BOARD OF STUDIES
NEW SOUTH WALES

2009

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, 17 and 21

Total marks – 100

Section I Pages 2–22

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16–27
- Allow about 1 hour and 45 minutes for this part

Section II Pages 23–32

25 marks

- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet for Questions 1–15.

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1 How are new alleles formed?

(A) By crossing over during meiosis

(B) By cloning a new variety in a population

(C) By mutation in the DNA of a gene

(D) By production of a new phenotype from the same DNA

2 Which scientist's work contributed to our understanding of the causes of infectious diseases?

(A) Frank Macfarlane Burnet

(B) Louis Pasteur

(C) James Watson

(D) Maurice Wilkins

3 Which of the following prevent entry of pathogens into the human body?

(A) The skin and phagocytosis

(B) The skin and chemical barriers

(C) Inflammation response and phagocytosis

(D) Inflammation response and chemical barriers

4 The potential for disease to spread through animal populations in intensive farming is heightened because the animals are kept close together.

A disease has been identified in animals in one enclosure on a farm.

Which procedure would best prevent the spread of the disease to animals in other enclosures on the farm?

(A) Isolate diseased animals from healthy animals then vaccinate all healthy animals.

(B) Vaccinate all animals so that healthy animals do not develop the disease and spread it further.

(C) Move the diseased animals into another enclosure to quarantine them from the healthy animals.

(D) Wash all animals with antiseptic solution so that the pathogen causing the disease cannot be spread from diseased animals to healthy animals.

5 Why was the importance of Mendel's work not widely accepted until some time after he completed his experiments?

(A) Mendel did not realise the importance of his own work.

(B) Mendel did not repeat his experiments so they were not seen as important by other biologists.

(C) Mendel published his results in a local scientific publication not accessed by many biologists.

(D) Mendel's description of sex linkage to explain his results was not understood by other biologists.

6 What is a role of the kidney in the excretory system of mammals?

(A) To remove salt from the body and to keep water in the body

(B) To remove water from the body and to keep salt in the body

(C) To remove nitrogenous waste from the body and to maintain water levels in the body

(D) To remove water from the body and to maintain levels of nitrogenous substances in the body

7 Thirty percent (30%) of the nucleotide bases in human DNA are adenine (A).

What is the percentage of guanine (G) bases in human DNA?

(A) 20%

(B) 30%

(C) 40%

(D) 70%

8 In humans, brown eye colour is dominant and blue eye colour is recessive. A brown-eyed boy and a blue-eyed girl have a blue-eyed mother.

What eye colour does the father have and why?

(A) Brown, because the gene for brown eye colour is sex linked.

(B) Brown, because at least one of the parents must have brown eyes.

(C) Blue, because at least two other members of the family have blue eyes.

(D) Blue, because at least one of the parents must be heterozygous for eye colour.

9 Which alternative best describes what happens to oxygen and carbon dioxide as blood travels through the lungs and muscles?

	Lung	*Muscle*
(A)	Oxygen dissolves in blood.	Carbon dioxide dissolves in blood.
(B)	Oxygen binds strongly to haemoglobin.	Carbon dioxide binds strongly to haemoglobin.
(C)	Oxygen binds strongly to haemoglobin.	Carbon dioxide dissolves in blood.
(D)	Carbon dioxide binds weakly to haemoglobin.	Oxygen binds weakly to haemoglobin.

10 Amylase is an enzyme that catalyses the breakdown of starch.

As the temperature rises, the activity of this enzyme will

(A) increase until the enzyme begins to denature.

(B) decrease until the substrate begins to denature.

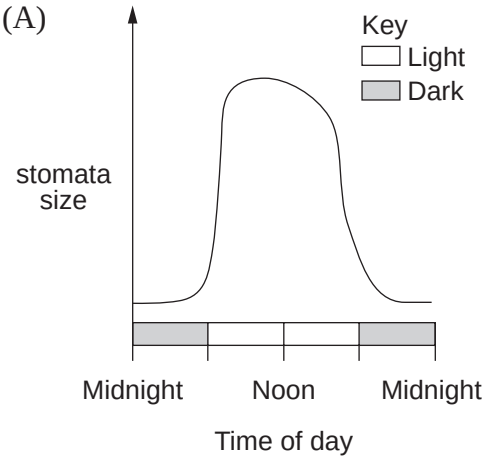
(C) increase until the optimum pH level is reached.

(D) decrease until the substrate reaches a maximum concentration.

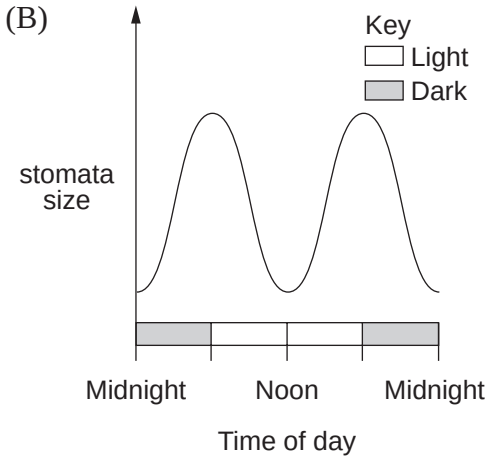
11 Experiments were carried out on plants living in different environments to measure the size of the leaf stomata at different times of the day. Previous investigations had shown that plants transpire more water when the size of the stomata is larger.

Which graph best represents a plant living in a dry environment?

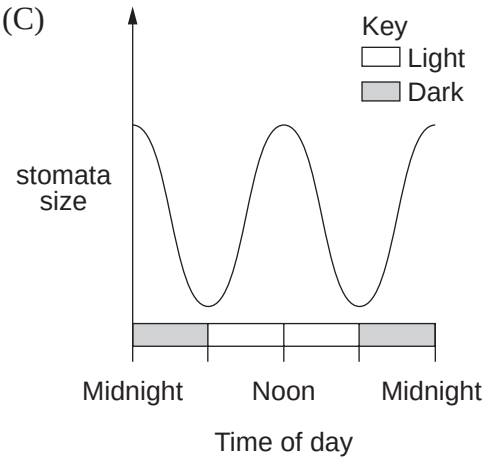
(A)



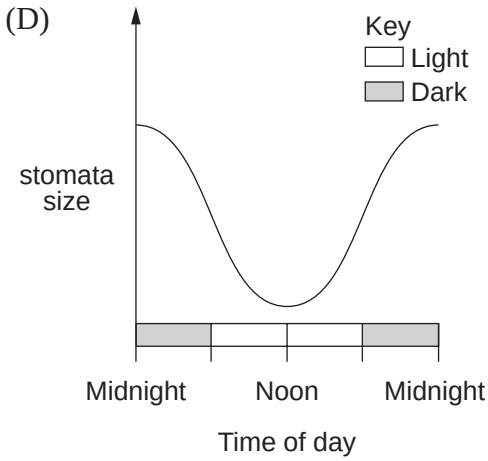
(B)



(C)



(D)



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12 A student conducted an experiment where carbon dioxide was bubbled through water. The student recorded the pH meter reading every 5 seconds.

Time (s)	*pH meter reading*
5	7.5
10	7.2
15	7.0
20	6.8

What would be the most valid conclusion the student could draw from these results?

(A) The change in pH was too small to be significant.

(B) The water became less acidic as the amount of CO_2 in the water increased.

(C) The water became more acidic as the amount of CO_2 in the water increased.

(D) The change in pH might not be related to the CO_2 being bubbled through the water.

13 Why do organ transplant patients need anti-rejection medication?

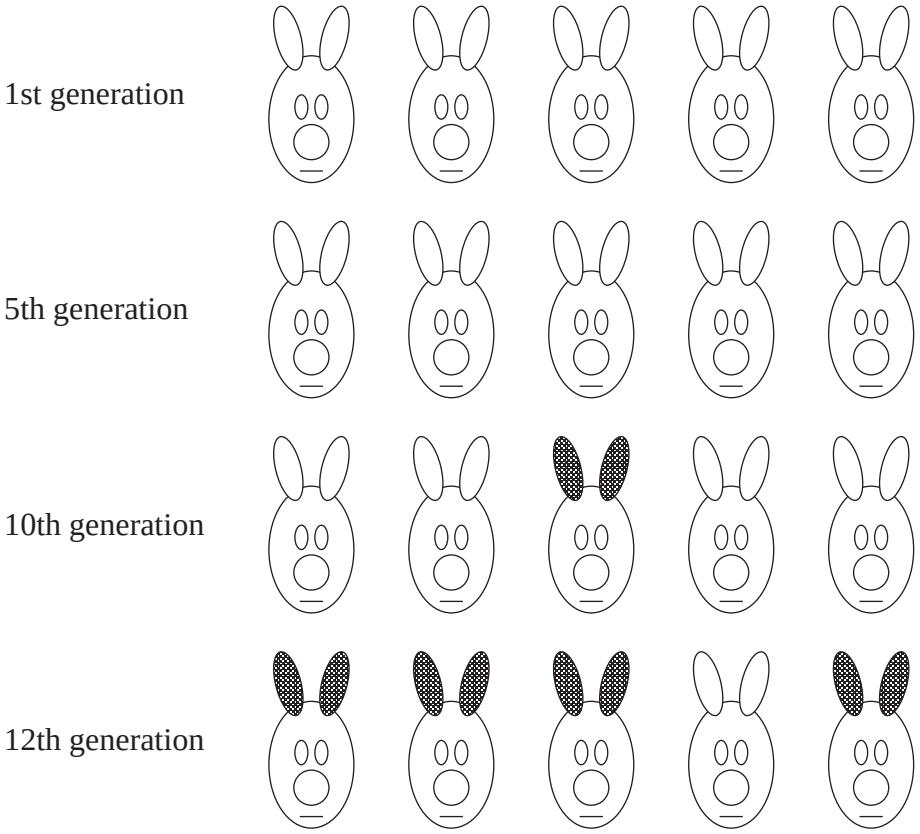
(A) To minimise infection

(B) To prevent T-lymphocyte growth

(C) To stimulate the interaction of B- and T-lymphocytes

(D) To prevent the recipient's blood type changing and adopting the immune system of the donor

14 The diagram shows phenotypic changes in a population over a number of generations.



Which evolutionary concept is demonstrated in the diagram?

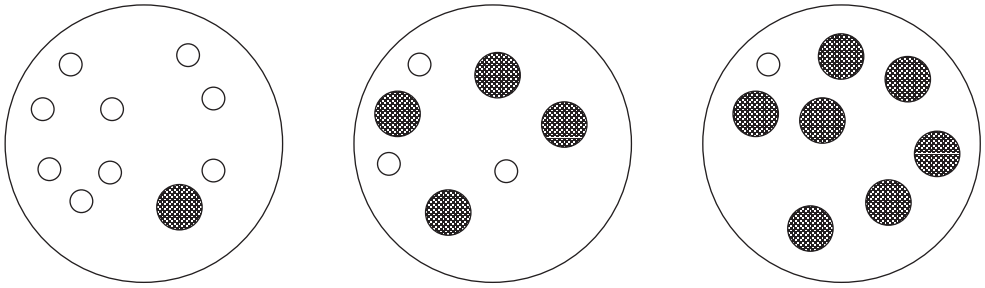
(A) Convergent evolution

(B) Divergent evolution

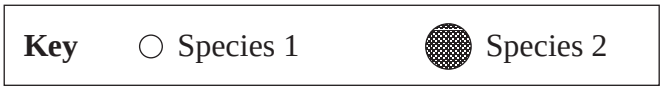
(C) Transitional forms

(D) Punctuated equilibrium

15 A patient was being treated for an infection using an antibiotic. At seven day intervals a swab was taken from the mouth and cultured onto a fresh agar plate.



Day 1 plate Day 8 plate Day 15 plate



What is the most likely cause of the change in mouth microflora shown in these culture plates?

(A) Species 1 was a food source for Species 2 allowing more of Species 2 to grow.

(B) Species 1 and Species 2 are both fungi, but Species 1 is killed by the antibiotic while Species 2 uses the antibiotic as food.

(C) As the numbers of Species 2 increased, they changed the chemical conditions of the agar plate stopping the growth of Species 1.

(D) There is normally a balance between the numbers of each species but the removal of Species 1 by the antibiotic allowed more of Species 2 to grow.

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Centre Number

Student Number

Section I (continued)

Part B – 60 marks
Attempt Questions 16–27
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Question 16 (3 marks)

Complete the following table. **3**

Pathogen	*Distinguishing characteristic of the pathogen*	*Disease caused by this type of pathogen*
Bacteria		
Fungi		
Protozoans		

Question 17 (6 marks)

As part of an independent research project, a student studied a genetic condition suffered by members of his family. The student wrote the following summary:

- I am male and I have the condition.
- My mother does not have the condition.
- My father and his brother have the condition.
- My father's sister and my father's mother do not have the condition.
- My father's father has the condition.

(a) Construct a pedigree of this family. **3**

(b) Why are diagrams, such as pedigrees, useful in analysing data? **1**

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(c) The student made the following conclusion from his study. **2**

"As only males have the condition, it must be a sex-linked genetic condition."

Assess the validity of the student's conclusion, and provide support for your assessment.

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Question 18 (5 marks)

On a ship at sea there is an outbreak of a disease affecting the human digestive system. **5**

Explain how cleanliness in food, water and personal hygiene practices on the ship could assist in controlling this disease.

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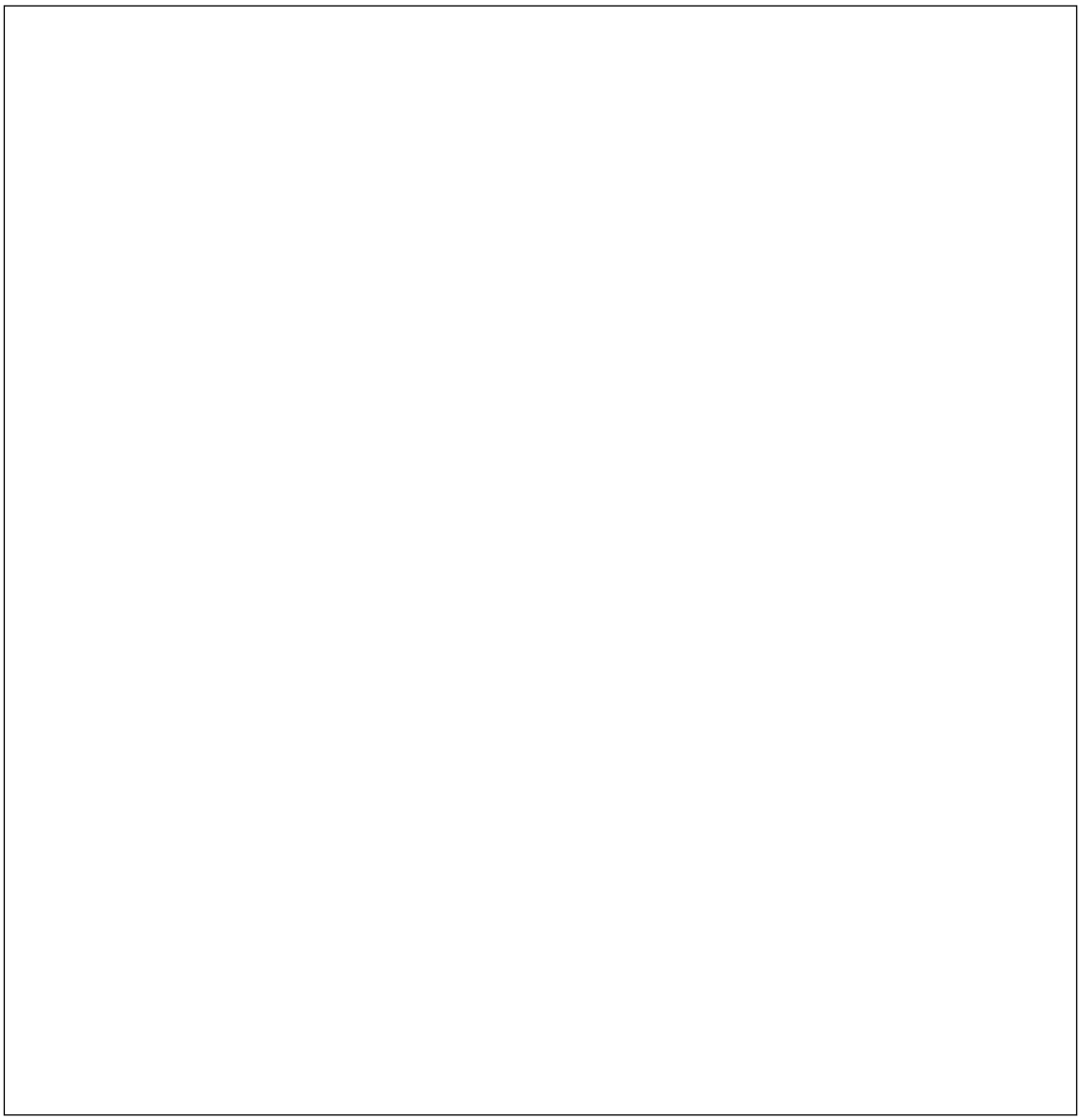
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Question 19 (6 marks)

Draw a diagram of a mammalian kidney. **6**

On your drawing, label THREE regions involved in the excretion of waste products AND indicate the main process that occurs in each of the three regions.



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Centre Number

Section I – Part B (continued)

Student Number

Question 20 (5 marks)

(a) Outline the steps you would follow in a first-hand investigation of pathogens and insect pests in plant shoots and leaves. **3**

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(b) Describe ONE possible risk in this investigation and ONE precaution needed to maintain safety. **2**

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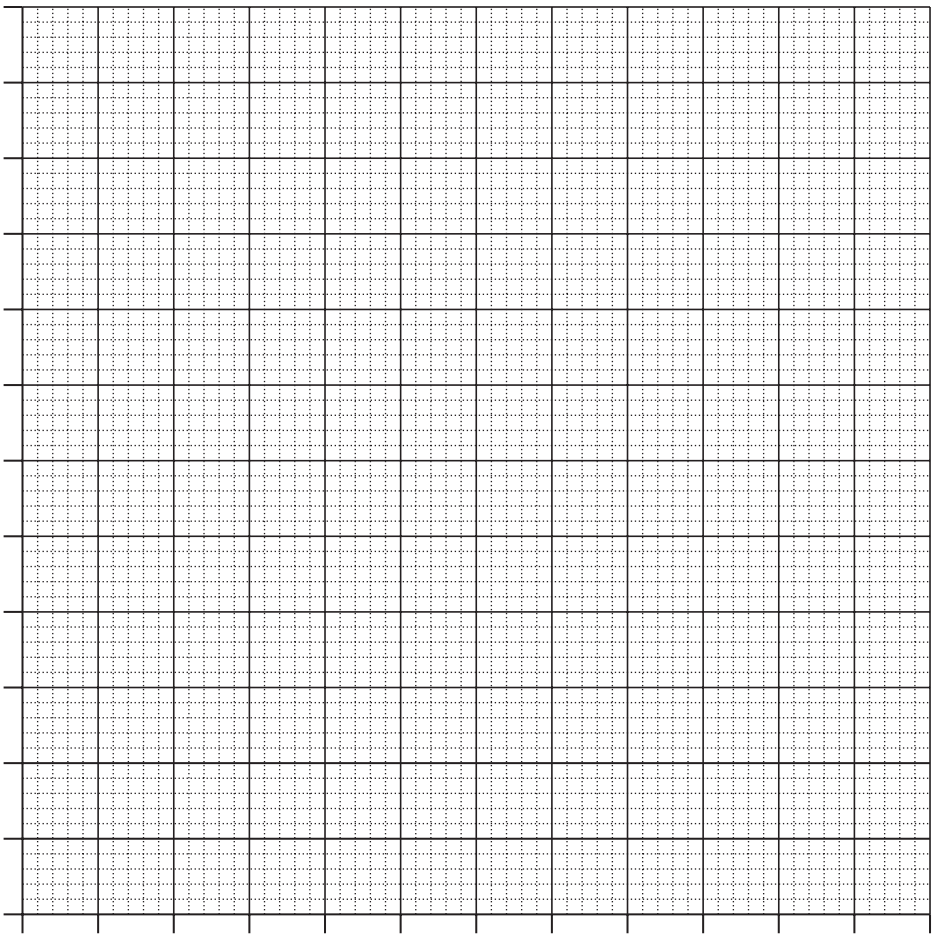
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Question 21 (6 marks)

The data in the table shows the results from an investigation that measured growth in a species of wheat.

Temperature (°C)	–5	0	5	10	12.5	15	17.5	20	22.5	25	27.5	30	35	40
Relative growth (%)	0	0	0	20	40	60	80	100	75	50	25	0	0	0

(a) Use the data to draw an appropriate graph. **4**



(b) From the graph, describe how the growth of wheat responds to temperature. **2**

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Question 22 (3 marks)

Construct a table to identify THREE types of T-lymphocytes, and outline the role of each type in the immune response. **3**

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Question 23 (5 marks)

(a)

A woman recently conceived Britain's first baby guaranteed to be free from hereditary breast cancer. Doctors screened for an embryo that was free from a gene that can cause breast cancer.

The screening was performed due to the long history of this form of cancer in the family and the fact that any daughter born with the gene would have a 50%–80% chance of developing breast cancer.

Explain the possible impact of this reproductive technology on the genetic composition of the population. **2**

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(b) Describe the potential impact of the use of reproductive technologies on the path of evolution using ONE named plant or animal that has been genetically altered. **3**

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Question 24 (6 marks)

An experiment was conducted to determine the effects on body function of increasing ambient temperature. Participants (100 individuals) were asked to lie down and remain as still as possible during the entire experiment. The following observations were made:

- The starting temperature of the room was 22°C.
- The mean body temperature of all participants at the start of the experiment was 37.1°C.
- As the room temperature increased, sweating and heart rate also increased.
- As the room temperature returned to 22°C, sweating and heart rate returned to normal.

In a control group of 100 participants who were lying down in a room where the ambient temperature was maintained at 22°C, no changes in sweating and heart rate were observed.

(a) Identify the dependent and independent variables in this experiment. **2**

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(b) Identify the body system that monitors and responds to changes in external temperature. **1**

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Question 24 continues on page 19

(c) Draw and label a model of a feedback mechanism that explains the observations made in the experiment. **3**

End of Question 24

Question 25 (4 marks)

A fisherman pricked his finger on a fish hook. Soon after he noticed that the injured finger was red and swollen. Some time later he felt a throbbing sensation in his arm. His doctor prescribed a course of antibiotics.

(a) Identify TWO defence adaptations used by the body in response to the injury. **2**

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(b) Identify the role of the antibiotics in the management of this injury. **2**

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Centre Number

Section I – Part B (continued)

Student Number

Question 26 (3 marks)

Describe how processes such as enantiostasis and homeostasis are used to maintain metabolic functions when salt concentration varies in plants living in estuarine environments. **3**

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Question 27 (8 marks)

Most offspring resemble their parents in a number of characteristics, but there are often some characteristics in the offspring that are unexpected. **8**

Explain, using examples, how genetics and the environment can affect the phenotype of individuals.

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Biology

Section II

25 marks
Attempt ONE question from Questions 28–32
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Pages

Question 28	Communication	24
Question 29	Biotechnology	25–26
Question 30	Genetics: The Code Broken?	27–28
Question 31	The Human Story	29–30
Question 32	Biochemistry	31–32

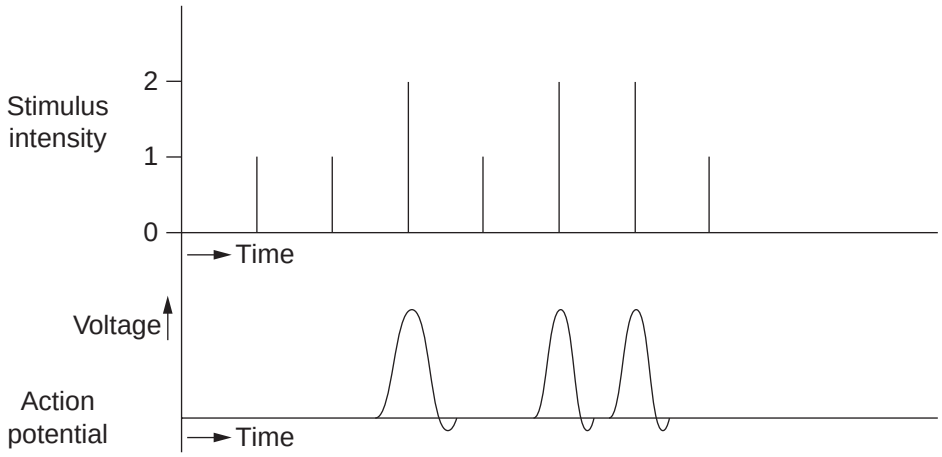
Question 28 — Communication (25 marks)

(a) Draw a diagram of the human eye and label THREE sites of refraction. **3**

(b) (i) Outline ONE technology that can be used to treat or prevent blindness. **1**

(ii) What are the possible implications for society of the use of this technology? **3**

(c) The graph shows the voltage changes recorded in a neurone when it was stimulated at different intensities.



Explain why all the stimuli do not generate an action potential. **5**

(d) (i) Why is the process of accommodation important in visual communication? **2**

(ii) Describe how you would use lenses to model the process of accommodation. **4**

(e) Explain how an understanding of hearing mechanisms has been used to develop technologies to overcome hearing difficulties. **7**

Question 29 — Biotechnology (25 marks)

(a) (i) What is used to cut DNA in recombinant DNA techniques? **1**

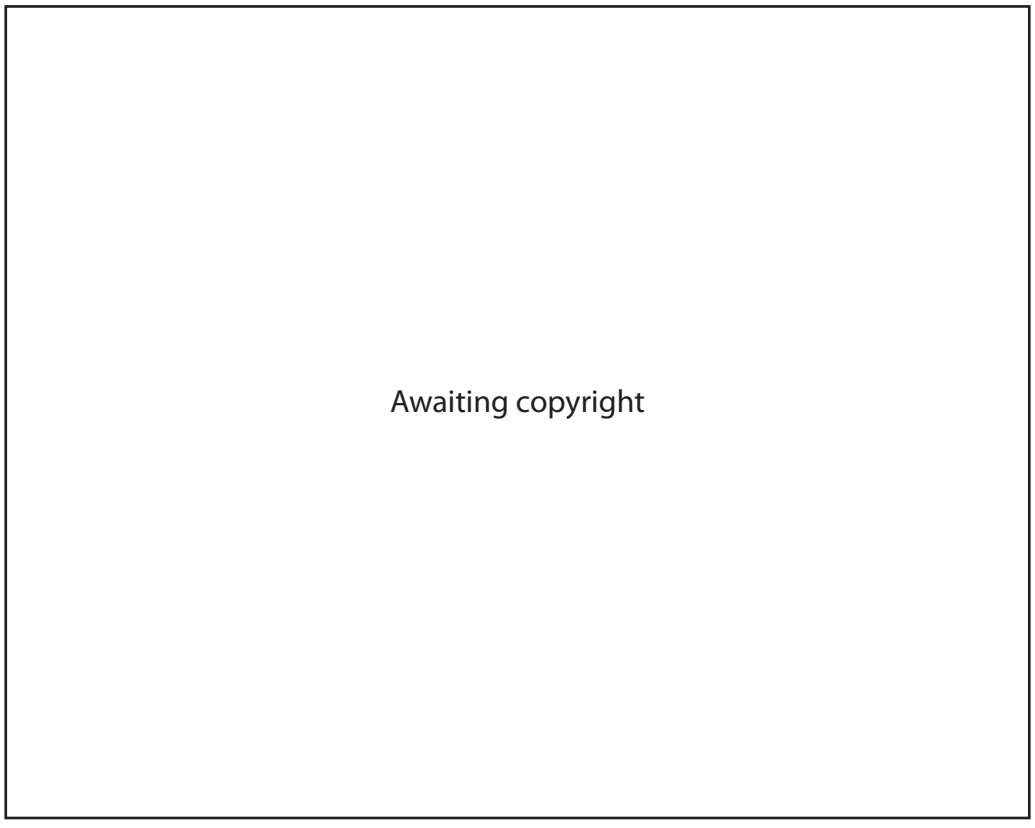
(ii) Outline the role of ligases in recombinant DNA techniques. **2**

(b) Before the 18th century, fermentation was a 'cottage' industry carried out in homes or small shops in villages. Early in the 18th century, fermentation began to develop into a large scale industry.

(i) Identify ONE fermentation product made prior to the 18th century. **1**

(ii) Describe ONE scientific discovery that has led to the expansion of fermentation since the 18th century. **3**

(c) The diagram represents a model of protein synthesis.



(i) Name TWO types of RNA. **1**

(ii) Describe the role of RNA in the processes occurring at **locations 1** and **2** in the diagram. **4**

Question 29 continues on page 26

Question 29 (continued)

(d) (i) Describe how you would extract DNA from cells. **5**

(ii) Outline how you would identify the DNA you extracted. **1**

(e) Explain how applications of modern biotechnology have produced products that are useful to humans. **7**

End of Question 29

Question 30 — Genetics: The Code Broken? (25 marks)

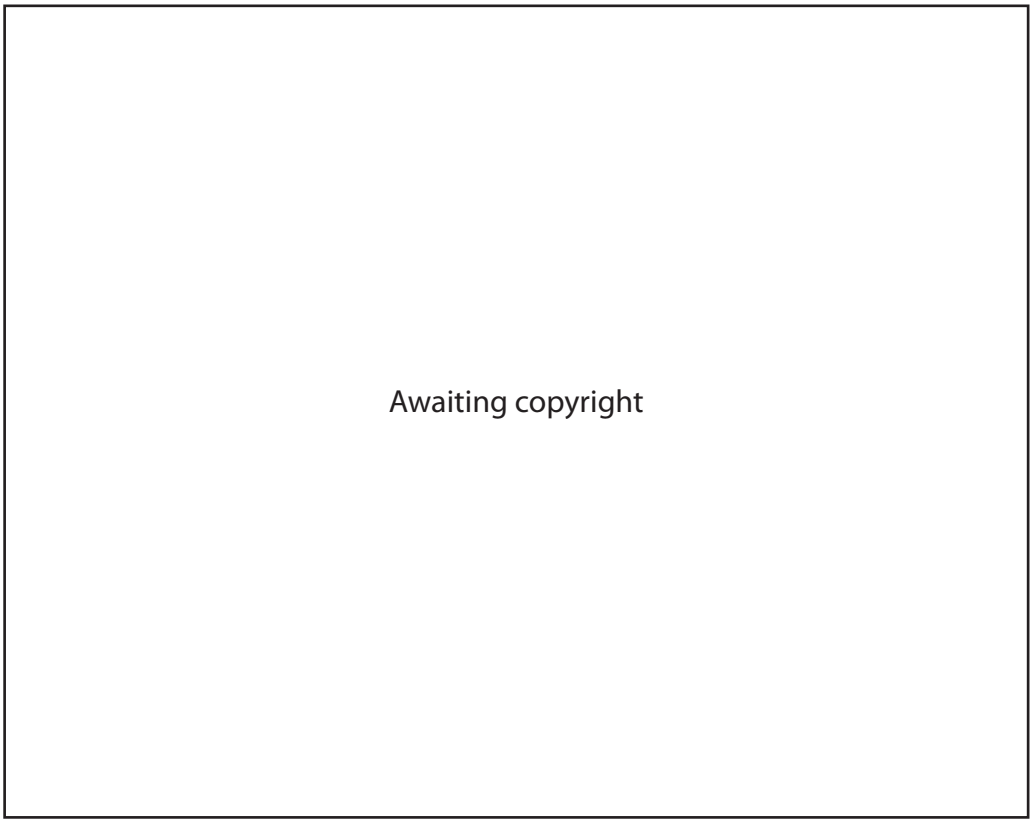
(a) (i) What are the multiple alleles in the inheritance of ABO blood groups? **1**

(ii) Using a diagram, show how parents with blood groups A and B could have a child with blood group O. **2**

(b) (i) Identify ONE example of cloning an animal or plant. **1**

(ii) Describe ONE possible benefit for society of the use of this cloning. **3**

(c) The diagram represents a model of protein synthesis.



Describe the processes occurring at each of the **locations 1**, **2** and **3** in the diagram. **5**

Question 30 continues on page 28

(d) The inheritance patterns of two genes indicate that they are linked. **6**

Describe how you would use a model of linkage to explain this.

(e) Explain how our understanding of genetic mutation could lead to the management of some diseases using gene therapy. **7**

End of Question 30

Question 31 — The Human Story (25 marks)

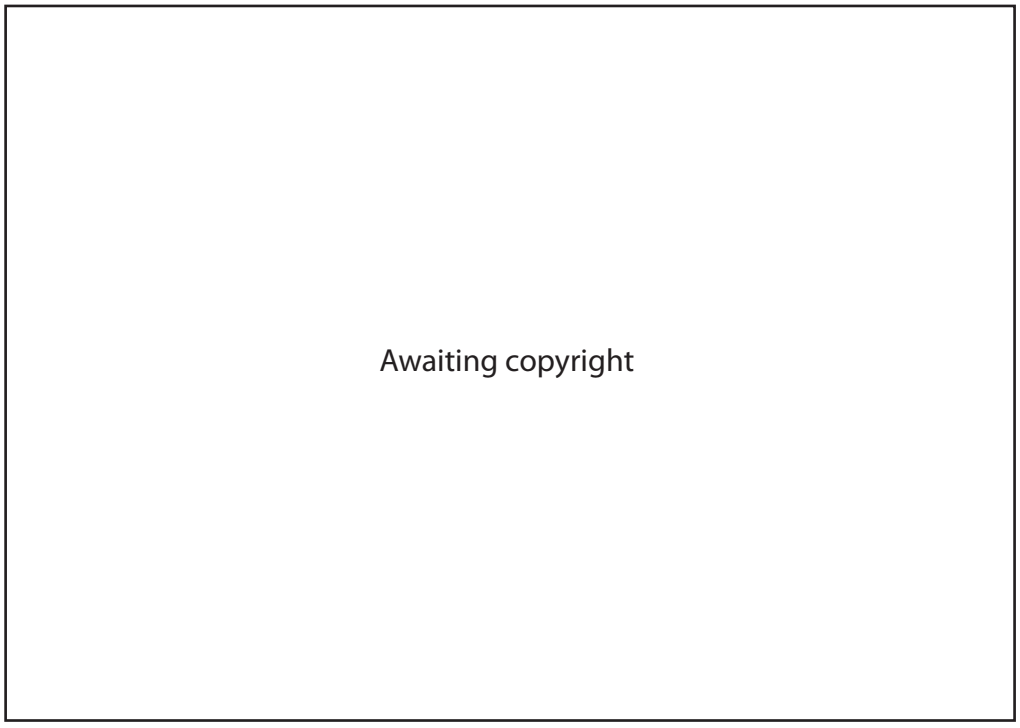
(a) Copy and complete the following table in your writing booklet. **3**

Classification level	*Human classification*	*Identifying feature*
	Primate	
	Hominid	
	Homo	

(b) (i) Identify ONE method used to date fossils. **1**

(ii) Outline the problems associated with relying only on the fossil record to interpret the past. **3**

(c) The diagram shows two different models of human migration and evolution.



Describe the evidence that can be used to support each of the theories shown in the diagram. **5**

Question 31 continues on page 30

(d) (i) Name TWO species (other than *Homo erectus* and *Homo sapiens*) known from fossil evidence that have been used to trace human evolutionary relationships. **1**

(ii) Outline the similarities and differences you would look for when studying fossils of these species. **5**

(e) Explain the biological evidence, other than fossils, that can be used to improve our understanding of the evolution of humans. **7**

End of Question 31

Question 32 — Biochemistry (25 marks)

(a) Outline how plants help to reduce greenhouse gases. **3**

(b) (i) Name one person who made a significant contribution to the discovery that plants were able to produce oxygen. **1**

(ii) Describe the evidence that the person you named in part (b) (i) used for demonstrating that plants were able to produce oxygen. **3**

(c) The diagram shows a chloroplast.

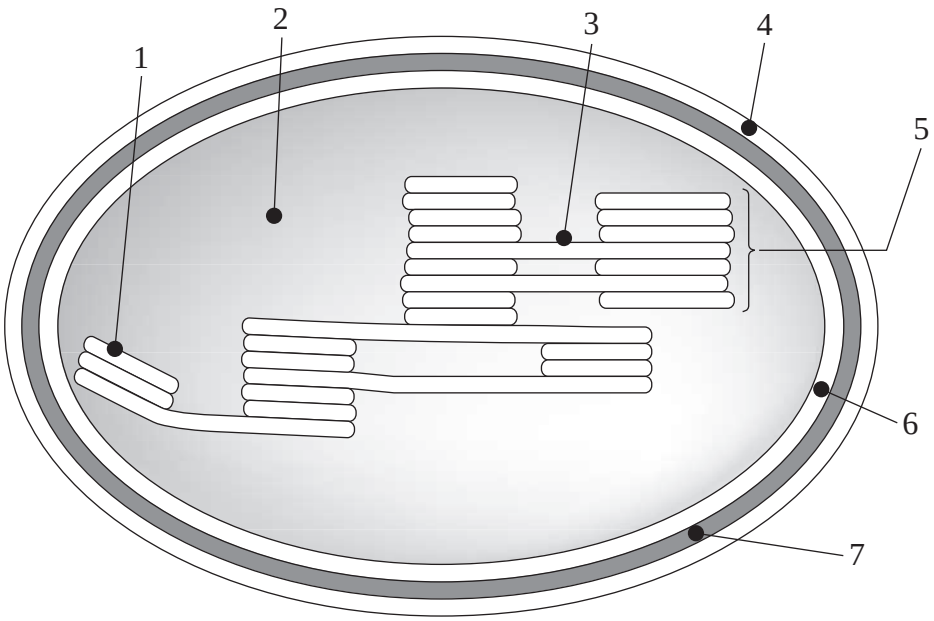


Diagram of a Chloroplast, Senior Biology, Knight and Sullivan, Longman Australia, 1991. Reproduced with the permission of Pearson Education Australia

(i) Which numbered feature in the diagram is the location of DNA? What is the name of this feature? **1**

(ii) Describe the photosynthetic processes occurring at locations 3 and 5. **4**

Question 32 continues on page 32

(d) It was shown by Engelman in 1882 that what we now know as photosynthesis occurred in Spirogyra only for violet and red wavelengths of light. **6**

Students looking at a range of green plants from their gardens found that for most plants, photosynthesis occurred across the full visible light range including green and yellow. This is due to the plants having pigments such as carotenes in addition to chlorophyll.

Describe how modern laboratory techniques can be used to determine the nature of the pigments and where they are located in the plant cells.

(e) The idea that plants obtain nourishment from water, light and air took nearly two centuries to develop. **7**

Explain how the use of isotopes in the latter part of the 20th century enhanced earlier discoveries about photosynthesis.

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