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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3216215542

BIOLOGY **9700/41**

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

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

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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	
Section A	
1	
2	
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5	
6	
7	
8	
Section B	
9 or 10	
Total	

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Section A

For Examiner's Use

Answer **all** the questions.

1 The Great Lakes, in North America, lie between the USA and Canada. A survey of birds of the Lake Ontario area has shown the relative abundance of birds between 1995 and 2005.

Table 1.1 shows the feeding habits and the relative change in numbers of some of the birds in the survey.

Table 1.1

name	feeding habit	percentage change in numbers between 1995 and 2005
mallard *Anas platyrhynchos*	amphibia, plants	+10.0
tree swallow *Tachycineta bicolor*	flying insects	–6.2
blue-winged teal *Anas discors*	aquatic insects, molluscs, plants	–12.3
pied-billed grebe *Podilymbus podiceps*	amphibia, aquatic insects, fish	–15.9
black tern *Chlidonias niger*	aquatic insects, fish, flying insects	–18.7

(a) Using the information in Table 1.1 suggest reasons for the changes in numbers of these birds.

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..... [4]

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(b) An ecosystem that has a wide range of species has a high biodiversity.

Explain the benefits of maintaining biodiversity.

For Examiner's Use

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..... [4]

[Total: 8]

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[Turn over

2 The disease-causing bacterium, *Pseudomonas aeruginosa*, may occur in the form of a 'biofilm'. A biofilm consists of a layer of bacteria, growing on a surface and attached to one another. Such biofilms are difficult to control by antibiotics.

For Examiner's Use

A mutant strain of *P. aeruginosa* has been found which produces biofilms that are indistinguishable from those of the wild-type bacteria. However, the mutant strain differs from the wild-type in its resistance to an antibiotic, **A**.

(a) Antibiotic **A** belongs to a group of antibiotics known as anti-pseudomonal penicillins.

(i) Describe the mode of action of penicillin on bacteria.

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..... [3]

(ii) Explain why penicillin does not affect viruses.

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..... [2]

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(b) Wild-type and mutant bacteria were grown on solid culture media both with antibiotic **A** and without antibiotic **A**.

For Examiner's Use

The subsequent change in numbers of living bacteria is shown in Fig. 2.1.

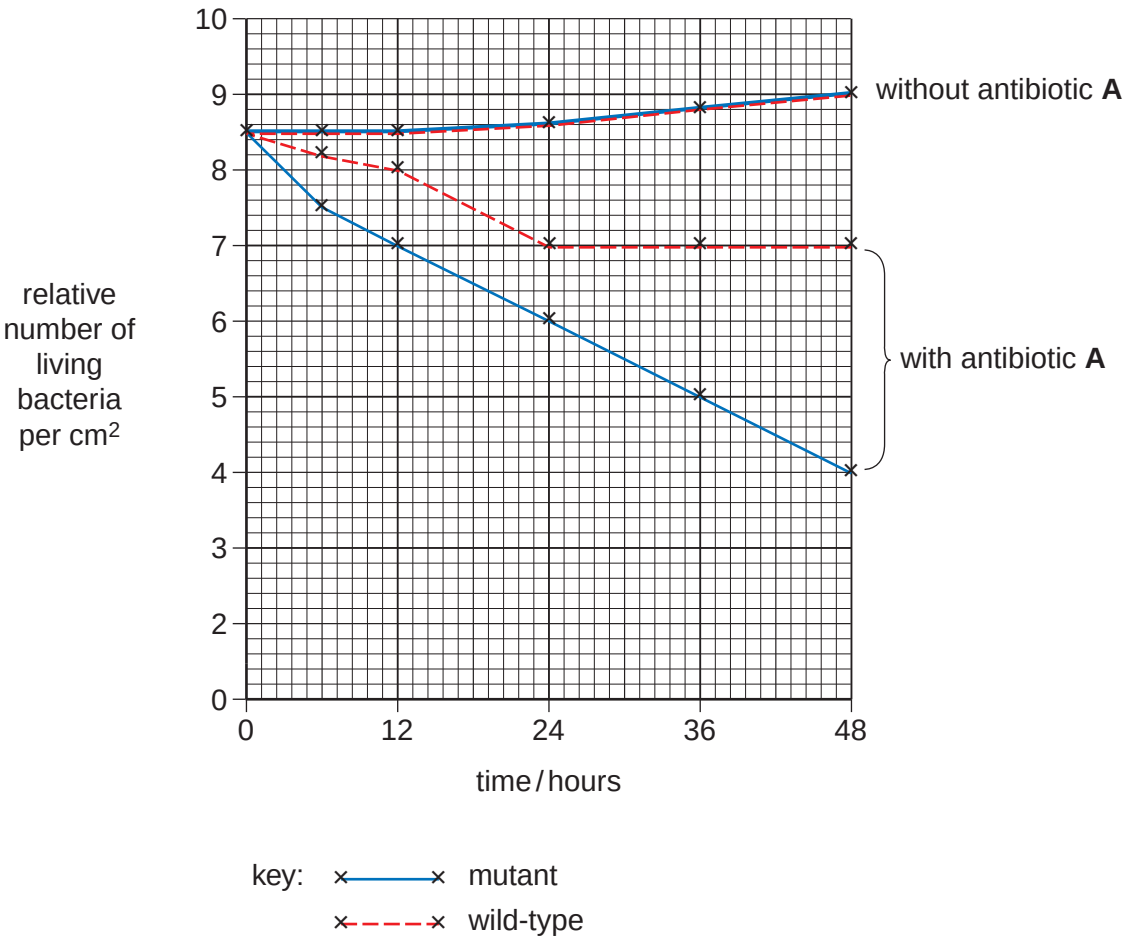


Fig. 2.1

With reference to Fig. 2.1, describe the changes in numbers of the wild-type and mutant bacteria on culture media with antibiotic **A and** without antibiotic **A**.

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For Examiner's Use

(c) The wild-type and mutant strains of this bacterium have different DNA sequences in part of a gene coding for an enzyme which is needed to produce polymers of glucose, called glucans. Glucans are secreted by bacteria and can bind to various molecules, including those of antibiotic **A**.

Explain

(i) how a mutation of a gene coding for an enzyme may result in an enzyme with reduced activity,

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(ii) the different effects of antibiotic **A**, shown in Fig. 2.1, on the wild-type and mutant strains of bacteria.

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(d) Explain the role of natural selection in the evolution of antibiotic resistance in bacteria.

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..... [3]

[Total: 16]

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3 A recent development in fertility treatment is called in-vitro maturation (IVM). This is both cheaper and safer than the standard procedure used in in-vitro fertilisation (IVF), especially for women with polycystic ovaries. Hormone treatment can be dangerous for women with this condition, in which a number of ovarian follicles mature at the same time.

For Examiner's Use

IVF and IVM are compared in Fig. 3.1.

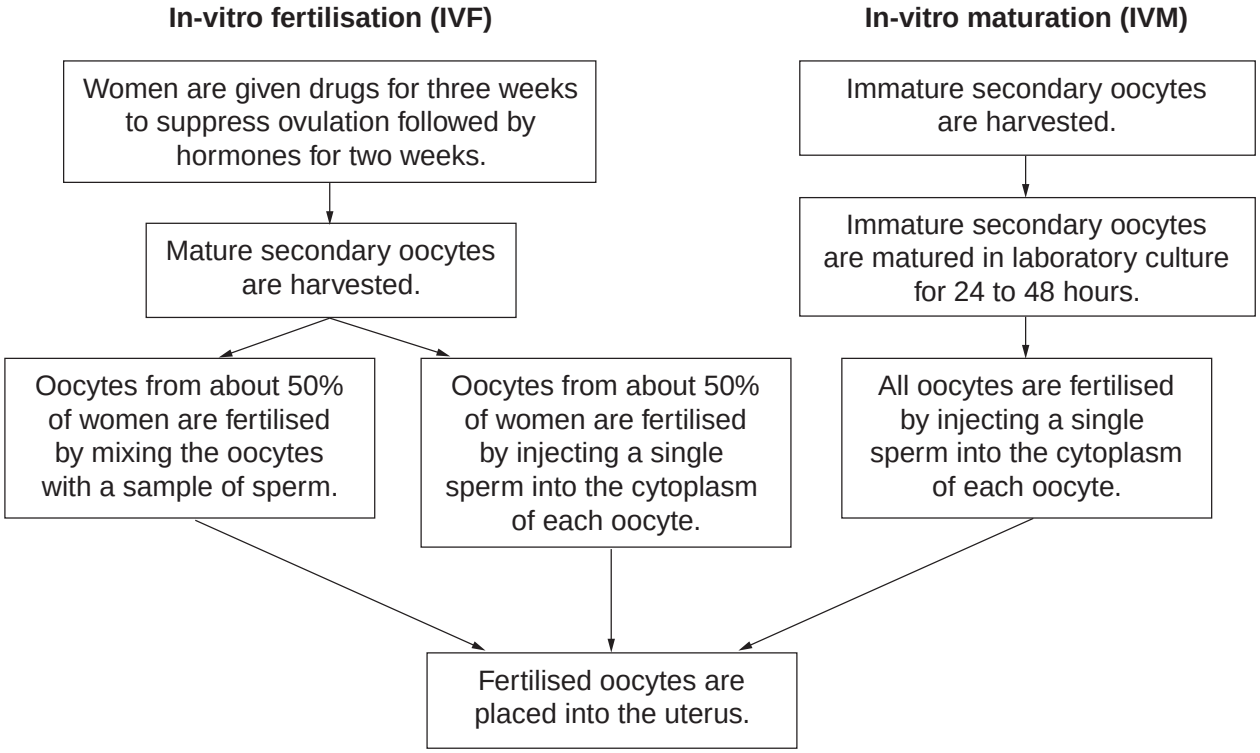


Fig. 3.1

(a) With reference to Fig. 3.1, explain why women are treated with hormones for two weeks after being given drugs to suppress ovulation at the beginning of IVF treatment.

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(b) State the roles of mitosis and meiosis in producing an immature secondary oocyte.

For Examiner's Use

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..... [3]

(c) Suggest one advantage and one possible disadvantage of fertilising an oocyte by injecting a sperm into its cytoplasm instead of mixing the oocyte with a sample of sperm.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 7]

For Examiner's Use

4 The secretion of insulin by the islets of Langerhans in the pancreas stimulates the liver to reduce the blood glucose concentration.

(a) Describe how the **liver** reduces blood glucose concentration, when insulin is secreted.

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(b) Almost all insulin used to treat type I diabetes is produced by genetically engineered bacteria or yeast. A summary of this procedure is shown in Fig. 4.1.

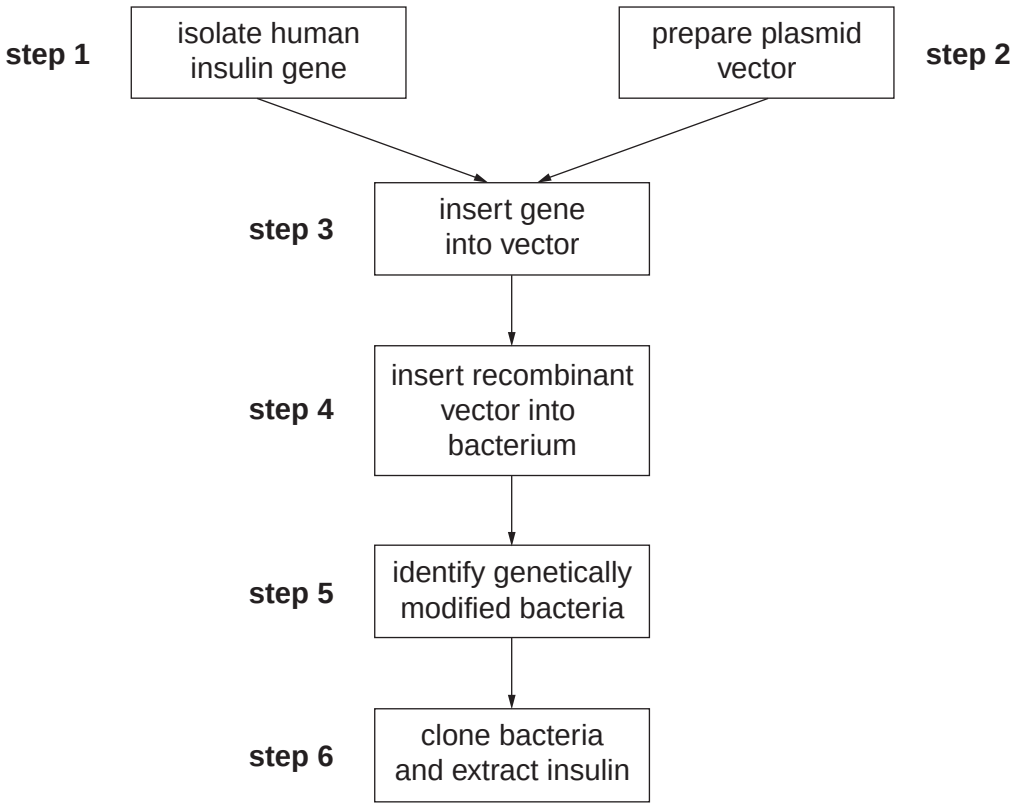


Fig. 4.1

For Examiner's Use

(i) One way of carrying out **step 1** is to collect mRNA from β cells from the pancreas. The relevant mRNA is then isolated and used to make DNA.

Suggest why isolating the mRNA coding for insulin in a β cell is easier than isolating the DNA for insulin in a β cell.

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..... [2]

(ii) Outline the use of restriction enzymes in **step 2**.

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..... [2]

(c) Most people with type I diabetes inject insulin. A recent product contains insulin that can be administered using a nasal spray. The spray is inhaled and the insulin is taken up through the lungs.

For Examiner's Use

Fig. 4.2 shows the concentration of insulin in the blood plasma in the 480 minutes after injecting or inhaling insulin. In both cases, the insulin was of the same type, obtained from genetically engineered *Escherichia coli*.

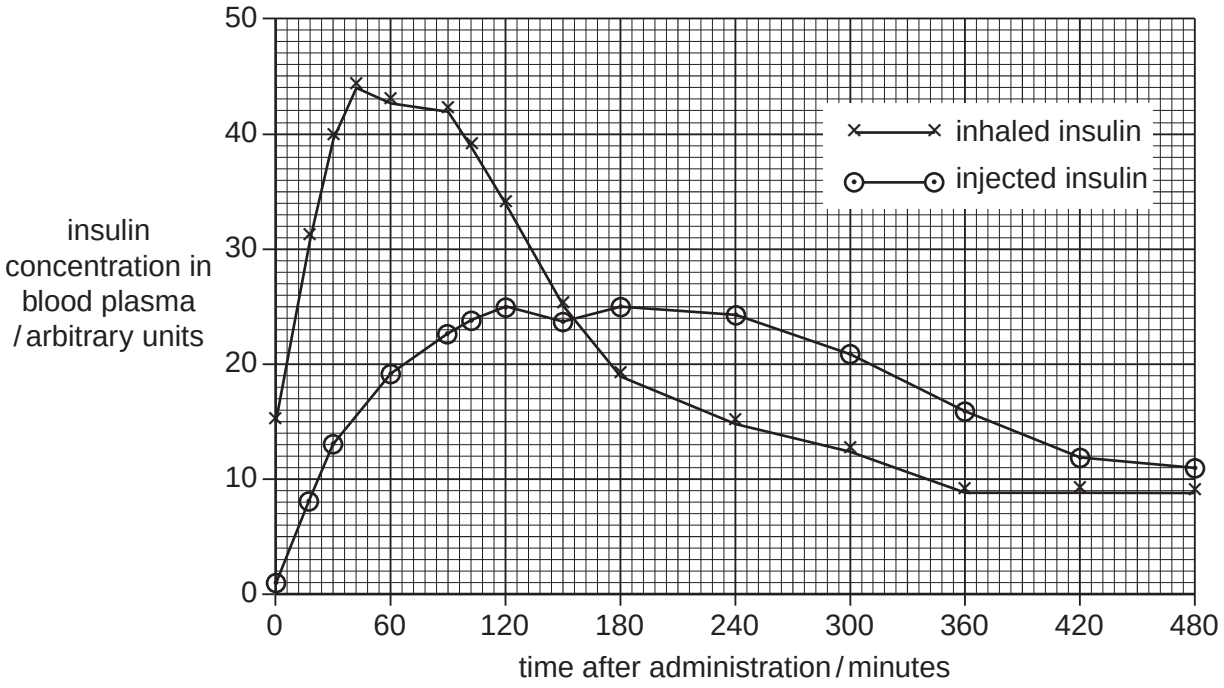


Fig. 4.2

Fig. 4.3 shows the concentration of glucose in the blood plasma in the 480 minutes after injecting or inhaling insulin.

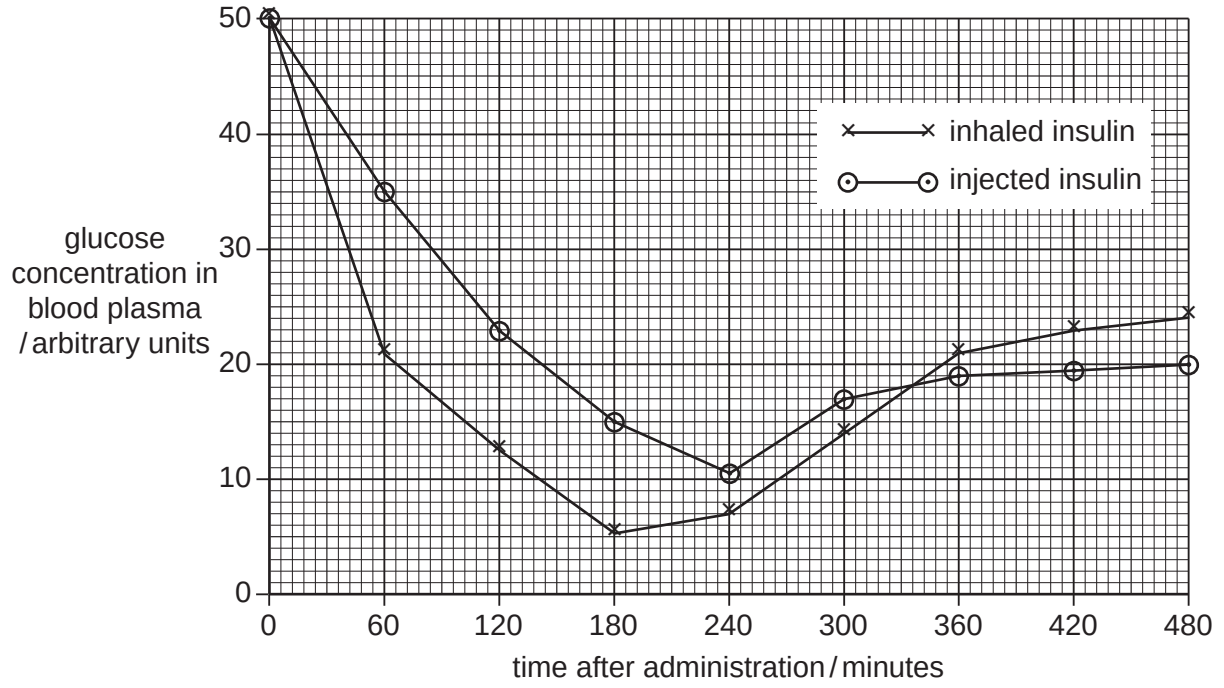


Fig. 4.3

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For Examiner's Use

(i) Compare the results for injected insulin and inhaled insulin shown in Fig. 4.2.

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..... [3]

(ii) With reference to Fig. 4.2, explain the differences in the blood glucose levels after injecting or inhaling insulin shown in Fig. 4.3.

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..... [3]

(iii) With reference to Figs. 4.2 and 4.3, suggest one advantage and one disadvantage of inhaling insulin rather than injecting it.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 15]

For Examiner's Use

5 Rice, *Oryza sativa*, is a staple food in many parts of the world. Rice is often grown in fields that are flooded with water for part of the growing season.

(a) The roots of young rice plants are highly tolerant of ethanol. Explain how this helps them to survive when the fields are flooded.

.....

.....

.....

..... [2]

(b) Rice grains have a similar structure to those of maize. The endosperm makes up most of the rice grain. The endosperm is surrounded by an aleurone layer, which contains hydrolytic enzymes. Outside the aleurone layer is the fused pericarp and testa, containing large amounts of cellulose.

(i) Describe the function of the endosperm.

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.....

.....

..... [2]

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Brown rice includes the pericarp and testa, whereas in white rice these have been removed during milling, along with most of the aleurone layer.

For Examiner's Use

Table 5.1 shows the nutrient content of samples of white and brown rice.

Table 5.1

	nutrient content per 100 g	
	white rice	brown rice
lipid / g	0.8	2.4
dietary fibre / g	0.6	2.8
calcium / mg	8	12
vitamin B_1 / mg	0.07	0.26
protein / g	6.0	7.4
carbohydrate / g	82.0	77.7

(ii) With reference to the structure of rice grains, suggest why brown rice contains more protein than white rice.

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..... [2]

(iii) Explain why brown rice contains less carbohydrate per gram than white rice.

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..... [1]

(iv) Explain why the grains of cereals such as rice are staple foods in many parts of the world.

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..... [2]

[Total: 9]

6 In sickle cell anaemia the recessive allele Hb^S replaces the normal allele Hb^A.

For Examiner's Use

- The frequency of Hb^S is much higher in West Africa than in most parts of the world.
- The frequency of Hb^S corresponds with the distribution of malaria.

(a) Explain what is meant by the term *allele.*

.....

..... [1]

(b) State whether the likely life expectancy is high or low in West Africa for individuals with the following genotypes. In each case give a reason for your answer.

Hb^AHb^A .....

.....

Hb^AHb^S .....

.....

Hb^SHb^S .....

..... [4]

(c) Explain why populations of West African descent living in the USA have a decreased frequency of the Hb^S allele compared to West African populations.

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[Total: 7]

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7 An investigation was carried out into the effects of a plant growth regulator, auxin (IAA), on apical dominance.

- The apical buds of 20 pea plants were cut off and discarded.
- The cut surfaces of 10 pea plants were coated with an inert paste containing auxin.
- The cut surfaces of the other group of 10 pea plants were coated with the inert paste alone.
- A further group of 10 pea plants did not have their apical buds removed and were not coated with paste. This was a control group.

The lengths of the side shoots of plants in each of the three groups were measured at regular time intervals and mean values calculated.

The results are shown in Fig. 7.1.

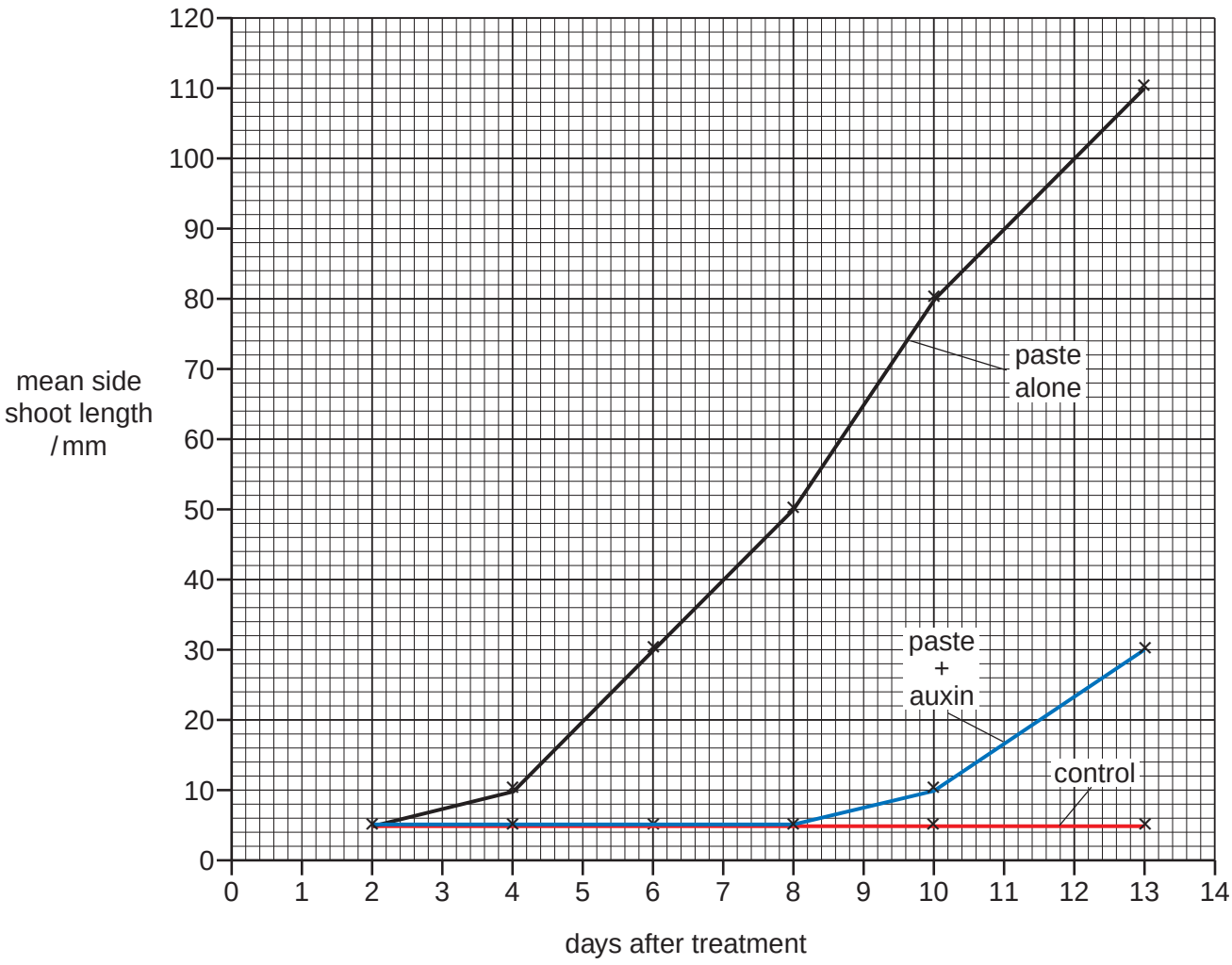


Fig. 7.1

(a) Explain why the side shoots increase in length when the terminal buds are removed.

For Examiner's Use

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..... [3]

(b) Calculate the percentage difference, at 13 days, in the mean length of side shoots of plants treated with paste alone compared with the plants treated with paste and auxin.

Give your answer to the nearest whole number.

Show your working.

Answer .....% [2]

(c) Using data from Fig. 7.1, describe **and** explain the effect of auxin on the growth of side shoots.

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..... [3]

[Total: 8]

For Examiner's Use

8 **(a)** In flowering plants, the light-dependent reactions are carried out by photosynthetic pigments which fall into two categories: primary pigments and accessory pigments.

Outline the role played by accessory pigments in the light-dependent reactions.

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..... [2]

(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PS I and PS II. PS I takes part in cyclic photophosphorylation but PS II does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

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(c) The rate of photosynthesis is affected by several environmental factors. Fig. 8.1 shows the effect of temperature on the rate of photosynthesis.

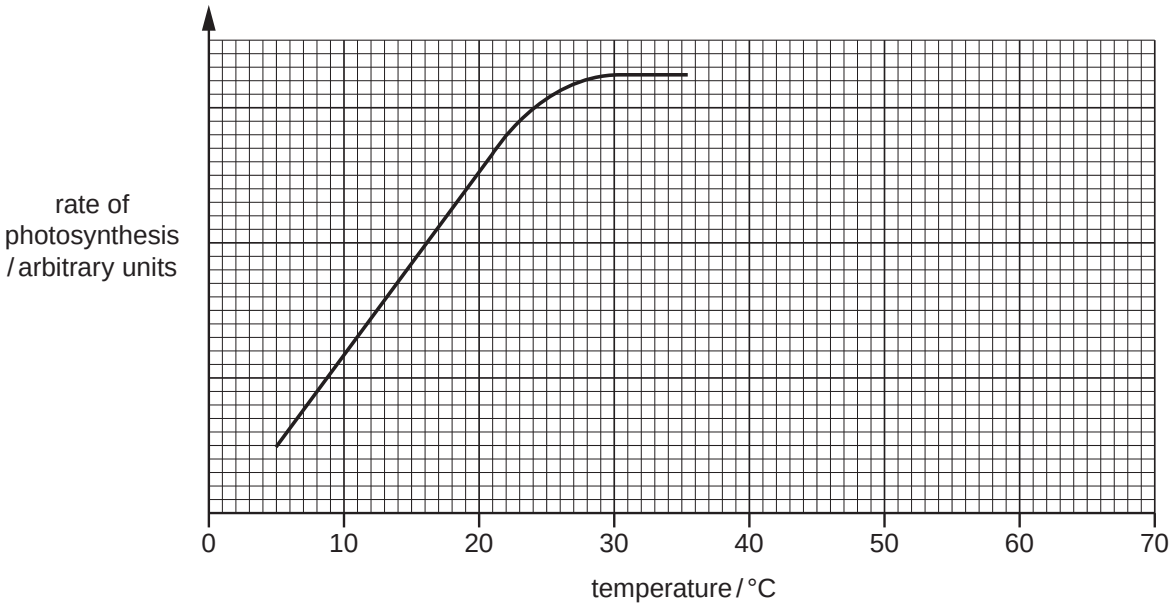


Fig. 8.1

For Examiner's Use

(i) Explain why the rate of photosynthesis levels out at 30 °C.

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(ii) On Fig. 8.1 continue the curve to indicate what would happen to the rate of photosynthesis if the temperature was increased to 70 °C. [1]

(iii) Explain why you have continued the curve in this way.

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..... [2]

(d) A palisade mesophyll cell is adapted to carry out photosynthesis. The table below lists some of the adaptations of a palisade mesophyll cell.

Complete the table to show how these adaptations help the cell to carry out photosynthesis.

adaptation	how the adaptation helps photosynthesis
thin cell wall	....
cylindrical shape	....
large vacuole	....
chloroplasts can be moved within the cell	....

[4]

[Total: 15]

Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Outline the behaviour of **chromosomes** during meiosis. [9]

(b) Describe the ways by which **gene** mutations can occur. [6]

[Total: 15]

10 **(a)** Outline the need for energy in living organisms using named examples. [9]

(b) Explain the different energy values of carbohydrate, lipid and protein as respiratory substrates. [6]

[Total: 15]

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8675946048

BIOLOGY **9700/42**

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2 hours

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Section A

For Examiner's Use

Answer **all** the questions.

1 The Great Lakes, in North America, lie between the USA and Canada. A survey of birds of the Lake Ontario area has shown the relative abundance of birds between 1995 and 2005.

Table 1.1 shows the feeding habits and the relative change in numbers of some of the birds in the survey.

Table 1.1

name	feeding habit	percentage change in numbers between 1995 and 2005
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tree swallow *Tachycineta bicolor*	flying insects	–6.2
blue-winged teal *Anas discors*	aquatic insects, molluscs, plants	–12.3
pied-billed grebe *Podilymbus podiceps*	amphibia, aquatic insects, fish	–15.9
black tern *Chlidonias niger*	aquatic insects, fish, flying insects	–18.7

(a) Using the information in Table 1.1 suggest reasons for the changes in numbers of these birds.

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..... [4]

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(b) An ecosystem that has a wide range of species has a high biodiversity.

Explain the benefits of maintaining biodiversity.

For Examiner's Use

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..... [4]

[Total: 8]

For Examiner's Use

2 The disease-causing bacterium, *Pseudomonas aeruginosa*, may occur in the form of a 'biofilm'. A biofilm consists of a layer of bacteria, growing on a surface and attached to one another. Such biofilms are difficult to control by antibiotics.

A mutant strain of *P. aeruginosa* has been found which produces biofilms that are indistinguishable from those of the wild-type bacteria. However, the mutant strain differs from the wild-type in its resistance to an antibiotic, **A**.

(a) Antibiotic **A** belongs to a group of antibiotics known as anti-pseudomonal penicillins.

(i) Describe the mode of action of penicillin on bacteria.

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.....

..... [3]

(ii) Explain why penicillin does not affect viruses.

.....

.....

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..... [2]

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(b) Wild-type and mutant bacteria were grown on solid culture media both with antibiotic **A** and without antibiotic **A**.

For Examiner's Use

The subsequent change in numbers of living bacteria is shown in Fig. 2.1.

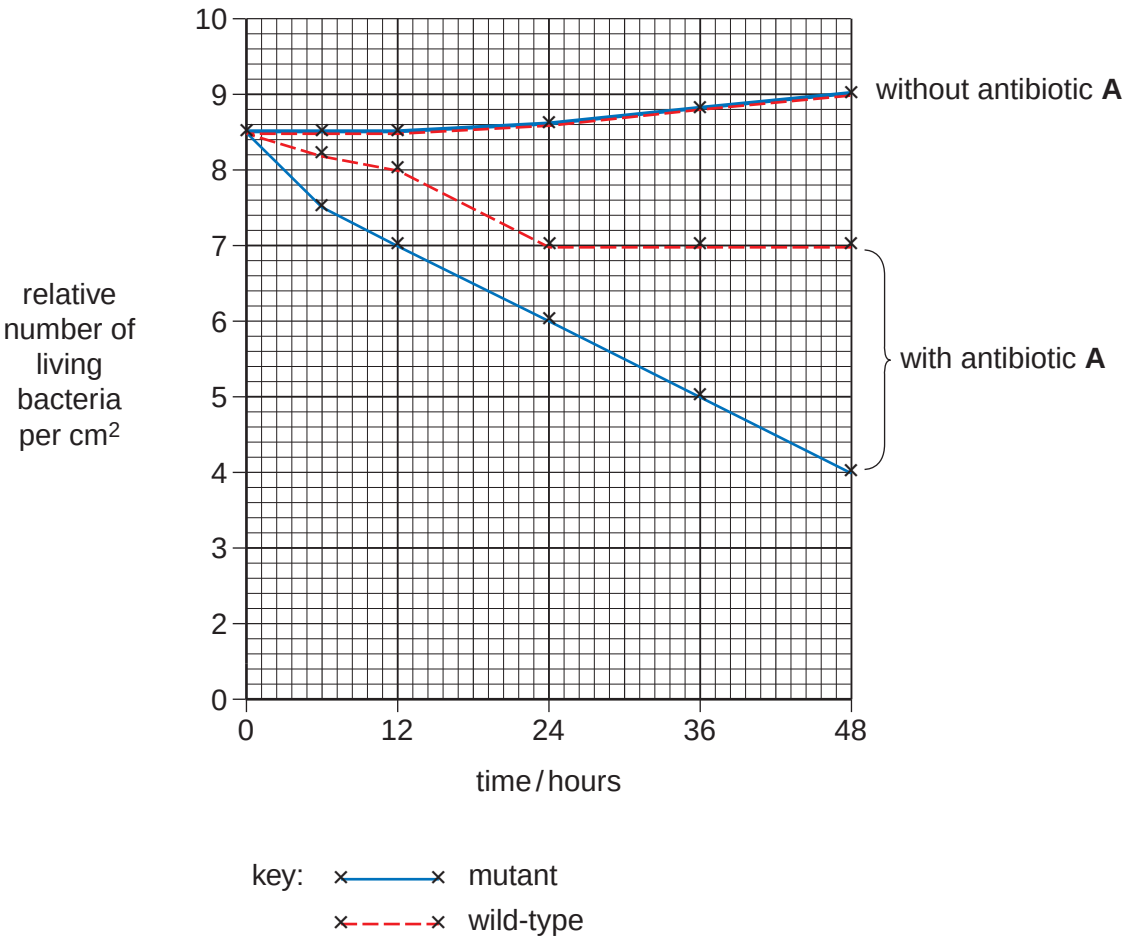


Fig. 2.1

With reference to Fig. 2.1, describe the changes in numbers of the wild-type and mutant bacteria on culture media with antibiotic **A and** without antibiotic **A**.

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..... [4]

For Examiner's Use

(c) The wild-type and mutant strains of this bacterium have different DNA sequences in part of a gene coding for an enzyme which is needed to produce polymers of glucose, called glucans. Glucans are secreted by bacteria and can bind to various molecules, including those of antibiotic **A**.

Explain

(i) how a mutation of a gene coding for an enzyme may result in an enzyme with reduced activity,

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..... [2]

(ii) the different effects of antibiotic **A**, shown in Fig. 2.1, on the wild-type and mutant strains of bacteria.

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(d) Explain the role of natural selection in the evolution of antibiotic resistance in bacteria.

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..... [3]

[Total: 16]

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3 A recent development in fertility treatment is called in-vitro maturation (IVM). This is both cheaper and safer than the standard procedure used in in-vitro fertilisation (IVF), especially for women with polycystic ovaries. Hormone treatment can be dangerous for women with this condition, in which a number of ovarian follicles mature at the same time.

For Examiner's Use

IVF and IVM are compared in Fig. 3.1.

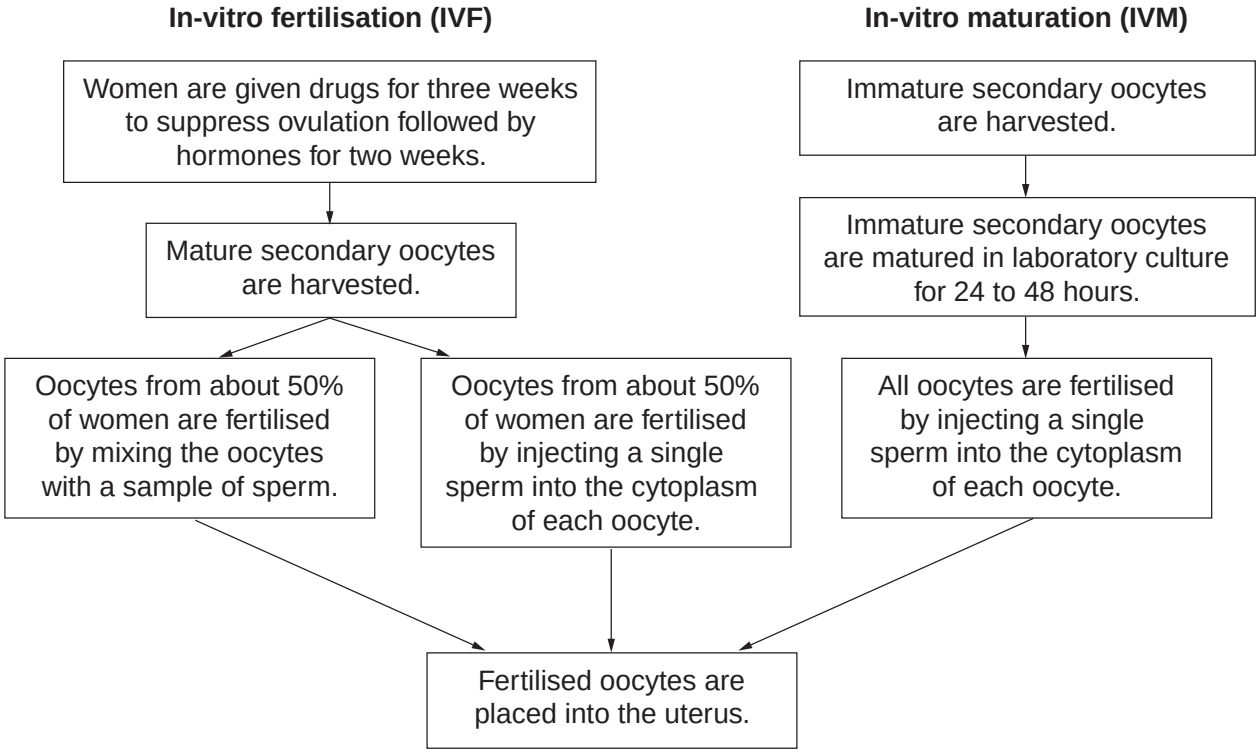


Fig. 3.1

(a) With reference to Fig. 3.1, explain why women are treated with hormones for two weeks after being given drugs to suppress ovulation at the beginning of IVF treatment.

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..... [2]

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(b) State the roles of mitosis and meiosis in producing an immature secondary oocyte.

For Examiner's Use

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..... [3]

(c) Suggest one advantage and one possible disadvantage of fertilising an oocyte by injecting a sperm into its cytoplasm instead of mixing the oocyte with a sample of sperm.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 7]

For Examiner's Use

4 The secretion of insulin by the islets of Langerhans in the pancreas stimulates the liver to reduce the blood glucose concentration.

(a) Describe how the **liver** reduces blood glucose concentration, when insulin is secreted.

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(b) Almost all insulin used to treat type I diabetes is produced by genetically engineered bacteria or yeast. A summary of this procedure is shown in Fig. 4.1.

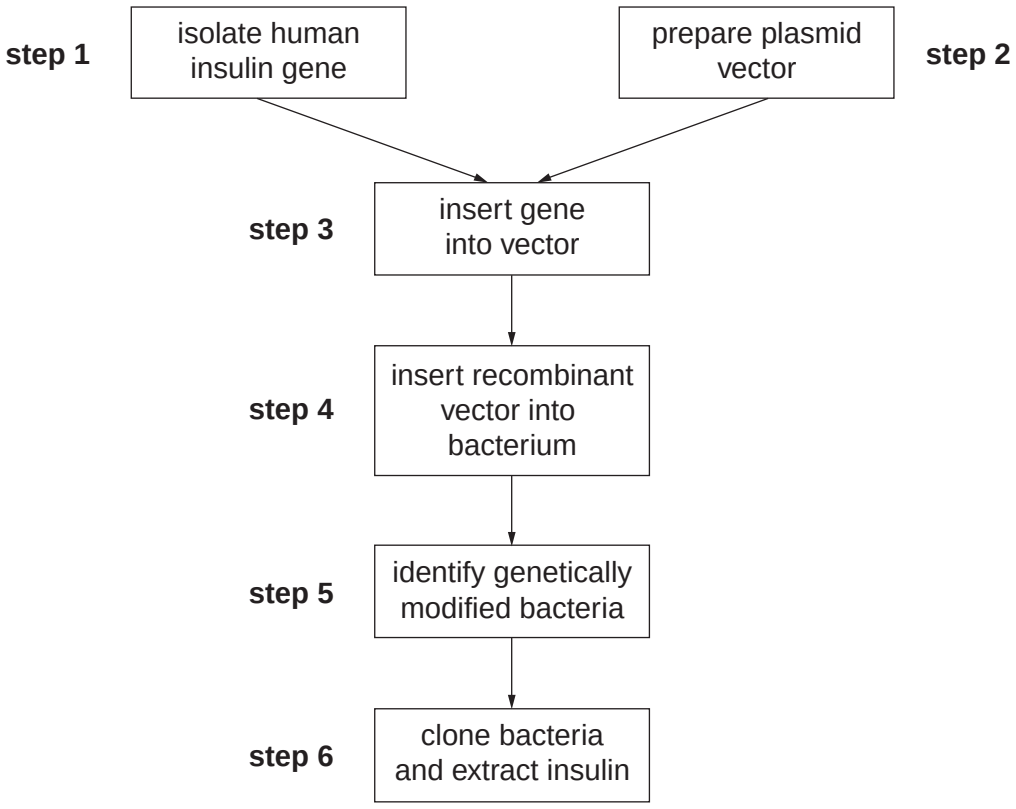


Fig. 4.1

For Examiner's Use

(i) One way of carrying out **step 1** is to collect mRNA from β cells from the pancreas. The relevant mRNA is then isolated and used to make DNA.

Suggest why isolating the mRNA coding for insulin in a β cell is easier than isolating the DNA for insulin in a β cell.

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..... [2]

(ii) Outline the use of restriction enzymes in **step 2**.

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..... [2]

(c) Most people with type I diabetes inject insulin. A recent product contains insulin that can be administered using a nasal spray. The spray is inhaled and the insulin is taken up through the lungs.

For Examiner's Use

Fig. 4.2 shows the concentration of insulin in the blood plasma in the 480 minutes after injecting or inhaling insulin. In both cases, the insulin was of the same type, obtained from genetically engineered *Escherichia coli*.

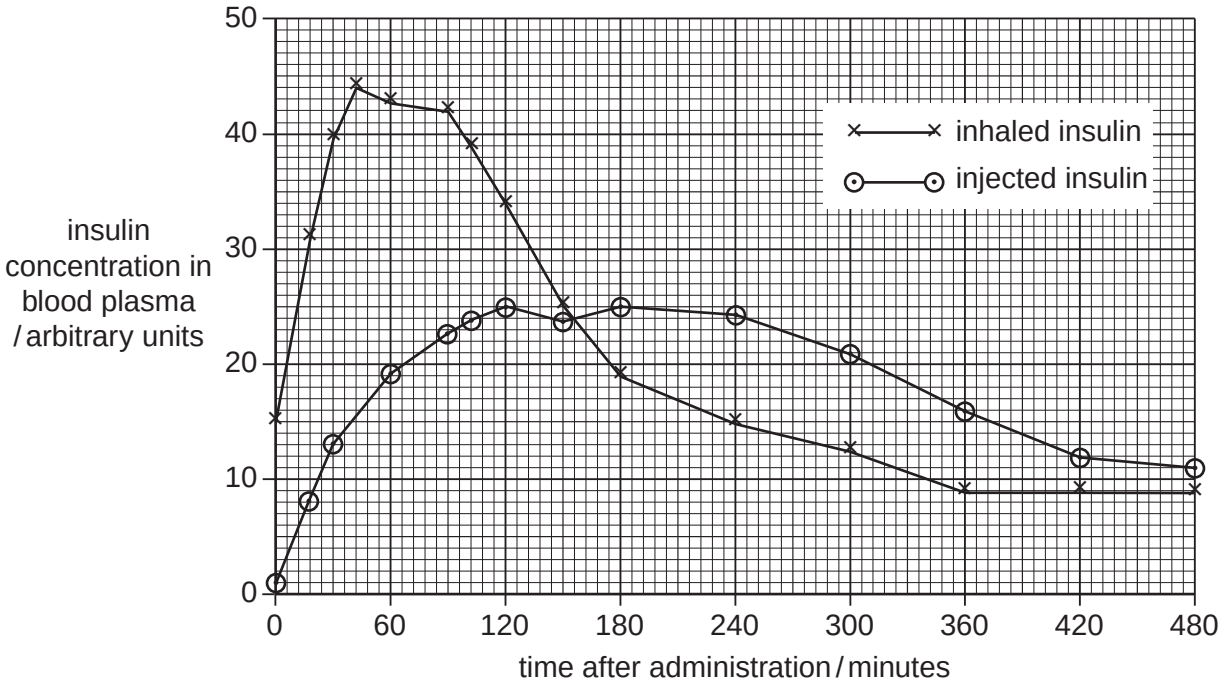


Fig. 4.2

Fig. 4.3 shows the concentration of glucose in the blood plasma in the 480 minutes after injecting or inhaling insulin.

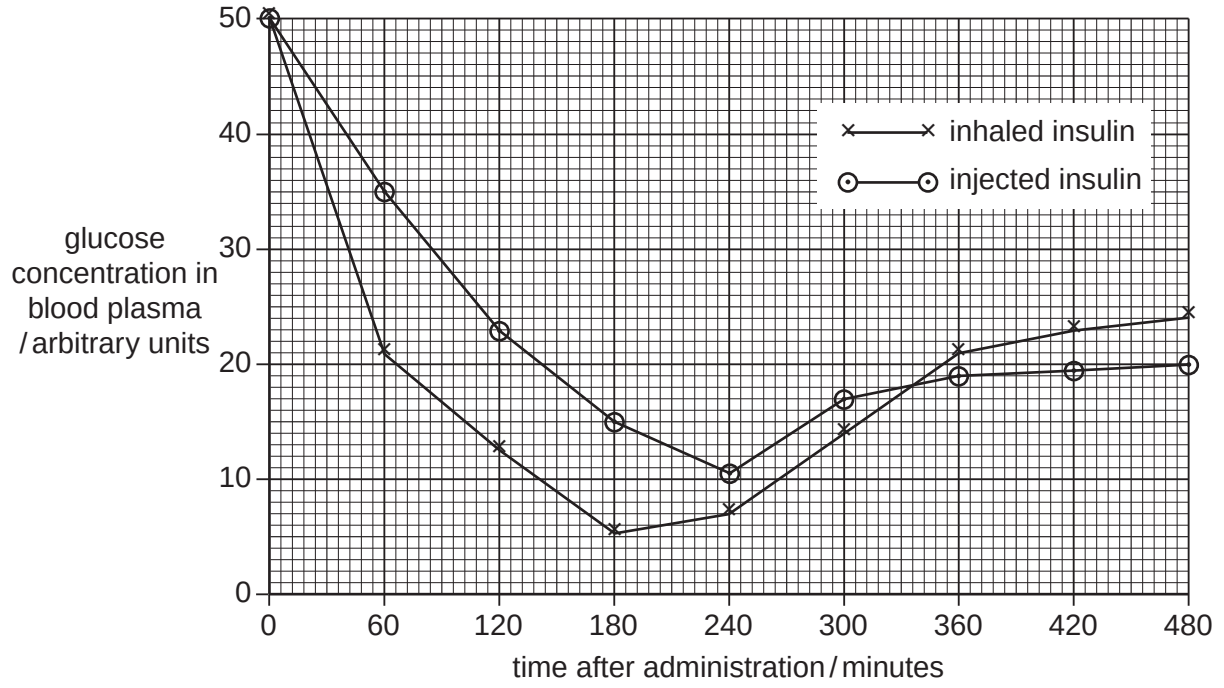


Fig. 4.3

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For Examiner's Use

(i) Compare the results for injected insulin and inhaled insulin shown in Fig. 4.2.

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..... [3]

(ii) With reference to Fig. 4.2, explain the differences in the blood glucose levels after injecting or inhaling insulin shown in Fig. 4.3.

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..... [3]

(iii) With reference to Figs. 4.2 and 4.3, suggest one advantage and one disadvantage of inhaling insulin rather than injecting it.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 15]

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[Turn over

For Examiner's Use

5 Rice, *Oryza sativa*, is a staple food in many parts of the world. Rice is often grown in fields that are flooded with water for part of the growing season.

(a) The roots of young rice plants are highly tolerant of ethanol. Explain how this helps them to survive when the fields are flooded.

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.....

.....

..... [2]

(b) Rice grains have a similar structure to those of maize. The endosperm makes up most of the rice grain. The endosperm is surrounded by an aleurone layer, which contains hydrolytic enzymes. Outside the aleurone layer is the fused pericarp and testa, containing large amounts of cellulose.

(i) Describe the function of the endosperm.

.....

.....

.....

..... [2]

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Brown rice includes the pericarp and testa, whereas in white rice these have been removed during milling, along with most of the aleurone layer.

For Examiner's Use

Table 5.1 shows the nutrient content of samples of white and brown rice.

Table 5.1

	nutrient content per 100 g	
	white rice	brown rice
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dietary fibre / g	0.6	2.8
calcium / mg	8	12
vitamin B_1 / mg	0.07	0.26
protein / g	6.0	7.4
carbohydrate / g	82.0	77.7

(ii) With reference to the structure of rice grains, suggest why brown rice contains more protein than white rice.

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.....

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..... [2]

(iii) Explain why brown rice contains less carbohydrate per gram than white rice.

.....

..... [1]

(iv) Explain why the grains of cereals such as rice are staple foods in many parts of the world.

.....

.....

.....

..... [2]

[Total: 9]

6 In sickle cell anaemia the recessive allele Hb^S replaces the normal allele Hb^A.

For Examiner's Use

- The frequency of Hb^S is much higher in West Africa than in most parts of the world.
- The frequency of Hb^S corresponds with the distribution of malaria.

(a) Explain what is meant by the term *allele.*

.....

..... [1]

(b) State whether the likely life expectancy is high or low in West Africa for individuals with the following genotypes. In each case give a reason for your answer.

Hb^AHb^A .....

.....

Hb^AHb^S .....

.....

Hb^SHb^S .....

..... [4]

(c) Explain why populations of West African descent living in the USA have a decreased frequency of the Hb^S allele compared to West African populations.

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..... [2]

[Total: 7]

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7 An investigation was carried out into the effects of a plant growth regulator, auxin (IAA), on apical dominance.

- The apical buds of 20 pea plants were cut off and discarded.
- The cut surfaces of 10 pea plants were coated with an inert paste containing auxin.
- The cut surfaces of the other group of 10 pea plants were coated with the inert paste alone.
- A further group of 10 pea plants did not have their apical buds removed and were not coated with paste. This was a control group.

The lengths of the side shoots of plants in each of the three groups were measured at regular time intervals and mean values calculated.

The results are shown in Fig. 7.1.

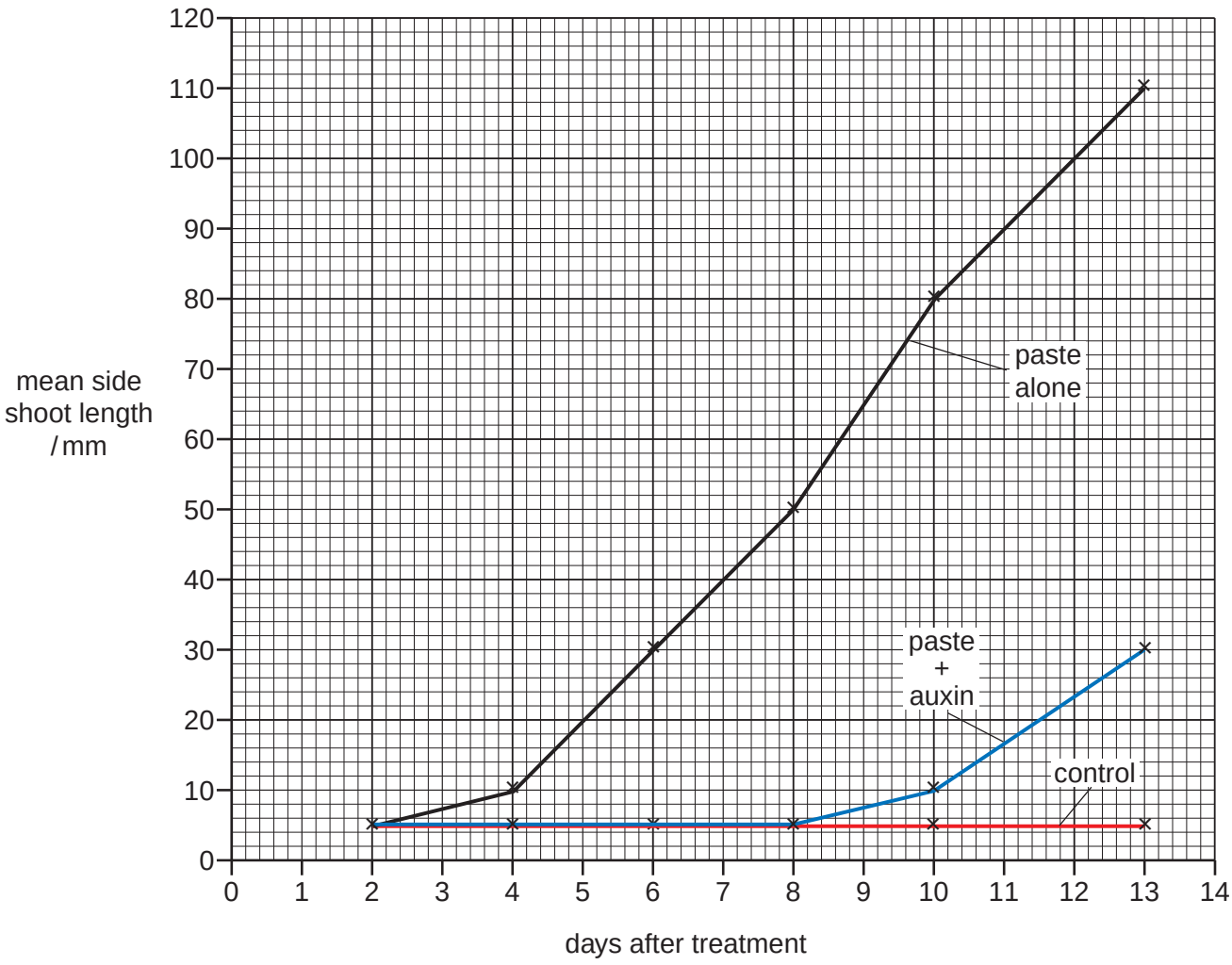


Fig. 7.1

(a) Explain why the side shoots increase in length when the terminal buds are removed.

For Examiner's Use

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..... [3]

(b) Calculate the percentage difference, at 13 days, in the mean length of side shoots of plants treated with paste alone compared with the plants treated with paste and auxin.

Give your answer to the nearest whole number.

Show your working.

Answer .....% [2]

(c) Using data from Fig. 7.1, describe **and** explain the effect of auxin on the growth of side shoots.

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..... [3]

[Total: 8]

For Examiner's Use

8 **(a)** In flowering plants, the light-dependent reactions are carried out by photosynthetic pigments which fall into two categories: primary pigments and accessory pigments.

Outline the role played by accessory pigments in the light-dependent reactions.

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..... [2]

(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PS I and PS II. PS I takes part in cyclic photophosphorylation but PS II does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

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..... [4]

(c) The rate of photosynthesis is affected by several environmental factors. Fig. 8.1 shows the effect of temperature on the rate of photosynthesis.

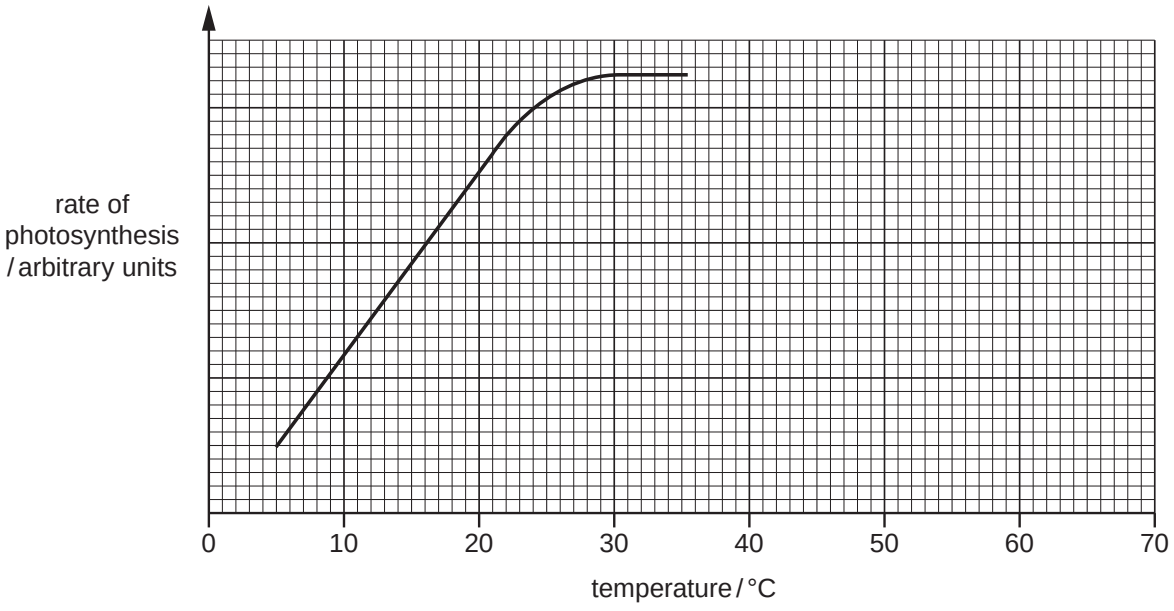


Fig. 8.1

For Examiner's Use

(i) Explain why the rate of photosynthesis levels out at 30 °C.

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..... [2]

(ii) On Fig. 8.1 continue the curve to indicate what would happen to the rate of photosynthesis if the temperature was increased to 70 °C. [1]

(iii) Explain why you have continued the curve in this way.

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..... [2]

(d) A palisade mesophyll cell is adapted to carry out photosynthesis. The table below lists some of the adaptations of a palisade mesophyll cell.

Complete the table to show how these adaptations help the cell to carry out photosynthesis.

adaptation	how the adaptation helps photosynthesis
thin cell wall	....
cylindrical shape	....
large vacuole	....
chloroplasts can be moved within the cell	....

[4]

[Total: 15]

Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Outline the behaviour of **chromosomes** during meiosis. [9]

(b) Describe the ways by which **gene** mutations can occur. [6]

[Total: 15]

10 **(a)** Outline the need for energy in living organisms using named examples. [9]

(b) Explain the different energy values of carbohydrate, lipid and protein as respiratory substrates. [6]

[Total: 15]

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General Certificate of Education Advanced Level

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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	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

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

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Section A

For Examiner's Use

Answer **all** the questions.

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.

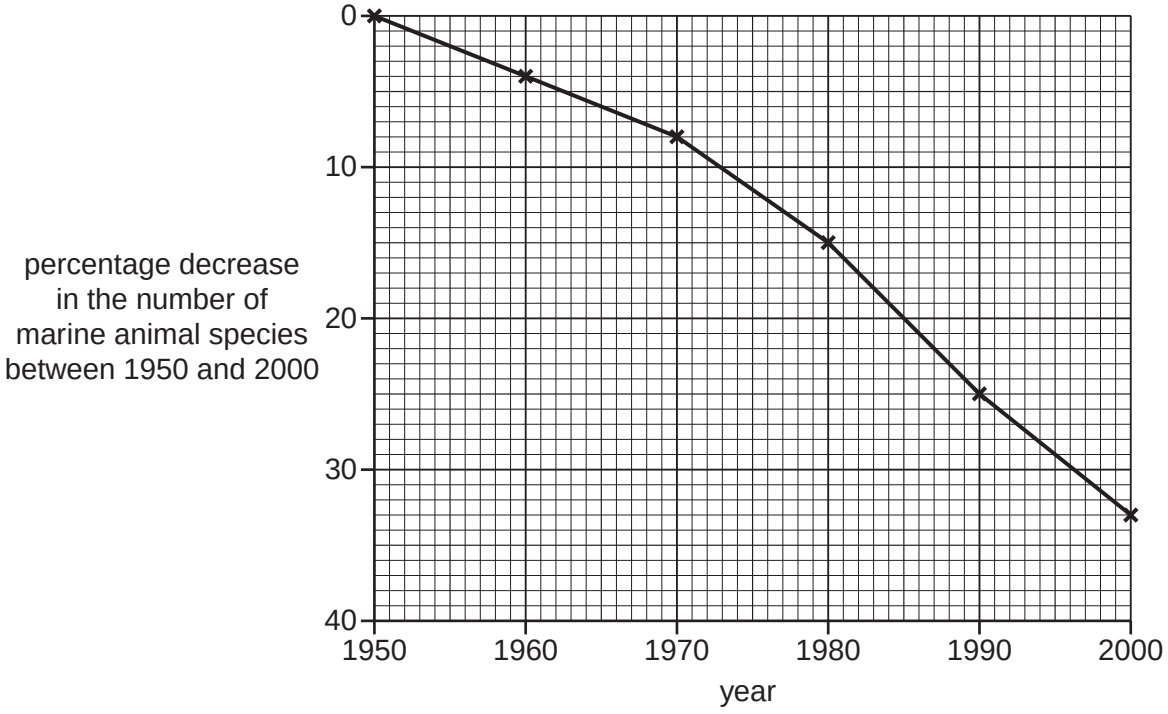


Fig. 1.1

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

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..... [3]

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

For Examiner's Use

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..... [2]

(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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..... [3]

[Total: 8]

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

For Examiner's Use

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..... [4]

(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.

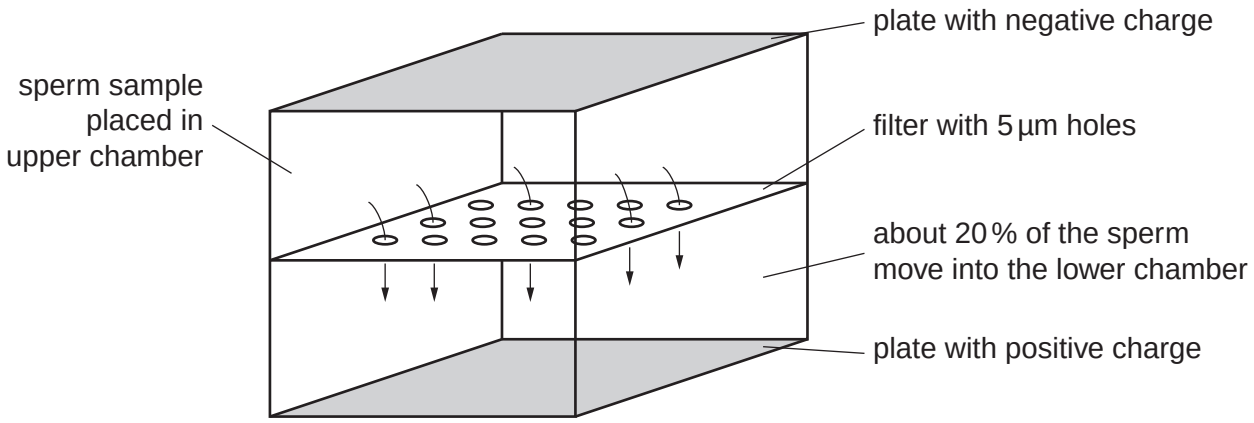


Fig. 2.1

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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..... [3]

[Total: 7]

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

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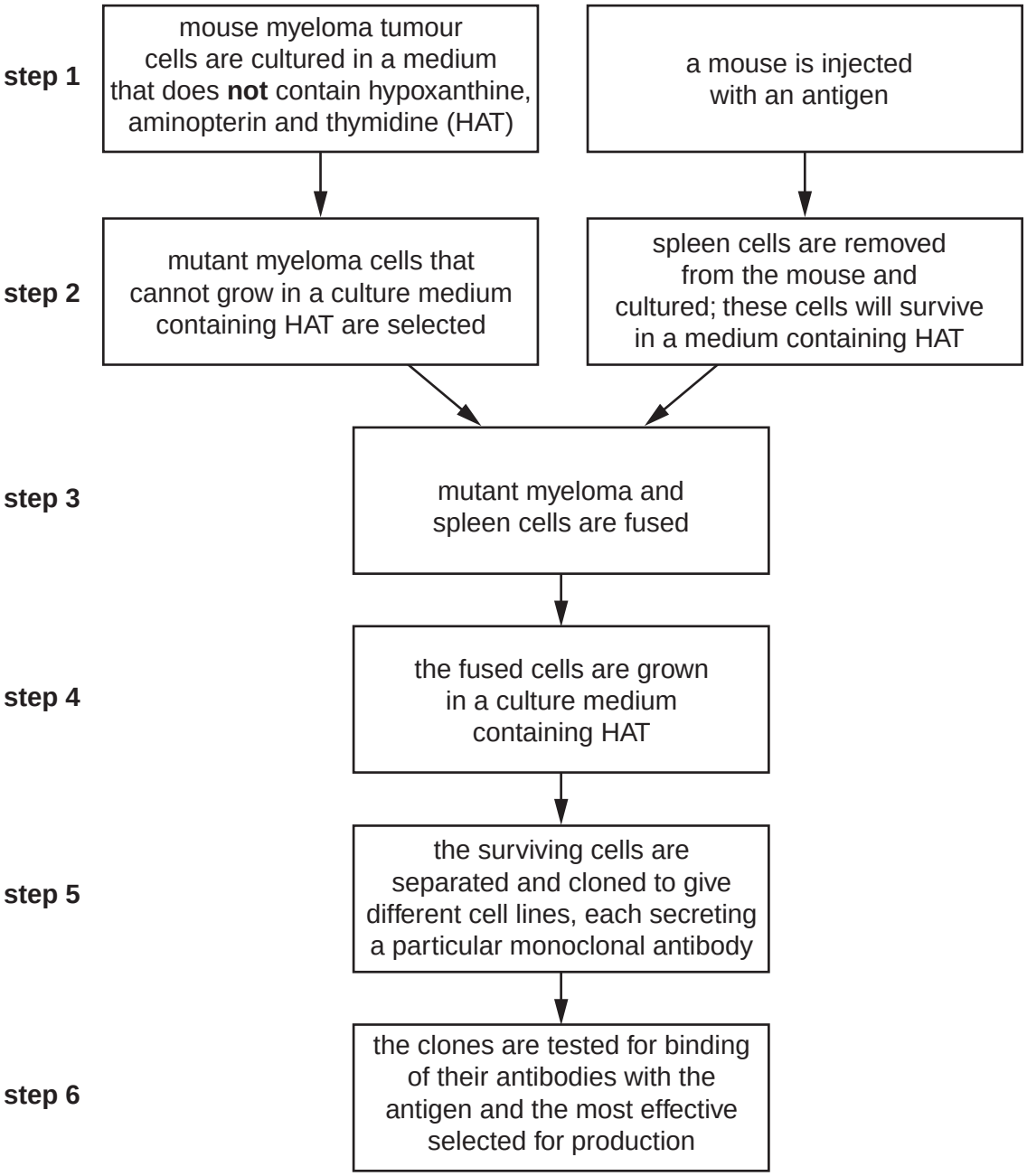


Fig. 3.1

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

..... [1]

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

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..... [2]

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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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..... [3]

(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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..... [2]

(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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..... [4]

[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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..... [2]

(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.

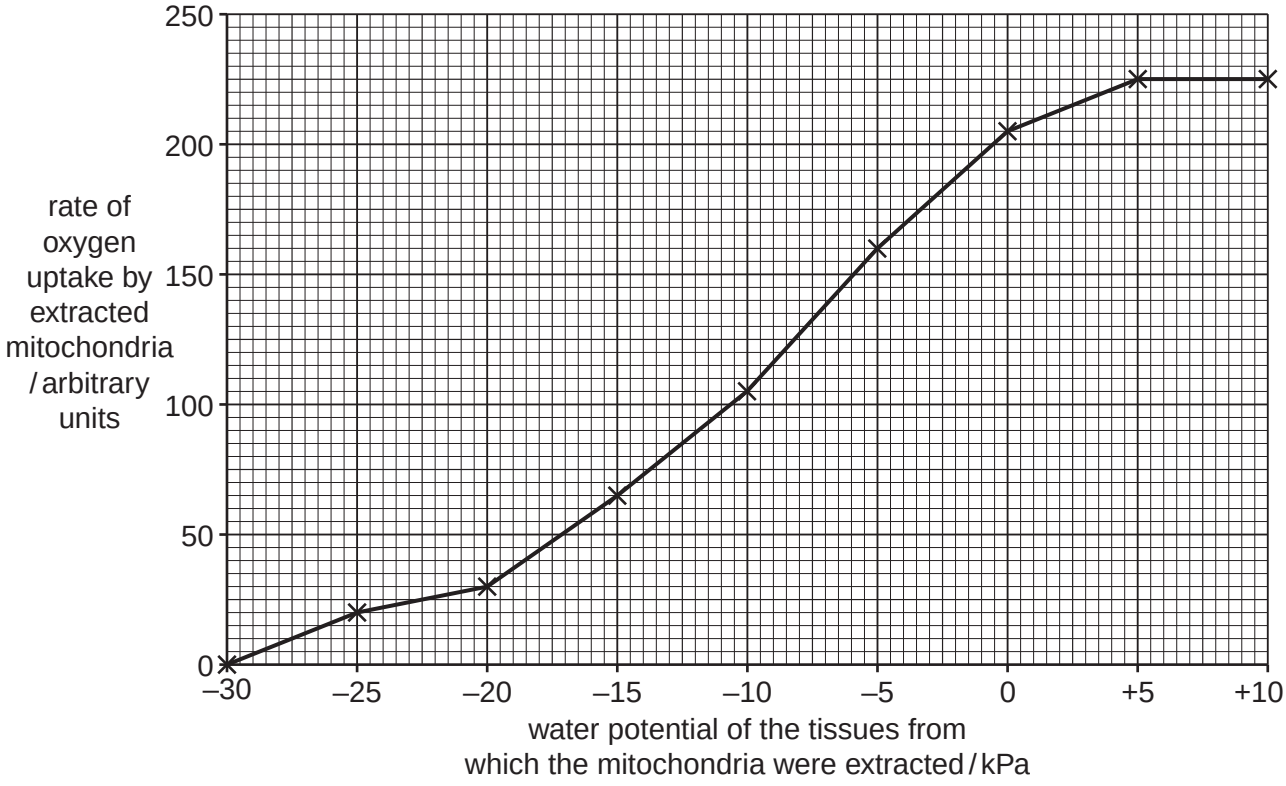


Fig. 4.1

For Examiner's Use

(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.

For Examiner's Use

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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.

1. .....

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2. .....

..... [2]

[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.

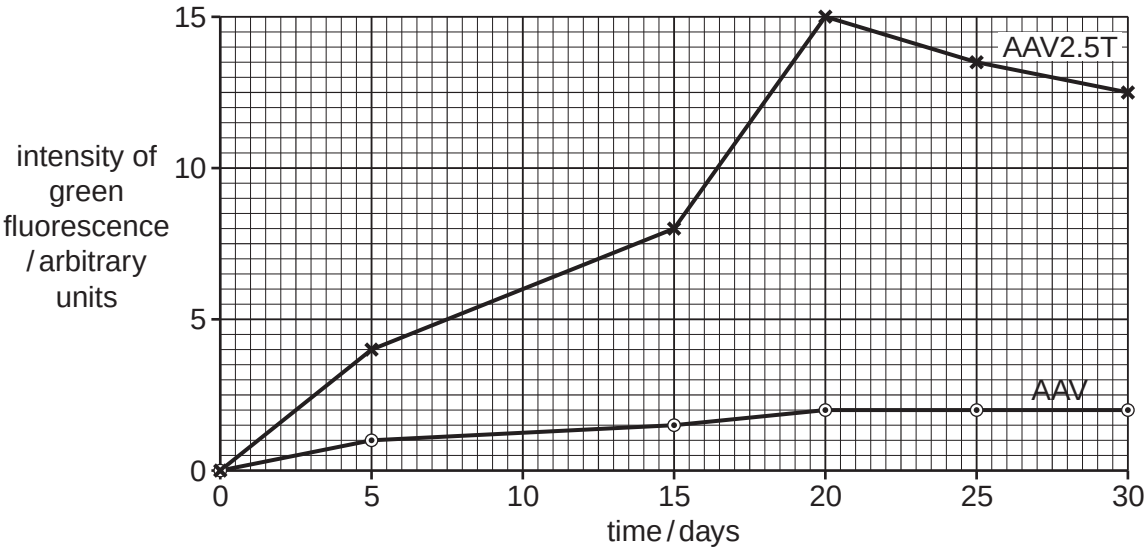


Fig. 5.1

(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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..... [2]

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

For Examiner's Use

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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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..... [4]

[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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..... [3]

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

For Examiner's Use

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

type of natural selection .....

explanation .....

..... [2]

[Total: 7]

For Examiner's Use

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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..... [2]

(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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..... [4]

(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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..... [2]

[Total: 8]

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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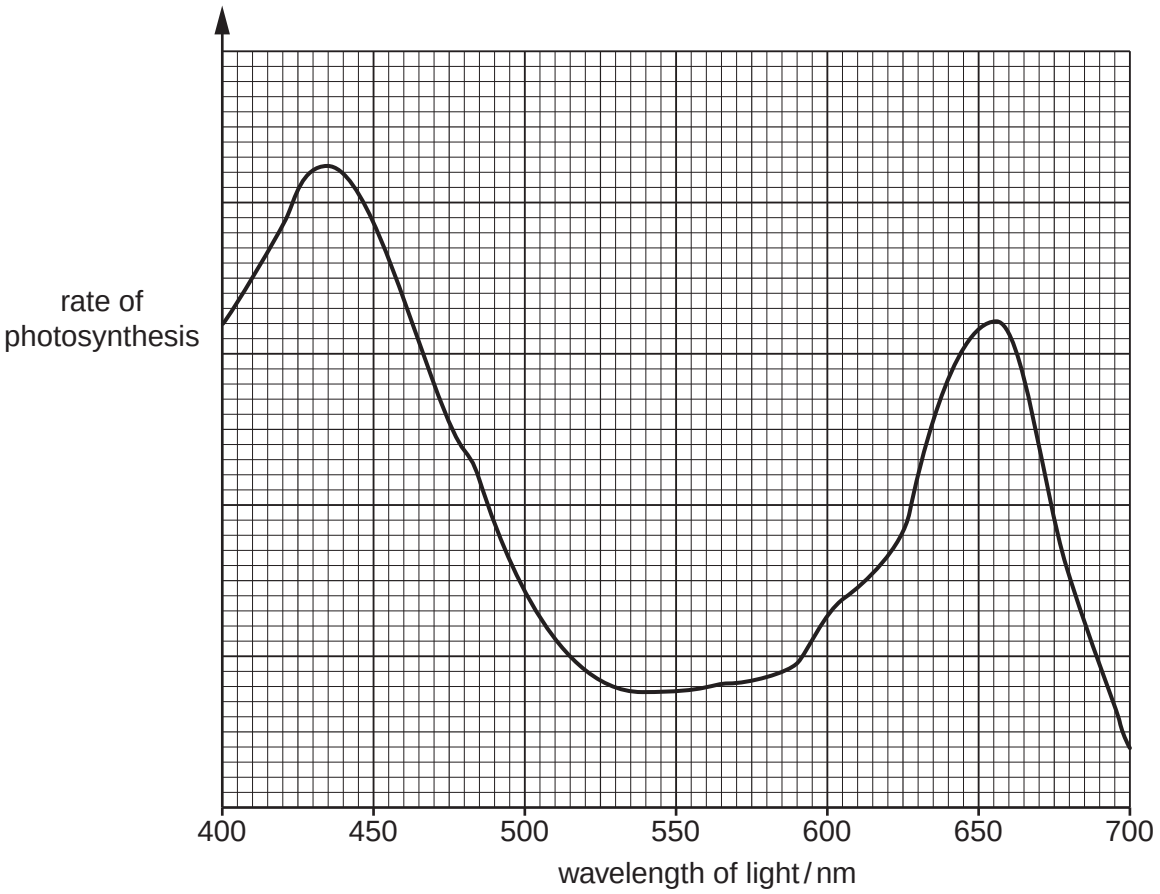


Fig. 8.1

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

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..... [4]

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

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1. .....

2. ..... [2]

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

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..... [3]

(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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..... [2]

(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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..... [4]

[Total: 15]

Section B

For Examiner's Use

Answer **one** question.

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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