordates, mammals and animals respectively. **3**

(b) Draw a diagram of a prosimian hand/foot and a human foot. Label two corresponding features of each hand/foot that demonstrate the differences between these primates. **4**

(c) The diagram compares the inheritance of nuclear DNA with mitochondrial DNA.



(i) Compare the pattern of inheritance of nuclear DNA with mitochondrial DNA. **1**

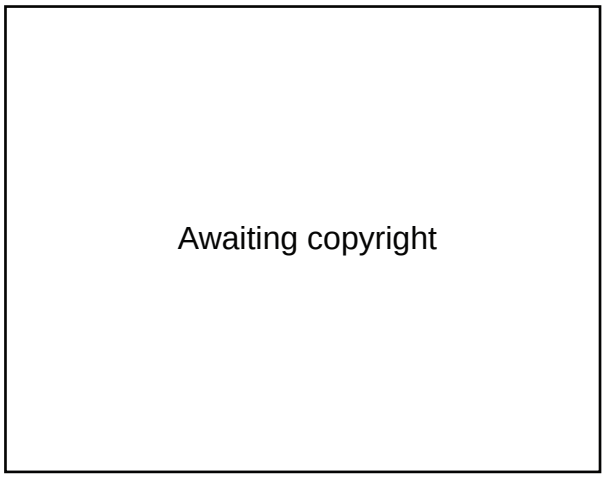
(ii) Assess whether the analysis of nuclear DNA or mitochondrial DNA is more useful to evolutionary biology. **4**

Question 34 continues on page 35

Answer parts (d)–(e) in a SEPARATE writing booklet.

(d) The graph below shows the results of an investigation into cranial capacity of fossil hominins.

- Data were obtained from measurements of hominin cranial capacity published in scientific journals
- Each data point on the graph represents the average cranial capacity of the adult skull at a single archaeological dig
- The results from 215 archaeological digs are represented



(i) Justify the methods used to collect and present the data. **4**

(ii) For either data point A or B propose the name of the hominin species and its regional location. **2**

(e) Assess the significance for future evolution of the similarities and differences in cultural development between humans and other primates. **7**

End of Question 34

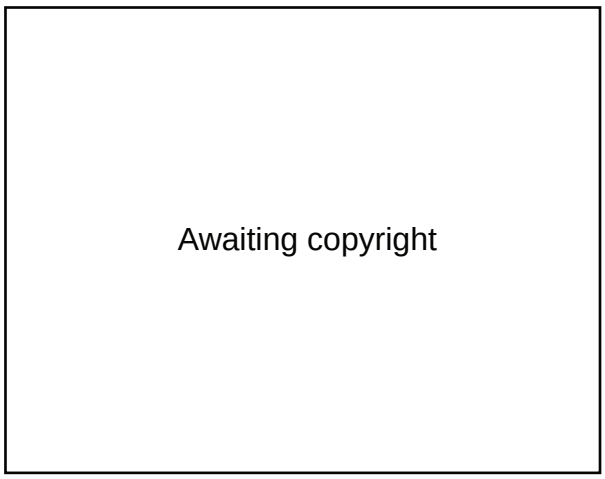
Question 35 — Biochemistry (25 marks)

Answer parts (a)–(c) in a writing booklet.

(a) Construct a table to identify the unique understanding of photosynthesis contributed by the experiments of Hales, Ingen-Housz and Priestley. **3**

(b) Draw a flowchart to show how a radioactive isotope can be used to show a biochemical pathway. **4**

(c) The graph shows absorption spectra of plant pigments obtained after chromatography.



(i) Identify the best labels for the X axis and Y axis respectively. **1**

(ii) Explain the usefulness of chromatography and another technology in developing our understanding of how non-green leaved plants photosynthesise. **4**

Question 35 continues on page 37

Question 35 (continued)

Answer parts (d)–(e) in a SEPARATE writing booklet.

(d) The following were concluded from experiments carried out by scientists. **6**

Date	*Observation*
1772	'Plants instead of affecting the air in the same manner as animal respiration, reverse the effects of breathing and keep the atmosphere sweet and wholesome.'
1905	'For a plant kept at a particular temperature, there is a maximal uptake of CO_2, but this is reached only if both light and CO_2 supply are adequate. However, at high temperatures, uptake of CO_2 rapidly decreases.'
1939	'Oxygen produced by isolated chloroplasts in ferric oxalate must all come from the reduction of ferric to ferrous iron and not from CO_2. Therefore, chloroplasts contain a mechanism, which under illumination evolves oxygen and reduces some unknown substance which is not carbon dioxide.'

Assess how these observations relate to the light and light-independent reactions in photosynthesis.

(e) Assess how our understanding of photosynthesis could lead to new technologies to resolve climate change issues. **7**

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