BOARD OF STUDIES
NEW SOUTH WALES

2002

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, 21 and 33

Total marks – 100

Section I Pages 2–23

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 25–32

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.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

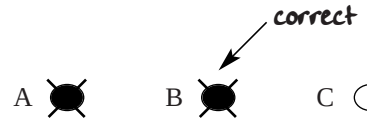
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



A ⊗ B ⊗ C ○ D ○

1 In a variety of garden peas, the allele for tall plants (*T*) is dominant over the allele for short plants (*t*). A cross between a tall plant and a short plant resulted in 50% of the offspring being short.

What were the genotypes of the parents?

(A) *Tt* and *tt*

(B) *Tt* and *Tt*

(C) *TT* and *Tt*

(D) *TT* and *tt*

2 In an endotherm, which of the following homeostatic responses would be produced by a sudden and prolonged decrease in ambient temperature?

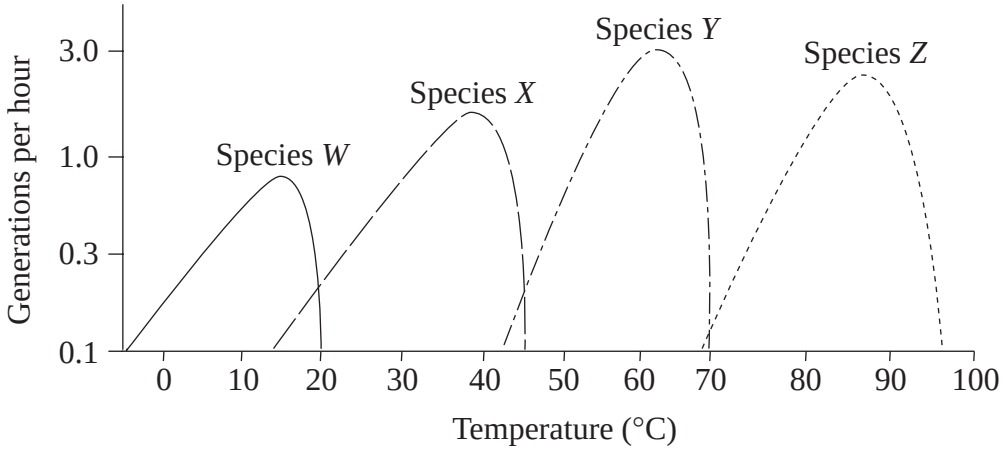
(A) Decreased uptake of oxygen

(B) Decreased muscular activity

(C) Decreased blood flow to the skin surface

(D) Decreased rate of internal metabolic processes

3 The graph shows information about four species of bacteria and their reproductive rates at different temperatures.



What conclusion can be drawn from this graph?

(A) All bacterial species can adapt to a broad range of temperatures.

(B) Individual species can reproduce in a broad range of temperatures.

(C) All bacterial species are limited to a range between 0°C and 100°C.

(D) Individual species reproduce in a relatively narrow range of temperatures.

4 The following paragraph describes a body response.

> The response is protective, and it makes nearby blood vessels leak. Plasma and white cells move into the affected area, diluting and destroying the infectious agent. This is why the infection site swells, reddens and feels hot. Although we tend to think of this response in terms of annoyance, soreness and pain, it is actually a beneficial response.

What response does this paragraph describe?

(A) Inflammation

(B) Cell differentiation

(C) The action of antibodies

(D) The activation of helper T-cells

5 An experiment was conducted to examine the effect of ultraviolet radiation on the development of antibiotic resistance in a strain of bacteria. The table summarises the outcomes of this experiment.

	Antibiotic resistance				
Treatment	*Antibiotic P*	*Antibiotic Q*	*Antibiotic R*	*Antibiotic S*	*Antibiotic T*
No exposure to ultraviolet radiation	✓	✓	✗	✗	✗
Exposure to ultraviolet radiation	✓	✓	✗	✓	✗

✓ = resistant ✗ = not resistant

Which of the following statements best summarises the stages in the development of the new strain of bacteria that was resistant to antibiotic *S*?

(A) Hybridisation → Mutation → Natural Selection

(B) Replication → Mutation → Natural Selection

(C) Mutation → Natural Selection → Replication

(D) Mutation → Hybridisation → Natural Selection

6 Metabolic processes in cells produce waste substances. These wastes are constantly removed from the cells.

Why is waste removal essential for metabolic activity to continue?

(A) Waste products prevent the entry of essential nutrients into the cell.

(B) Metabolism of waste products produces chemicals that kill cells.

(C) Waste products alter the internal chemical environment of the cells and the metabolic processes would stop.

(D) Retention of waste products causes cells to lose water by osmosis and they become dehydrated.

7 A biologist studied the concentration of urine produced by a terrestrial mammal, a freshwater fish and a marine fish.

Which row of observations would be the most likely for these organisms in their natural environment?

	Terrestrial mammal	*Freshwater fish*	*Marine fish*
(A)	Produces dilute urine	Produces concentrated urine	Produces dilute urine
(B)	Produces concentrated urine	Produces dilute urine	Produces dilute urine
(C)	Produces dilute urine	Produces concentrated urine	Produces concentrated urine
(D)	Produces concentrated urine	Produces dilute urine	Produces concentrated urine

8 The table lists the causative agents for four different diseases.

Disease name	*Causative agent*
Influenza	Virus
Creutzfeldt-Jacob disease	Prion
Ringworm	Fungus
Food poisoning	Bacterium

For which of these diseases would treatment with antibiotics be most appropriate?

(A) Influenza

(B) Creutzfeldt-Jacob disease

(C) Ringworm

(D) Food poisoning

9 Which of the following is an example of quarantine used to control the spread of disease across regions of Australia?

(A) Killing weeds in infested forests using herbicides and direct removal

(B) Sterilisation of all food products that come from overseas

(C) Sterilisation of all food products before packaging

(D) Removal of fruit from cars travelling interstate

10 During the last 50 years, over-use of prescription drugs has led to the emergence of resistant strains of pathogens. Why is this a problem?

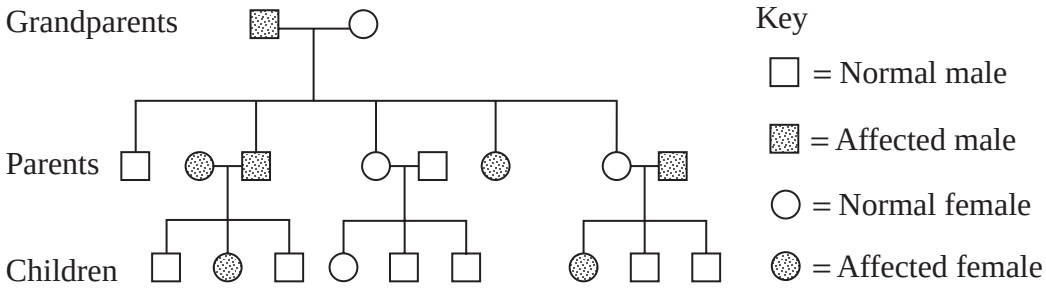
(A) Resistant pathogens will cause new diseases.

(B) Many diseases may become untreatable.

(C) Prescription drugs will cause the release of toxins by pathogens.

(D) A single prescription drug can no longer kill all strains of a pathogen.

11 Polycystic kidney disease is a rare disorder affecting 1 : 1250 live-born infants. The pedigree shows the incidence of this disease in a family.



Which of the following statements best describes the mechanism of inheritance of this disorder?

(A) Sex-linked and dominant

(B) Sex-linked and recessive

(C) Non sex-linked and dominant

(D) Non sex-linked and recessive

12

Accident victim's fingers saved, stored and transplanted onto other hand

Doctors have successfully transplanted the fingers of a man's severed hand in the first operation of its kind in Australia.

The man was critically injured in a train accident. His left arm was severed and right arm crushed.

A team of medical staff operated to replace the crushed fingers of his right hand, using those that were saved from his severed left arm.

The man is expected to have almost normal use of his hand within nine months.

Transplanted organs and tissues are often rejected. Why was there no tissue rejection in the man described in the above paragraph?

(A) The man's skin was damaged so his first line defences were not functional.

(B) Antigens on the man's left hand fingers were the same as those on his right hand.

(C) The man lost so much blood that lymphocytes were not present in sufficient numbers to cause an immune response.

(D) There was no blood supply to the transplanted fingers so mixing of donor and recipient antigens did not occur.

13 Which of the following statements best describes the process of hybridisation frequently used in agriculture?

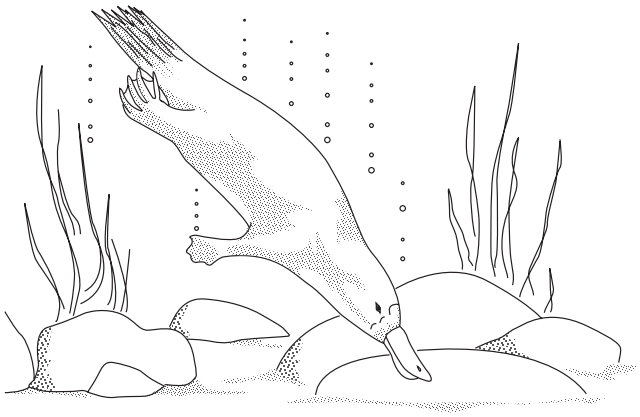
(A) The transfer of a gene from one species to another

(B) The crossing of two genetically different strains of a species

(C) The production of genetically identical offspring by cloning

(D) The artificial selection and breeding of suitable offspring within a species

14



O! Thou prehistoric link,
kin to beaver, rooster, skink,
duck, mole, adder, monkey, fox,
palaeozoic paradox!

HARRY BURRELL,
The Mud-Sucking Platypus
with permission of
Harper Collins Publishers

Which technique would be used to measure the extent of the evolutionary relationship between the platypus and the eight other animals mentioned in the poem above?

(A) Identifying fossils that are transitional between the platypus and the animals listed

(B) Sampling DNA and identifying similarities between the animals listed

(C) Comparing the anatomical features of each animal

(D) Comparing the embryos of each animal

15 The steps involved in DNA replication and protein production are summarised below.

Step *A*:	DNA is copied and each new cell gets a full copy.	DNA replication
Step *B*:	Information is copied from DNA and taken to cytoplasm.	Protein synthesis
Step *C*:	Ribosome reads information and assembles protein.	
Step *D*:	Protein formation is completed.	

In which step would a mutation lead to the formation of a new allele?

(A) Step *A*

(B) Step *B*

(C) Step *C*

(D) Step *D*

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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.

Marks

Question 16 (4 marks)

'Modern methods of disease control place more emphasis on prevention than on treatment.' **4**

Discuss this statement using at least ONE example in your answer.

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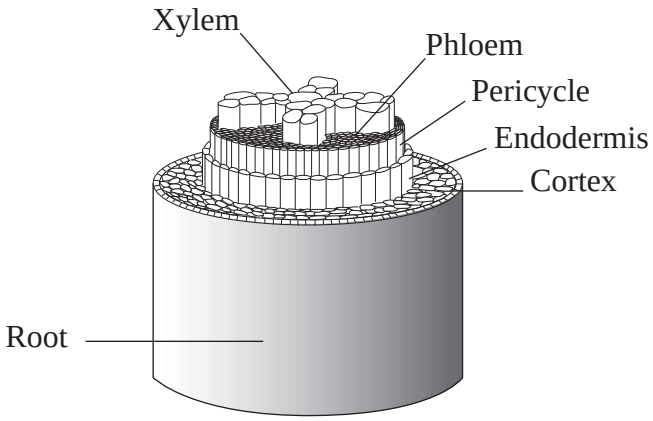
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Marks

Question 17 (6 marks)

The diagram shows the arrangement of tissues in a young plant root.



(a) From this diagram, draw a transverse section of the plant root. Clearly label the location of xylem and phloem tissue. **3**

(b) Describe ONE current theory about the processes responsible for the movement of materials through phloem tissue in plants. **3**

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Marks

Question 18 (4 marks)

Investigators gathered data on a group of 100 smokers for a period of 10 years. During this time 12 people in the group developed lung cancer, two died in traffic accidents, and three died of heart attacks. The investigators used this data to state that smoking caused lung cancer. **4**

Describe how this investigation could be improved.

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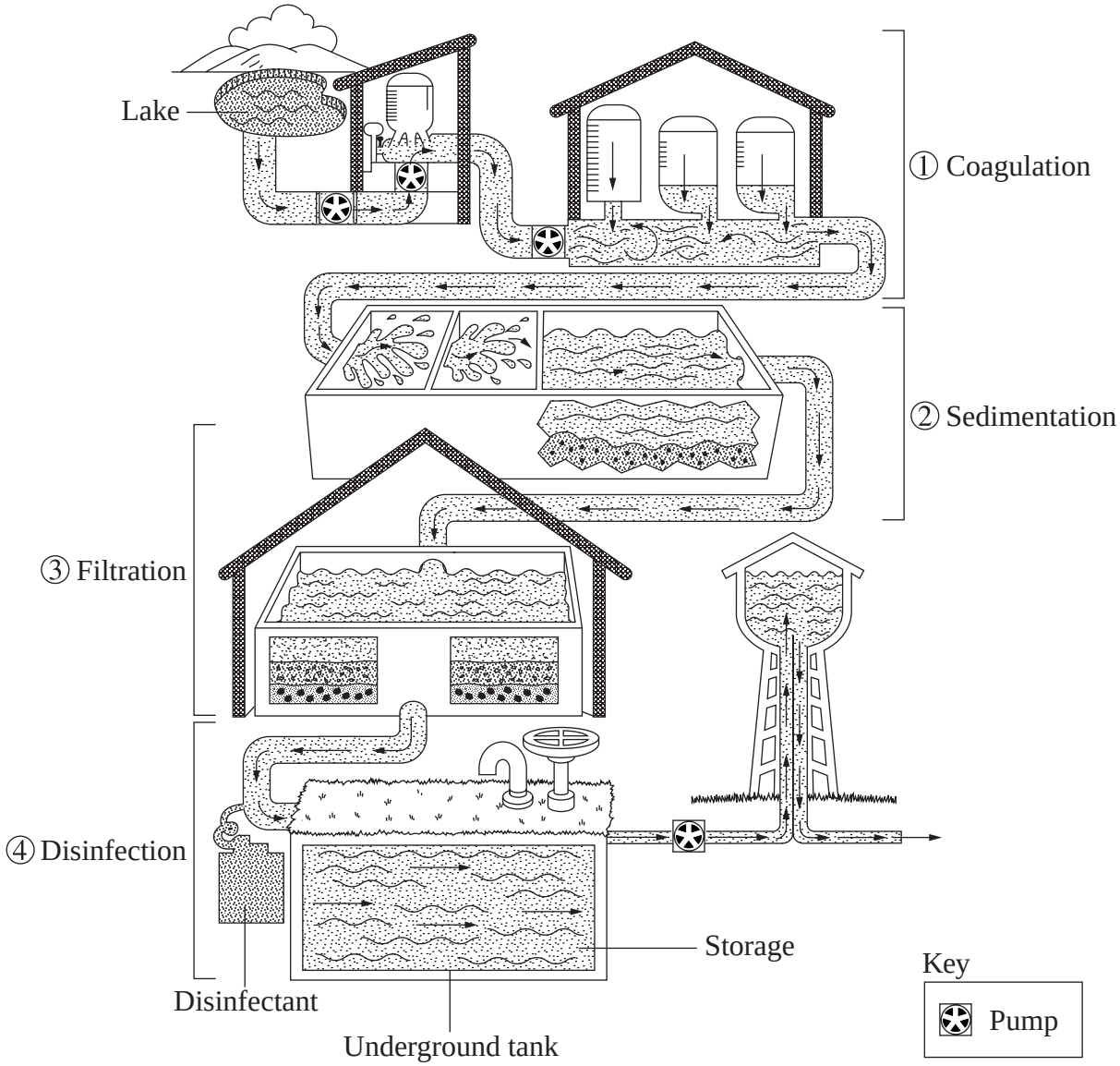
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Question 19 (3 marks)

Please turn over

Question 19 (3 marks)

The diagram summarises one method used to treat water to make it suitable for drinking.



Question 19 continues on page 15

Marks

Question 19 (continued)

The treatment method illustrated on page 14 has four processes which can remove the contaminants that may be found in water extracted from the lake. **3**

Select ONE of the four processes and explain how this process reduces the risk of infection from pathogens.

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Question 20 (4 marks)

Outline how mitosis and cell differentiation assist in the maintenance of health. **4**

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Marks

Question 21 (8 marks)

Describe a first-hand investigation used to estimate the size of red blood cells on a prepared microscope slide. **8**

In your description include:

- a list of equipment used;
- a safety precaution needed;
- the step-by-step method used;
- a scaled diagram of a red blood cell.

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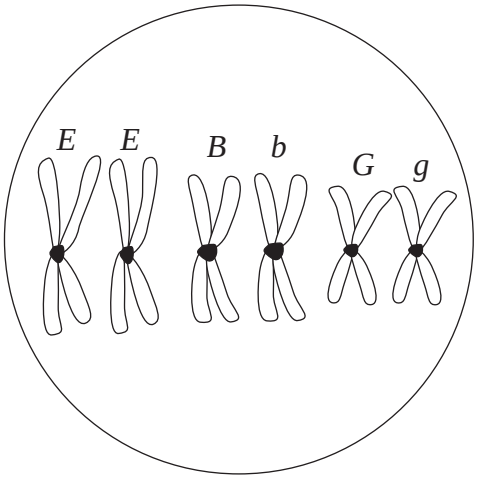
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Marks

Question 22 (4 marks)

The diagram shows a cell containing three pairs of chromosomes just prior to a *meiotic* division. **4**



Assuming that random segregation occurs, construct a table that lists the possible genotypes that could be produced and states the expected frequency for each genotype.

Marks

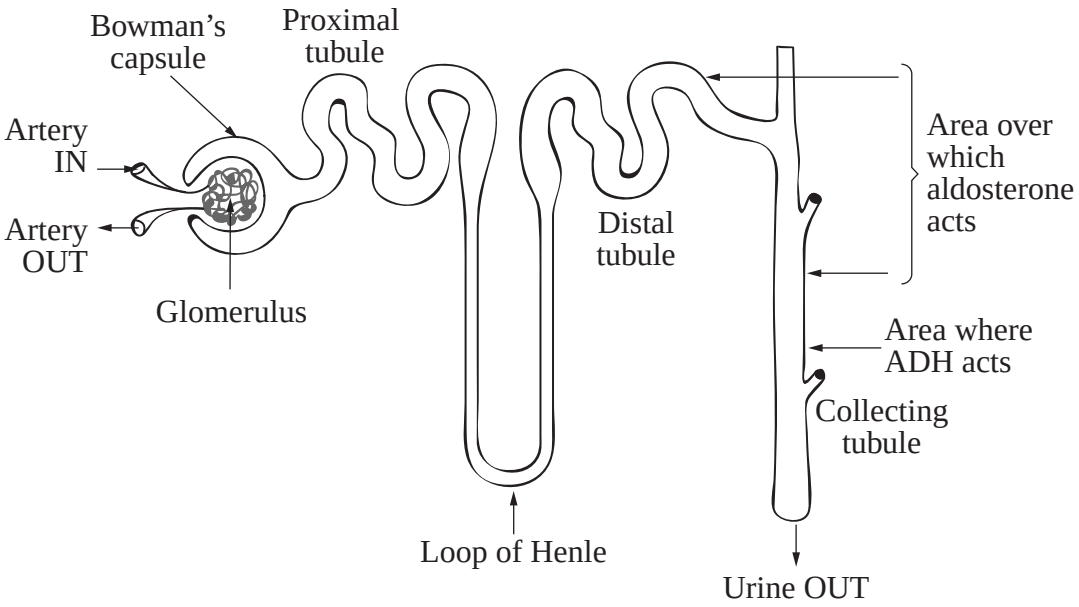
Question 23 (6 marks)

The diagram represents a nephron which is the functional unit of the kidney.

Nephrons make urine by:

- filtering small molecules and ions from the blood;
- reabsorbing the needed amounts of useful materials.

Surplus or waste molecules and ions flow out as urine.



(a) Identify the area where filtration occurs, by marking it with an *X* on the diagram. **1**

(b) Identify the area where reabsorption occurs, by shading it on the diagram. **1**

(c) Discuss the importance of hormone replacement therapy for people who cannot secrete aldosterone. **4**

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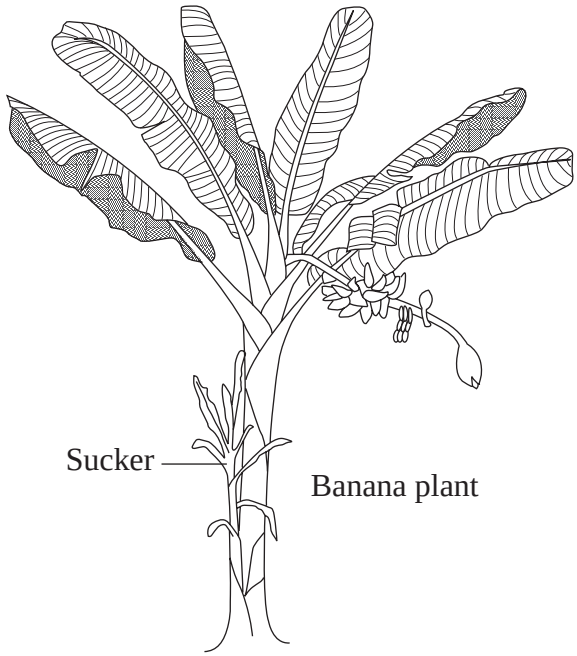
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Marks

Question 24 (4 marks)

Traditionally, banana plants in Australia have been propagated asexually by cutting out and planting suckers from the adult plant. **4**



There is a growing trend to produce disease-free plants in laboratories through a process of cloning from disease-free tissues from existing plants.

Assess the potential impact of this cloning process on the genetic diversity of banana plants in Australia.

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Section I – Part B (continued)

Marks

Question 25 (4 marks)

(a) Define the concept of *punctuated equilibrium* in evolution. **1**

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(b) How does punctuated equilibrium differ from the process proposed by Darwin? **3**

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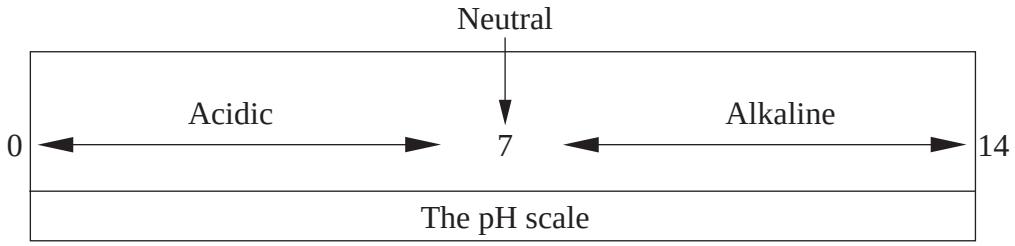
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Marks

Question 26 (5 marks)

The following is an extract from a gardening website. **5**



> Hydrangeas are amazingly versatile in that you can alter the flower colour by changing the pH of the soil. In acid soils, hydrangeas produce blue flowers. In alkaline soils, hydrangeas produce mauve, pink and red flowers.

Describe a first-hand investigation that could be used to verify the effects of pH on the colour of hydrangea flowers.

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Marks

Question 27 (8 marks)

Evaluate the contributions made by both Louis Pasteur and Robert Koch to our present understanding of the causes and possible prevention of infectious diseases. **8**

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

Marks

Question 28 — Communication (25 marks)

(a) (i) Outline the function of the organ of Corti in hearing. **1**

(ii) State the relationship between wavelength, frequency and pitch of a sound. **2**

(iii) Compare TWO structures used by animals to produce sound. **2**

(b) (i) During a first-hand investigation, a student acquired three photographs of cross-sections of the human brain. The student then lost the labels and mixed up the photographs. **3**

What structural features of the cerebrum, cerebellum and medulla oblongata could the student use to identify each photograph correctly?

(ii) Draw a sketch of the brain and clearly label those regions involved in speech. **3**

(c) The data in the table gives the focal length of six lenses which have the same diameter but different thickness.

Thickness of lens (mm)	*Focal length* (cm)
10	12.5
9	14.0
8	15.5
7	18.0
6	21.0
5	25.0

(i) Graph the data on the graph paper provided on page 33. **4**

(ii) State the relationship between lens thickness and focal length. **1**

(iii) Refer to the information above in explaining how human eyes can focus on objects at different distances. **2**

(d) The light signal reaching the retina is transformed into electrochemical signals. **7**

Describe the different structures and processes in the retina that can achieve the energy transformation described above.

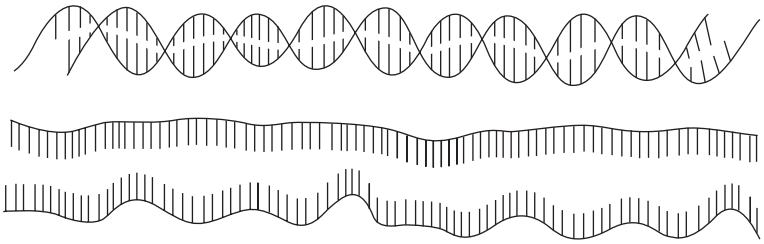
Marks

Question 29 — Biotechnology (25 marks)

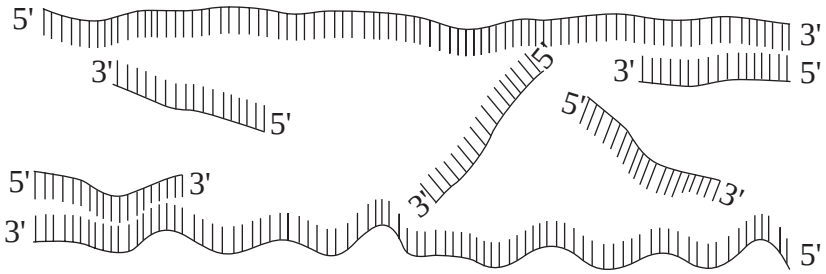
(a) (i) State ONE difference between RNA and DNA. **1**

(ii) The diagram illustrates three steps involved in the Polymerase Chain Reaction (PCR).

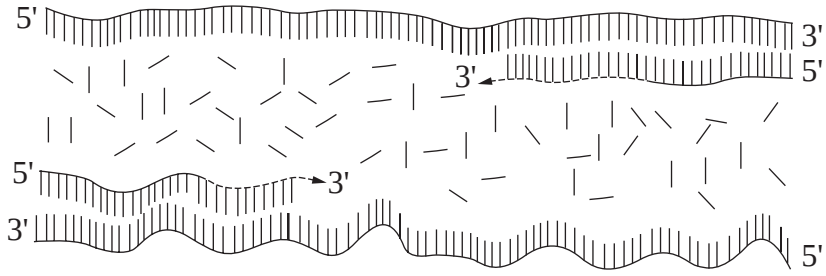
Step 1



Step 2



Step 3



(1) Give ONE use of PCR. **1**

(2) State what is happening in each of the steps shown in the diagram above. **3**

(b) (i) Describe a first-hand investigation that you have carried out to test ONE condition that influences the rate of activity of enzymes. **4**

(ii) What variables need to be controlled in this investigation? **2**

Question 29 continues on page 28

Marks

Question 29 (continued)

(c) The data in the table compares the rate of fermentation for two different strains of yeast. This rate is measured as a decrease in specific gravity of the mixture, where a lower specific gravity indicates a higher alcohol content.

Time (hours)	*Specific gravity*	
	Yeast *A*	Yeast *B*
0	11	11
50	10	8
100	8	4
150	6	3
200	5	2
250	5	2

(i) Graph the data on the graph paper provided on page 33. **4**

(ii) Compare the alcohol production of the two different yeasts. **1**

(iii) Describe a process that could have been used to produce yeast strain *B*. **2**

(d) There are many applications and areas of research in biotechnology. **7**

Select ONE application of biotechnology. Describe both the process used and the outcome(s) of this process.

End of Question 29

Marks

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

(a) (i) State ONE difference between a haploid cell and a diploid cell from the same species. **1**

(ii) Define the term *linkage* with reference to genes. **1**

(iii) Explain how linkage can be used to map chromosomes. **3**

(b) During your study of this option, you were required to construct a model of DNA.

(i) Describe the model you constructed. **3**

(ii) Justify the design of your model. **3**

(c) The data in the table shows the results of measuring the heights of 1000 adult humans.

Height group (m)	*Number of individuals in group*
1.60–1.64	58
1.65–1.69	92
1.70–1.74	178
1.75–1.79	322
1.80–1.84	190
1.85–1.89	110
1.90–1.94	50
1.95–1.99	0

(i) Graph the data on the graph paper provided on page 33. **4**

(ii) Define what is meant by *polygenic inheritance*. **1**

(iii) How does the pattern of polygenic inheritance of height in humans compare with the pattern of inheritance discovered by Gregor Mendel in his research on pea plants? **2**

(d) Selective breeding is different to gene cloning but both processes may change the genetic nature of species. **7**

Using appropriate examples, explain the above statement.

Marks

Question 31 — The Human Story (25 marks)

(a) (i) Name ONE significant hominid fossil. **1**

(ii) Describe TWO structural features of this fossil that would identify it as a primate. **2**

(iii) Use ONE of the features you described in part (ii), to compare humans with apes. **2**

(b) Theories of hominid evolution have been developed by anthropologists such as the Leakey family, Johanson, Broom, Tobias, Dart and Goodall.

(i) Describe ONE major discovery made by ONE of the above scientists that has added to our knowledge of hominid evolution. **3**

(ii) Explain how this discovery increased understanding of hominid evolution. **3**

(c) The data shows the radioactive decay of carbon 14 (C^{14}) over time.

Time (years)	*Fraction of original radioactivity* (%)
0	100
5 000	54
10 000	29
15 000	16
20 000	8
25 000	5
30 000	2
35 000	1

(i) Graph the data on the graph paper provided on page 33. **4**

(ii) A fossil sample was found to contain 40% of its original radioactivity. Estimate the age of the fossil. **1**

(iii) Explain why measurement of carbon 14 (C^{14}) content in a hominid fossil may not be a useful radiometric dating technique. **2**

(d) Cultural development has been a significant feature of human evolution. **7**

Discuss the complex cultural development of humans in comparison with other primates.

Marks

Question 32 — Biochemistry (25 marks)

(a) (i) Define what is meant by the *half-life of an isotope*. **1**

(ii) Describe ONE use of radioisotopes in biochemistry. **1**

(iii) Outline the evidence provided by Hill and Scarisbruck, and Ruben that increased understanding of photosynthesis. **3**

(b) In the seventeenth and eighteenth centuries, progress towards understanding plant growth was assisted by the experiments of:

- Van Helmont
- Hales
- Ingen-Housz
- Senebier
- Saussure.

(i) Describe an investigation that could test the observation(s) of ONE of the above scientists. **4**

(ii) What variables would need to be controlled in this investigation? **2**

Question 32 continues on page 32

Question 32 (continued)

(c) The data in the table shows the results of an experiment which examined the rate of photosynthesis (as a percentage of the maximum rate) for a group of plants exposed to light of different wavelengths.

Wavelength (nm)	*Rate of photosynthesis* (% of maximum)
400	23
450	98
500	70
550	46
600	60
650	96
700	67
750	0

(i) Graph the data on the graph paper provided on page 33. **4**

(ii) Using the above information, predict what rate of photosynthesis would occur if these plants were exposed to light of 575 nm wavelength for a prolonged period of time. **1**

(iii) Explain why the action spectrum of photosynthesis does not match that of chlorophyll. **2**

(d) Explain the role of photosynthesis research in confirming the relationship between ATP production and photosynthesis. **7**

End of paper

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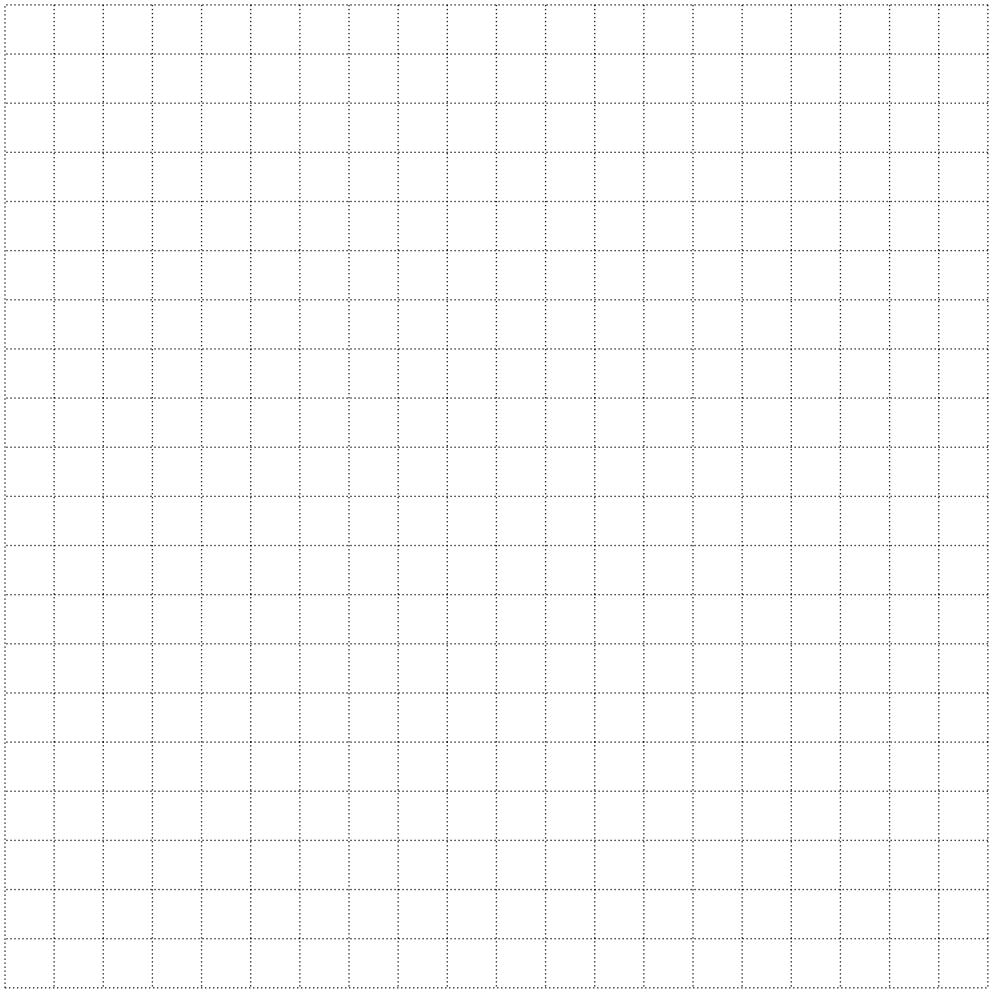
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Biology

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This page is to be detached, completed and attached to the inside front cover of your writing booklet for the option question you have attempted.



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