OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY 2806/01

Unifying Concepts in Biology

Tuesday **20 JUNE 2006** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator
Ruler (cm/mm)

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Read each question carefully before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu	Max.	Mark
1	13	
2	14	
3	11	
4	10	
5	12	
TOTAL	60	

This question paper consists of 17 printed pages, 3 blank pages and an insert.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 *Tradescantia* is a genus of plants that is found in North and South America. The genus has many species which are found in different types of habitat. *Tradescantia sillamontana* and *Tradescantia fluminensis* are two of these species.

Fig. 1.1, on the insert, shows typical shoots of these plants. The photographs of the shoots are life size. Fig 1.1 **A** is *T. sillamontana* and **B** is *T. fluminensis.*

(a) Describe **two** ways in which the shoot of *T. sillamontana* differs from the shoot of *T. fluminensis*, as shown in Fig.1.1.

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Table 1.1 shows the numbers of stomata in six random microscope fields of view of the lower epidermis from each of the species.

Table 1.1

number of stomata seen in microscope fields of view	
T. sillamontana	*T. fluminensis*
13	16
12	21
13	19
17	21
16	18
14	19
mean	mean

(b) (i) Calculate the mean number of stomata per field of view for each species **to the nearest whole number**. Insert your answers in Table 1.1. [1]

(ii) State **two** precautions that should be taken to ensure that the data in Table 1.1 is a valid comparison between the two species.

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T. sillamontana originates in Mexico and *T. fluminensis* in Brazil. Table 1.2 shows climate data for the areas from which the plants originate.

Table 1.2

month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mexico	mean monthly temperature / °C	14	17	20	23	26	27	28	28	26	22	18	15
	mean monthly rainfall / mm	18	23	16	29	40	68	62	76	151	78	26	20
Brazil	mean monthly temperature / °C	26	26	26	26	26	26	26	27	28	28	28	27
	mean monthly rainfall / mm	300	347	407	384	352	220	185	98	43	36	58	143

(c) *T. sillamontana* is found growing in the open, where there is no shade, whilst *T. fluminensis* is found growing in the shade of trees.

Use the information provided by Fig.1.1 and Tables 1.1 and 1.2 to explain how each species is adapted to its natural habitat.

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Fig. 1.2 shows how the rate of photosynthesis of each of the species changes with light intensity.

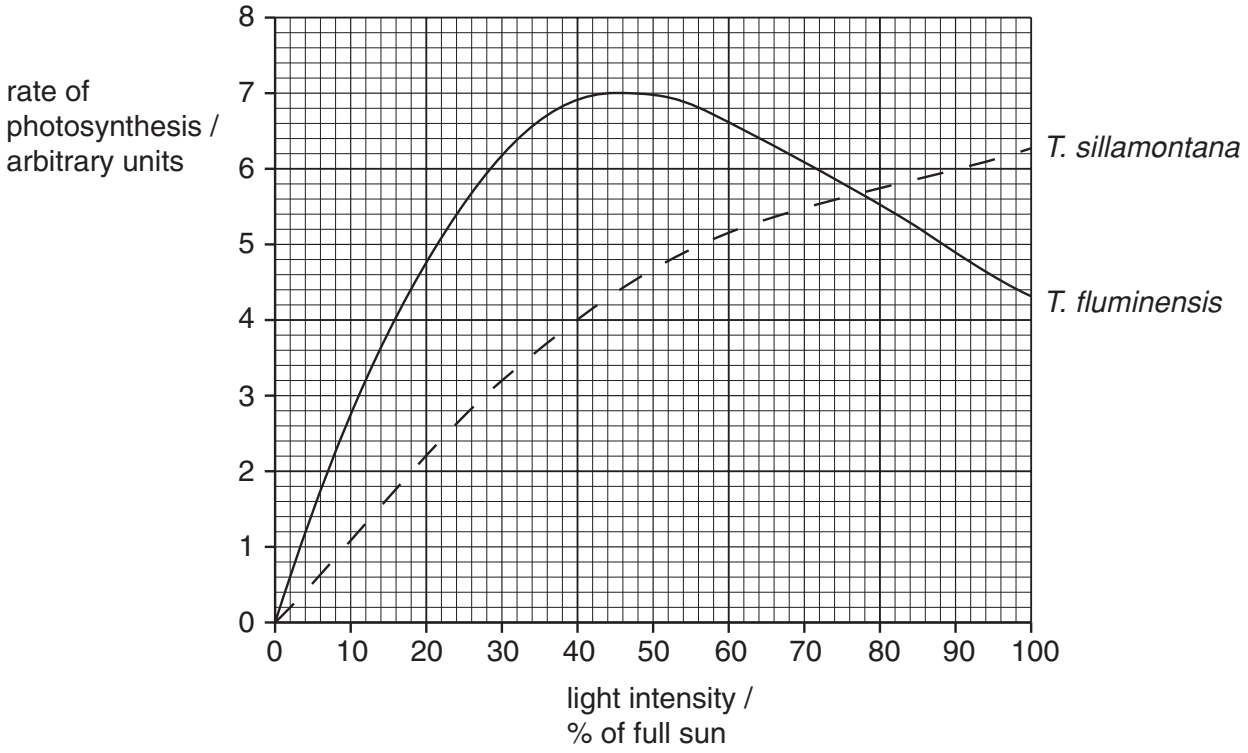

Fig. 1.2

(d) Explain how the data in Fig. 1.2 provides information about the adaptations of *T. sillamontana* and *T. fluminensis* to their environments.

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[Total: 13]

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2 Read the passage below and answer the questions which follow.

DNA vaccines

Mice and monkeys have been successfully immunised against several important infectious diseases using experimental DNA vaccines, in the form of plasmids. Plasmids are small circular DNA molecules.

During the 1990s, researchers found that mouse muscle and other mouse tissues were able to absorb plasmids which had been injected into the animals. Any genes that were part of this plasmid DNA were transcribed and translated. The resulting proteins were transferred to the plasma membranes (cell surface membranes) of the mouse muscle cells. The proteins were exposed on the muscle plasma membranes together with receptor molecules that allow the immune system to recognise cells as self or non-self. Proteins that are presented at the cell surface in this way stimulate the lymphocytes of the immune system very effectively.

This discovery allows plasmid DNA to be used as a vaccine, even though the DNA does not itself act as an antigen. Most vaccines contain proteins, or fragments of proteins, that are extracted from the surface of pathogens. It is a complex and costly procedure to purify these protein antigens.

Fig. 2.1 shows a simplified diagram of a DNA vaccine. This plasmid codes for two antigens, **A** and **B**.

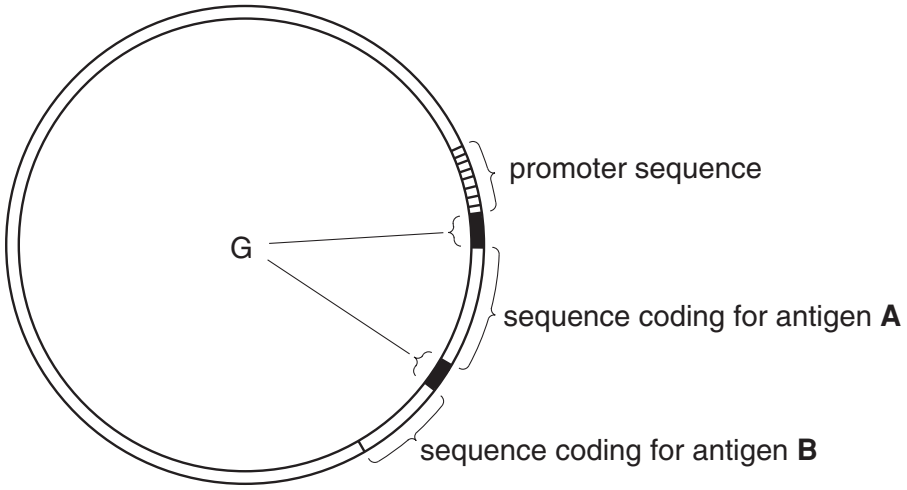

Fig. 2.1

(a) State **three** ways in which the structure of plasmid DNA differs from the structure of a protein molecule.

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(b) (i) Define the term *antigen*, as used in the passage.

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(ii) Suggest why proteins presented at the cell surface are able to stimulate an immune response more effectively than proteins dissolved or suspended in the blood or tissue fluids.

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(c) (i) Explain why a promoter sequence is needed as part of the plasmid if the vaccine is to work.

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(ii) Suggest why it may be desirable to include nucleotide sequences coding for more than one antigen in a DNA vaccine.

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(iii) Sequences of nucleotides, labelled **G** on Fig 2.1, code for groups of amino acids at the beginning of each polypeptide. These amino acid sequences direct the newly synthesised polypeptides to the Golgi apparatus of the muscle cell.

Explain how this makes the vaccine effective.

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(d) Suggest **three** reasons why researchers may be more concerned about the potential risks of DNA vaccines as compared with protein-based vaccines.

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[Total: 14]

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3 Very large numbers of disposable food and drink containers are used each year. Most of these containers are made from polymers, such as polystyrene. Polystyrene is not synthesised by any type of living organism. The styrene that polymerises to give polystyrene is made using petroleum as a raw material and is entirely man-made.

A polymer which has many of the desirable properties of polystyrene is polylactic acid, made by the condensation of large numbers of lactic acid molecules.

The lactic acid is produced by allowing a species of bacterium to ferment starch under anaerobic conditions. The metabolism of these bacteria is similar to that of a mammalian muscle cell under anaerobic conditions.

(a) Outline how these bacteria produce lactic acid from starch.

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(b) Two sets of empty plastic food cups, one made from polystyrene and the other from polylactic acid, were buried in soil.

The cups were dug out and examined at intervals. Each time, they were reburied in the soil.

After 60 days, the polystyrene cups remained unchanged while the polylactic acid cups had completely disintegrated.

When the experiment was repeated, using soil that had been heated in an oven to 120 °C for one hour and then cooled, both types of plastic cup remained unchanged after 60 days.

Explain these findings **and** suggest why they are important for society.

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(c) After a lawn had been cut using a mower, the grass cuttings were piled up in a corner of the garden.

Ten days later, the heap of grass cuttings had steam rising from it.

A tube was pushed into the heap and an air sample was obtained from near its centre. This air sample was dried and then analysed to find the percentages of oxygen and carbon dioxide present. These concentrations could be measured to an accuracy of ±1 %.

A thermometer was also inserted into the centre of the heap and the temperature was recorded.

The results of the investigation are shown in Table 3.1, which also shows data for the air above the ground near the heap.

Table 3.1

sampling point	oxygen concentration / %	carbon dioxide concentration / %	temperature / °C
near the centre of the heap of grass	13	8	42
above the ground near the heap	21	0	16

As the heap of grass was in the shade for several hours before the readings were taken, it could **not** have become warm by absorbing solar radiation.

Explain the results shown in Table 3.1.

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[Total: 11]

[Turn over

4 Lugworms are common animals that burrow in the sand of the seashore, just above the low tidemark. They are found where there is mild wave action and where the sand is rich in organic matter. The main external features of a lugworm are shown in Fig. 4.1.

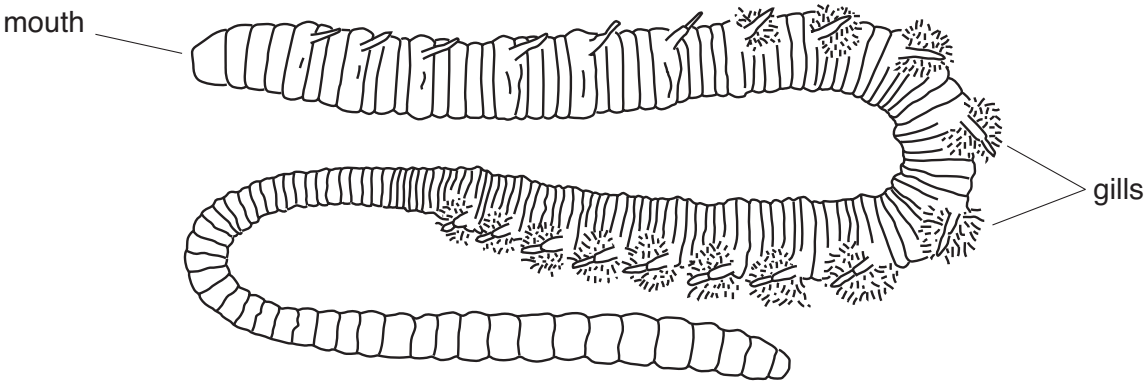

Fig. 4.1

Each lugworm makes a U-shaped burrow which reaches the surface in two places, as shown in Fig. 4.2.

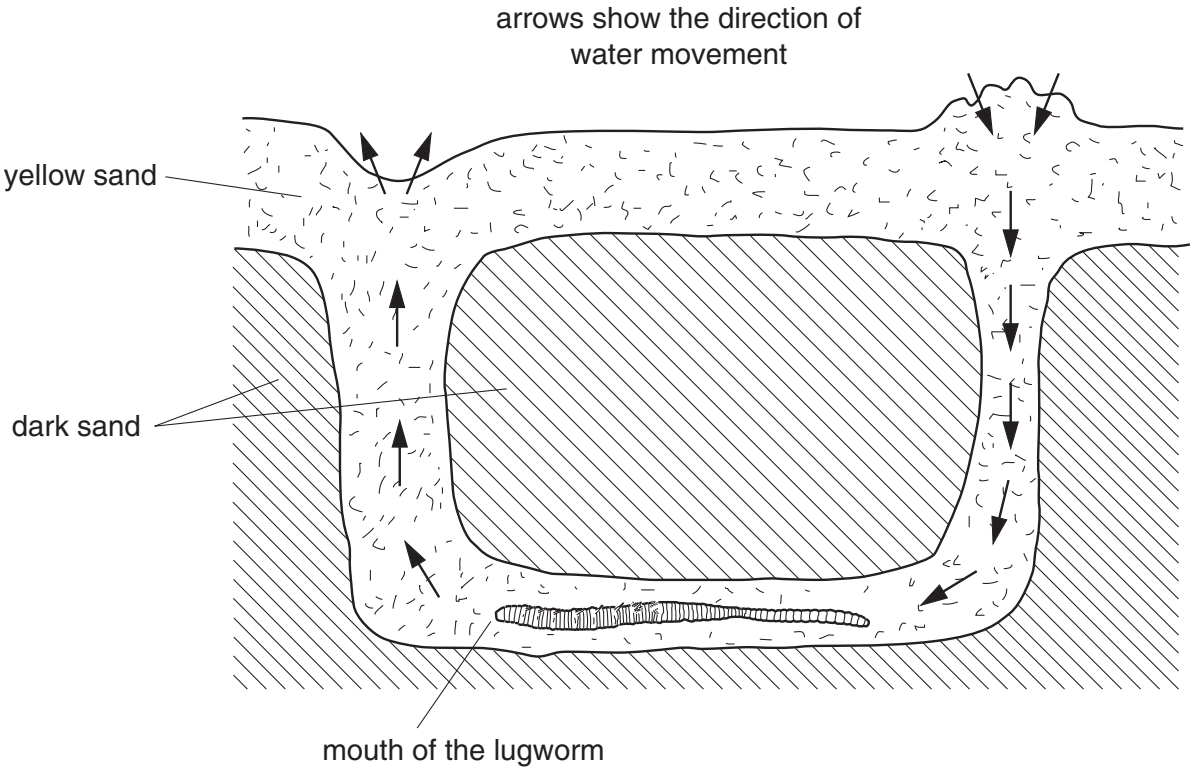

Fig. 4.2

While the beach is covered by the tide, the lugworm moves its body so that a current of seawater passes down the burrow, over the worm and up through the porous sand, in the direction shown. These ventilation movements allow water to flow slowly past the tufts of gills. The gills are feathery outgrowths of the body wall and appear dark red because they contain many small blood vessels.

A lugworm's blood plasma has a high concentration of haemoglobin dissolved in it. There are no red blood cells. Fig. 4.3 shows dissociation curves for lugworm haemoglobin and for human haemoglobin.

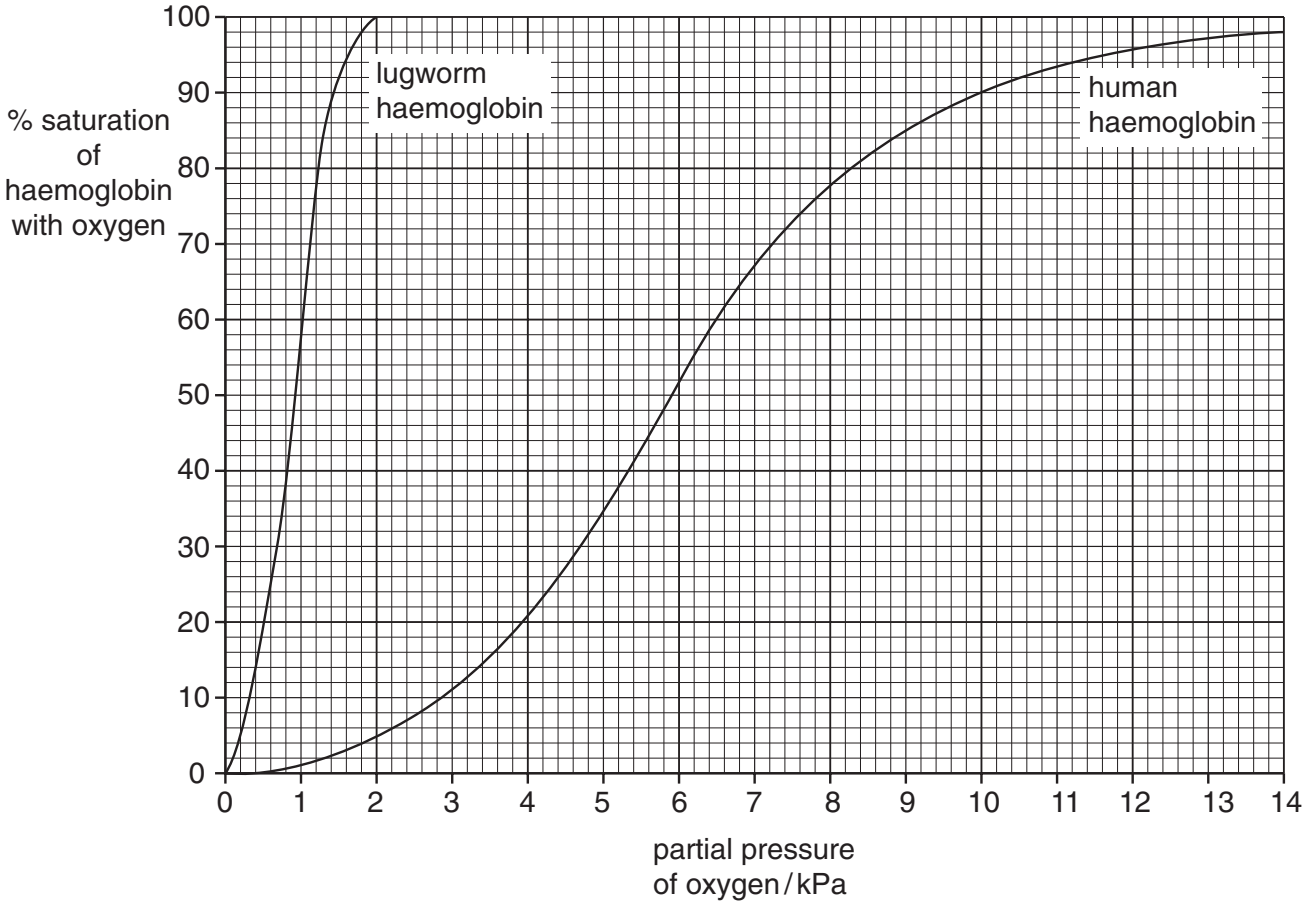

Fig. 4.3

(a) Describe and explain **one** way in which the dissociation curve for lugworm haemoglobin differs from that for human haemoglobin.

difference .....

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explanation .....

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[Turn over

(b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Describe the similarities and differences between the adaptations for gas exchange and transport of oxygen in mammals and lugworms.

You will gain credit for using information given in question 4.

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Quality of Written Communication [1]

[Total: 10]

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5 White clover, *Trifolium repens*, is a common plant of lawns, road verges and pastures throughout Europe.

White clover can reproduce asexually by developing roots from stems that grow along the soil surface. Such reproduction results in a clone of plants, some of which may still be connected whilst others have become separated as independent plants.

White clover is also able to reproduce sexually, by producing seeds as a result of cross-fertilisation but it cannot produce seed by self-fertilisation.

(a) (i) Suggest why white clover plants that are growing separately but are members of the same clone, cannot successfully fertilise each other.

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(ii) Explain why it may be an advantage for populations of white clover if cross-fertilisation takes place.

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Some white clover plants store a substance called linamerin in their leaves. This substance can be hydrolysed by an enzyme, called linamerinase, to produce hydrogen cyanide.

Hydrogen cyanide is a powerful inhibitor of some of the enzymes essential for oxidative phosphorylation in mitochondria.

Linamerin only comes into contact with linamerinase when cells are damaged. Damage causes the enzyme to be released from lysosomes. This damage may be the result of herbivores feeding or it may be caused by ice crystals, which can develop within cells.

(b) Suggest

(i) how an ice crystal may cause release of linamerinase from a lysosome;

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(ii) why hydrogen cyanide is harmful to both clover plants and herbivores.

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Question 5 continues on the next page

The ability of clover plants to produce hydrogen cyanide is genetically determined.

Populations of white clover were sampled at different sites across Europe. At each site the percentage of plants that were **unable** to produce hydrogen cyanide was determined. In Fig. 5.1, the results of these surveys are plotted against the mean January temperature for each site.

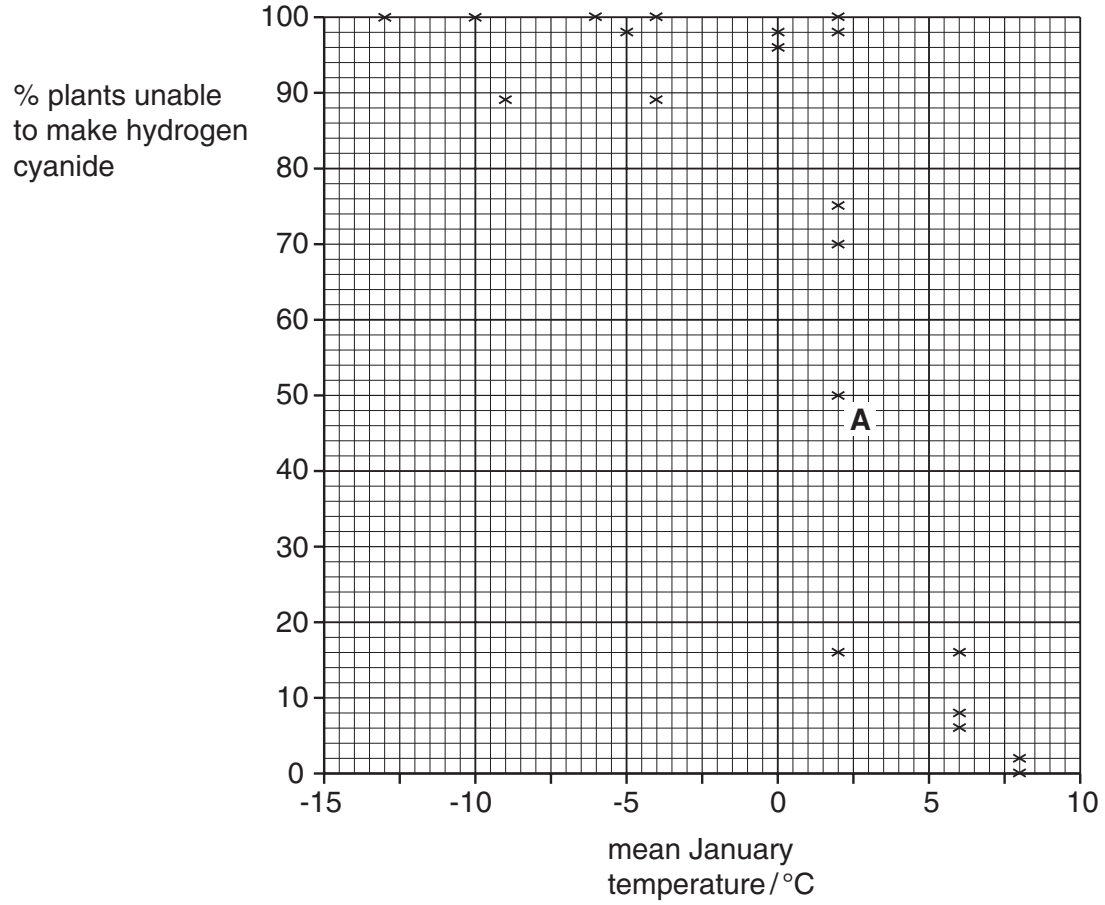

Fig. 5.1

(c) Comment on the data shown in Fig. 5.1.

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(d) It has become generally accepted that the global climate is getting warmer as a result of the production of carbon dioxide by human activity.

Explain how natural selection would change the population of white clover represented by the point in Fig. 5.1 labelled **A**, if the climate became consistently warmer.

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[Total: 12]

END OF QUESTION PAPER