

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

**2003**

**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, 11, 13 and 17

**Total marks – 100**

**Section I** Pages 2–19

**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 16–29
- Allow about 1 hour and 45 minutes for this part

**Section II** Pages 21–32

**25 marks**

- Attempt ONE question from Questions 30–34
- 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* ↙

---

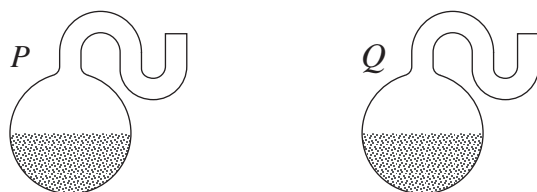
- 1** Spinifex is also called porcupine grass because its leaves can curl up into a needle shape. The stomates are located in sunken grooves on the underside of the leaf and are enclosed as the leaf curls up.

Which process do these adaptations best reduce?

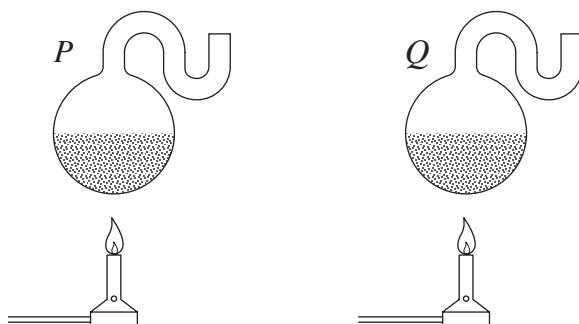
- (A) Conduction
  - (B) Pollination
  - (C) Translocation
  - (D) Transpiration
- 2** What was MacFarlane Burnet's major contribution to science?
- (A) Better understanding of the immune response
  - (B) Identification of complementary bases in DNA
  - (C) Proposal of the one gene–one protein hypothesis
  - (D) Identification of the importance of chromosomes
- 3** A small Australian mammal that lives in the alpine regions of New South Wales has specific features that enable it to retain body heat. Identify the features that are most likely to be present in the mammal described.
- (A) Long ears, rounded body, long legs
  - (B) Short ears, rounded body, short legs
  - (C) Short ears, slender body, long legs
  - (D) Short ears, slender body, short legs
- 4** What are three products extracted from donated blood?
- (A) Oxygen, water and urea
  - (B) Red blood cells, salts and oxygen
  - (C) Plasma, platelets, and red blood cells
  - (D) Platelets, hormones and amino acids

- 5 The following diagram summarises the steps of an experiment similar to that carried out by Louis Pasteur, which identified microbes as agents of decay.

*Step 1* Two swan-neck flasks are filled partially with equal volumes of beef broth.



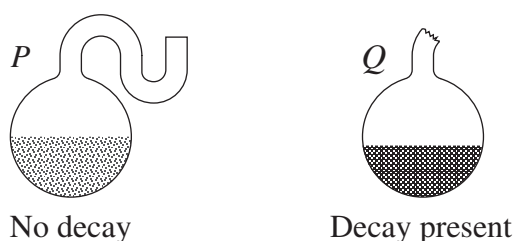
*Step 2* The broth is boiled for at least 20 minutes.



*Step 3* The neck of Flask *P* is left intact whereas the other is broken.



*Step 4* The flasks are observed two weeks later for evidence of decay

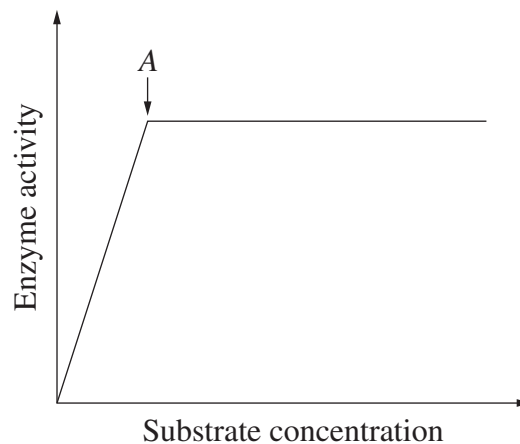


Which of the following statements best explains the results obtained?

- (A) There were no microbes in the air around Flask *P* at Steps 3 or 4.
- (B) There were no microbes in Flask *P* at the beginning of the experiment.
- (C) Microbes in Flask *Q* were not all killed by boiling, and multiplied following the cooling down of the flask.
- (D) Any microbes present in both Flasks *P* and *Q* were killed by the boiling process, and only Flask *Q* allowed microbes to re-enter.

- 6 The incidence of malaria is currently increasing world wide. Which of the following strategies is currently the most effective means of reducing the spread of malaria?
- (A) Quarantine all infected people
  - (B) Reduce mosquito breeding grounds
  - (C) Treat all infected people with high doses of antibiotics
  - (D) Genetically modify human red blood cells to make them malaria-resistant

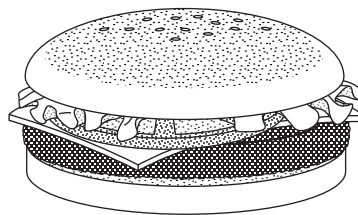
- 7 The graph represents the relationship between substrate concentration and enzyme activity for a metabolic reaction.



Which statement is an accurate interpretation of the graph?

- (A) Point A is the maximum level of enzyme concentration.
  - (B) Increasing substrate concentration beyond Point A will not increase the rate of reaction.
  - (C) Increasing substrate concentration beyond Point A will increase the rate of reaction.
  - (D) Increasing the enzyme activity beyond Point A will not increase the rate of reaction.
- 8 What is the function of T-helper cells?
- (A) Initiation of inflammation
  - (B) Phagocytosis of bacteria and viruses
  - (C) Promotion of B-cell and T-cell activity
  - (D) Production of specific antibodies against pathogens

- 9 How many sex chromosomes does a normal human female inherit from her mother?
- (A) 1  
 (B) 2  
 (C) 23  
 (D) 46
- 10 Deoxyribonucleic acid (DNA) is a double-stranded nucleic acid molecule. For all double strands of DNA, which one of the following statements is true?
- (A) The numbers of adenine (A) and guanine (G) bases are equal.  
 (B) The numbers of guanine (G) and cytosine (C) bases are equal.  
 (C) The numbers of thymine (T) and cytosine (C) bases are equal.  
 (D) The numbers of adenine (A), guanine (G), thymine (T) and cytosine (C) bases are equal.
- 11 The table lists the types of microbes identified in a cheeseburger prepared at an outdoor market.



Type of microbe	Description of microbe
<i>Staphylococcus epidermidis</i>	Common skin organism
<i>Lactobacillus bulgari</i>	Organism present in dairy products
<i>Saccharomyces cerevisiae</i>	Baker's yeast
<i>Bacillus subtilis</i>	Non-pathogenic microbe with widespread environmental occurrence

Would it be safe to eat this cheeseburger?

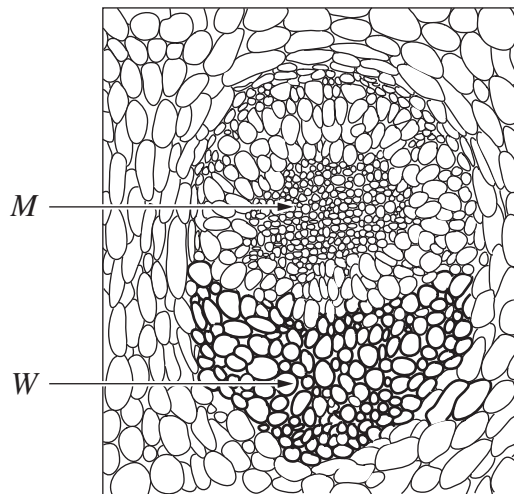
- (A) No, food should be completely free of microbes.  
 (B) No, lactobacillus and saccharomyces are highly pathogenic.  
 (C) Yes, organisms that grow in or on the human body do not cause disease.  
 (D) Yes, most of the food we eat is contaminated by different types of microbes.

- 12 Following birth, each baby in Australia has a sample of blood taken that is tested for the genetic disease phenylketonuria (PKU). This disease affects both genders equally and can be found in babies of parents who do not show the disease.

Which of the following best describes the mechanism of inheritance for phenylketonuria?

- (A) Co-dominant
- (B) Dominant
- (C) Recessive
- (D) Sex-linked

- 13 Which alternative correctly describes the process involved in the movement of materials in the cells labelled *M* and *W*?

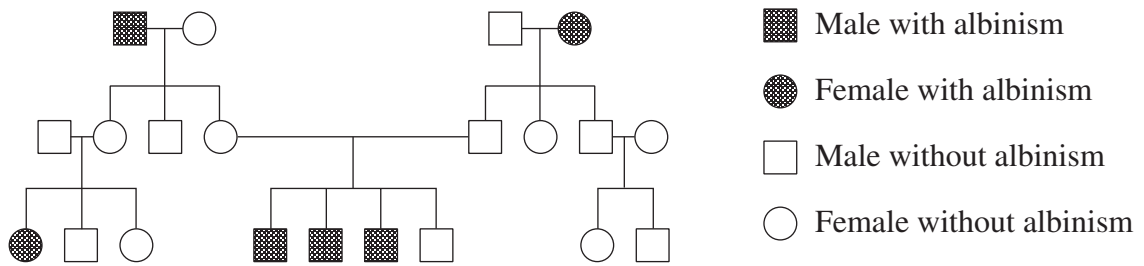


A typical vascular bundle from a stem

Mauseth, James D, 1988, *Plant Anatomy*, Benjamin/Cummings Pub. Co., California

	<i>M</i>	<i>W</i>
(A)	Active transport	Active transport
(B)	Active transport	Passive transport
(C)	Passive transport	Active transport
(D)	Passive transport	Passive transport

- 14 The pedigree chart below shows a possible pattern of inheritance for human albinism. Albinism is a condition in which people do not produce pigment in their skin, hair and eyes.



Which of the following statements is correct?

- (A) People with albinism are homozygous for albinism.  
 (B) The gene for normal skin pigmentation is recessive.  
 (C) There are two genes that code for albinism.  
 (D) Albinism is a sex-linked characteristic.
- 15 The tortoiseshell cat has a combination of black and orange fur. The gene for black fur is represented by  $X^b$  and the gene for orange fur is represented by  $X^o$ . A tortoiseshell female cat ( $X^b X^o$ ) mates with an orange male cat ( $X^o Y$ ).

Which alternative shows the probable percentages of coat colours in the litter of kittens?

- (A) 50% tortoiseshell females and 50% orange males  
 (B) 50% orange females and 50% tortoiseshell males  
 (C) 25% black females, 25% orange females, 25% black males, 25% orange males  
 (D) 25% tortoiseshell females, 25% orange females, 25% black males, 25% orange males



--	--	--	--	--

Centre Number

Section I (continued)

--	--	--	--	--	--	--	--	--

Student Number

Part B – 60 marks

Attempt Questions 16–29

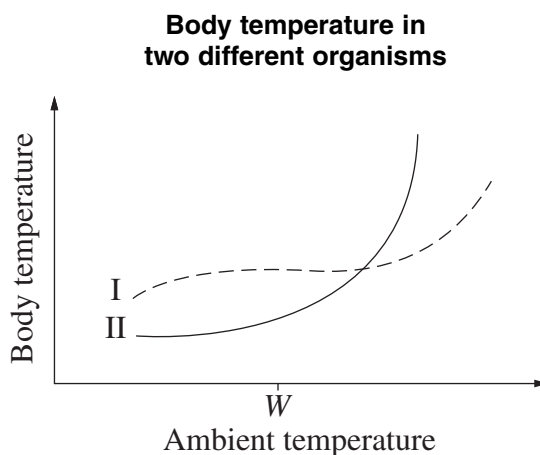
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Marks

Question 16 (4 marks)

The graph shows the variation in body temperature for two different organisms over a range of ambient temperatures.



- (a) State the term applied to animals that exhibit the type of body temperature response shown by organism I. 1

.....

- (b) Name an Australian native animal that would exhibit a response similar to curve II? 1

.....

- (c) Describe how a response by organism II would assist in temperature control when the ambient temperature increases beyond  $W$ . 2

.....  
 .....  
 .....  
 .....

**Question 17** (5 marks)

- (a) Describe an investigation that you have carried out to demonstrate the effect of dissolved carbon dioxide on the pH of water. **3**

.....  
.....  
.....  
.....  
.....  
.....

- (b) Explain why the removal of carbon dioxide from living cells is important. **2**

.....  
.....  
.....  
.....

**Question 18** (4 marks)

Draw a labelled diagram to show how a specific feedback mechanism plays an essential role in homeostasis. **4**

# Biology

--	--	--	--	--

Centre Number

## Section I – Part B (continued)

--	--	--	--	--	--	--	--	--

Student Number

**Marks**

### Question 19 (3 marks)

The widespread use of antibiotics for the treatment of bacterial infections has led to the development of antibiotic resistance in some species of bacteria. From your studies of evolution and the mechanisms of inheritance, explain how resistance has developed in bacteria.

**3**

.....

.....

.....

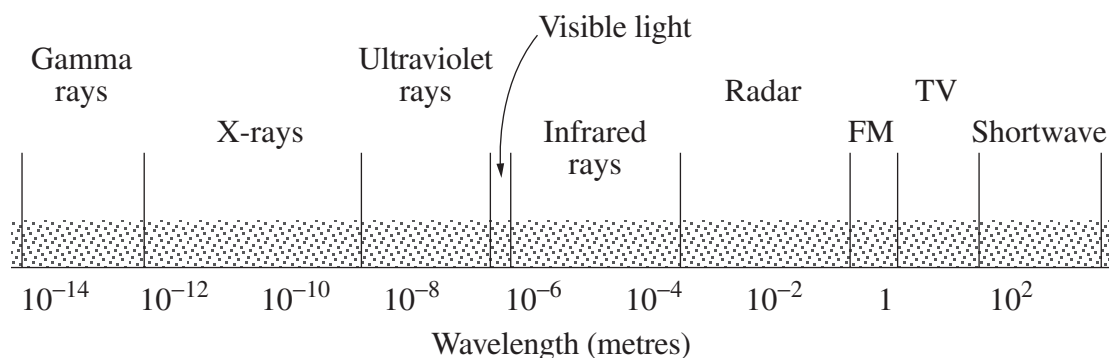
.....

.....

**Please turn over**

**Question 20** (3 marks)

The diagram shows various forms of radiation that are part of the electromagnetic spectrum.



- (a) Select ONE form of radiation that is considered to be a mutagen. 1

.....

- (b) Describe evidence that supports the mutagenic nature of the selected form of radiation. 2

.....  
 .....  
 .....  
 .....

**Question 21** (3 marks)

- (a) Name ONE technology that could be used to establish evolutionary relationships. 1

.....

- (b) Explain how the data revealed by this technology can be used to establish evolutionary relationships. 2

.....  
 .....  
 .....  
 .....

--	--	--	--	--

Centre Number

Section I – Part B (continued)

--	--	--	--	--	--	--	--	--

Student Number

**Marks**

**Question 22** (4 marks)

Discuss some ethical considerations arising from the development of genetically modified animals. **4**

.....

.....

.....

.....

.....

.....

.....

.....

**Question 23** (3 marks)

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

.....

.....

(b) Outline methods used by estuarine plants to maintain appropriate internal salt concentration. **2**

.....

.....

.....

.....

**Question 24** (8 marks)

- (a) Describe how the important work carried out by Rosalind Franklin enabled James Watson and Francis Crick to identify the structure of DNA. **2**

.....  
.....  
.....  
.....

- (b) In 1962, James Watson, Francis Crick and Maurice Wilkins were awarded the Nobel Prize in Medicine for identifying the structure of DNA. Using examples, evaluate the impact of this discovery on current genetic technology. **6**

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

**Question 25** (4 marks)

You have carried out first-hand investigations that have attempted to model biological concepts.

**4**

Discuss the use and limitations of models when illustrating biological concepts.

.....

.....

.....

.....

.....

.....

.....

.....

.....

**Question 26** (3 marks)

Clarify, using examples, the difference between the terms *allele* and *gene*.

**3**

.....

.....

.....

.....

.....

.....

.....

.....

BLANK PAGE



Biology

--	--	--	--	--

Centre Number

Section I – Part B (continued)

--	--	--	--	--	--	--	--	--

Student Number

**Marks**

**Question 27** (4 marks)

Old age is not a disease. Discuss the difficulties in defining the terms *health* and *disease*.

**4**

.....

.....

.....

.....

.....

.....

.....

.....

**Please turn over**

**Question 28** (4 marks)

A standard NSW vaccination schedule for diphtheria/pertussis/tetanus (DPT) is shown.

**4**

<i>Age</i>
2 months
4 months
6 months
18 months
4 years

Propose reasons for the frequent vaccination between 2 months and 4 years.

.....

.....

.....

.....

.....

.....

.....

.....



BLANK PAGE

# Biology

## Section II

25 marks

Attempt ONE question from Questions 30–34

Allow about 45 minutes for this section

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

---

	Pages
Question 30    Communication .....	22–23
Question 31    Biotechnology .....	24–25
Question 32    Genetics: The Code Broken? .....	26–27
Question 33    The Human Story .....	28–30
Question 34    Biochemistry .....	31–32

**Question 30 — Communication (25 marks)**

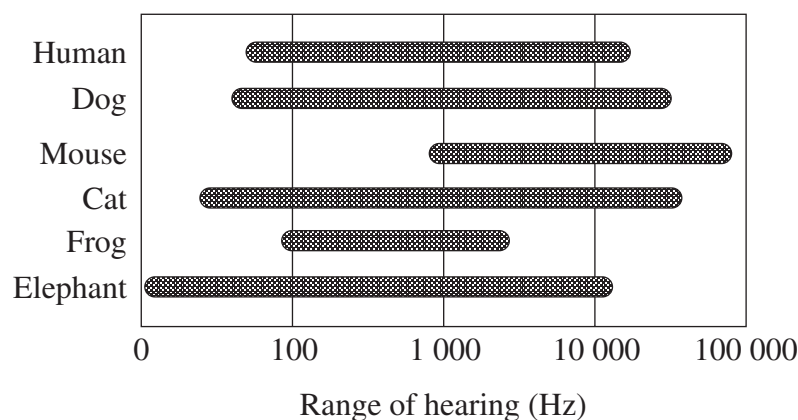
- (a) For each stimulus in the table, name an appropriate receptor. Clearly label your answers to (1), (2) and (3) in your writing booklet.

<i>Receptor</i>	<i>Stimulus</i>	<i>Sense</i>	
(1)	Black-and-white photograph	Vision	<b>1</b>
(2)	Pin prick	Touch	<b>1</b>
(3)	Concert band	Hearing	<b>1</b>

- (b) Following an industrial accident, a person was found unconscious with no apparent injury to the face and eyes. Upon recovery the person experienced blindness in the right eye.

- (i) Based on the evidence provided, propose ONE possible cause for the loss of sight in the right eye. **2**
- (ii) Discuss how loss of sight in one eye would affect other aspects of vision. **3**

- (c) The chart shows the range of frequencies that selected animals can hear.



- (i) Identify the animal that has the narrowest range of hearing. **1**
- (ii) Explain the possible reasons for the differences in sound frequencies detected by humans and other animals. **4**

**Question 30 continues on page 23**

Question 30 (continued)

- (d) During your study of Communication you gathered secondary information relating the structure and function of a mammalian ear.
- (i) Describe how you processed and analysed the gathered information. **4**
  - (ii) State how you assessed the reliability of the data obtained. **1**
- (e) Recent advances in health care have significantly extended life expectancy. As people age, both vision and hearing become impaired. Evaluate identified technologies that have been developed to deal with these problems. **7**

**End of Question 30**

**Question 31 — Biotechnology (25 marks)**

- (a) (i) Define the term *artificial selection*. 1
- (ii) Describe a change that has been produced in ONE named animal species or ONE named plant species as a result of artificial selection of characteristics suitable for agricultural stock. 2
- (b) (i) Outline the fermentation processes involved in either bread or alcohol production. 2
- (ii) Explain how changes in scientific knowledge have modified the traditional methods of bread or alcohol production. 3
- (c) (i) The following table summarises the activity of three different enzymes A, B and C that can join amino acids to form polypeptide chains. 2

<i>pH</i>	<i>Temperature (°C)</i>	<i>Enzyme A activity</i>	<i>Enzyme B activity</i>	<i>Enzyme C activity</i>
2.0	4	low	low	none
	37	low	high	none
	72	low	none	none
5.5	4	low	low	none
	37	medium	medium	none
	72	low	none	low
7.5	4	medium	low	none
	37	high	low	low
	72	low	low	high
11.0	4	none	none	none
	37	none	none	none
	72	none	none	none

Explain which of the enzymes, A, B or C would be most likely to function in a human cell (human cell pH range = 7.36–7.44).

- (ii) Describe the function of ONE enzyme involved in recombinant DNA technology. 3

**Question 31 continues on page 25**



Question 31 (continued)

- (d) During your study of Biotechnology you gathered secondary information to identify that complementary DNA is produced by either reverse transcribing RNA or the Polymerase Chain Reaction.
- (i) Describe how you processed and analysed the gathered information. **4**
  - (ii) State how you assessed the reliability of the data obtained. **1**
- (e) Evaluate current uses of industrial fermentation biotechnology. **7**

**End of Question 31**

**Question 32 — Genetics: The Code Broken? (25 marks)**

- (a) (i) Define the term *recombinant DNA*. 1
- (ii) Outline TWO steps used in the production of recombinant DNA. 2
  
- (b) (i) Outline the benefits of the Human Genome Project. 2
- (ii) Discuss the use of gene therapy to manage EITHER a named genetic disease, OR a named form of cancer, OR AIDS. 3
  
- (c) Paternity testing involves a number of procedures used to determine the biological father of a child.

The following data show results of two different procedures attempting to identify the biological father of a child. Maternity of the child has been verified.

Procedure 1: **ABO blood groups**

<i>Mother</i>	<i>Child</i>	<i>Male 1</i>	<i>Male 2</i>	<i>Male 3</i>
A	O	O	A	B

Procedure 2: **DNA fingerprint data**

<i>Molecular weight</i>	<i>Weight marker</i>	<i>Mother</i>	<i>Child</i>	<i>Male 1</i>	<i>Male 2</i>	<i>Male 3</i>
6000	█				█	
5500	█	█	█			
5000	█					
3000	█	█			█	█
2000	█			█		
1500	█		█			█
1000	█			█		

**Question 32 continues on page 27**

	<b>Marks</b>
Question 32 (continued)	
(i) From the ABO blood group data, identify which male(s), if any, can be excluded as the biological father of the child.	<b>1</b>
(ii) From the DNA fingerprint data, identify which male(s), if any, can be excluded as the biological father of the child.	<b>1</b>
(iii) Explain which of these two methods is more accurate in paternity testing.	<b>3</b>
 (d) During your study of Genetics: The Code Broken, you gathered secondary information to assess the evidence that analysis of genes provides for evolutionary relationships.	
(i) Describe how you processed and analysed the gathered information.	<b>4</b>
(ii) State how you assessed the reliability of the data obtained.	<b>1</b>
 (e) Evaluate the current use of gene cloning in animals and plants.	<b>7</b>

**End of Question 32**

**Question 33 — The Human Story (25 marks)**

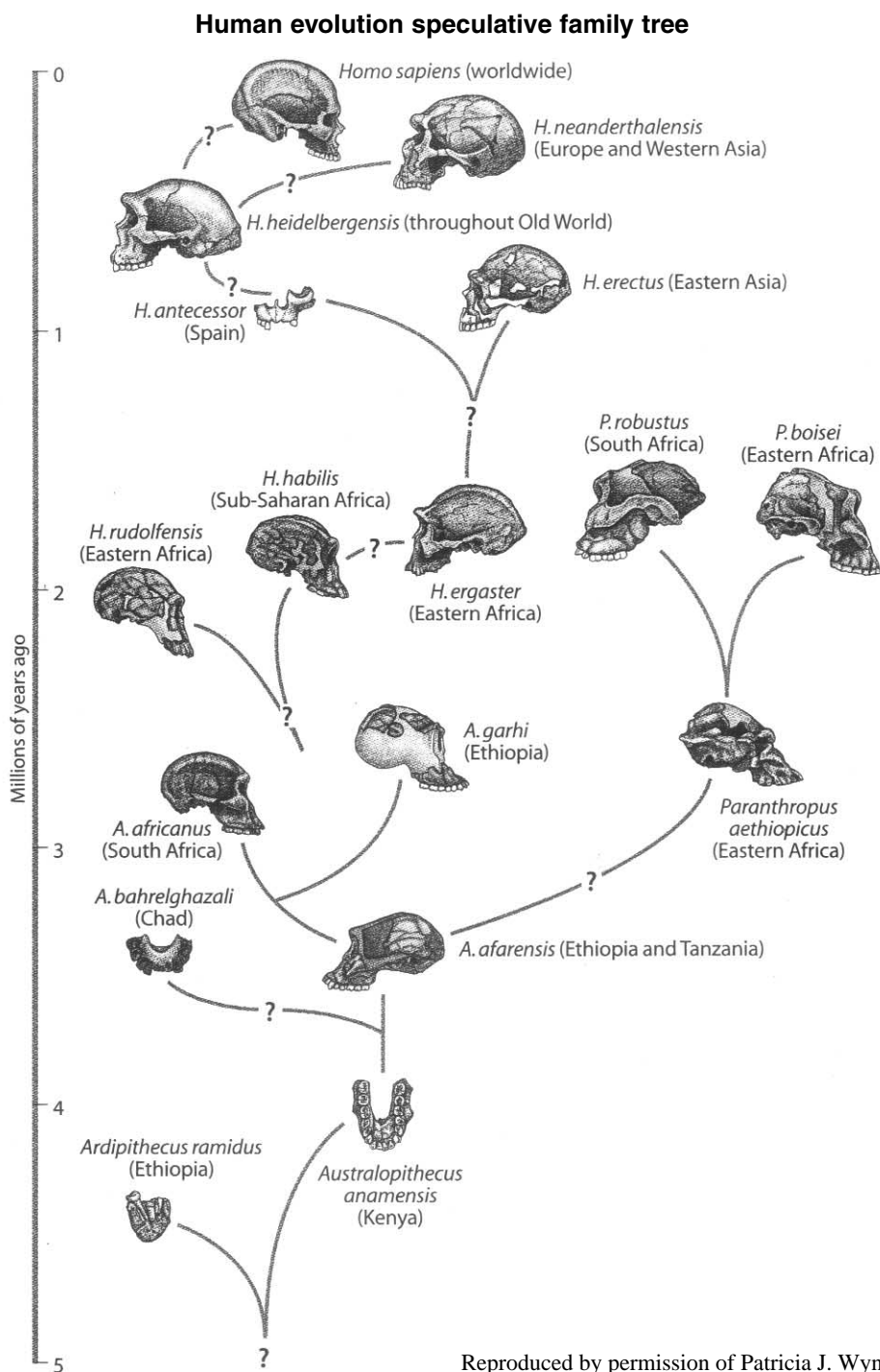
- (a) Complete the information missing in cells of the table marked (1), (2) and (3). **3**  
Clearly label your answers to (1), (2) and (3) in your writing booklet.

<i>Level of classification</i>	<i>Classification</i>	<i>Distinguishing characteristics</i>
Kingdom	Animal	Heterotrophic; eucaryotic
Phylum	Chordate	Hollow dorsal nerve cord
Class	Mammalia	Mammary glands
Order	(1)	Opposable thumb
(2)	Hominidae	Upright stance
Genus	<i>Homo</i>	(3)
Species	<i>sapiens</i>	Large brain to body mass ratio; flat face; abstract thought; complex social structures

**Question 33 continues on page 29**

Question 33 (continued)

- (b) The diagram shows possible evolutionary relationships between a number of fossils.



- (i) Outline the differences between absolute dates and relative dates for the age of fossils. 2
- (ii) The diagram contains many question marks. Discuss TWO reasons for this uncertainty. 3

Question 33 continues on page 30

Question 33 (continued)

(c) The table and map show the frequency and distribution of human blood types.

Mourant A E, et al., 1976, *The Distribution of the Human Blood Groups and Other Polymorphisms*, 2nd ed.

<i>Population group</i>		<i>Blood group O (%)</i>	<i>Blood group A (%)</i>	<i>Blood group B (%)</i>	<i>Blood group AB (%)</i>
United Kingdom	①	47	42	8	3
France	②	43	47	7	3
Greece	③	40	42	14	4
Russia	④	33	36	23	8
Australian Aborigines	⑤	61	39	0	0
Peruvian Indians	⑥	100	0	0	0



Reprinted by permission of Oxford University Press.

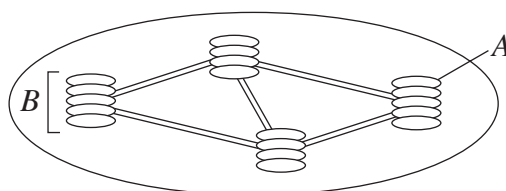
- (i) Propose an explanation for the variation in the frequency of blood group *B* shown in the table. 2
- (ii) Account for the limited variation in blood groups in the Australian Aborigines and Peruvian Indians. 3
- (d) During your study of *The Human Story* you gathered secondary information to account for changes in human population numbers in the last 10 000 years.
  - (i) Describe how you processed and analysed the gathered information. 4
  - (ii) State how you assessed the reliability of the data obtained. 1
- (e) The ‘Out of Africa model’ and the theory of regional continuity (multi-regional hypothesis) are two different models used to explain human evolution that have been developed in recent years. 7

Select ONE model, and use evidence to evaluate the model.

**End of Question 33**

**Question 34 — Biochemistry (25 marks)**

(a) The diagram shows a chloroplast.



- (i) Name structure A. 1
  - (ii) Outline the functions of structure B. 2
- (b)
- (i) Identify the reactants required for the production of ATP. 1
  - (ii) Explain the role of NADPH in the Calvin Cycle. 4
- (c) Biology students conducted the following experiment. On Day 1 seedlings, pots and soil were weighed. To each pot an equal mass of soil and volume of water were added. One seedling was then planted in each pot and all pots were exposed to the same environment.

On Day 10 the students returned and weighed the plants and the soil. The average weights from the experiment are shown in the table below.

<i>Item</i>	<i>Average weight (g)</i>
Plastic pot	2
Soil on Day 1	20
Seedling on Day 1	1
Soil on Day 10	19.9
Seedling on Day 10	11

- (i) Explain how van Helmont would have interpreted these results. 2
- (ii) Radioactive tracers can be incorporated into plants. Explain how the use of radioactive oxygen ( $^{18}\text{O}$ ) has advanced the understanding of photosynthesis. 3

**Question 34 continues on page 32**

Question 34 (continued)

- (d) During your study of Biochemistry you have gathered secondary information to identify the products of photosynthesis.
- (i) Describe how you processed and analysed the gathered information. **4**
  - (ii) State how you would have assessed the reliability of the data obtained. **1**
- (e) Evaluate the potential uses of the products of photosynthesis in replacing at least TWO named materials frequently obtained from non-renewable resources. **7**

**End of paper**