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Tasmanian Certificate of Education

BIOLOGY

Senior Secondary 5C

Subject Code: BIO5C

External Assessment

2005

Part 1

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Section Total

/33

Pages: 11
Questions: 4

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CANDIDATE INSTRUCTIONS

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Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

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The 2005 Biology Information Sheet can be used throughout the examination.

Question 1**For
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Three groups of students, **A**, **B**, and **C**, carried out an experiment to investigate the effect of temperature on the action of the enzyme sucrase. Sucrase breaks down sucrose.

Each group of students set up seven test tubes. Each test tube was kept at a different temperature. The time taken for the sucrose to break down completely was recorded and the results from the three groups were averaged.

The results of the experiment are shown in the table below:

Test-tube	Temperature (°C)	Time taken for sucrose to break down completely (minutes)			
		Group A	Group B	Group C	Average
1	0	49	53	51	51.0
2	10	15	14	16	15.0
3	20	10	6	9	8.3
4	30	4	5	4	4.3
5	40	4	7	6	5.7
6	50	26	30	28	28.0
7	60	90	140	100	110.0

- (a) State one hypothesis that this experiment may have been designed to test. (3 marks)

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- (b) (i) State the dependent variable in your hypothesis. (1 mark)

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- (ii) State the independent variable in your hypothesis. (1 mark)

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- (c) State why a well-designed experiment has only one independent variable. (2 marks)

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Question 1 continues opposite.

Question 1 (continued)**For
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- (d) Identify four factors that must be held constant throughout this experiment. (2 marks)

(i)

(ii)

(iii)

(iv)

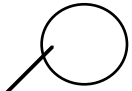
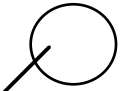
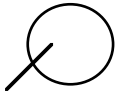






- (e) Using the data in the table, explain what indicates that the results at 60°C are less precise than the results at any other temperature. (2 marks)


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Question 2

A student set up the following experiment to test the hypothesis that: ‘Antibiotic X prevents the growth of bacteria’.

	Agar plate 1	Agar plate 2	Agar plate 3
Method	 Surface covered with bacterium A	 Surface covered with bacterium B	 Surface covered with bacterium C
			
	Incubation at 37°C for 48 hours		
Result			

 Disc of the same antibiotic X placed on each plate

 Clear zone indicates no growth of bacteria here
 Bacterial growth

The plates were incubated at 37°C for 48 hours. The diagram of plates 1, 2 and 3 depict the results.

- (a) Critically evaluate the appropriateness of the student’s hypothesis. (2 marks)

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- (b) What are **two** essential components of experimental design that are missing from the student’s experiment? Explain why each is necessary.

- (i)
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- (2 marks)

- (ii)
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- (2 marks)

Question 2 continues opposite

Question 2 (continued)**For
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- (c) The student concluded that the hypothesis was incorrect. Discuss the validity of this conclusion in relation to the design of this experiment. (3 marks)

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Question 3**For
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Researchers are involved in relocating Tasmanian Devils to Maria Island in order to establish a population of the marsupial that is free of 'facial-tumour disease'. To ensure success of this project the researchers must determine the most effective way of providing sufficient and suitable food for the animals on the island.

- (a) Discuss the ethical issues that must be considered during the relocation operation. (3 marks)

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- (b) In designing experiments to determine preferred food items and food quantities, the researchers have been given a choice of conducting trials over the full extent of the island or using a 0.5 ha fenced enclosure.

What choice would you make in this situation? Give reasons for your choice. (4 marks)

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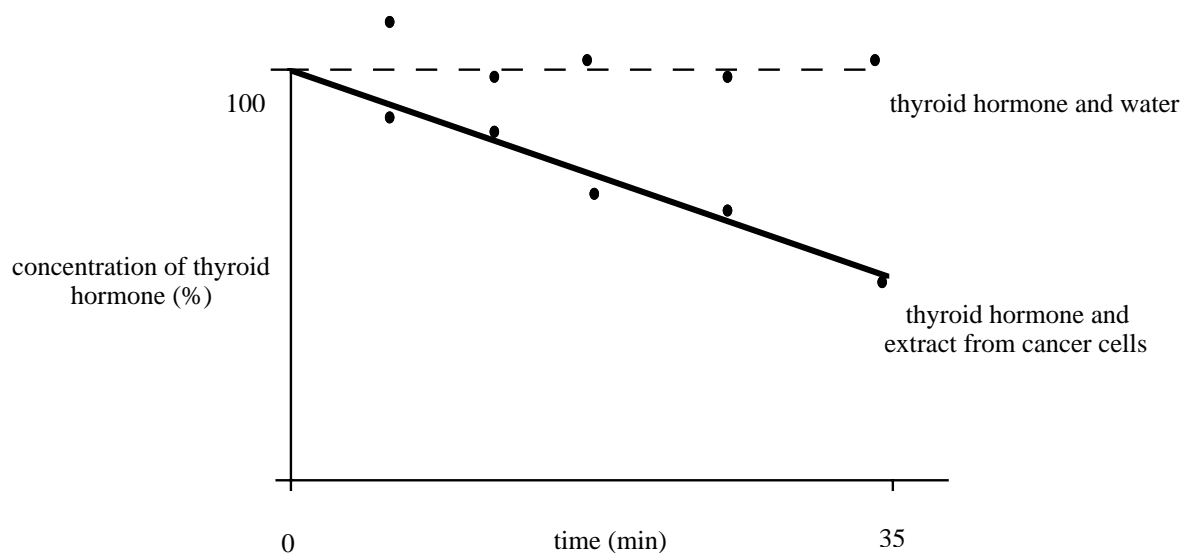
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Question 4**For
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Two sets of test tubes were used in an experiment. The first set contained thyroid hormone and water. The second set contained thyroid hormone and an extract taken from cancer cells. Samples were taken from the two sets of test tubes at regular intervals and the concentration of thyroid hormone was recorded and graphed.

The following graph shows the results of the experiment:



- (a) State the purpose of the set of test tubes containing thyroid hormone and water. (2 marks)

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- (b) Research scientists often culture cancer cells in a laboratory. It would be far less expensive and less time-consuming if such cells were simply extracted from cancer patients using a biopsy.

Suggest TWO different reasons why this is not the preferred method. (4 marks)

- (i)

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- (ii)

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Tasmanian Certificate of Education

BIOLOGY

Senior Secondary 5C

Subject Code: BIO5C

External Assessment

2005

Part 2

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 7 Demonstrate knowledge and understanding of the chemical basis of life.

Section Total

/33

Pages: 11
Questions: 5

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CANDIDATE INSTRUCTIONS

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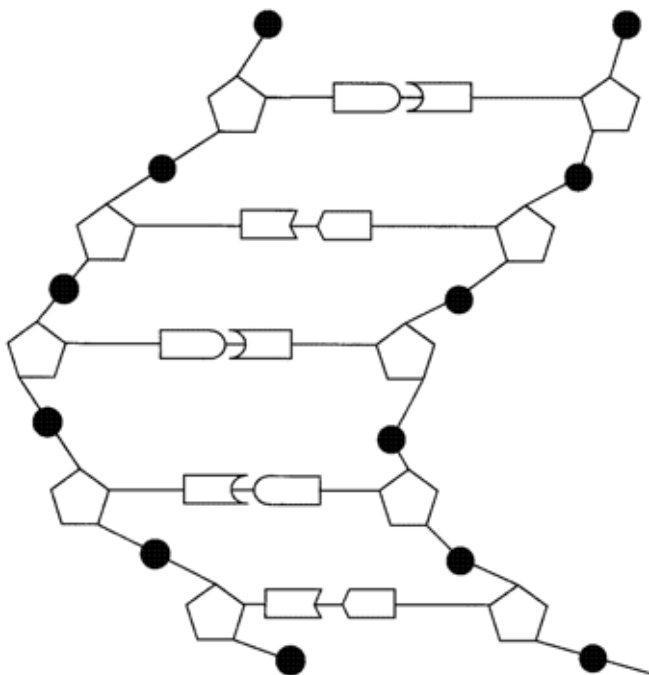
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Question 5**For
Marker
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Only**

This diagram shows the structure of a portion of a DNA molecule:



(Source: King, R. J. and Sullivan, F. M., *Senior Biology*, Longman Australia, Pearson Education Australia.)

(a) On the diagram: (1 mark)

- (i) Circle and label **one** nucleotide
- (ii) Label a deoxyribose sugar molecule.

(b) (i) What term is used to describe the production of RNA from DNA? (1 mark)

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(ii) Why is it important for this process to be accurate?

Explain your answer in terms of enzyme production.

(2 marks)

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Question 5 continues opposite.

Question 5 (continued)

- (c) One form of osteoarthritis in humans is believed to be the result of a mutation in the DNA of the Type II Collagen Alpha 1 gene (COL2A1).

A small region of the mRNA coded by this DNA of both the mutant COL2A1 allele and the normal COL2A1 allele is shown below (**Table 1**).

	mRNA						
Normal sequence of COL2A1	...AAG	AUG	GUC	CGU	CUG	GAC	CUG...
Mutant sequence of COL2A1	...AAG	AUG	GUC	UGU	CUG	GAC	CUG...

Table 1

- (i) What feature of the sequences in **Table 1** indicates that it is mRNA and not DNA? (1 mark)

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- (ii) What base substitution would have occurred in the template strand of DNA resulting in this change in the mRNA? (1 mark)

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- (iii) Using the information in the genetic code in **Table 2**, describe the effect of the mutation on the amino acid sequence which would be produced from this mRNA. (2 marks)

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Table 2 – Part of the genetic code

mRNA	Amino Acid	mRNA	Amino Acid
UUU	phe	UGU	cys
UUC	phe	UGC	cys
UUA	phe	UGA	stop
UUG	phe	UGG	tryp
CUU	leu	CGU	arg
CUC	leu	CGC	arg
CUA	leu	CGA	arg
CUG	leu	CGG	arg
AUU	iso	AGU	gly
AUC	iso	AGC	gly
AUA	iso	AGA	gly
AUG	met	AGG	gly

Question 6**For
Marker
Use
Only**

- (a) *Amylase* is an enzyme that hydrolyses starch into sugars in humans. An experiment was performed to determine the effect of temperature on amylase activity. The data collected are given in the following table.

Temperature (°C)	Rate of production of sugar (g/min)
0	0.0
10	0.4
20	0.6
30	0.8
40	1.0
50	0.4
60	0.2
70	0.0

Incubation at 0°C and 70°C gave the same rates of sugar production. If the tubes containing these samples were then incubated at 40°C, what results would you expect and why? Answer the question by completing the following table. (4 marks)

Prior incubation temperature (°C)	New incubation temperature (°C)	Expected result (g/min)	Reason
0	40		
70	40		

- (b) Explain why the effect of an inhibitor on an enzyme may be reduced by increasing the concentration of the substrate. (3 marks)

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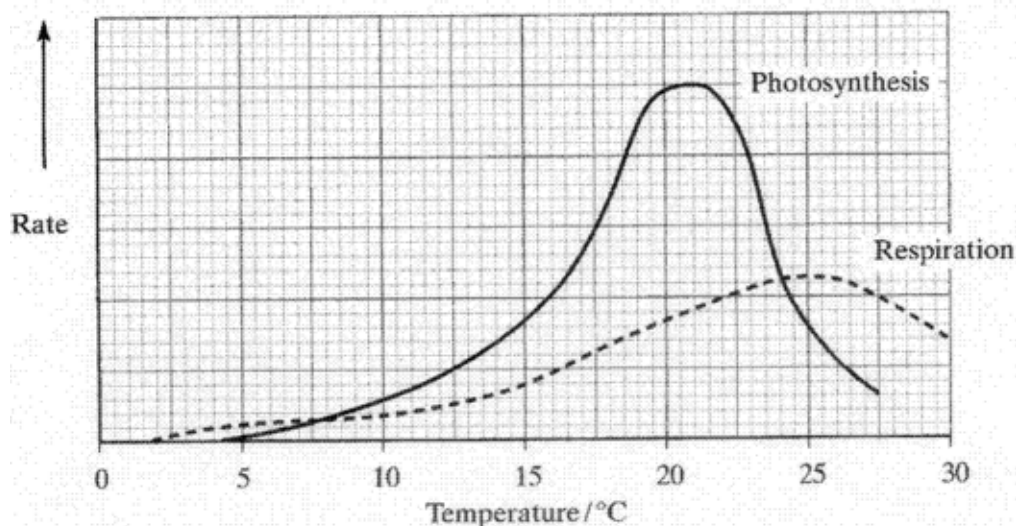
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Question 7

Potato plants originate from the Andes mountains in South America. They are adapted for survival in a cool climate. The potatoes we eat are food storage organs, called tubers, and are produced on underground stems.

The graph shows the rates of photosynthesis and respiration for one variety of potato plant, over a range of temperatures.



- (a) Between which temperatures is there a net gain in energy by the potato plant? (1 mark)

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- (b) When this variety was grown in a hot climate, with a mean daytime temperature of 24°C, it failed to produce tubers.

Use information in the graph to explain why no tubers were produced. (2 marks)

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- (c) Suggest why the rate of photosynthesis decreases above 21°C. (2 marks)

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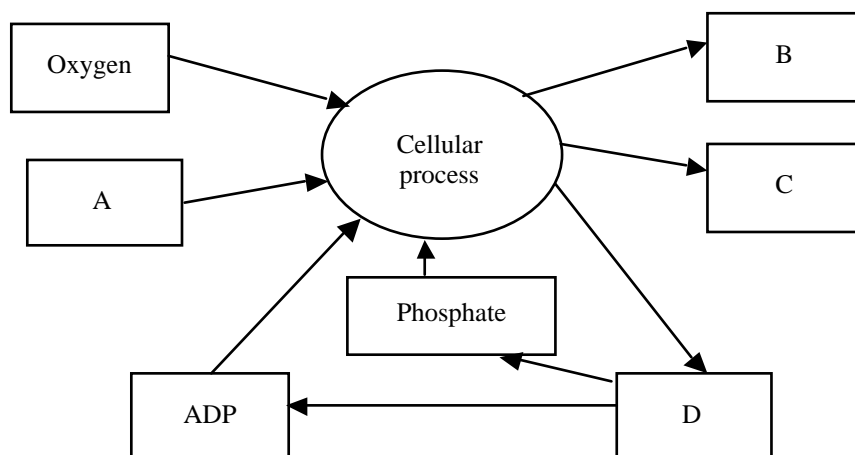
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Question 8**For
Marker
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- (a) Refer to the following diagram, which shows molecules involved in a cellular process.



- (i) Identify the cellular process that is occurring. (1 mark)

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- (ii) Identify the four substances A, B, C and D. (2 marks)

A.....

B.....

C.....

D.....

- (b) The process depicted above produces similar products to another cellular process. Name the other process and discuss why the one depicted here is far more efficient. (3 marks)

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Question 9**For
Marker
Use
Only**

- (a) Refer to the following table, which shows the results of an experiment in which the synthesis of a polysaccharide from glucose in a test tube was investigated. The changes in the concentrations of the polysaccharide and four other substances, A, B, C and D in the test tube were recorded over a 20-minute interval.

Time (min)	Concentration of substance (arbitrary units)				
	Polysaccharide	A	B	C	D
0	0	35	0	2	60
5	4	15	20	2	40
10	6	5	30	2	30
15	7	0	35	2	25
20	7	0	35	2	25

The concentrations that were measured were for: *glucose*, the enzyme *maltase*, *ADP* and *ATP*. Suggest which of these correspond to A, B, C, and D in the table, giving reasons for your choices. (4 marks)

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- (b) Vitamins and minerals are two groups of essential nutrients needed by humans in small quantities.

- (i) What is the key chemical difference between these two groups of nutrients? (2 marks)

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- (ii) Herbivores get their minerals by eating plants, but how do the plants obtain minerals? (1 mark)

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Tasmanian Certificate of Education

BIOLOGY

Senior Secondary 5C

Subject Code: BIO5C

External Assessment

2005

Part 3

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 8 Demonstrate knowledge and understanding of cells.

Section Total

/32

Pages: 7
Questions: 5

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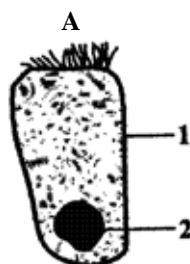
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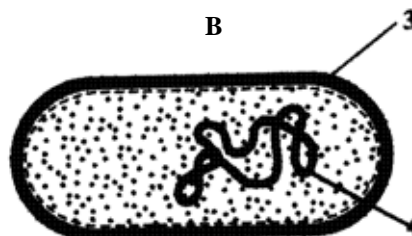
Question 10

Consider the diagrams of the two different cells.

(The diagrams are not drawn to the same scale.)



Cell from lining
of windpipe



Bacterium

- (a) Name structures 1 and 3 and discuss the difference in their function. (3 marks)

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- (b) Which of these cells is prokaryotic? Give evidence *from the diagram* to support your answer. (2 marks)

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- (c) What is the similarity between structures 2 and 4? (1 mark)

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- (d) What kind of microscope has been used to photograph cell A? Give a reason for your answer. (2 marks)

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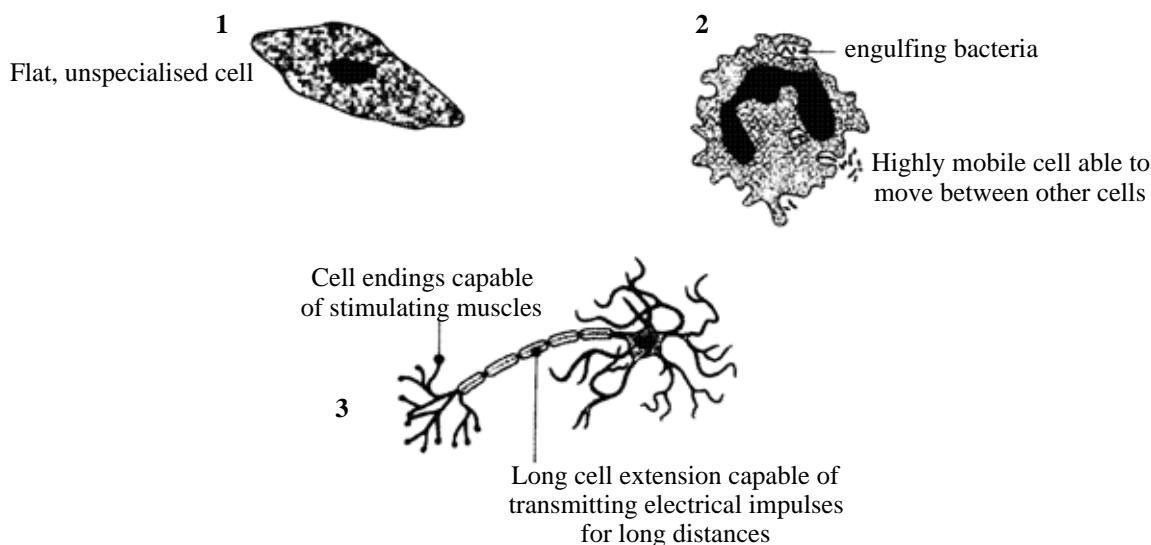
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Question 11

Refer to the following diagrams, which show three different cells from the same person.



- (a) Discuss this statement:

‘These three cells perform different functions and therefore contain different genetic material.’ (2 marks)

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- (b) Cell 2 is part of the human immune system. Discuss *two* ways that the cell’s structure suits its function in this system. (2 marks)

(i)

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(ii)

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Question 12**For
Marker
Use
Only**

- (a) Grapevines in Tasmania are usually propagated from cuttings that are removed from existing vines. What kind of cell division occurs when these cuttings start growing, and how is this significant to the grower? (3 marks)

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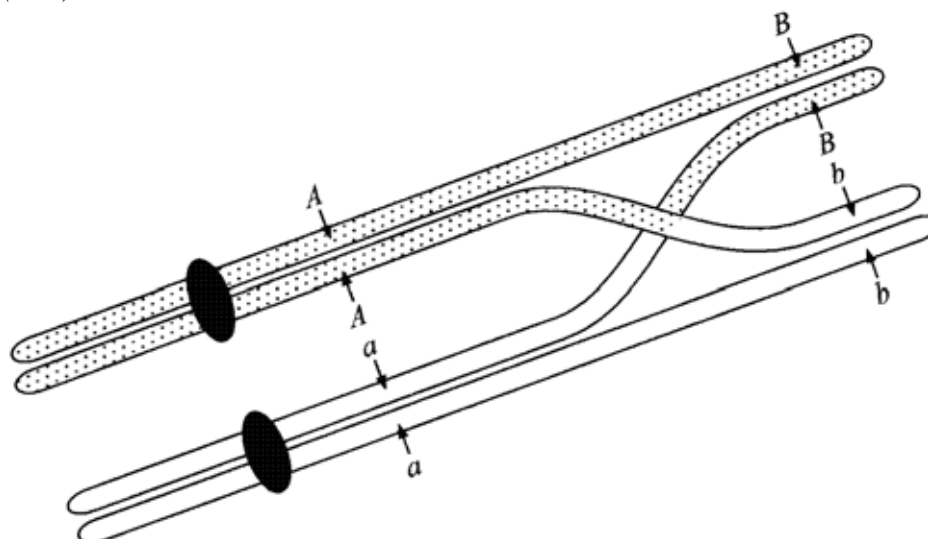
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- (b) The diagram below shows two homologous chromosomes during cell division. One of the homologous chromosomes carries dominant genes (*A*, *B*) and the other, recessive genes (*a*, *b*).



- (i) What type of cell division is occurring? (1 mark)

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- (ii) List the genotypes of the daughter cells. (2 marks)

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- (iii) What is the significance of crossing over during the process of gamete formation? (2 marks)

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Question 13

- (a) Refer to the following table, which shows the concentrations of potassium ions and magnesium ions in plant root cells and in the surrounding soil water.

	Concentration of potassium ions (mmol/L)	Concentration of magnesium ions (mmol/L)
plant root cells	4.00	0.40
soil water	0.12	0.80

Potassium ions and magnesium ions both move into plant root cells from the soil water.

Explain why it can be concluded that plants absorb potassium ions by a different process from that by which they absorb magnesium ions and identify the process used in each case. (4 marks)

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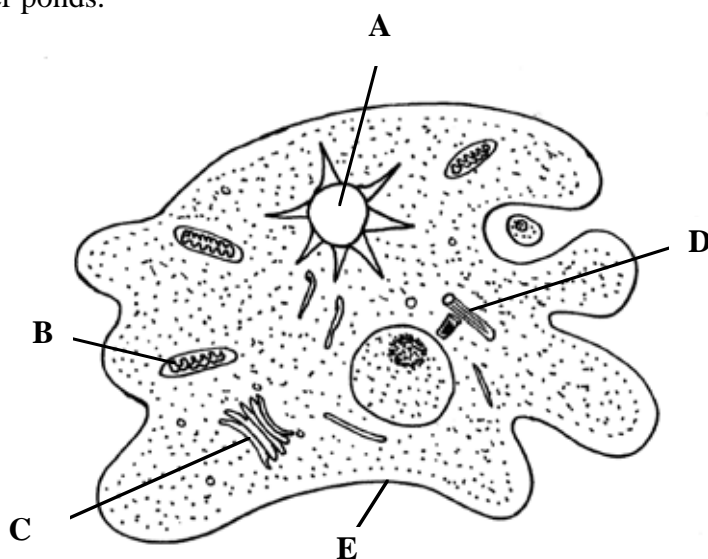
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- (b) The diagram is of a single-celled protozoan called *amoeba proteus*, commonly found in freshwater ponds.



Question 13 continues opposite.

Question 13 (continued)**For
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Use
Only**

- (i) Name structure A and describe its function. (2 marks)

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- (ii) When this *amoeba* is placed in a mild salt solution, the activity of structure A slows. Explain this observation. (3 marks)

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/9**Question 14**

A student placed a carrot and a potato (of exactly the same mass) into some blue food-dye solution. The vegetables were peeled before the experiment. After 32 minutes the carrot was blue throughout but the potato took 108 minutes to become blue throughout. Provide a possible explanation for this result. (3 marks)

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Tasmanian Certificate of Education

BIOLOGY

Senior Secondary 5C

Subject Code: BIO5C

External Assessment

2005

Part 4

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 9 Demonstrate knowledge and understanding of organisms.

Section Total

/34

Pages: 15
Questions: 5

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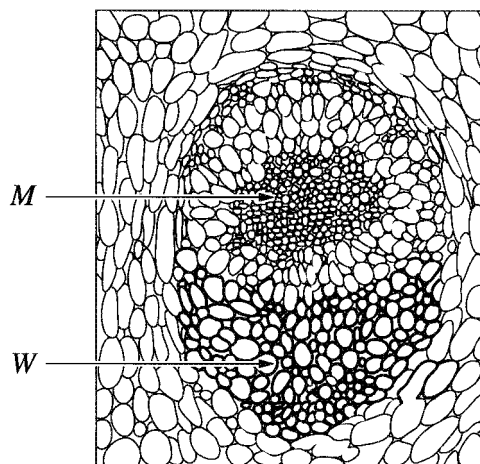
You should make sure you answer all parts within each question so that the criterion can be assessed.

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Question 15**For
Marker
Use
Only**

- (a) The diagram shows a cross section of a transport organ in a herbaceous *dicotyledonous* plant.

A typical vascular bundle from a stem



(Source: Mauseth, J. D. 1988, *Plant Anatomy*, Benjamin/Cummings Pub. Co., USA.)

Complete this table, which refers to the diagram:

(3 marks)

Diagram letter	M	W
Name of tissue		
Material transported		
Active or passive transport		

- (b) The table shows the mass of water that is absorbed by a plant and the mass of water vapour that is lost, at different times during the day.

Time of day	Rate of water absorption in g per hour	Rate of water vapour loss in g per hour
04.00	1.5	0.25
08.00	1.5	2.0
12.00	3.6	5.0
16.00	5.5	7.5
20.00	3.3	2.5
24.00	2.0	0.75

Question 15 continues opposite.

Question 15 (continued)**For
Marker
Use
Only**

- (i) What is the process of water vapour loss called? (1 mark)

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- (ii) What is the net change in mass of the plant at 08.00? (1 mark)

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- (iii) At which time is the plant most likely to show signs of wilting? Explain your answer. (2 marks)

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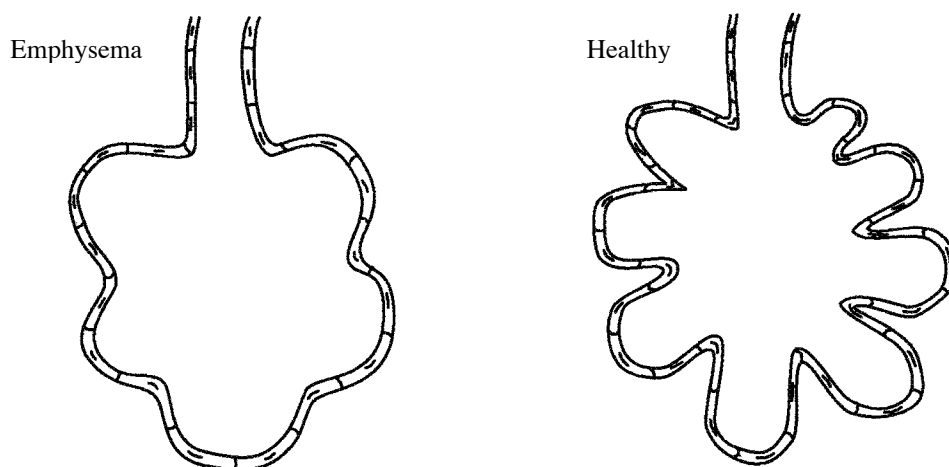
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Question 16**For
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- (a) Healthy alveoli in human lungs have many folds. In patients with emphysema the alveoli lose their folds as shown here in the diagram.



List two symptoms of a patient with emphysema. Explain each of the symptoms.
(4 marks)

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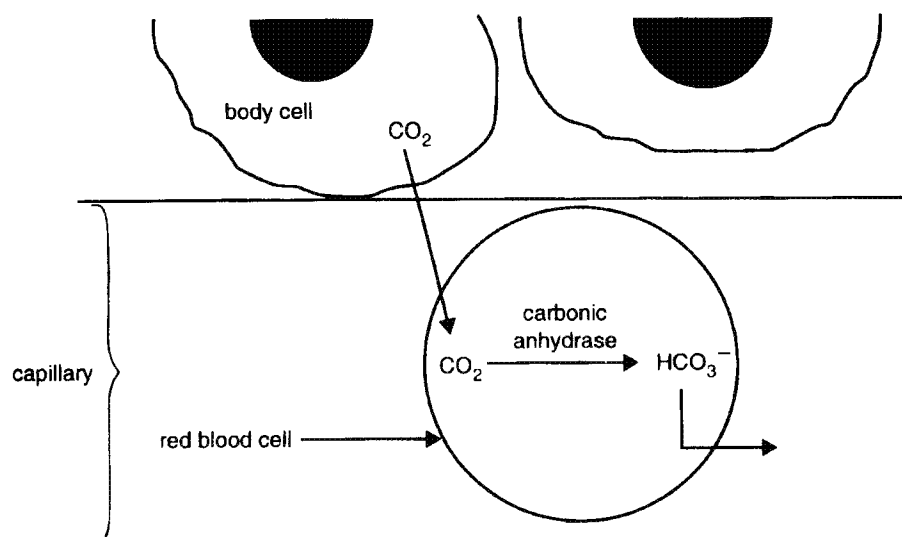
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Question 16 continues opposite.

Question 16 (continued)

**For
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- (b) (i) In mammalian blood, carbon dioxide (CO_2) is transported largely in the form of the bicarbonate ion (HCO_3^-). CO_2 produced in cells moves into capillaries and then into red blood cells where it is converted to bicarbonate ions by the action of the enzyme *carbonic anhydrase*. The bicarbonate ions produced in the red blood cells move back into the plasma. These events are summarised in the following diagram.



Explain how this conversion of carbon dioxide to bicarbonate ions in red blood cells assists in the removal of carbon dioxide from body cells. (3 marks)

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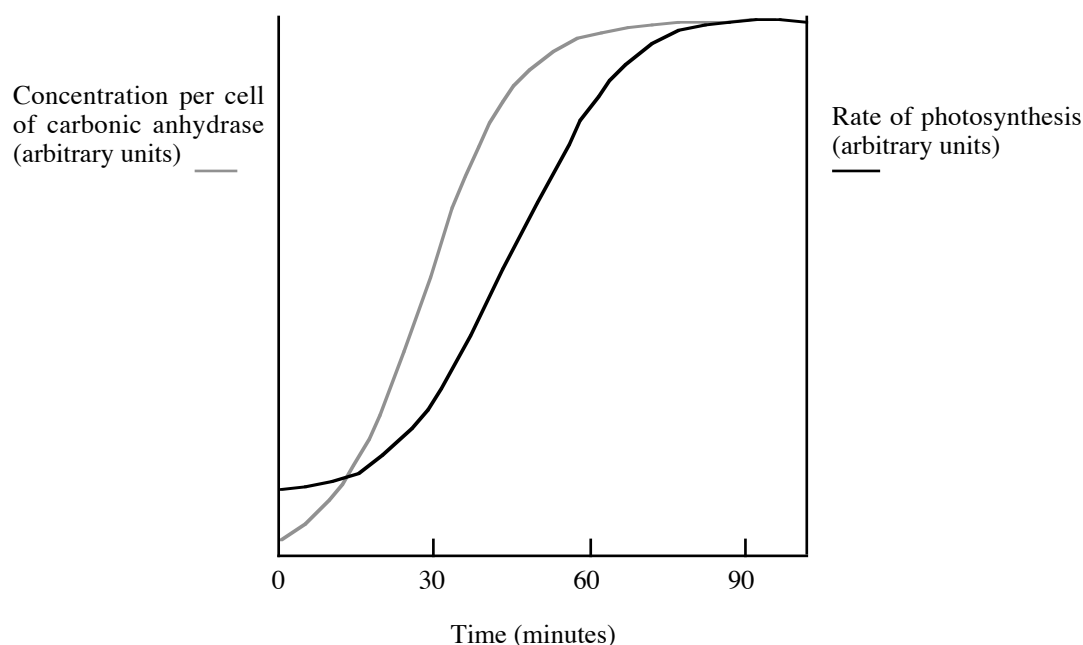
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Question 16 continues over the page.

Question 16 (continued)**For
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Use
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- (ii) In plants the enzyme *carbonic anhydrase* can also assist the reverse of the reaction described in part (b)(i), that is, the conversion of bicarbonate ions into carbon dioxide $\text{HCO}_3^- \rightarrow \text{CO}_2$.

Chlorella is a type of alga found in fresh and salt water, where bicarbonate ions may be common. When carbon dioxide is in high concentration, *chlorella* produces little carbonic anhydrase. In an experiment *chlorella* cells were transferred from water with a high concentration of carbon dioxide to water with a low concentration of carbon dioxide. Light and temperature were kept constant and a high concentration of bicarbonate ions was provided. The results are shown in the following graph



Describe the process that *Chlorella* uses in a low carbon dioxide environment. (3 marks)

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Question 17**For
Marker
Use
Only**

- (a) The tortoiseshell cat has a combination of black and orange fur. The allele for black fur is represented by X^b and the allele for orange fur is represented by X^o . A tortoiseshell female cat (X^bX^o) mates with an orange male cat (X^oY).

- (i) Using a diagram, show the genotypes and phenotypes of the F_1 generation and state the probable percentages of these. (3 marks)

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- (ii) Which, if any, allele is dominant in the above example? Explain your answer. (2 marks)

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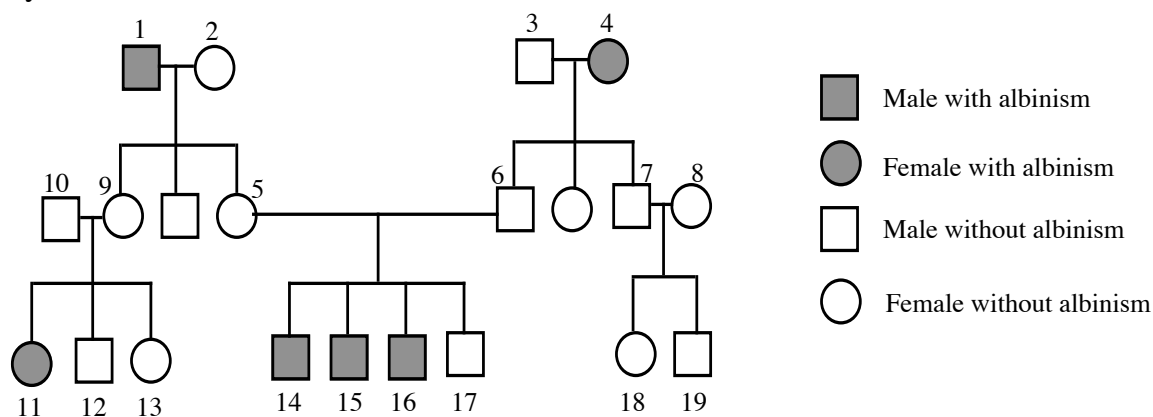
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Question 17 continues over the page.

Question 17 (continued)

- (b) 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.



Is Albinism dominant or recessive? Explain why, using a specific cross from the pedigree. (3 marks)

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Question 18**For
Marker
Use
Only**

There are populations of geckos (a small type of lizard) that consist of all-female members. They reproduce by a process called parthenogenesis, in which the females produce normal eggs but these are not fertilised. There are other populations that have male and female members which reproduce sexually.

- (a) Give **one** advantage and **one** disadvantage of reproducing by parthenogenesis. (2 marks)

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- (b) Would you expect all populations of geckos that reproduce by parthenogenesis to be genetically similar? Explain your answer. (2 marks)

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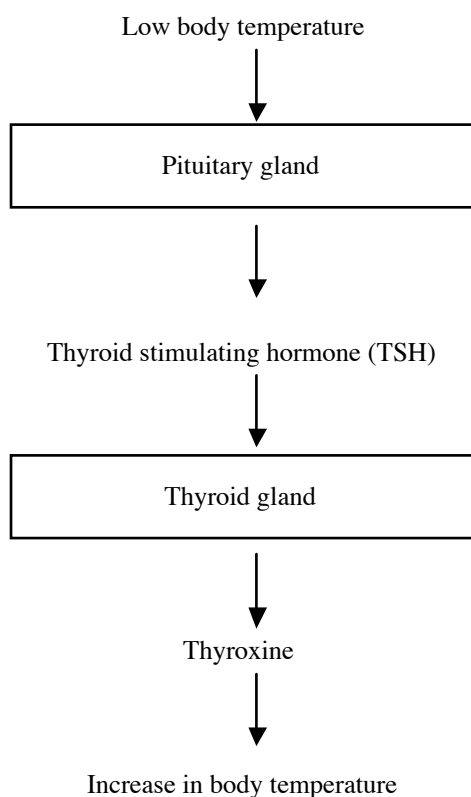
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Question 19**For
Marker
Use
Only**

Refer to the following diagram, which shows how the hormone *thyroxine* is involved in the control of body temperature.



Demonstrate your understanding of the concept of ‘negative feedback’ in maintaining homeostasis by explaining the control of body temperature illustrated above. (5 marks)

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Tasmanian Certificate of Education

BIOLOGY

Senior Secondary 5C

Subject Code: BIO5C

External Assessment

2005

Part 5

Time: 35 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 10 Demonstrate knowledge and understanding of the interaction of organisms in their environment.

Section Total

/34

Pages: 11
Questions: 6

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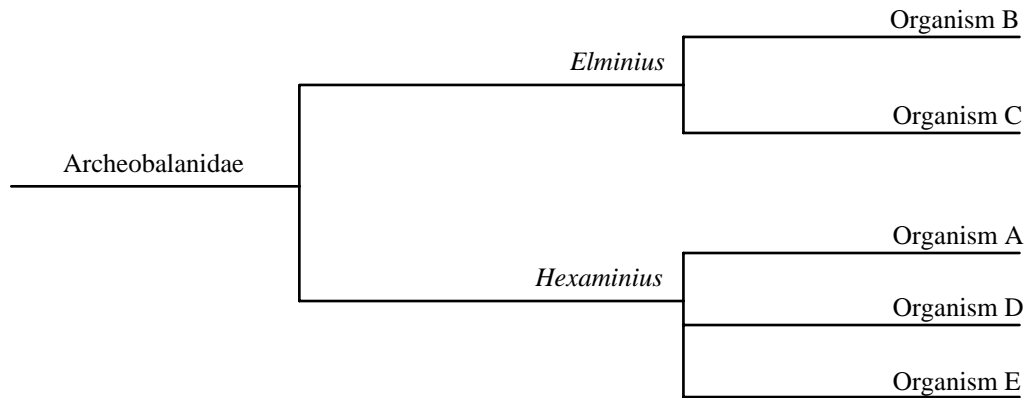
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The 2005 Biology Information Sheet can be used throughout the examination.

Question 20

A biologist discovered two species of barnacles that resembled each other, one in New Zealand and the other in Australia. Organism A was given the specific name *popeiana*. Organism B was given the specific name *covertus*. Later, species C, D and E were found. The relationships between the species are illustrated using the following diagram.



- (a) Give the binomial name for organism A. (1 mark)

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- (b) Is organism C, or organism E, more closely related to organism A? Explain your answer. (2 marks)

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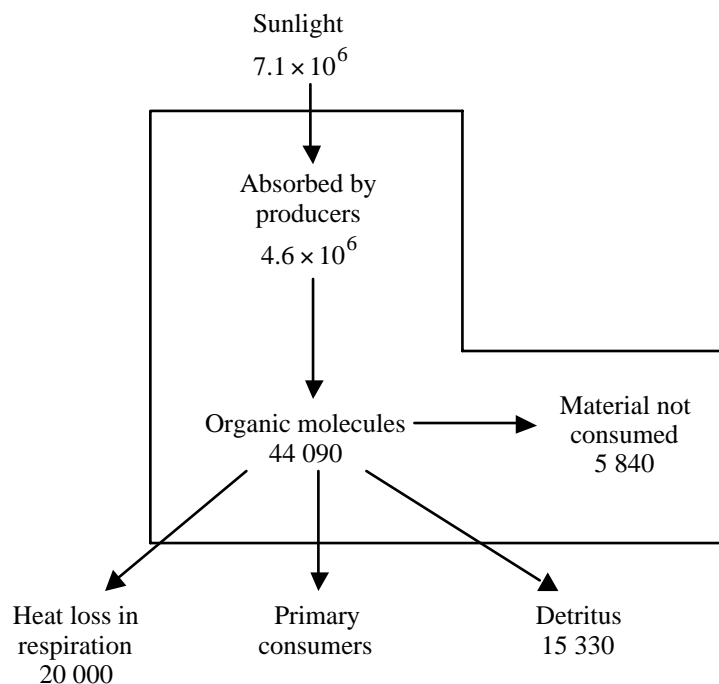
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Question 21**For
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- (a) The diagram shows the annual transfer of energy in a forest ecosystem. The figures are in kJm^{-2} .



- (i) Although the producers absorb $4.6 \times 10^6 \text{ kJm}^{-2}$, only about 1% of this is transferred to organic molecules. Suggest **one** reason for this. (1 mark)

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- (ii) Calculate the energy transferred to primary consumers in this ecosystem. (1 mark)

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- (iii) Explain why a food chain rarely contains more than four trophic levels. (3 marks)

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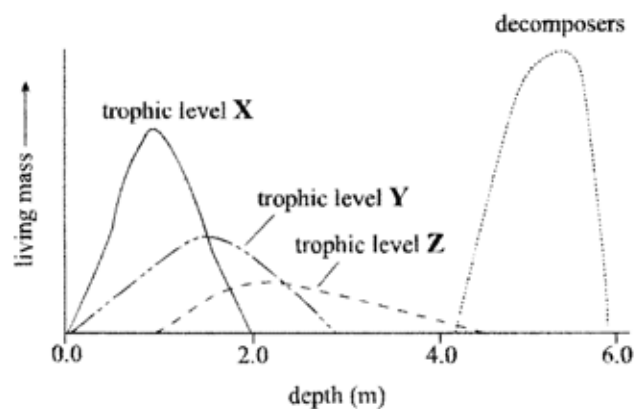
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Question 21 (continued)**For
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- (b) Refer to the following graph, which shows the distribution of the living mass of organisms in four trophic levels of a lake community at various depths.



- (i) State one piece of evidence from the graph that shows that organisms in trophic level **X** are autotrophs. (1 mark)

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- (ii) Explain why the living mass of decomposers is greater than that of any other single trophic level in the lake. (2 marks)

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- (iii) Present trophic levels X, Y and Z in the above graph as a pyramid of living biomass. (1 mark)

Question 22**For
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- (a) Arctic and Antarctic waters are near freezing. Despite the low temperatures, seals and whales live successfully in these seas.
- (i) Data were collected on some of the characteristics of seals and compared with equivalent data about humans. The data are given in the following table.

Feature	Human	Seal
1. Mass (kg)	80	80
2. Average body temperature (°C)	37	37
3. O ₂ consumption/kg/hr	0.21	0.80
4. Body fat (%)	25	58

From the data provided, explain how features 3 and 4 assist seals to live in Arctic and Antarctic waters. (4 marks)

Feature 3

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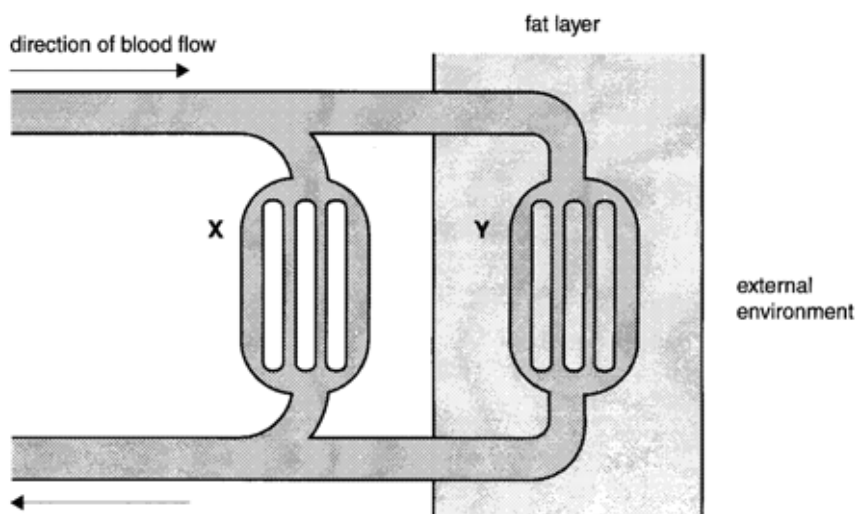
Feature 4

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- (ii) Seals spend part of their time lying in the sun. In this situation, a seal faces a potential problem of overheating. The following diagram shows the arrangement of blood vessels in the body of a seal. Note that **X** and **Y** are alternative pathways and blood flow can bypass the fat layer.



Question 22 continues opposite.

Question 22 continued**For
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Explain the conditions under which blood would mainly flow through capillary network X. (2 marks)

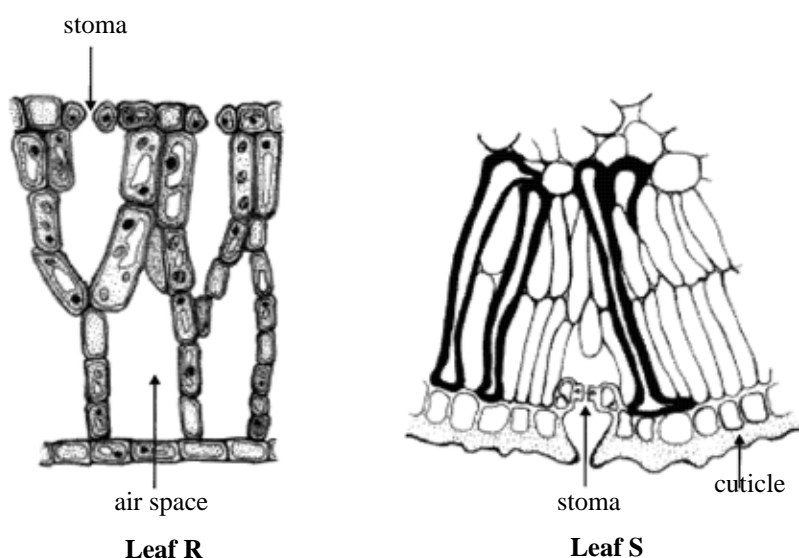
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- (b) *Potamogeton* is an aquatic plant that grows on the surfaces of ponds. A transverse section of a portion of a pondweed leaf is shown as Leaf R. Leaf S is a transverse section of a portion of a leaf from a *Hakea*, a plant which grows in dry places.



Note the location of stomata in each of the leaves.

- (i) Explain the advantage of stomata being located on the upper rather than the lower surface of pondweed leaves (Leaf R). (1 mark)

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- (ii) What is the function of the large air spaces in pondweed leaves? (1 mark)

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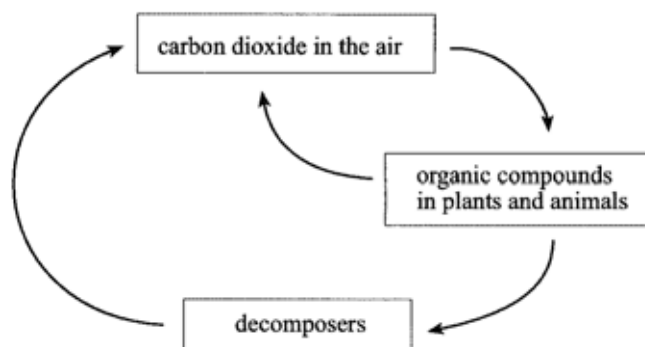
- (iii) What is the function of the very thick cuticle of *Hakea* leaves? (1 mark)

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Question 23

Refer to the following diagram, which shows the carbon cycle in a stable woodland community.



- (a) With reference to the diagram above, state the role of decomposers in the carbon cycle. (2 marks)

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- (b) Recent discussions on what to do about global warming have produced the idea that farmers should reduce the amount of ploughing they do. Ploughing allows air to enter the soil and helps with the recycling of both carbon and nitrogen. A reduction in ploughing would cut the oxidation of organic matter being stored in soils, which would then act as another carbon 'sink'.

Explain how a reduction in the amount of ploughing would lead to more carbon being stored in the soil. (3 marks)

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Question 24**For
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The Pedra Branca Skink, *Niveoscincus palfreymani*, is a small lizard found only on Pedra Branca Rock, a small craggy island located 26 km off the southeastern coast of Tasmania. Pedra Branca Rock was connected to Tasmania during the ice age, 20 000-15 000 years ago, but has been isolated since as a result of higher sea levels. No living or fossil record of this lizard has been found anywhere else, whether in Tasmania or on the Australian mainland.

The existence of *Niveoscincus palfreymani* on Pedra Branca Rock is a result of speciation. Explain how this speciation could have occurred. (4 marks)

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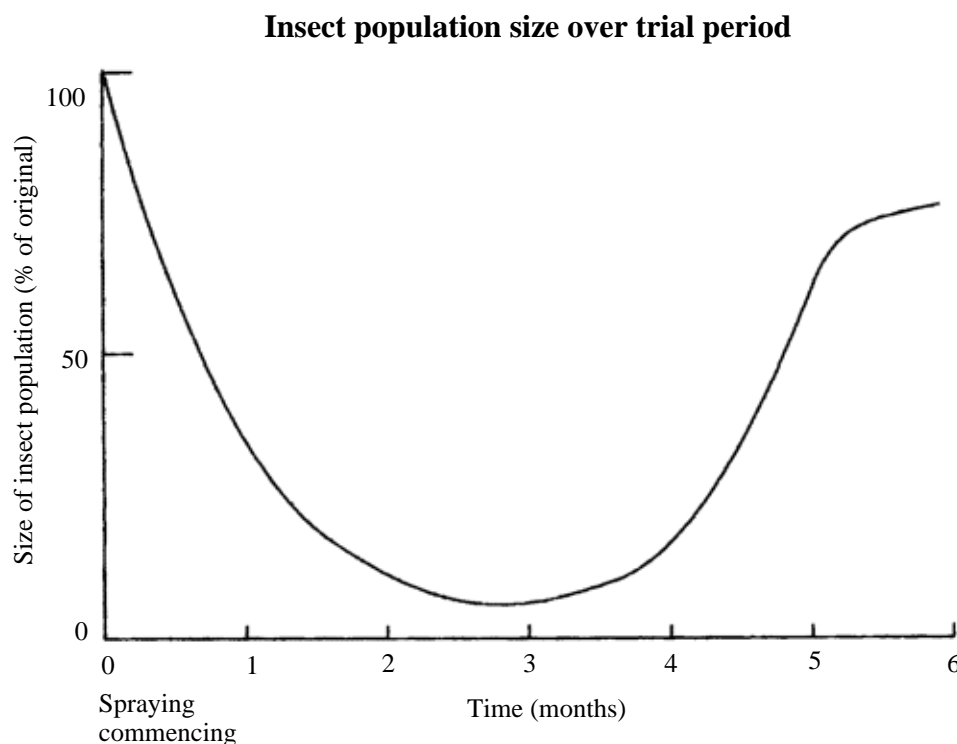
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Question 25**For
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A scientific study was carried out to test the effect of commercially produced pyrethrum on an insect population on an isolated island. Pyrethrum was sprayed at weekly intervals for six months. During this time the climatic conditions on the island remained constant.

The following graph shows the change in the insect population during the study.



- (a) (i) What kind of population growth is occurring during month 5? (1 mark)

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- (ii) Provide an explanation for why this growth is occurring at this time in the 6-month spraying cycle. (2 marks)

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- (b) Provide a reason for the change in growth during month 6. (1 mark)

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