Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2004
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA5
Unit 5 Inheritance, Evolution and Ecosystems

Tuesday 22 June 2004 Morning Session

No additional materials are required.
You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

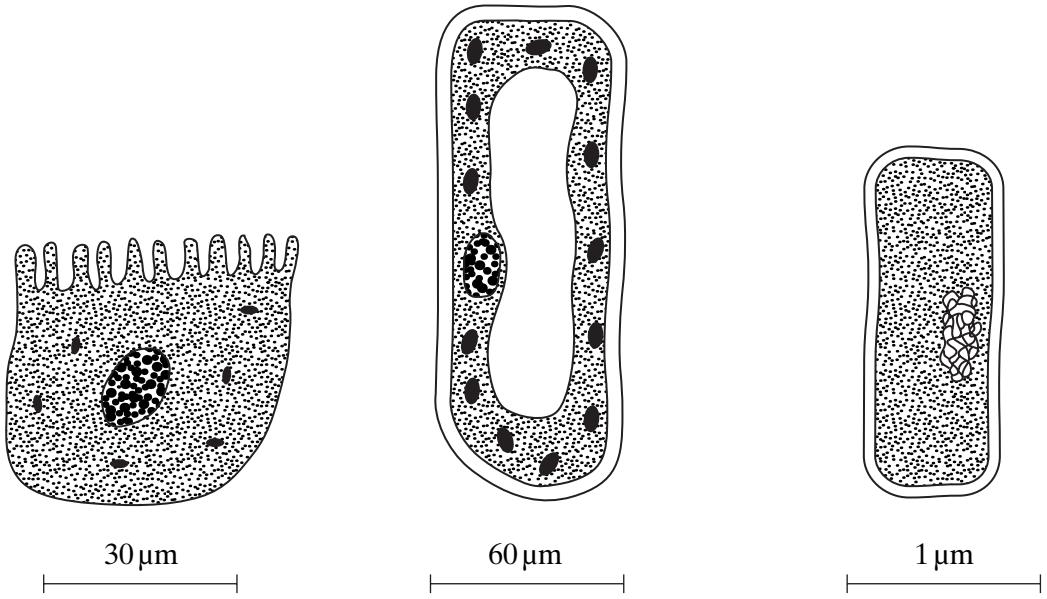
Information

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 The drawings show three cells. Two of the cells are from multicellular organisms and one is a single-celled organism. The three organisms belong to different kingdoms.



Cell A **Cell B** **Cell C**

Name the kingdom to which each organism belongs. In each case, give **one** feature of the cell, visible in the drawing, which is characteristic of the kingdom and which helps to distinguish it from cells of organisms belonging to the other two kingdoms.

Cell A Kingdom .....

Feature .....

.....

Cell B Kingdom .....

Feature .....

.....

Cell C Kingdom .....

Feature .....

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(6 marks)

6

2 Division of the nucleus by meiosis produces haploid cells from a diploid cell. Nuclei produced by mitosis have the same number of chromosomes as the parent nucleus.

(a) What is the biological importance of reducing the chromosome number when the cell divides by meiosis?

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(2 marks)

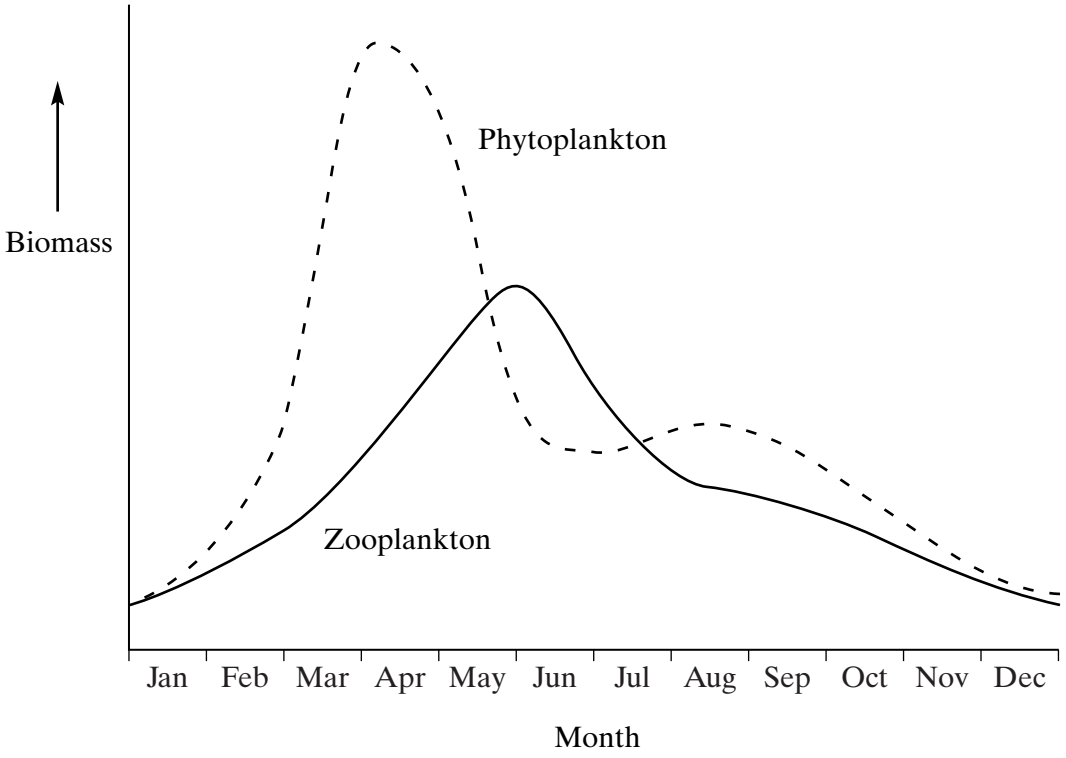
(b) The table gives one difference between meiosis and mitosis. Complete the table by giving **three** further differences.

	Meiosis	**Mitosis**
1	Reduces the chromosome number	Maintains the same chromosome number as in the parent nucleus
2		
3		
4		

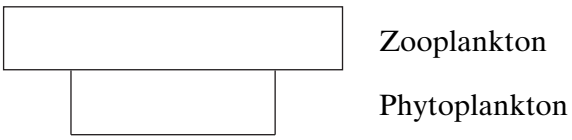
(3 marks)

5

3 Phytoplankton are microscopic photosynthesising organisms which live in water. In favourable environmental conditions they have a very high rate of reproduction. They are eaten by microscopic animals called zooplankton. In an investigation, samples of water were removed from a lake at intervals over a twelve-month period and the biomasses of these organisms were determined. The results are shown in the graph.



The diagram shows the relationship between the biomass of the phytoplankton and the biomass of the zooplankton for one of the months during this investigation.



(a) Use the graph to give **one** month in which this relationship would have been found.

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(1 mark)

(b) Explain why the biomass of the primary consumers is less than the biomass of the producers in most communities.

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(3 marks)

(c) Explain why the biomass of the phytoplankton in the lake could be less than that of the zooplankton, as shown in the diagram.

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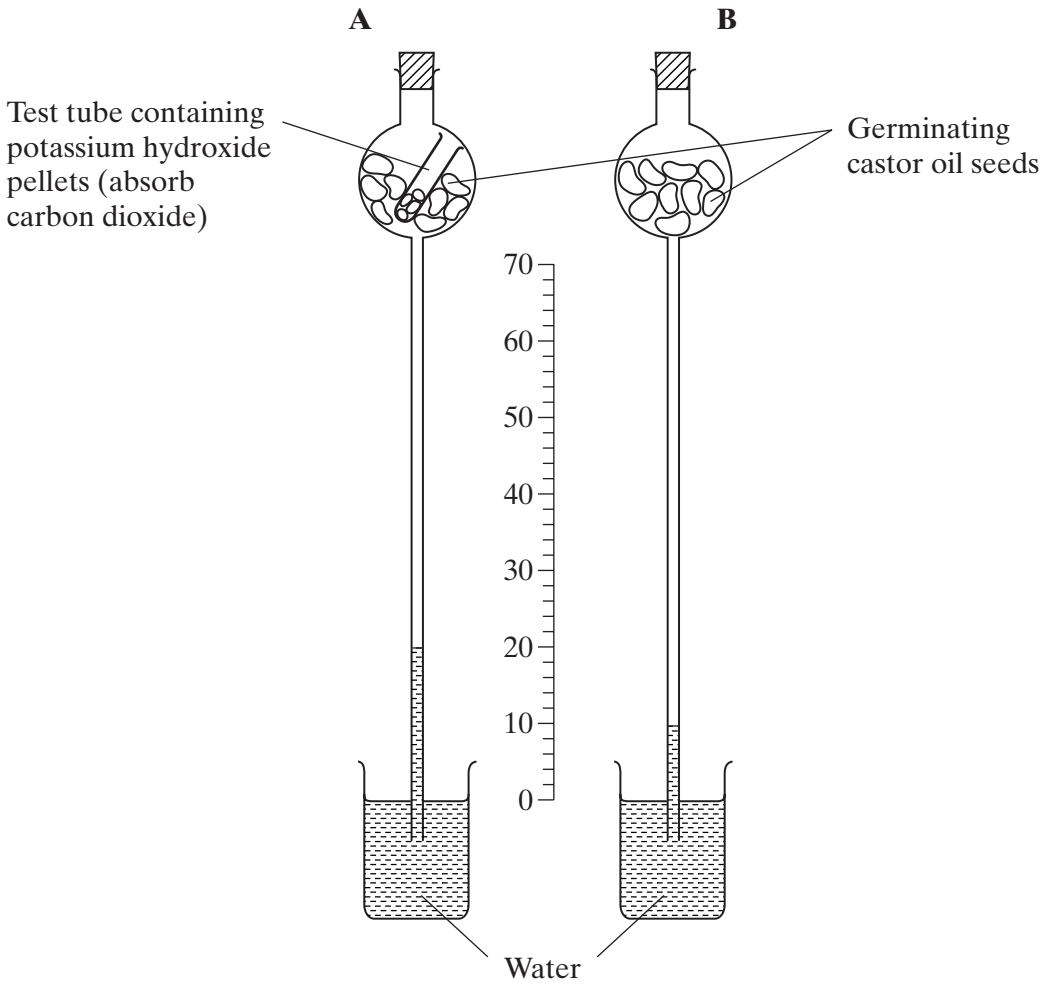
(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

4 The two sets of apparatus shown in the diagram were used to find the volume of oxygen used and the volume of carbon dioxide produced by germinating castor oil seeds. Both **A** and **B** contained the same mass of seeds. Apparatus **A** also contained a small test tube of potassium hydroxide pellets which absorbed carbon dioxide from the air in the apparatus. Over a 24-hour period, the water rose up the glass tube in each apparatus. The water rose further in apparatus **A** than in apparatus **B**.



(a) The changes in volume of gas in apparatus **A** and in apparatus **B** were calculated. Explain how the changes in volume in apparatus **A** and apparatus **B** could be used to find

(i) the volume of oxygen used by the seeds; .....

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(1 mark)

(ii) the volume of carbon dioxide produced by the seeds. .....

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(2 marks)

(b) (i) The main food reserve of castor oil seeds is a substance called triricinolein. The equation shows oxidation of this substance.

$$2\ C_{57}H_{104}O_9 + 157\ O_2 \longrightarrow 114\ CO_2 + 104\ H_2O$$

Use the equation to calculate the respiratory quotient (RQ) when triricinolein is used as the respiratory substrate. Show your working.

RQ = ...

(2 marks)

(ii) The RQ for the germinating castor oil seeds, determined using the apparatus in the diagram, was 0.85. Apart from experimental error, suggest **one** reason for the difference between this value and the answer to part (b)(i).

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(1 mark)

6

5 Mayflies are insects which lay their eggs in streams and rivers. The nymphs which hatch from the eggs live in the water for several years.

Mayfly nymphs were collected by disturbing the gravel of a stream bed. A net placed immediately downstream caught any animals which were washed out of the gravel. Eight samples were collected from shallow, fast-flowing parts of the stream and eight from deeper, slow-flowing parts. Nymphs from two different families of mayfly were found. The results are given in the table.

	Family Caenidae		**Family Baetidae**	
	Shallow water	**Deep water**	**Shallow water**	**Deep water**
Mean number of nymphs	2.38	12.88	24.50	6.00
Standard deviation	1.51	7.92	6.72	1.51

(a) Describe how you would have collected the samples in order to ensure they were representative of the habitats being investigated and could be compared with each other.

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(3 marks)

(b) Which **one** of the four samples showed the greatest variation within the sample? Give evidence from the table for your answer.

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(1 mark)

(c) The two families of mayfly nymph occupy different ecological niches.

(i) What is meant by the term *ecological niche*?

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(1 mark)

(ii) Describe the evidence in the table which suggests that the two families of mayflies occupy different ecological niches.

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(1 mark)

(iii) Explain the advantage to these two families of mayflies of occupying different ecological niches.

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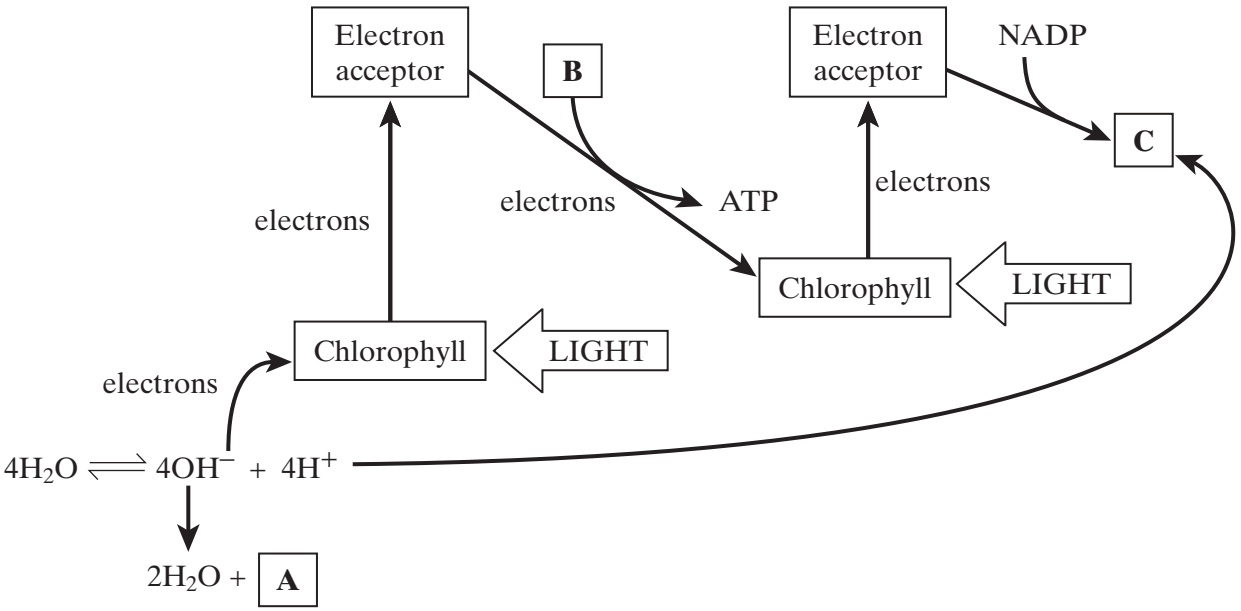
(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

6 The diagram shows the light-dependent reactions of photosynthesis.



(a) In which part of a chloroplast do the light-dependent reactions occur?

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(1 mark)

(b) Name the substances in boxes **A**, **B** and **C**.

A .....

B ..... + ...

C .....

(3 marks)

(c) Use information in the diagram to explain

(i) the role of chlorophyll in photolysis;

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(3 marks)

(ii) how the energy of light is converted into chemical energy in the light-dependent reactions.

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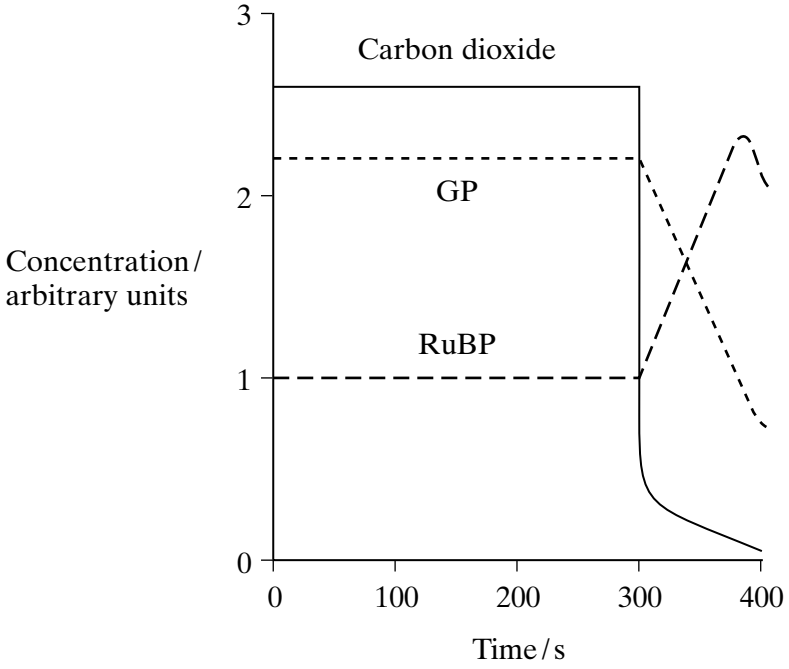
(3 marks)

QUESTION 6 CONTINUES ON THE NEXT PAGE

(d) In an investigation, single-celled algae were kept in bright light and were supplied with carbon dioxide containing radioactive carbon atoms. After 300 seconds, the carbon dioxide supply was turned off. The graph shows how the concentrations of carbon dioxide, glycerate 3-phosphate (GP) and ribulose bisphosphate (RuBP) changed.



(i) Explain why, between 0 seconds and 300 seconds, the concentration of radioactive GP remained constant.

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(3 marks)

(ii) Explain why, between 300 seconds and 380 seconds, the concentration of radioactive RuBP increased.

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(2 marks)

7 Warfarin is a substance which inhibits blood clotting. Rats which eat warfarin are killed due to internal bleeding. Some rats are resistant to warfarin as they have the allele $\mathbf{W^R}$. Rats have three possible genotypes:

$\mathbf{W^RW^R}$	resistant to warfarin
$\mathbf{W^RW^S}$	resistant to warfarin
$\mathbf{W^SW^S}$	susceptible (not resistant) to warfarin.

In addition, rats with the genotype $\mathbf{W^RW^R}$ require very large amounts of vitamin K in their diets. If they do not receive this they will die within a few days due to internal bleeding.

(a) How can resistance suddenly appear in an isolated population of rats which has never before been exposed to warfarin?

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(1 mark)

(b) A population of 240 rats was reared in a laboratory. They were all fed on a diet containing an adequate amount of vitamin K. In this population, 8 rats had the genotype $\mathbf{W^SW^S}$, 176 had the genotype $\mathbf{W^RW^S}$ and 56 had the genotype $\mathbf{W^RW^R}$.

(i) Use these figures to calculate the actual frequency of the allele $\mathbf{W^R}$ in this population. Show your working.

Answer .....

(2 marks)

(ii) The diet of the rats was then changed to include only a small amount of vitamin K. The rats were also given warfarin. How many rats out of the population of 240 would be likely to die within a few days?

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(1 mark)

QUESTION 7 CONTINUES ON THE NEXT PAGE

(c) In a population of wild rats, 51% were resistant to warfarin.

(i) Use the Hardy-Weinberg equation to estimate the percentage of rats in this population which would be heterozygous for warfarin resistance. Show your working.

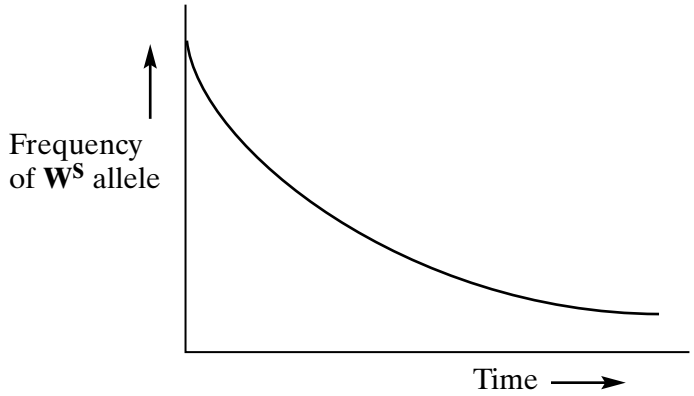
Answer ..... %

(3 marks)

(ii) If all the susceptible rats in this population were killed by warfarin, more susceptible rats would appear in the next generation. Use a genetic diagram to explain how.

(2 marks)

(iii) The graph shows the change in the frequency of the $\mathbf{W^S}$ allele in an area in which warfarin was regularly used. Describe and explain the shape of the curve.



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(4 marks)

(iv) Give **two** assumptions that must be made when using the Hardy-Weinberg equation.

1 .....

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2 .....

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(2 marks)

15

Turn over ▶

8 (a) Substances found in fallen leaves contain the elements carbon and nitrogen. Explain how the activities of decomposers and nitrifying bacteria recycle the substances in fallen leaves for re-use by the trees.

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(7 marks)

(b) Explain how the felling and burning of trees on a large scale could affect the concentration of carbon dioxide in the atmosphere.

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(2 marks)

(c) Both rapidly-growing softwood trees and slow-growing hardwood trees grow in tropical rainforests. The seeds of both kinds of tree lie dormant on the floor of a mature forest and only germinate when exposed to light and warmth. However, the seedlings of many hardwood species grow more successfully beneath the protective canopy of the softwood trees.

When a small area of trees has been cut down, it can return naturally to tropical rainforest. Suggest and explain how re-establishment of the rainforest ecosystem may occur in such areas.

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(6 marks)

15

END OF QUESTIONS

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