Rewarding Learning

ADVANCED
General Certificate of Education
2017

Centre Number

Candidate Number

Biology

Assessment Unit A2 1
assessing
Physiology and Ecosystems

[AB211]

MV18

MONDAY 12 JUNE, AFTERNOON

Time

2 hours, plus your additional time allowance.

Instructions to Candidates

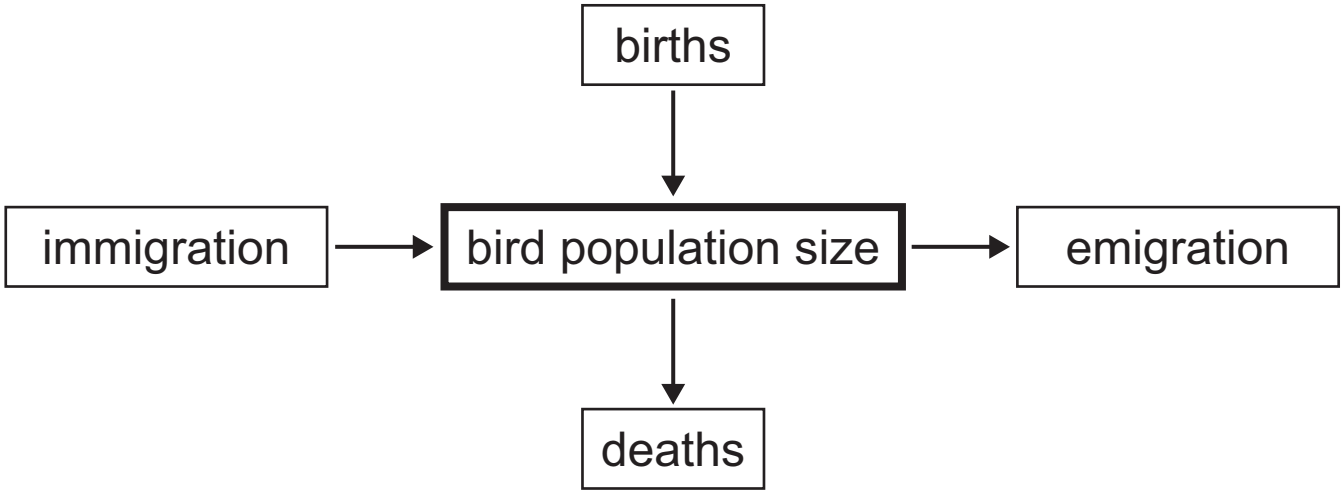
Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Complete in black ink only.
Answer **all nine** questions.

Information for Candidates

The total mark for this paper is 90.
Section A carries 72 marks. Section B carries 18 marks.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
You are reminded of the need for good English and clear presentation in your answers.
Use accurate scientific terminology in all answers.
You should spend approximately **25 minutes** on Section B.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in Section B, and awarded a maximum of 2 marks.

Section A

1 The diagram below shows factors which affect the size of a bird population.



(a) Using the information in the diagram, complete the equation below. [1 mark]

bird population size = **initial population** + **(births –** _____ **)**

+ **(**_____ **– emigration)**

(b) Identify **two** factors which could cause a decrease in the number of births. [2 marks]

1. _____

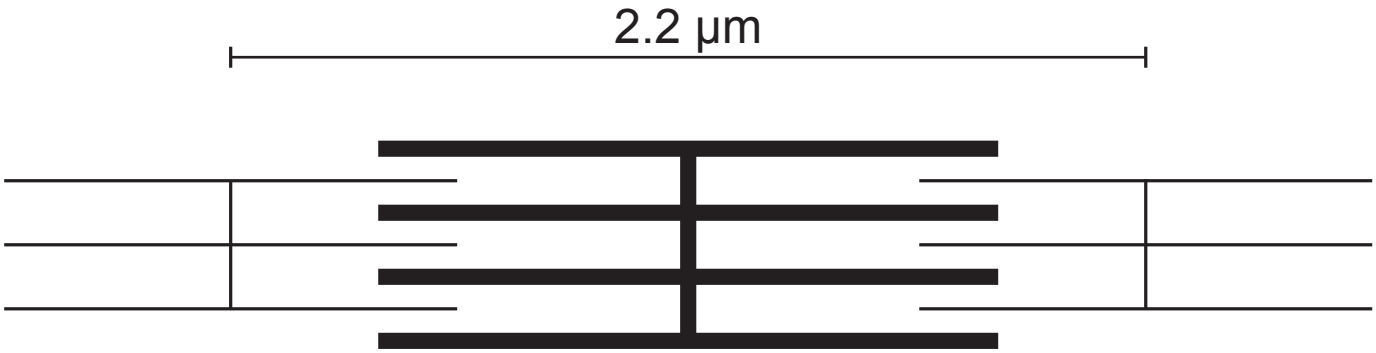
2. _____

(c) With reference to the diagram above, state **one** factor which would not affect a population of bacteria in a beaker. [1 mark]

_____

2 The diagrams below represent one sarcomere in both relaxed and contracted states. (Scale bars are included.)

Relaxed



Contracted

(a) State the name of the inorganic ion required for muscle contraction and describe its role. [2 marks]

Ion _____

Role _____

_____

_____

(b) A myofibril in the biceps muscle consists of 10 000 sarcomeres.

Using this information and the diagram on page 4, calculate the actual length of the **myofibril** in millimetres when in the **contracted** state. [3 marks]

(Show your working.)

_____ mm

3 Flowering plants can be classified as long-day plants (**LDP**) or short-day plants (**SDP**).

In an investigation, long and short-day plants were exposed to 5 different lighting regimes.

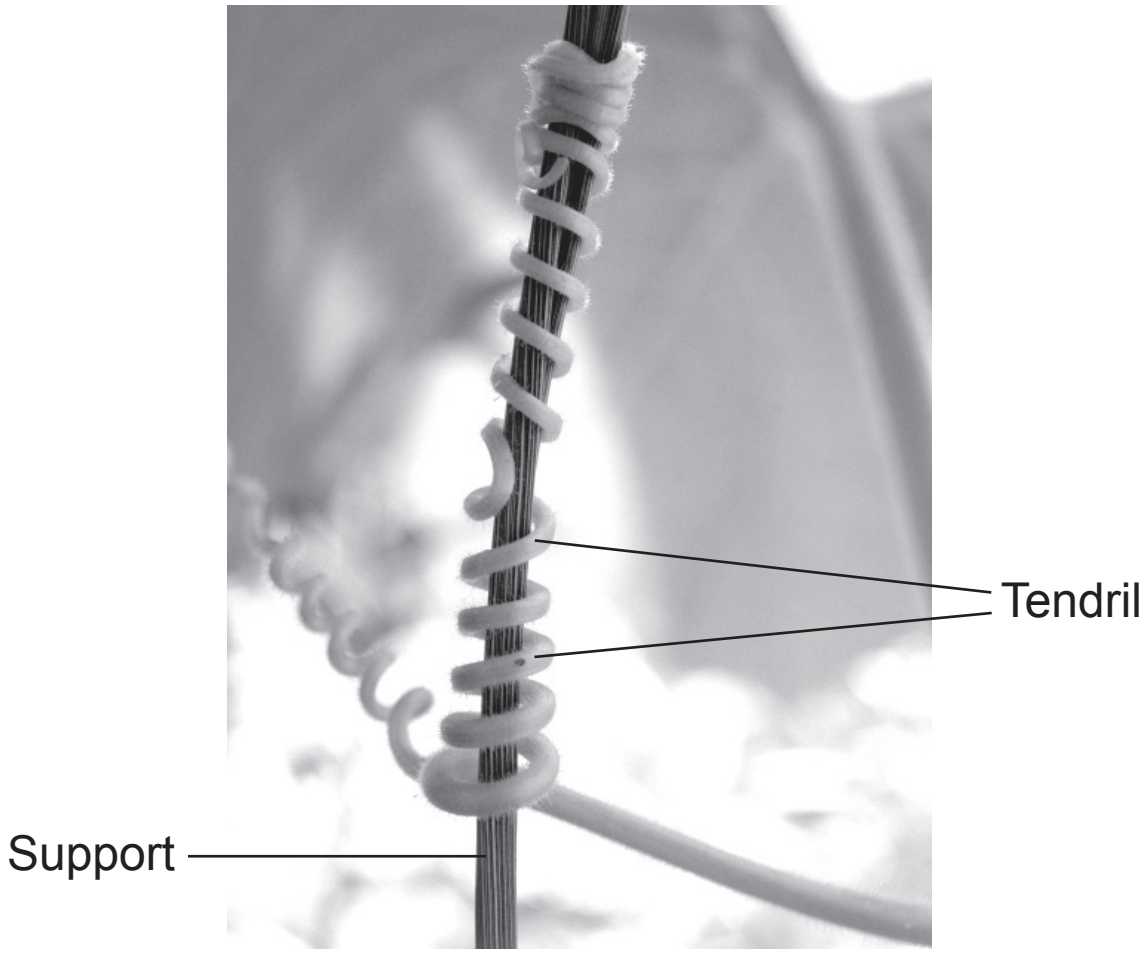
(R = red light, FR = far-red light)

(a) (i) Complete the table by indicating whether the plant will flower (✔) or not flower (✘). [2 marks]

	Lighting regime	Flowering response	
		LDP	SDP
1		✘	✔
2			
3			
4			
5			

(ii) Explain the result for lighting regime **4** in terms of phytochrome conversion. [3 marks]

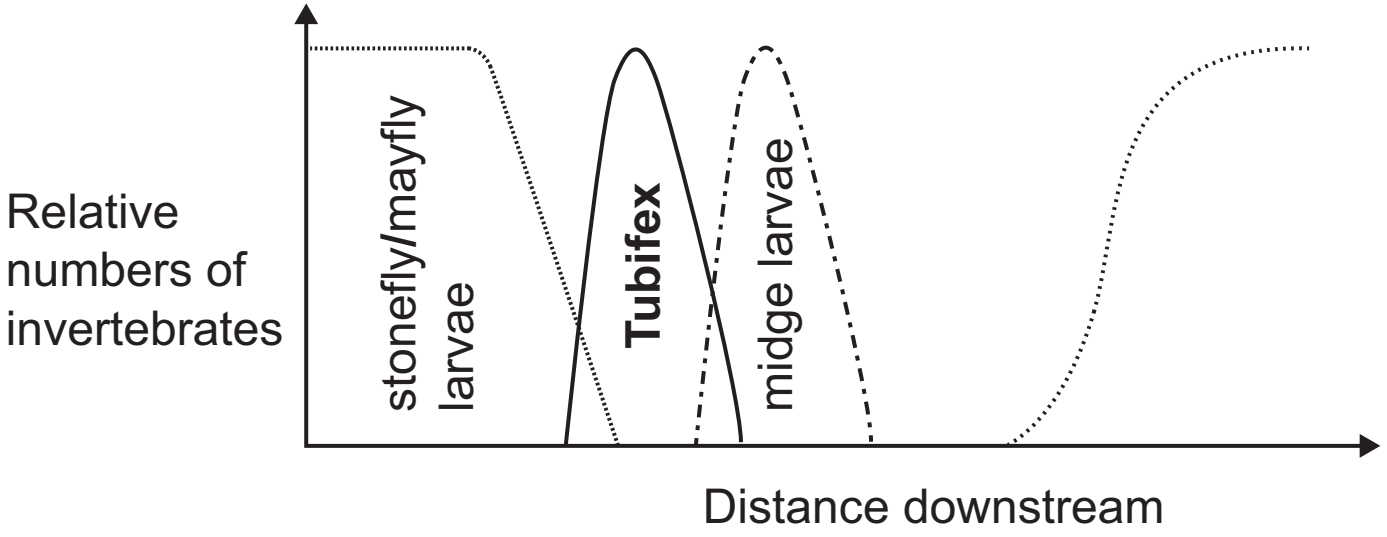
(b) Some plant species, such as sweet pea (**Lathyrus odoratus**), produce small shoots called tendrils. These tendrils grow around stems or other supports, as shown below. This growth response is known as thigmotropism and is controlled by auxin in a similar way to phototropism. In thigmotropism, the stimulus is contact with the support and **not** light.

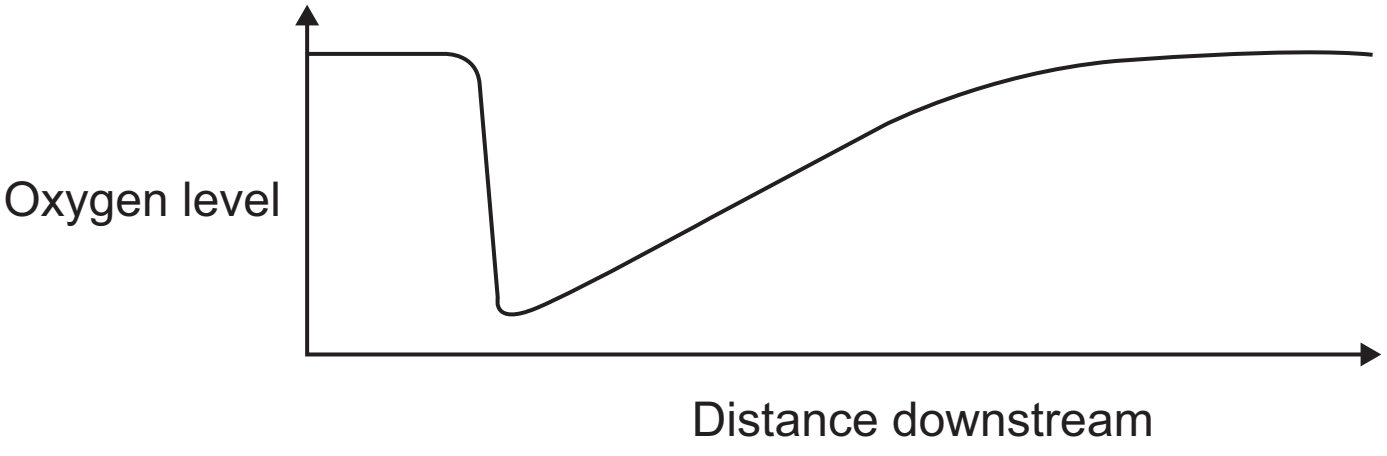


Suggest a mechanism by which this growth response may occur. [2 marks]

4 Ecologists can measure the quality of water in a river by assessing the number of indicator species present. These are often invertebrates. The oxygen levels and relative numbers of invertebrates along a section of river are shown in the graphs below.

An organic pollutant was released into the river along this section.



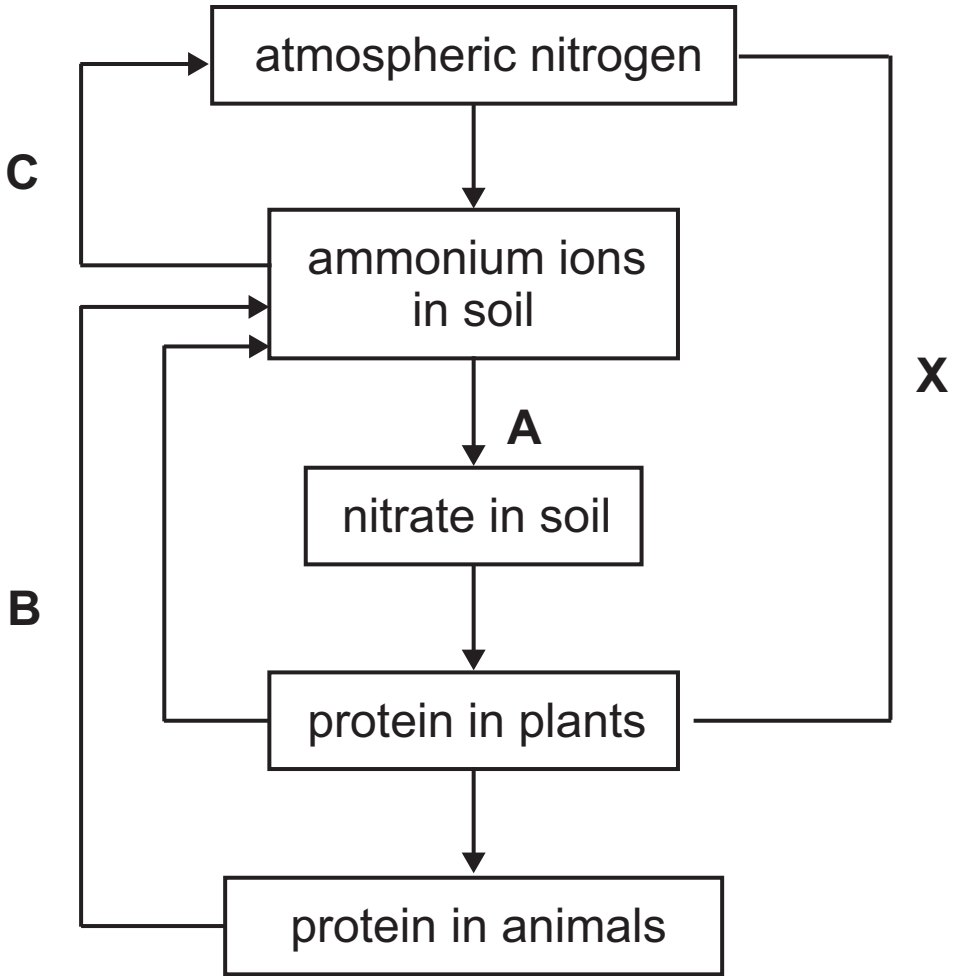


(a) Using an arrow, indicate on either x-axis the distance downstream at which the organic pollutant is released into the river. [1 mark]

(b) Explain the effect of the organic pollutant on the oxygen in the river at this site. [2 marks]

(c) **Tubifex** worms are deep red in colour. Suggest a possible reason for this colour in worms living in an environment with a low partial pressure of oxygen. Explain this adaptation. [2 marks]

5 A summary of the nitrogen cycle is shown in the diagram below.



(a) Identify processes **A**, **B** and **C**. [3 marks]

A _____

B _____

C _____

(b) (i) Process **A** is carried out by organisms in the soil. State the name of the kingdom to which these organisms belong. [1 mark]

_____

(ii) Describe **one** soil condition which would promote process **A**. [1 mark]

_____

_____

(iii) Describe **two** ways in which a farmer could develop or maintain such a condition. [2 marks]

1. _____

_____

2. _____

_____

(c) The process labelled **X** on the diagram occurs in root nodules of leguminous plants such as clover.

(i) Describe how atmospheric nitrogen can be used to make plant protein, via process **X**. [2 marks]

Researchers wished to investigate the effect of fertiliser concentration on the number of root nodules present in clover.

(ii) Predict the relationship between fertiliser concentration and the number of root nodules. [1 mark]

The researchers grew clover in different concentrations of nitrate.
The concentrations used were 0, 5, 10, 15, 20, 25 mmol dm^{-3}.

(iii) Suggest why this range was chosen. [2 marks]

They gathered data for three individual plants at each concentration.

The results are shown in the table below.

Nitrate concentration /mmol dm^{-3}	Number of root nodules		
	Plant 1	Plant 2	Plant 3
0	21	26	20
5	19	21	17
10	15	16	13
15	12	11	9
20	7	6	9
25	4	3	4

(iv) Identify the main conclusion that can be drawn from this data. [1 mark]

_____

_____

(v) Suggest **two** reasons for the variation in the data at each nitrate concentration. [2 marks]

1. _____

_____

2. _____

_____

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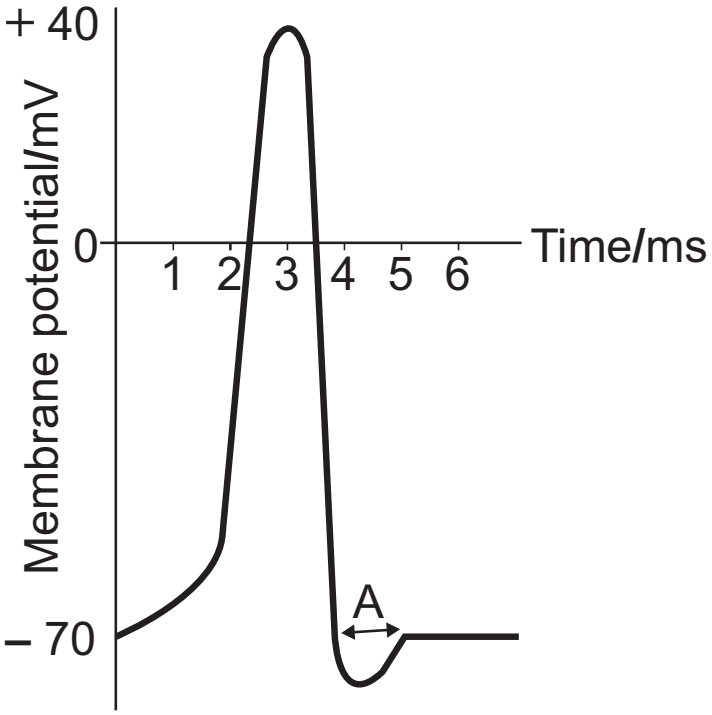
(Questions continue overleaf)

6 The changes in membrane potential during the generation of an action potential are shown below.



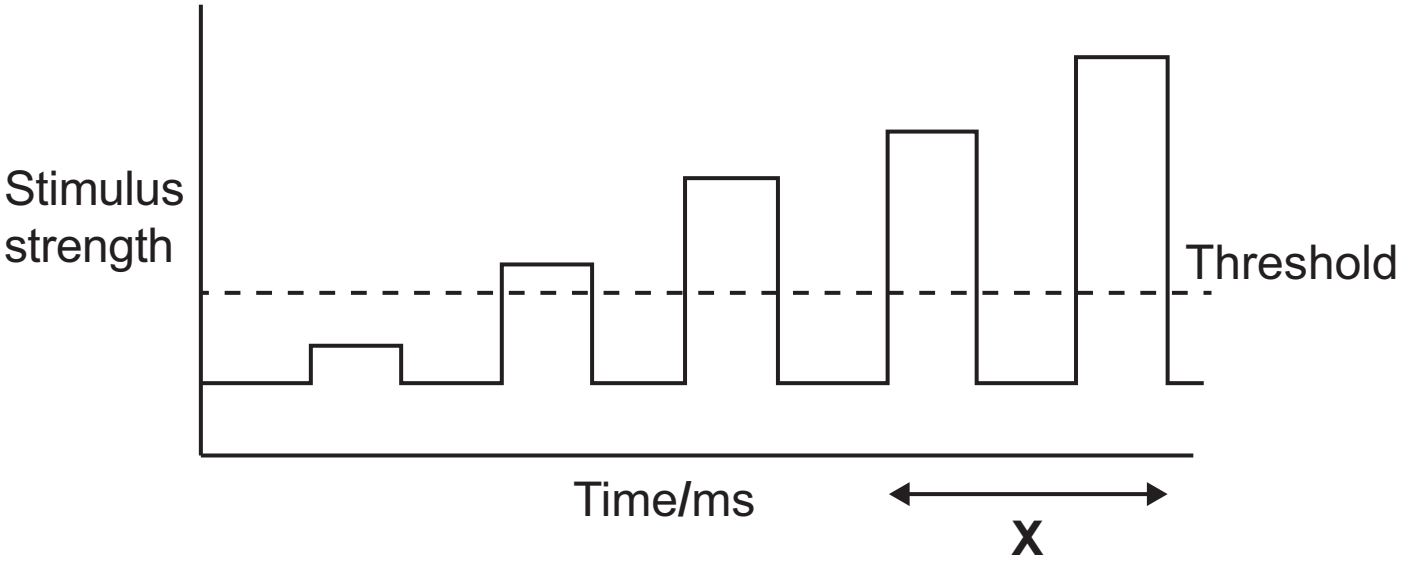
(a) (i) Explain the change in membrane potential between 1 and 3 ms. [2 marks]

(ii) State the term that describes the period labelled **A** on the graph and explain its importance. [2 marks]

(b) Researchers investigated the relationship between the strength of a stimulus and the number of action potentials per unit time.

The results are summarised below.

Number of action potentials	0	3	6	10	10



(i) Describe the relationship between stimulus strength and the number of action potentials. [2 marks]

(ii) Explain the results shown in the section labelled **X**. [2 marks]

_____

_____

_____

_____

_____

_____

(iii) State **two** suitable controlled variables for this investigation. [2 marks]

1. _____

2. _____

7 Forest fires are common in Canada. After a fire, it may take 70 to 80 years for trees such as Jack pine (**Pinus banksiana**) to form mature forest and up to 140 years for the canopy to close completely. (With canopy closure the sky is no longer directly visible from the forest floor.)

(a) (i) State the type of succession that occurs after a forest fire. [1 mark]

_____

(ii) Give **one** reason why this type of succession is relatively fast. [1 mark]

_____

_____

_____

_____

(iii) As the forest canopy closes, light intensity on the forest floor decreases. Describe and explain how **one** other environmental factor changes as the forest canopy closes. [2 marks]

_____

_____

_____

_____

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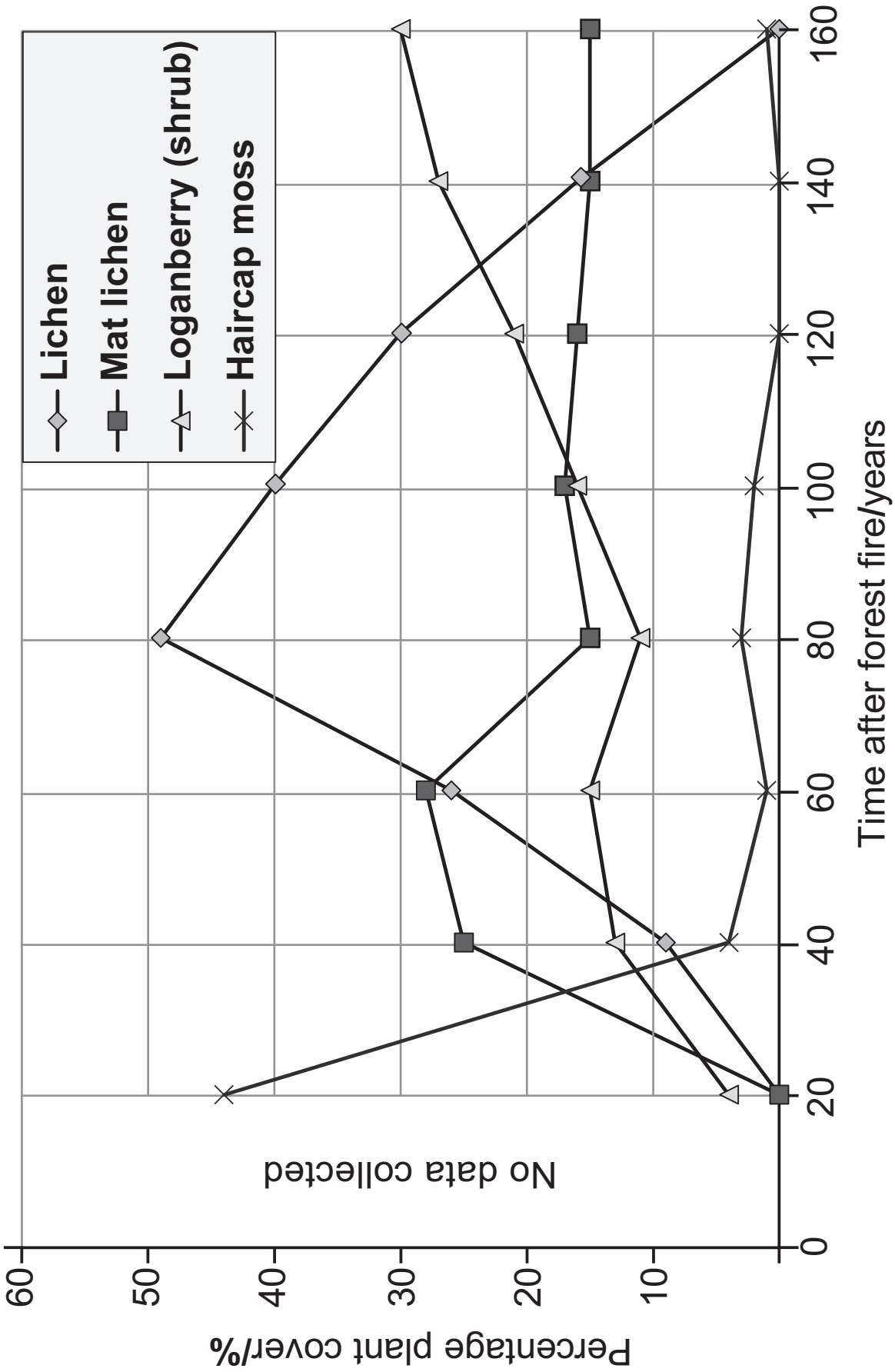
(Questions continue overleaf)

The percentage cover of four plant species that recolonise the forest floor in the years following a fire is shown in the graph opposite on page 25.

(b) (i) Explain why the information shown in the graph represents part of a community. [1 mark]

(ii) Explain the trend shown for Haircap moss. [2 marks]



Jack pine trees produce cones that contain seeds.
The cones are ‘glued’ closed, so their seeds cannot be released in ‘normal’ conditions. The glue only melts at high temperature.

(c) Using this information and your understanding of succession, suggest reasons why a forest fire will lead to an increased number of new Jack pine trees.
[3 marks]

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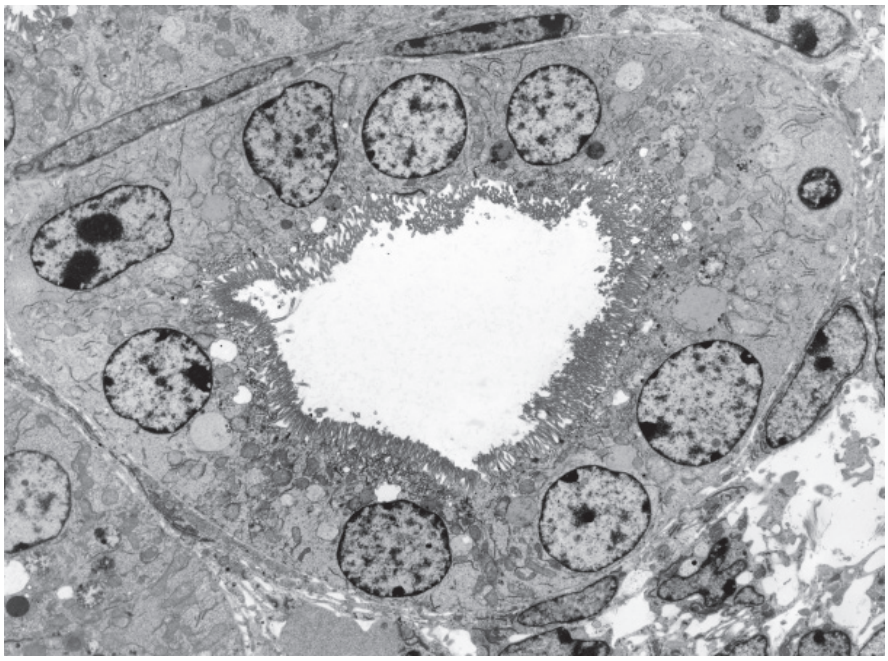
8 The electron micrograph below is a transverse section (T.S.) through a proximal convoluted tubule (PCT) in the mammalian kidney.



(a) (i) Name the cells which line the inner surface of the PCT. [1 mark]

_____

(ii) The membranes of these cells contain many glucose transport proteins.
Describe and explain **one** other adaptation of these cells for their function. [2 marks]

_____

_____

_____

_____

_____

Individuals with type 2 diabetes often have too much glucose in their blood. To help regulate blood glucose level, a new group of drugs is being used to reduce reabsorption of glucose in the proximal tubule. These drugs act by inhibiting glucose transport proteins.

(b) (i) Suggest how these drugs inhibit glucose transport proteins. [2 marks]

There are two main types of glucose transport protein, referred to as SGLT1 and SGLT2. SGLT1 is responsible for 10**%** of glucose reabsorption.

(ii) Suggest why drugs targeting SGLT2 result in a more successful treatment of type 2 diabetes.
[2 marks]

(iii) Describe what would happen to the solute potential (ψ_s) of the urine of a person treated with these drugs. Explain your answer. [2 marks]

(c) Autoimmune conditions occur when the immune system attacks the body's own structures. Goodpasture disease is an autoimmune condition in which basement membranes are damaged.

The table on page 31 compares the blood plasma and glomerular filtrate composition of a normal individual and an individual suffering from Goodpasture disease.

Sample sites within kidney	Concentration/g dm^{-3}							
	Protein		Glucose		Sodium		Urea	
	Norm	GP	Norm	GP	Norm	GP	Norm	GP
Afferent arteriole (blood plasma)	80	80	1.2	1.2	34	34	0.3	0.3
Bowman's capsule (glomerular filtrate)	0.5	60	1.2	1.2	34	34	0.3	0.3

Norm = normal individual
GP = concentration in Goodpasture sufferer

(i) Identify evidence from the table which shows the effect of Goodpasture disease on the basement membrane. Explain your answer. [2 marks]

(ii) In Goodpasture disease, a molecule in the basement membrane acts as an antigen, stimulating an immune response. Suggest precisely how the immune system could cause damage to the basement membrane in Goodpasture sufferers. [3 marks]

Goodpasture sufferers may be prescribed the immunosuppressant drug cyclophosphamide. This drug forms crosslinks with DNA, preventing DNA replication. The drug will target several cell types in the immune system.

(iii) Suggest how this drug can reduce damage to the basement membrane. [2 marks]

Section B

Quality of written communication is awarded a maximum of 2 marks in this section.

9 **(a)** Describe how light rays from coloured objects that are different distances from the eye are focused on the retina, and subsequently stimulate receptor cells. [9 marks]

(b) Describe how visual acuity and visual sensitivity are achieved in the eye. [7 marks]

Quality of written communication [2 marks]

(a) Describe how light rays from coloured objects that are different distances from the eye are focused on the retina, and subsequently stimulate receptor cells.

(b) Describe how visual acuity and visual sensitivity are achieved in the eye.

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
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Total Marks	

Examiner Number