

B O A R D O F S T U D I E S
NEW SOUTH WALES

2005

**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 23–33

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.

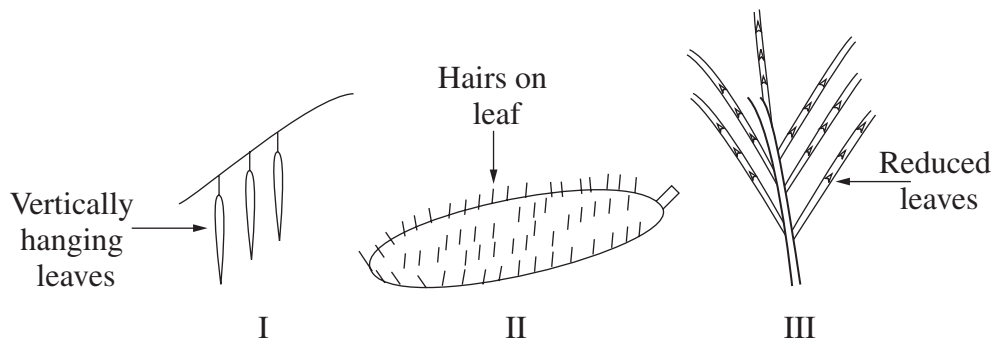
A B C D

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
correct →

- 1 What is a function of haemoglobin?
- (A) Fights disease
 - (B) Transports oxygen
 - (C) Gives blood its colour
 - (D) Carries salts in the blood
- 2 Which TWO scientists were able to crystallise DNA to develop the first model of DNA?
- (A) Beadle and Tatum
 - (B) Darwin and Wallace
 - (C) Franklin and Wilkins
 - (D) Koch and Pasteur
- 3 Lung cancer is one of the diseases linked to smoking.
To what category of disease does lung cancer belong?
- (A) Environmental
 - (B) Infectious
 - (C) Nutritional
 - (D) Viral
- 4 Gregor Mendel described the physical traits in pea plants as being controlled by two 'factors'.
What term is now used to describe the factors Mendel identified?
- (A) Chromosomes
 - (B) Genes
 - (C) Hybrids
 - (D) Polypeptides
- 5 How is the pathogen for malaria transmitted?
- (A) *Anopheles* mosquito
 - (B) Direct human contact
 - (C) Particles in air
 - (D) *Plasmodium falciparum*

- 6 Which of the following best describes the main focus of epidemiology?
- (A) Diseases related to the skin
 (B) Changes in the characteristics of a species
 (C) Factors involved in the occurrence, prevalence and spread of disease
 (D) How the body maintains its functions in response to variations in the environment
- 7 The features of leaves shown in the diagram are adaptations found in some Australian plants.



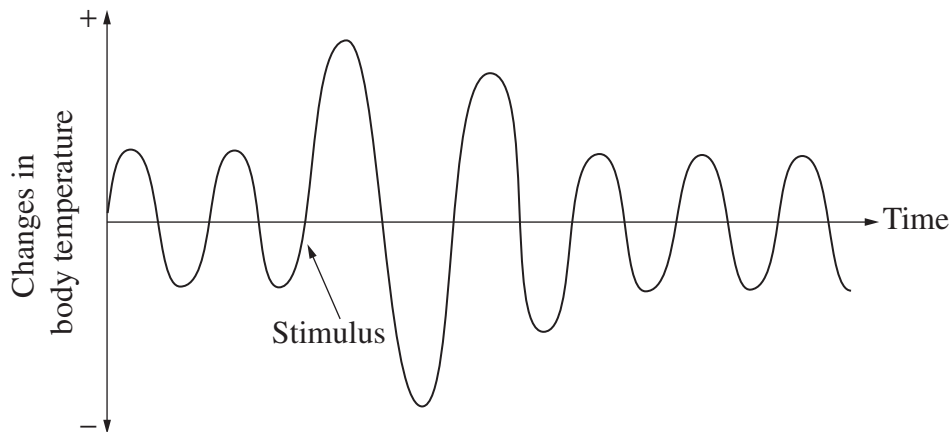
What is the function of these adaptations?

- (A) Assist in plant growth
 (B) Allow the transport of water
 (C) Assist in reducing water loss
 (D) Reduce the impact of predators
- 8 Recycling of sewage so that it can be used as drinking water is one possible solution to the current water shortages in Australia.

Which of the following would health authorities be concerned about?

- (A) The change to the taste of the water
 (B) The risk of infection from pathogens would increase
 (C) The reluctance of the general public to drink treated sewage
 (D) The effect that water with sediments could have on plumbing systems

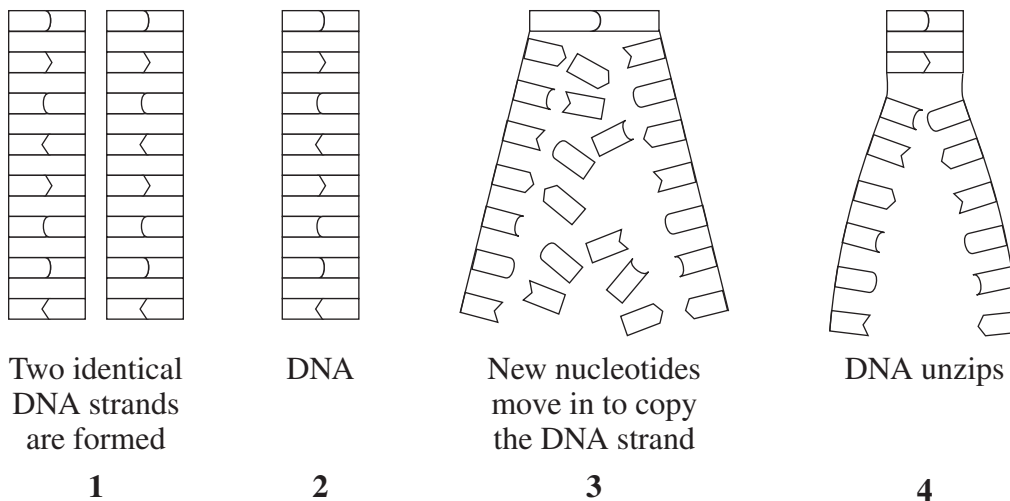
- 9 The graph models the effect of an environmental stimulus on temperature control in mammals.



Reproduced by permission of Oxford University Press Australia from Biology: The Spectrum of Life, 2nd edition, by Peter aubusson et al (c) Oxford University Press, www.oup.com.au

What does this graph represent?

- (A) A reflex action
 - (B) An immune response
 - (C) An impulse pathway
 - (D) A feedback mechanism
- 10 The diagram represents a model of DNA replication. The steps are NOT in the correct order.

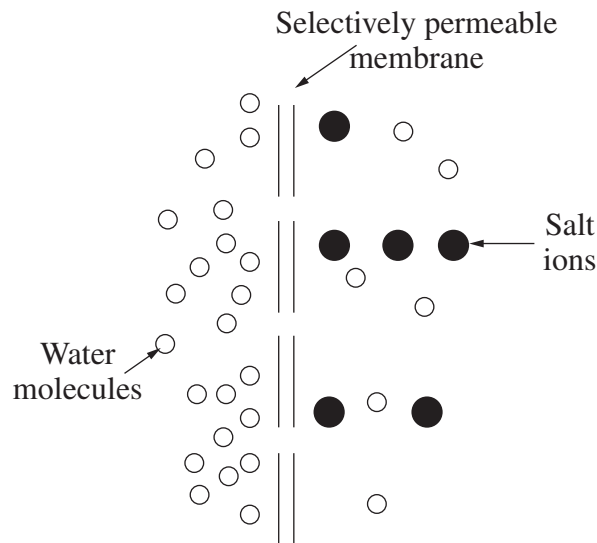


Reproduced by permission of Oxford University Press Australia from Biology: The Spectrum of Life, 2nd edition, by Peter aubusson et al (c) Oxford University Press, www.oup.com.au

Which of the following is the correct order?

- (A) 1, 2, 3, 4
- (B) 2, 3, 4, 1
- (C) 2, 4, 3, 1
- (D) 4, 3, 2, 1

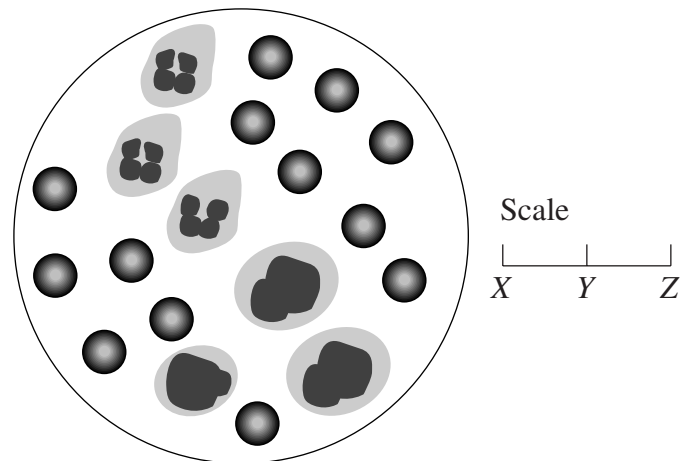
- 11 How do vaccines prevent disease?
- (A) Vaccines stop antigens triggering an immune response.
 - (B) Vaccines stimulate the production of specific antibodies.
 - (C) Vaccines will inhibit the inflammation response in the body.
 - (D) Vaccines restrict the vector's ability to inhabit a variety of environments.
- 12 The diagram is a model of an important biological process.



What prediction can be made using the model?

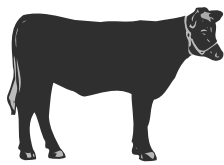
- (A) Salt ions move by osmosis into an area of low solute concentration from an area of high solute concentration.
- (B) Salt ions move by diffusion from an area of high solute concentration to an area of low solute concentration.
- (C) Water molecules move by diffusion from an area of high solute concentration to an area of low solute concentration.
- (D) Water molecules move by osmosis from an area of low solute concentration to an area of high solute concentration.

- 13 The diagram represents red and white blood cells seen under a light microscope.



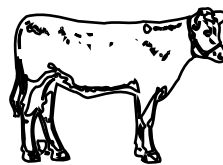
What do X, Y and Z represent on the scale?

- (A) 0, 10, 20 nm
 (B) 0, 10, 20 μm
 (C) 0, 50, 100 μm
 (D) 0, 50, 100 mm
- 14 A geneticist was studying coat colour in a herd of Shorthorn cattle. She performed the following cross:



Red coat

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White coat

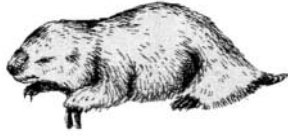
The results of the cross are shown in the table below.

<i>Phenotype</i>	<i>Offspring number</i>
White coat	0
Red coat	0
Red and white coat (roan)	157
Total	157

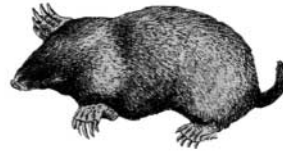
The roan coat colour was the result of which type of inheritance?

- (A) Co-dominance
 (B) Dominant/recessive
 (C) Heterozygous parents
 (D) Hybridisation

- 15 The two animals pictured are not closely related. They burrow and live most of their life underground.



Australian marsupial mole
(*Notorcytes caurinus*)



European placental mole
(*Talpa europaea*)

Which of the following explains how these two animals can be used to illustrate Darwin/Wallace's theory of evolution by natural selection and isolation?

- (A) They demonstrate comparative anatomy.
- (B) They must have evolved from a common ancestor.
- (C) They demonstrate that an organism can change its characteristics to suit its current environment.
- (D) They have evolved similar structures in response to similar environmental conditions.

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Centre Number

Section I (continued)

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Student Number

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) **Marks**

(a) Define the term *pathogen*. **1**

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(b) Complete the table below to distinguish between bacteria and viruses. **2**

	<i>Characteristic/feature of organism</i>
Bacteria	
Virus	

Question 17 (3 marks)

Use an example to outline the role of the nervous system in maintaining homeostasis.

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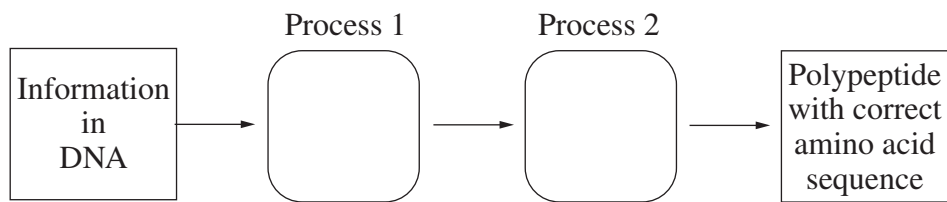
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Question 18 (4 marks)

This flow chart represents a model of polypeptide production.

4



In the table below, name and outline what occurs in Processes 1 and 2.

<i>Name of process (word or phrase)</i>	<i>Outline of process</i>
Process 1
Process 2

Question 19 (4 marks)

During your study of Biology you have been required to gather and analyse information on an infectious disease.

4

Fill in the table below for ONE infectious disease.

Name of the disease

<i>Feature</i>	<i>Description</i>
Cause
Symptoms
Treatment
Prevention

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Centre Number

Section I — Part B (continued)

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Student Number

Marks

Question 20 (3 marks)

This table shows the results of the analysis of urine samples of three organisms.

3

<i>Organism</i>	<i>Terrestrial mammal</i>	<i>Freshwater fish</i>	<i>Marine fish</i>
<i>Urine concentration</i>	concentrated	dilute	concentrated
<i>Form of nitrogen waste</i>	urea	ammonia	urea

Using information from the table, explain the differences in urine concentration of these three organisms.

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Question 21 (8 marks)

Carbon dioxide is one of the substances carried in mammalian blood.

- (a) Why is it necessary for excess carbon dioxide to be removed from blood? **1**

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- (b) In what forms is carbon dioxide transported in blood? **2**

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- (c) You performed a first-hand investigation to demonstrate the effect of dissolved carbon dioxide on the pH of water. **5**

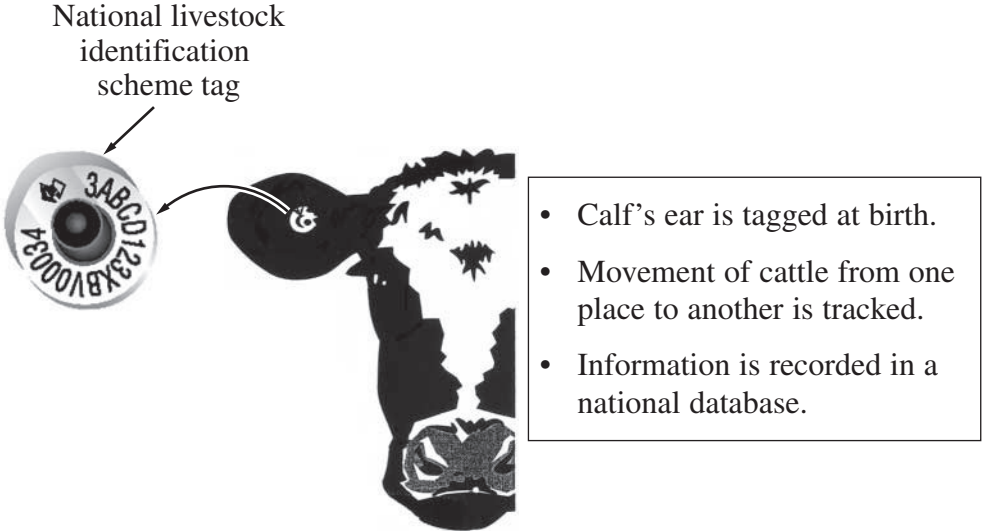
Outline your method, identifying the variables AND account for how you ensured the reliability of your data.

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Question 22 (4 marks)

Lifetime traceable tags as shown in the diagram are now required on all cattle in Australia.

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Department of Primary Industries, Victoria, 'National Livestock Identification Scheme (NLIS)' on <http://wwdpi.vic.gov.au/dpi>

Discuss the use of this strategy in dealing with diseases.

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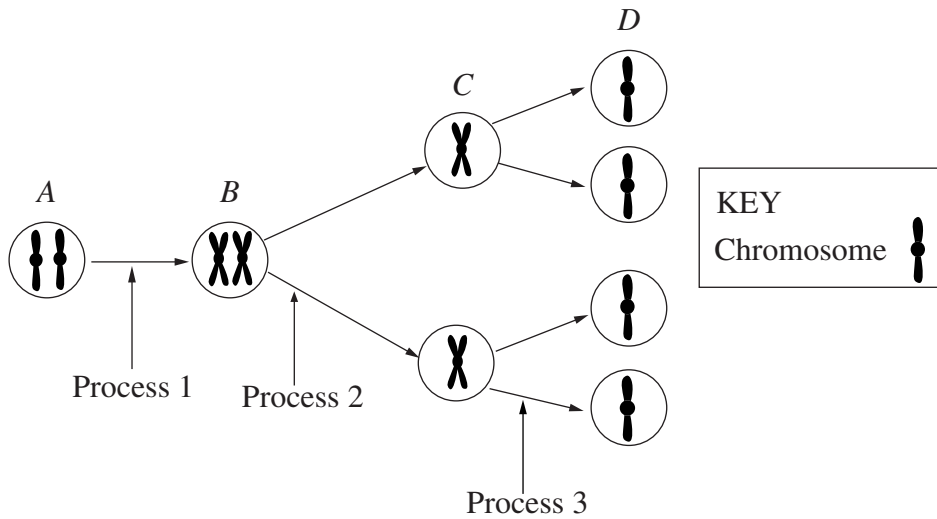
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Question 23 (5 marks)

The flow diagram below is a representation of one pair of homologous chromosomes in a cell during meiosis.



(a) Identify ONE characteristic of the cells labelled D. 1

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(b) Identify what occurs in Process 1. 1

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(c) Identify where crossing over would occur, and explain how crossing over affects the inheritance of genes. 3

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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 24 (6 marks)

Nick’s wife Maria has a history of red-green colour blindness in her family. Jack, their two-year old son, may be red-green colour blind. Maria’s brothers, Vincent and Paul, are colour blind but her brother, James, is not. Maria’s mother Anne, is a carrier of red-green colour blindness. Her father, John, is unaffected.

- (a) Construct a family pedigree to show the inheritance of this sex-linked genetic disorder. **4**

- (b) Predict whether Jack will be colour blind. Justify your answer. **2**

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Question 25 (8 marks)

Use the information provided to answer the following questions.

The Locust Plague

The Australian plague locust is a damaging, recurring, insect pest of pastures and crops throughout south-eastern Australia. The greatest activity is when locusts feed and move, usually from spring to autumn. Locust occurrence depends entirely on weather and feed conditions. Locusts reproduce rapidly, migrate hundreds of kilometres overnight and destroy large areas of pastures and crops.

Adapted from David Croft, 'Plague Locusts and Spring', IREC Farmers' Newsletter, No. 167, Winter 2004, p18.

- (a) Identify ONE appropriate method to estimate how widespread a locust infestation might be. **1**

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- (b) State ONE other valid piece of information that could be collected about locusts, and identify how this information is useful in developing a method for controlling the pest. **2**

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Question 25 continues on page 19

Question 25 (continued)

Media release about fighting locust plagues

Pesticide to fight locust plague

Spraying pesticide is effective in killing the locusts before they hatch. Costs are low and the procedures for spraying are well developed. Spraying close to harvest times is illegal and strict rules also prevent spraying near houses, roads and watercourses, as well as in national parks and endangered species' habitats.

Fungus to fight locust plague

A biological control, based on a naturally occurring Australian fungus, has been developed by the CSIRO. It is effective against locusts and grasshopper pests. The fungal spores have no environmental effects on aquatic organisms and are suitable for use in organic-beef-growing areas. Costs are low. The fungus is an Australian native species.

Adapted from Steve Letts, 'Australia's largest locust plague', 12 November 2005, Landline, ABC Online, by permission of ABC Content Sales.

- (c) Assess the impacts of these alternative strategies of locust control on society and the environment.

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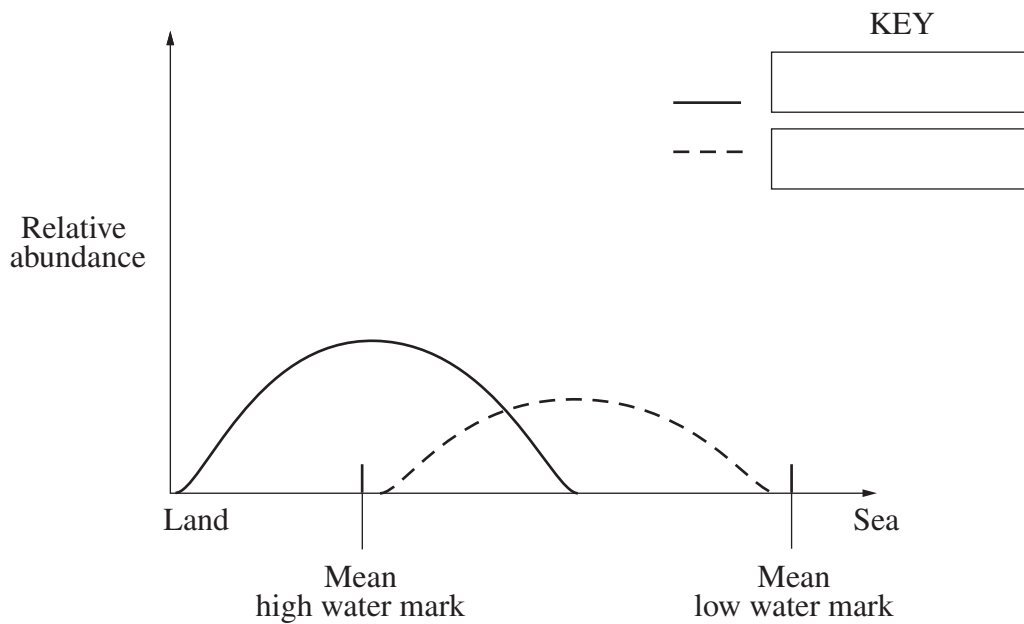
Question 26 (4 marks)

The graph illustrates the relative distribution of two species of mangrove growing on the margin of an estuary.

4

The main characteristics of the leaves of these mangrove plants are:

<i>Mangrove</i>	<i>Characteristics</i>
Species A	Leaves covered with salt crystals
Species B	Leaves with thick waxy cuticles



Complete the KEY in the boxes provided above, to identify which line represents Species A and which line represents Species B. Justify your answer.

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Centre Number

Section I — Part B (continued)

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Student Number

Marks

Question 27 (8 marks)

The influenza virus has a high rate of mutation which can lead to changes of the viral surface antigens that contain protein.

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Analyse the impact of high mutation rates for this virus and the implications for human health.

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Question 27 continues on page 22

Biology

Section II

25 marks

Attempt ONE question from Questions 28–32

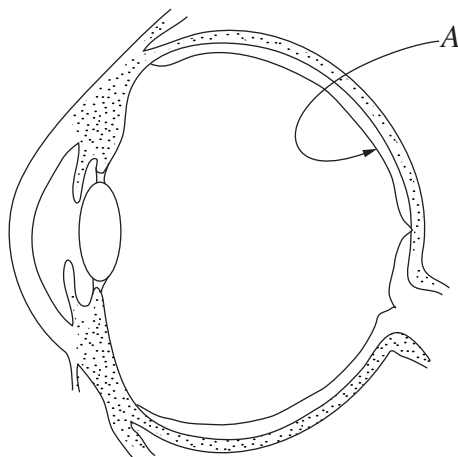
Allow about 45 minutes for this section

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

	Pages
Question 28 Communication	24–25
Question 29 Biotechnology	26
Question 30 Genetics: The Code Broken?	27–29
Question 31 The Human Story	30–31
Question 32 Biochemistry	32–33

Question 28 — Communication (25 marks)

(a) The diagram provided is of the human eye.



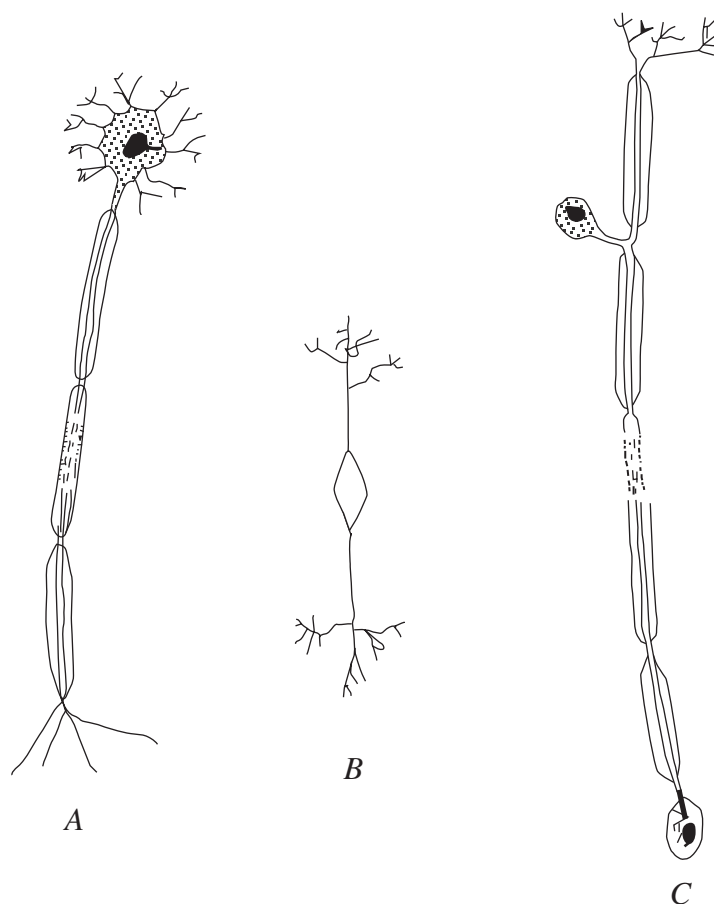
- (i) Identify the part of the organ labelled A. 1
 - (ii) Using TWO labelled diagrams, show how the eye accommodates the focus of near and far objects. 3
- (b) Two of your elderly relations have developed loss of sight. One case is due to cataracts and the other is due to myopia.
- (i) Describe each of these conditions. 2
 - (ii) Compare the technologies available to correct these conditions. 4
- (c) Hearing aids and cochlear implants are technological advances that have been developed to assist people with hearing difficulties. 7

Evaluate the benefits and limitations of BOTH technologies.

Question 28 continues on page 25

Question 28 (continued)

(d) The diagram provides a pictorial representation of the structure of neurones.



- (i) From the diagram, identify TWO differences between neurones. 2
- (ii) Assess the use of prepared slides or micrographs when gathering information about the structure of neurones. 3
- (iii) Explain why NOT all stimuli generate an action potential. 3

End of Question 28

Question 29 — Biotechnology (25 marks)

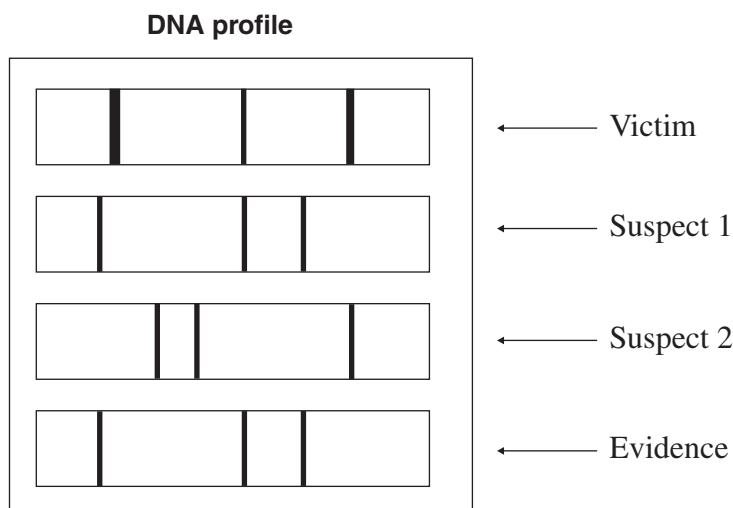
(a) The equation for fermentation in the production of alcohol is



- (i) What is the name of the product *A* in the above word equation? 1
 - (ii) Name and describe a modern industrial fermentation process that produces large quantities of consistent product. 3
- (b)
- (i) Define the term *recombinant DNA technology*, and give an example. 2
 - (ii) Compare recombinant DNA technology and artificial selection. 4
- (c) Research into biotechnology including medicine, animal biotechnology, and aquaculture, has led to the development of a variety of applications. 7

Evaluate the limitations and expected benefits of particular applications that you presented in TWO of your case studies.

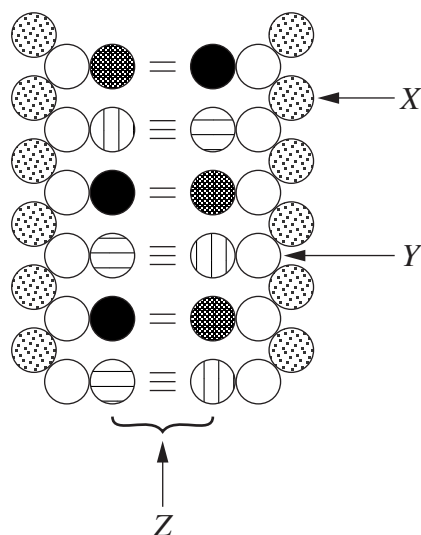
(d) The diagram represents the DNA profiles from a murder case.



- (i) Justify which one of the suspects could have been the murderer. 2
- (ii) Explain why a sample would be taken from the victim as well as the suspects. 3
- (iii) Outline the use of DNA fingerprinting as an investigation tool in forensic cases. 3

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

- (a) During your study of this option you constructed a model of DNA. The diagram represents a model made by a student.

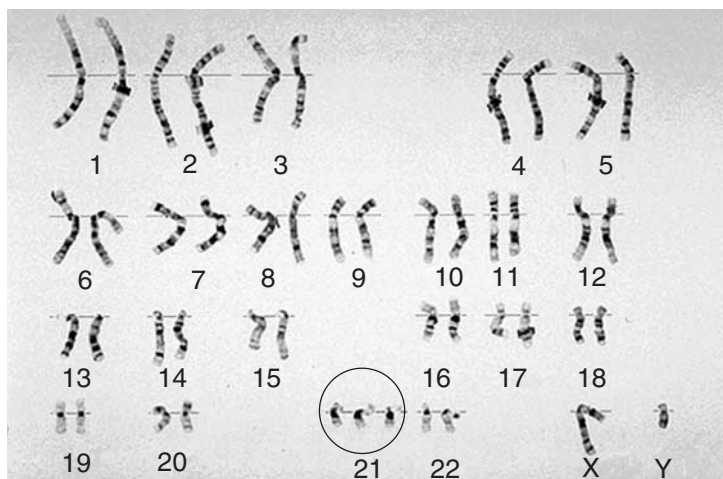


- (i) In this model, name TWO of the parts labelled X, Y and Z. 2
- (ii) Is this a useful model of a DNA molecule? Support your choice with TWO reasons. 2

Question 30 continues on page 28

Question 30 (continued)

- (b) The diagram shows the arrangement of human chromosomes. A chromosomal abnormality is circled.



- (i) Determine how many chromosomes this person has, and name the type of chromosomal disorder. 2
- (ii) Compare the effect of germ line and somatic mutations on a species. 4
- (c) The Human Genome Project has identified the DNA-base sequence of all human chromosomes. A significant amount of work still needs to be done so that this information can be used to benefit humans. 7

Using examples, evaluate the limitations and expected benefits of the Human Genome Project.

Question 30 continues on page 29

Question 30 (continued)

- (d) Indian corn has four grain types that involve combinations of colour (*b*) and appearance (*r*).

Four genes are involved, which are located on two pairs of homologous chromosomes (each gene on a separate chromosome). The alleles are:

B = black **b** = yellow **R** = round **r** = wrinkled

- (i) The table below shows the results of a dihybrid cross between two heterozygous parents, (**BbRr** × **BbRr**).

<i>Grain phenotype</i>	Observed number of offspring
Black and round	144
Black and wrinkled	48
Yellow and round	48
Yellow and wrinkled	16
Total	256

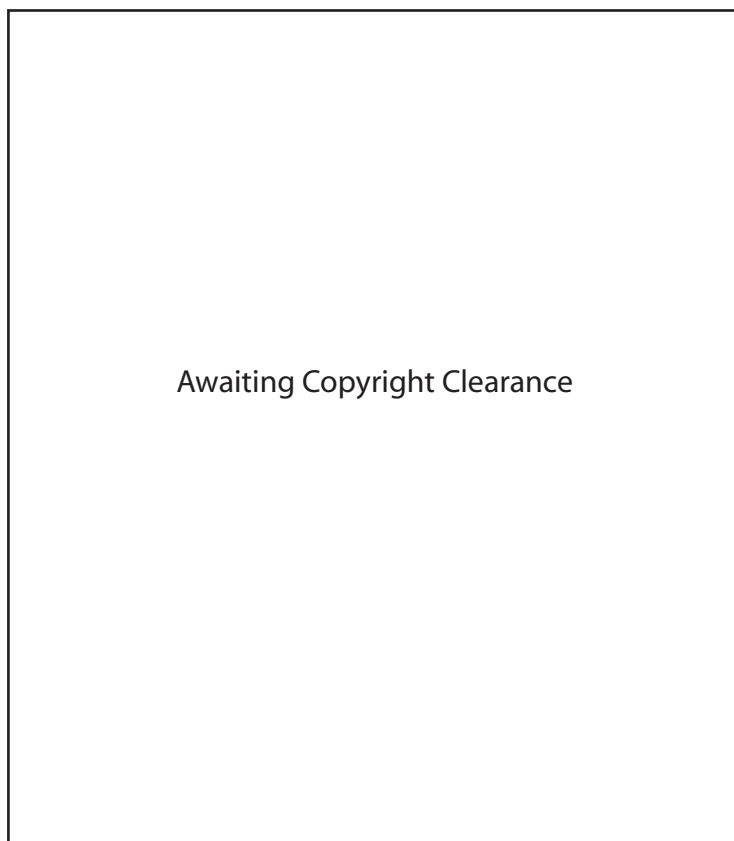
Using this data, calculate the ratio of phenotypes in this cross. **1**

- (ii) If, however, **B** and **r** are on one chromosome and **b** and **R** are on another, draw a Punnett square of a dihybrid cross (**BbRr** × **BbRr**). Include the phenotypic and genotypic ratios of the offspring. **3**
- (iii) Explain how cross-breeding experiments can identify the relative positions of linked genes. **4**

End of Question 30

Question 31 — The Human Story (25 marks)

- (a) A student was investigating evolutionary relationships between humans and other primates. The diagram models the data collected.

Chromosome 5 in apes and humans

- (i) What is this type of analysis called? **1**
- (ii) Identify **THREE** ways in which this model is useful in showing evolutionary relationships. **3**
- (b) (i) Outline **ONE** feature for any **TWO** of the following groups into which humans are classified. **2**
- primate
 - hominid
 - *Homo sapiens*
- (ii) Discuss the difficulty of interpreting the past using only fossil records. **4**

Question 31 continues on page 31

Question 31 (continued)

- (c) Analyse future trends in biological evolution in terms of increased population mobility, modern medicine and genetic engineering. 7
- (d) In 2004 a team of Australian and Indonesian researchers outlined the discovery of the remains of dwarf-sized people who lived on the island of Flores in Central Indonesia. They belong to a species new to science and have been named *Homo floresiensis*. Dating techniques suggest that the remains are up to 95 000 years old.

Homo floresiensis were island people, no more than one-metre tall, with brains the size of newborn modern humans. However, they exhibited behavioural sophistication and intelligence. Their discovery suggests that instead of following a simple evolutionary path, culminating in *Homo sapiens*, (Figure 1) human evolution developed more varied forms than previously thought (Figure 2).

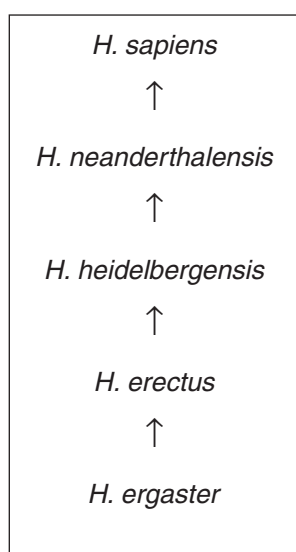


Figure 1

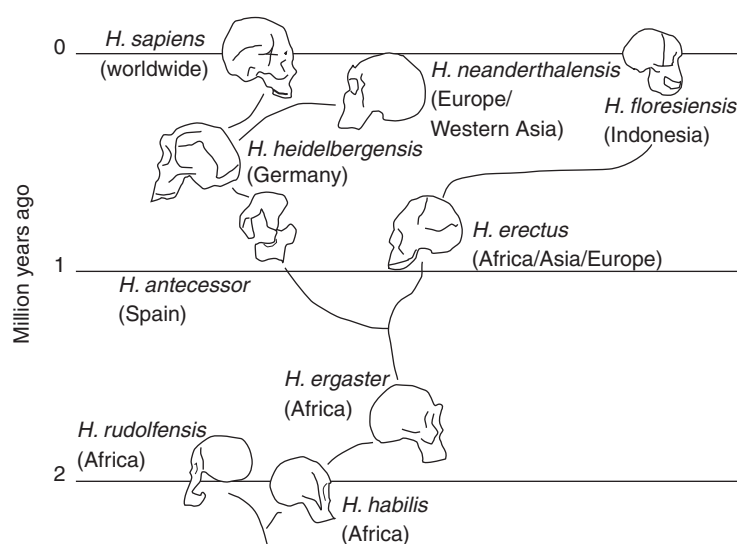


Figure 2

© NewScientist

- (i) Distinguish between relative and absolute dating technique, and outline an absolute dating technique that could be used to date the fossils of *Homo floresiensis*. 3
- (ii) Outline a mechanism that led to the development of *Homo floresiensis* as a distinct species. 2
- (iii) Name the TWO models of human evolution shown in Figure 1 and Figure 2 and compare the evidence that supports them. 3

End of Question 31

Question 32 — Biochemistry (25 marks)

- (a) In the late 1770s the Dutch scientist Jan Ingen-Housz performed a series of experiments shown in the diagrams.



- (i) Name ONE pigment that can be extracted from leaves. **1**
- (ii) Identify THREE pieces of information that can be obtained from these experiments. **3**
- (b) Two species of plants, X and Y, have been selected for studies on photosynthesis. The plants are two months old, 30 cm tall and 900 g in weight. It is found that their oxygen production varies as shown in the table below.

<i>Time</i> (hour)	<i>Volume of oxygen</i> <i>produced by species X</i> (mL)	<i>Volume of oxygen</i> <i>produced by species Y</i> (mL)
1	2	5
2	4	10
3	6	15
4	8	20
5	10	25

- (i) Based on the information provided, identify TWO microscopic structural differences between plants X and Y. Support your answer using examples. **3**
- (ii) You processed information from secondary sources about light absorption and the Calvin cycle. Identify the sites of light absorption and the Calvin cycle and explain their locations. **3**

Question 32 continues on page 33

Question 32 (continued)

(c)

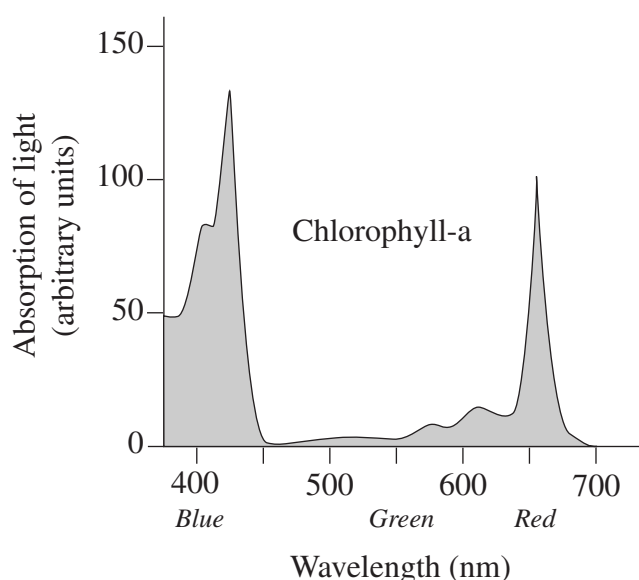
Green algae have had their photosynthetic pathways reprogrammed to produce hydrogen which can be used as an alternative energy source.

Wired Magazine, Issue 10.04, April 2002

An understanding of photosynthetic biochemical pathways has impacted on the development of new technologies.

Evaluate the potential uses of photosynthesis in replacing at least **THREE** named materials presently obtained from other non-renewable resources. **7**

(d) The following figure shows the absorption spectrum of chlorophyll-a.



M Rowland, 1992, Biology, Thomas Nelson and Sons Ltd, Walton-on-Thames, Surrey, p 145.

The owners of a glasshouse are covering the glass with a filter to produce a crop in the shortest possible time.

- (i) Explain which filter you would suggest. **3**
- (ii) Describe photosystems I and II and explain their role in photosynthesis. **5**

End of paper

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