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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1053462426

BIOLOGY **9700/43**

Paper 4 Structured Questions A2 **October/November 2010**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the number of the Section B question you have answered in the grid below.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
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Section B	
9 or 10	
Total	

This document consists of **19** printed pages and **5** lined pages.

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Section A

Answer **all** the questions.

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1 **(a)** A 50-year study of marine animal biodiversity in the coastal waters of Canada was carried out.

The percentage decrease in the number of marine animal species between 1950 and 2000 is shown in Fig. 1.1.

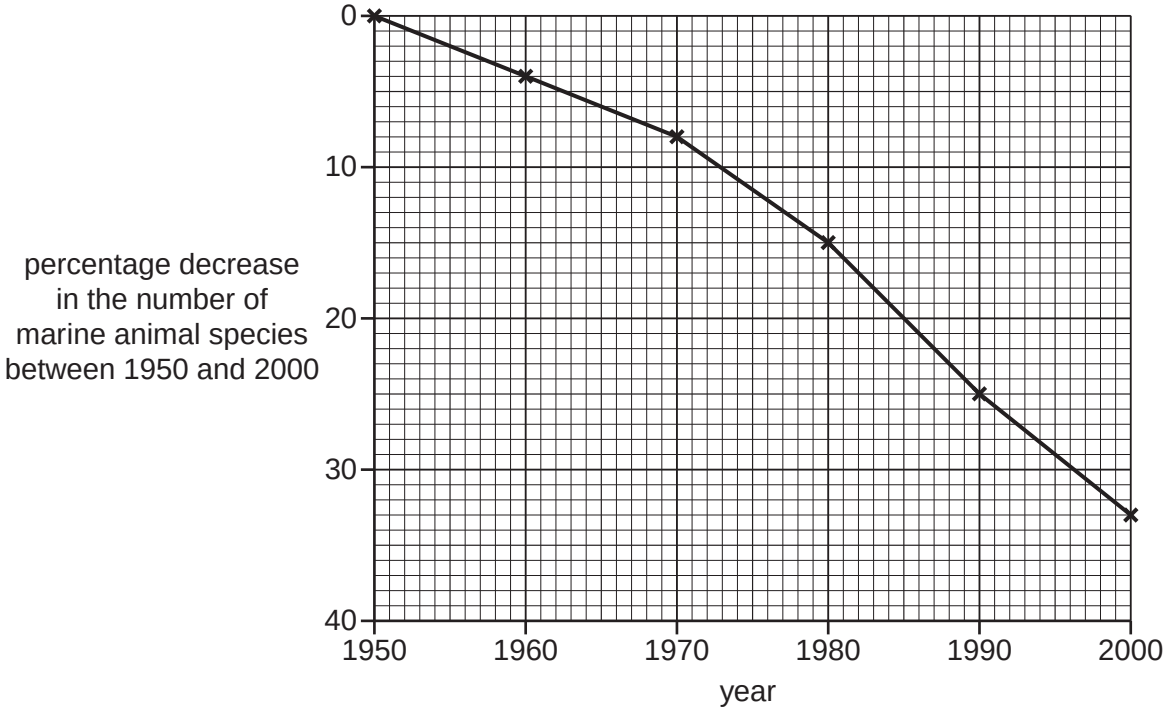


Fig. 1.1

Suggest explanations for the decrease in the number of marine animal species between 1950 and 2000.

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(b) Explain what is meant by the term *biodiversity*.

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(c) Discuss the benefits of maintaining the biodiversity of a marine ecosystem, such as that in the coastal waters of Canada.

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[Total: 8]

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2 **(a)** Describe the maturation of a spermatid into a spermatozoon (sperm).

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(b) A method of sorting damaged from undamaged sperm has undergone trials at an *in vitro* fertilisation (IVF) clinic in Australia. It is hoped to use the procedure when attempting IVF with sperm from men with fertility problems.

The sorting process is shown in Fig. 2.1.

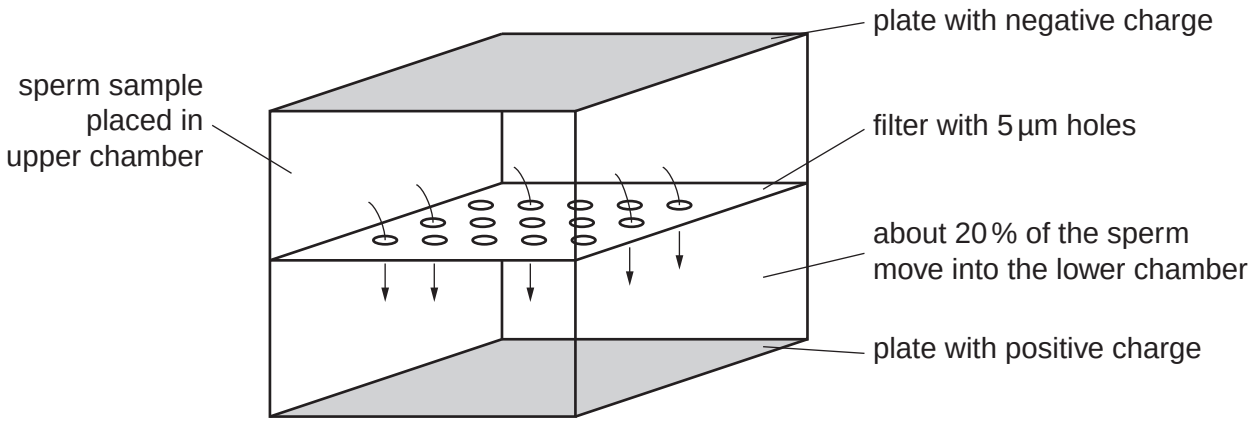


Fig. 2.1

Sperm left in the upper chamber have, on average, twice as much damage to their DNA as those that move into the lower chamber.

In the body, sperm which mature normally move slowly through the epididymis, gradually accumulating molecules of a negatively charged protein in their cell surface membranes. Other sperm move more quickly through the epididymis.

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With reference to the information given, including that in Fig. 2.1, explain why only some of the sperm move into the lower chamber.

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[Total: 7]

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3 Fig. 3.1 shows a method of producing monoclonal antibodies.

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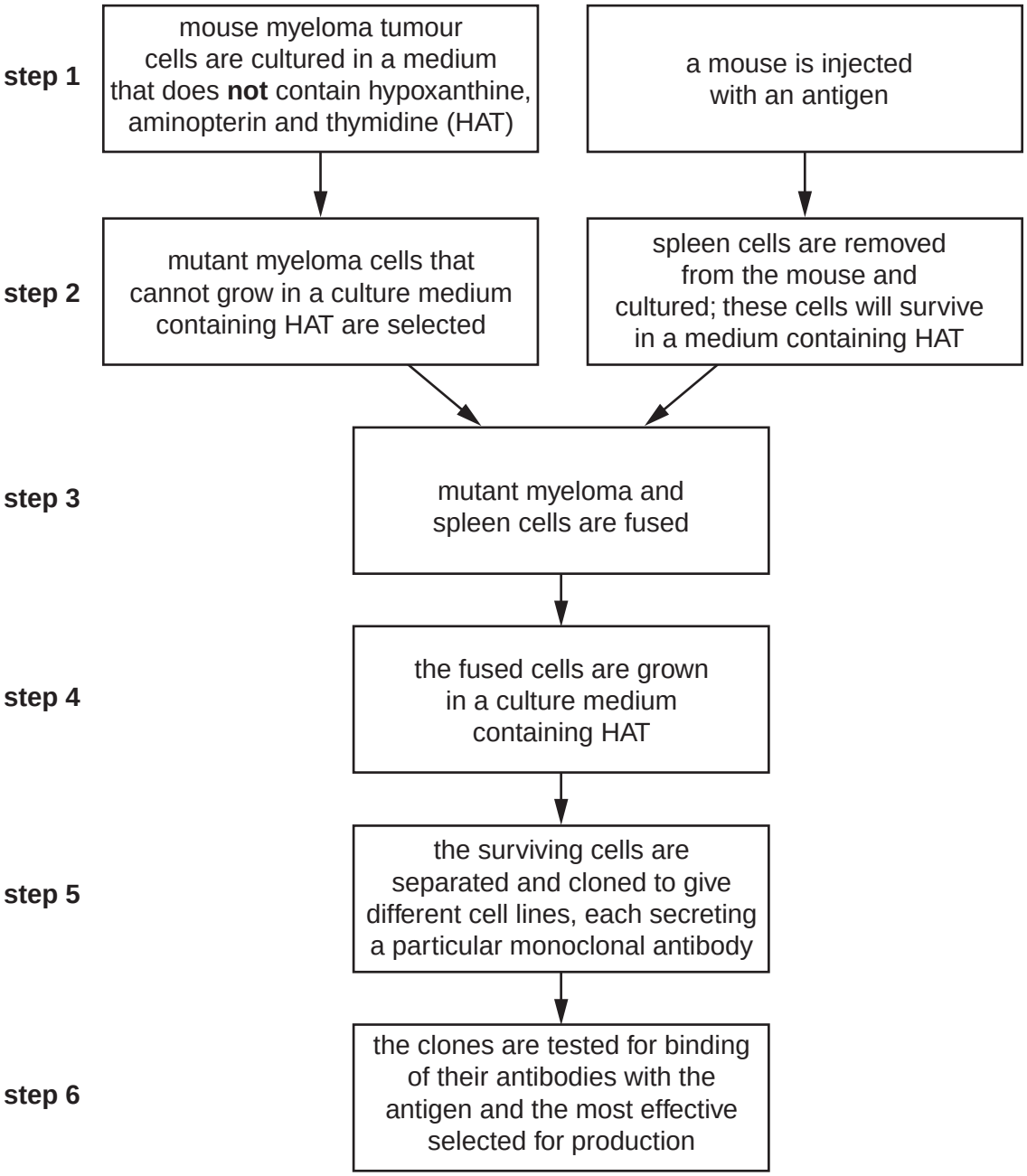


Fig. 3.1

(a) (i) Name this method of producing monoclonal antibodies.

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(ii) Describe what is meant by the term *monoclonal antibody*.

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(iii) Describe, in detail, the molecular structure of one of the antibodies produced in **step 6**. You may wish to use an annotated diagram to answer the question.

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(b) The mutant myeloma cells used in **step 2** are myeloma cells with a gene mutation that prevents them from growing in a culture medium containing hypoxanthine, aminopterin and thymidine (HAT).

(i) Suggest why cells with this gene mutation **cannot** grow in a culture medium containing HAT.

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(ii) Explain why the mutant myeloma cells **can** grow in a culture medium containing HAT after they have been fused with mouse spleen cells (**steps 3** and **4**).

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(iii) Suggest why growing the fused cells in a culture medium containing HAT (**step 4**) is an important part of the procedure shown in Fig. 3.1.

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(c) Suggest advantages of using monoclonal antibodies for pregnancy testing.

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[Total: 16]

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4 Maize, *Zea mays*, is a cereal crop that is adapted for growth at high temperatures. However, it does not cope with drought as well as some other crops, such as sorghum.

An investigation was carried out into the effect of low water availability on the activity of mitochondria taken from maize seedlings.

Young seedlings were uprooted and left in dry air for varying periods of time to reduce the water potential of their tissues.

(a) Explain why this treatment reduced the water potential of the maize seedling tissues.

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(b) After drying in air, mitochondria were extracted from the tissues of the seedlings. The extracted mitochondria were provided with succinate, which is one of the intermediate compounds in the Krebs cycle, and also with ADP and inorganic phosphate. The rate at which the extracted mitochondria took up oxygen was measured. The results are shown in Fig. 4.1.

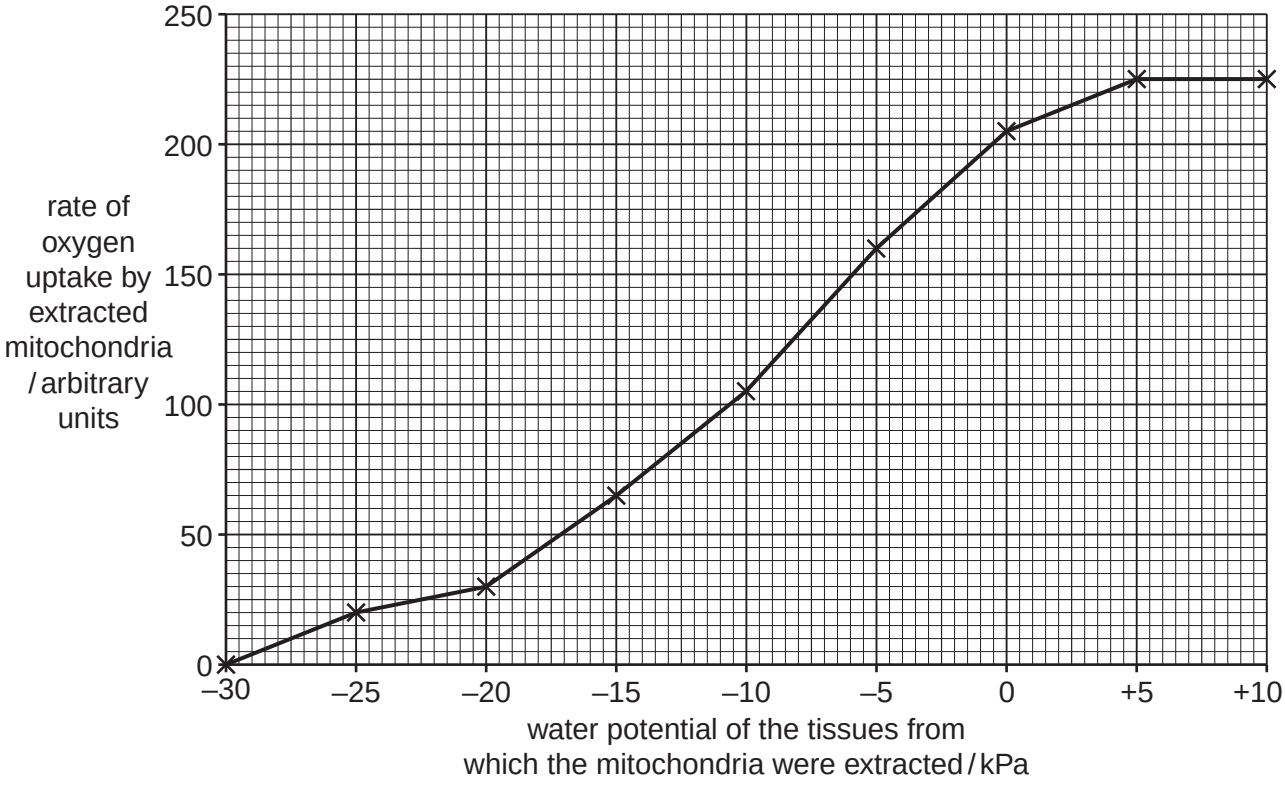


Fig. 4.1

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(i) Describe the results shown in Fig. 4.1.

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(ii) The mitochondria take up oxygen. Explain how this oxygen, plus the succinate, ADP and inorganic phosphate, are used by the mitochondria.

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(c) In a further experiment, it was found that mitochondrial membranes lost their normal structure when the water potential was low.

(i) Suggest why membranes in cells lose their normal structure when the water potential is low.

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(ii) Suggest how this could explain the results shown in Fig. 4.1.

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(d) In tissues where water potential is low, the mitochondria of sorghum are affected in a very similar way to those of maize.

Describe **two** ways in which sorghum plants are adapted to prevent the development of low water potentials in their tissues during drought conditions.

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[Total: 16]

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5 Many attempts have been made to find methods of using gene therapy to treat cystic fibrosis. One approach uses viruses to deliver normal alleles of the CFTR gene into epithelial cells of the airways. Viral delivery systems have two main problems:

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- The virus may trigger an immune response which destroys the infected cells.
- Most non-pathogenic viruses are not very good at getting into cells, so very few cells receive the allele.

A team of researchers in the USA developed a new strain (AAV2.5T) of AAV, a non-pathogenic virus. AAV2.5T has an improved ability to bind with epithelial cells of the airways. Genes for the CFTR protein and for an enzyme, luciferase, were added to the DNA of the viruses. Luciferase produces a fluorescent green protein when luciferin is added.

The normal AAV strain and the AAV2.5T strain were added to cultures of epithelial cells from the airways. After adding luciferin, the numbers of cells that had taken up the viral genes was estimated using the intensity of the green fluorescence which developed.

The results are shown in Fig. 5.1.

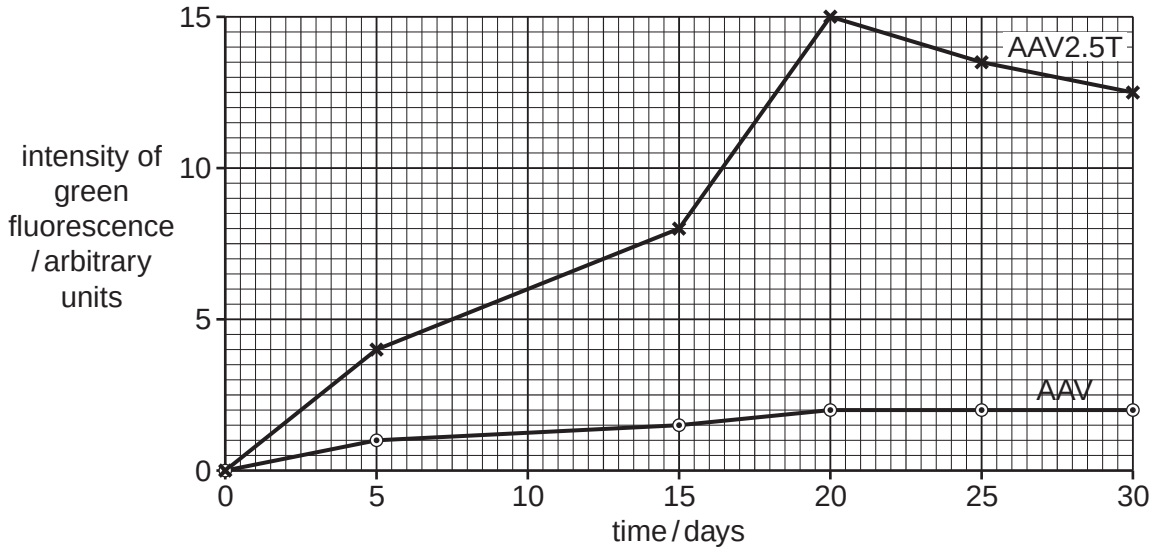


Fig. 5.1

(a) With reference to Fig. 5.1, compare the ability of the two viral strains, AAV and AAV2.5T, to infect epithelial cells from the airways.

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(b) Explain why the researchers added a gene for luciferase to the viral DNA.

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(c) Suggest how delivering normal alleles of the CFTR gene into epithelial cells in the airways could relieve the symptoms of cystic fibrosis.

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[Total: 8]

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6 From 1975 to 1977 one of the Galapagos Islands, Daphne Major, experienced a severe drought. A ground finch, *Geospiza fortis*, feeds on seeds on Daphne Major.

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Fig. 6.1 shows the ground finch, *G. fortis*.



Fig. 6.1

- One of the few plants that survived the drought produced large seeds inside tough fruits.
- Many *G. fortis* died during the drought and the population declined from 1400 in 1975 to 190 in 1977.
- The mean beak depth of those *G. fortis* that died was 10.68 mm and the mean beak depth of those that survived was 11.07 mm.
- The mean beak depth of *G. fortis* before the drought was 10.86 mm.

(a) Calculate the percentage decrease in population size between the years 1975 and 1977.

Show all the steps in your calculation and give your answer to the nearest whole number.

Answer ..... % [2]

(b) Suggest why some *G. fortis* were able to survive the drought while others died.

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(c) Natural selection was taking place on Daphne Major.

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State the type of natural selection operating on *G. fortis* **during** the drought **and** explain your answer.

type of natural selection .....

explanation .....

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[Total: 7]

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7 Urea is the main nitrogenous waste product in humans. It is made in the liver and excreted by the kidneys in urine.

(a) Define the term *excretion*.

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(b) The kidneys regulate the water potential of body fluids. This is known as osmoregulation and involves a negative feedback system.

Outline the role of negative feedback in osmoregulation.

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(c) Investigations have shown that when a person remains in a cold environment for more than 15 minutes there is increased urine production. This is called cold diuresis.

Suggest how exposure to cold can lead to cold diuresis.

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[Total: 8]

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8 **(a)** The rate of photosynthesis at different wavelengths of light can be measured and plotted as a graph. This is called an action spectrum and is shown on Fig. 8.1.

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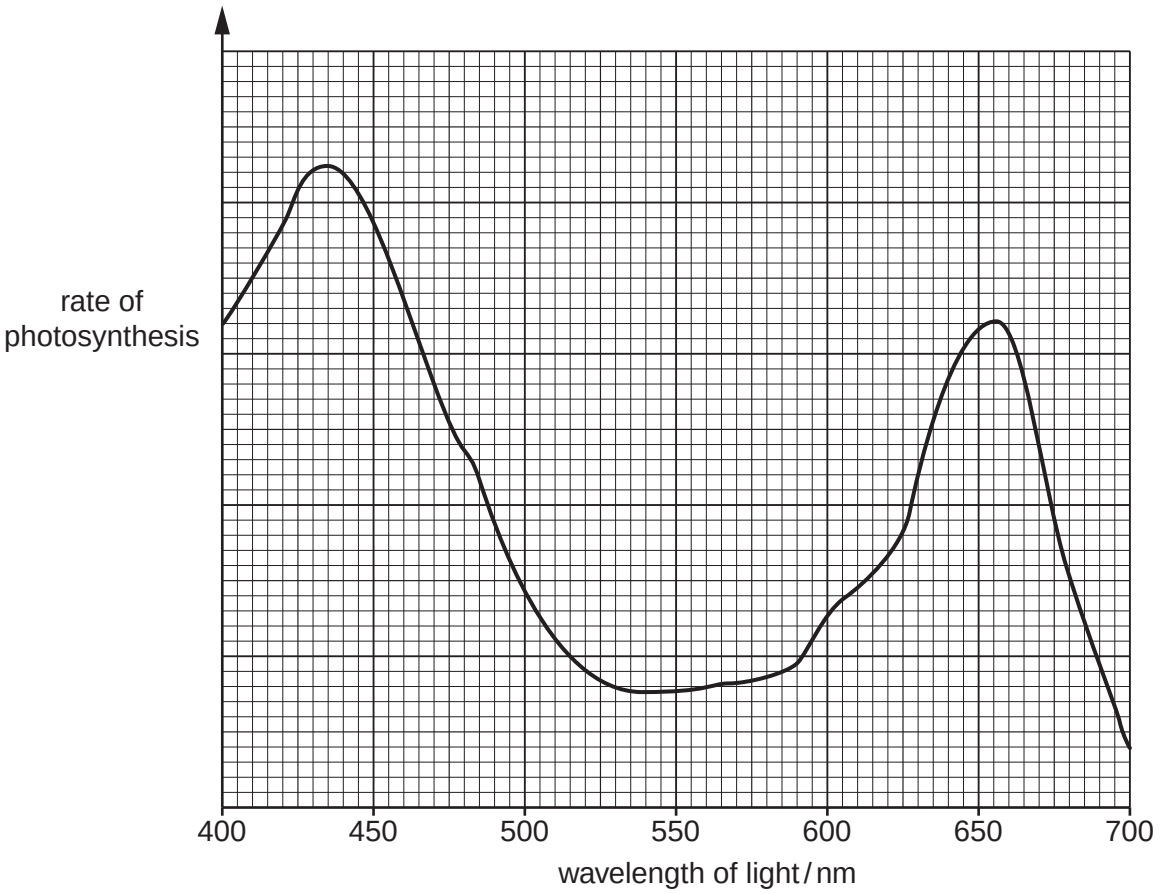


Fig. 8.1

Describe and explain the effects of different wavelengths of light on the rate of photosynthesis.

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(b) **(i)** Name two products of the light-dependent stage of photosynthesis that are used in the light-independent stage.

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(ii) Describe how these two products are used in the light-independent stage of photosynthesis.

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(c) The rate of photosynthesis is affected by factors other than the wavelength of light. These factors may act as limiting factors.

Explain what is meant by the term *limiting factor*.

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(d) Carbon dioxide concentration in the atmosphere may be a limiting factor in photosynthesis.

Describe how carbon dioxide reaches the photosynthetic cells in a leaf.

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[Total: 15]

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Section B

Answer **one** question.

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9 **(a)** Explain how meiosis and fertilisation may result in genetic variation in offspring. [7]

(b) Explain, using examples, how the environment may affect the phenotype of an organism. [8]

[Total: 15]

10 **(a)** Describe the structure of ATP and the role of ATP as the energy currency in all living organisms. [8]

(b) Outline anaerobic respiration in mammalian cells and describe how it differs from anaerobic respiration in yeast cells. [7]

[Total: 15]

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Question 6 Figure 6.1 © Photograph of Ground Finch; http://www.justbirds.it/.

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