Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

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0123456789

BIOLOGY **9700/04**

Paper 4 A Level Structured Questions **For Examination from 2016**

SPECIMEN PAPER

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 on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.

Electronic calculators may be used.
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.

This document consists of **24** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

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Section A

Answer **all** the questions.

1 Corals are simple marine animals and usually exist in colonies of thousands of individuals.

Fig. 1.1 shows a coral colony.

Fig. 1.1

Corals absorb calcium carbonate from the sea to build their skeletons, which help to form large coral reefs. Coral reefs provide a home for about 25% of known fish species and have the highest biodiversity of any marine ecosystem.

(a) Corals, although they are animals, are sometimes mistaken for members of the plant kingdom.

State **two** ways in which corals differ from plants.

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..... [2]

(b) Outline what is meant by the term ecosystem.

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(c) Coral reefs are at risk of damage due to human activities. All the coral reefs in three regions were classified as being at low, medium or high risk of damage.

Table 1.1 shows the areas of coral reef at risk of damage in these three regions.

Table 1.1

region	area of coral reef at risk of damage ($\times 10^3$ km^2)			percentage of coral reef at high risk of damage
	low	medium	high	
Caribbean Sea	9	8	7	29
Indian Ocean	20	15	10	
Pacific Ocean	60	30	9	

(i) Complete Table 1.1, giving your answers, **to the nearest whole number**. [1]

(ii) Suggest how human activities could damage coral reefs.

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..... [3]

[Total: 8]

2 ATP is the universal energy currency which provides the immediate source of energy for cellular processes.

(a) Fig. 2.1 shows some ways in which ATP may be synthesised and used in cells.

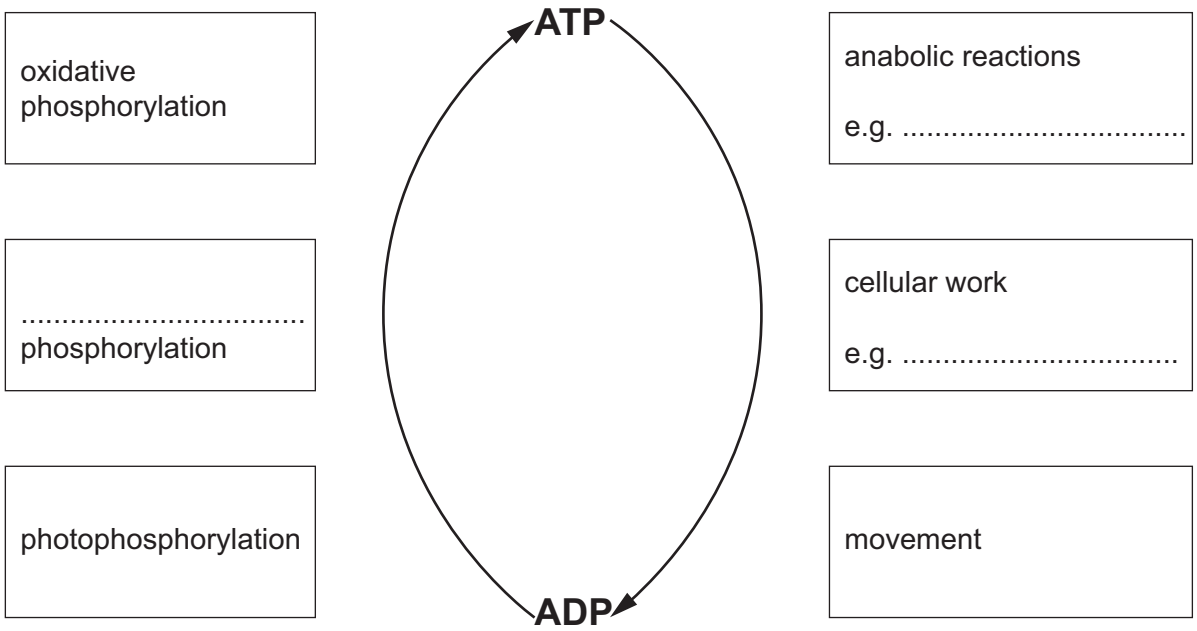

Fig. 2.1

(i) Complete Fig. 2.1 by writing correct terms or examples on the three dotted lines provided. [3]

(ii) Name the molecule that is required to react with ATP in order to convert ATP into ADP and an inorganic phosphate.

..... [1]

(iii) Name the membrane-bound enzyme responsible for phosphorylating ADP to make ATP.

..... [1]

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(b) During a sporting event an athlete may have to carry out respiration in anaerobic as well as aerobic conditions to produce sufficient ATP.

Fig. 2.2 outlines both processes in a muscle cell and shows how a liver cell is linked to these processes.

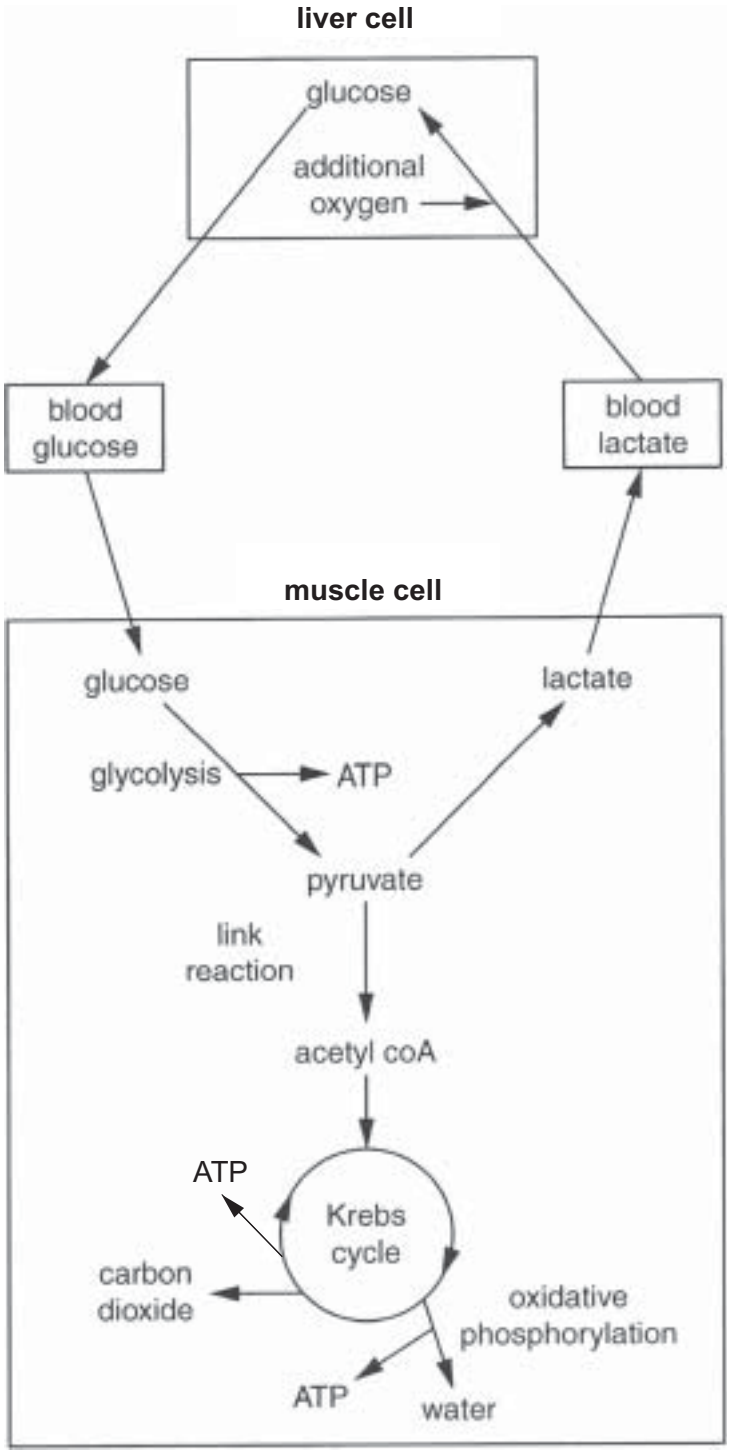

Fig. 2.2

You may refer to Fig. 2.2 in answering questions **(i)** to **(v)**.

(i) Glucose produced in the liver cell can be released into the blood to maintain blood glucose concentration.

State **one** use of glucose **within** the liver cell.

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..... [1]

(ii) Suggest why respiration is said to be less efficient in anaerobic conditions than in aerobic conditions.

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..... [2]

(iii) Complete the table to indicate, within the muscle cell, the exact locations of glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation.

process	exact location
glycolysis	
link reaction	
Krebs cycle	
oxidative phosphorylation	

[4]

(iv) Glucose is phosphorylated at the start of glycolysis in the muscle cell.

Suggest why this phosphorylated glucose does **not** diffuse out of the cell into the surrounding tissue fluid.

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..... [2]

(v) Additional oxygen is required in the metabolic pathways involved in the conversion of lactate to glucose.

State the term given to this additional oxygen.

..... [1]

[Total: 15]

3 **(a)** The human kidneys process 1200 cm^3 of blood every minute. This 1200 cm^3 of blood contains 700 cm^3 of plasma. As this blood passes through the glomeruli of the kidneys, 125 cm^3 of fluid passes into the renal capsules (Bowman's capsules). This fluid is called the glomerular filtrate and is produced by a process is called ultrafiltration.

(i) Calculate the percentage of plasma that passes into the renal capsules.

Show your working and give your answer to **one decimal place**.

answer ..... % [2]

(ii) Explain how the **structure** of the glomerular capillaries is adapted for ultrafiltration.

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..... [2]

(b) Explain why the epithelial cells of the proximal convoluted tubule have many mitochondria in them.

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(c) Of the 125 cm^3 of glomerular filtrate that enters the renal capsules each minute, only 45 cm^3 reaches the loops of Henle.

Name **two** substances that are reabsorbed into the blood from the proximal convoluted tubule, **apart from water**.

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..... [2]

[Total: 8]

4 Fig. 4.1 shows a diagram of a stoma, its guard cells and adjacent epidermal cells.

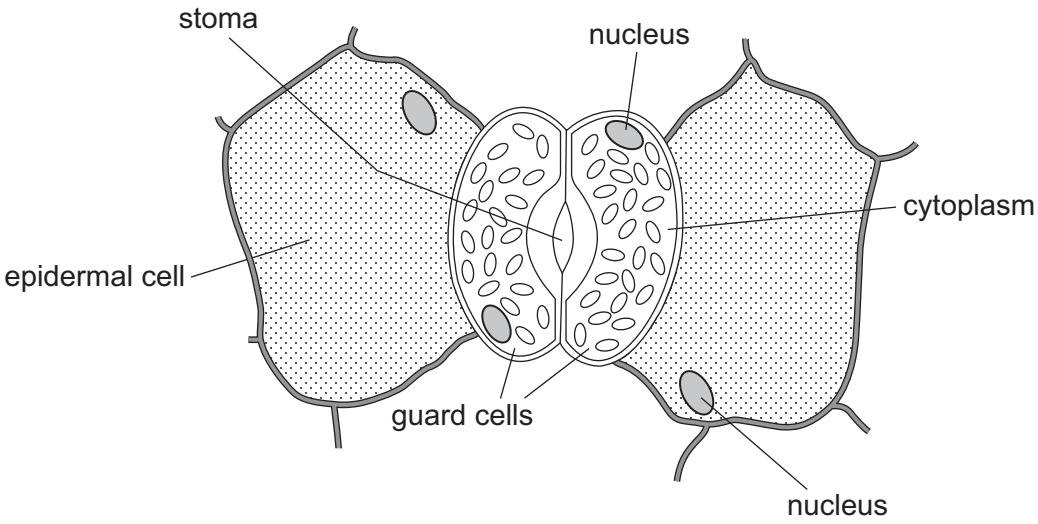

Fig. 4.1

(a) Guard cells have chloroplasts while epidermal cells do not have chloroplasts.

State **one other** difference, visible in Fig. 4.1, between guard cells and epidermal cells.

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..... [1]

(b) During stomatal closure:

(i) state precisely where abscisic acid (ABA) binds

..... [1]

(ii) identify the ion that diffuses from the guard cells to epidermal cells

..... [1]

(iii) compare the relative water potential of the guard cells with that of epidermal cells

.....[1]

(iv) describe the change in volume of the guard cells.

..... [1]

(c) The following experiment was carried out to investigate the effect of light intensity on the rate of photosynthesis of a water plant, *Elodea.*

- *Elodea* was cut into three pieces, each 10 cm long.
- Each piece of *Elodea* was placed in a glass tube, containing 0.5% sodium hydrogen carbonate solution, which was then sealed with a bung.
- Tube **A** was placed 10 cm away from a lamp.
- Tube **B** was placed 5 cm away from a lamp.
- Tube **C** was placed in a dark room.
- An oxygen sensor was used to measure the percentage of oxygen in the solutions at the start of the experiment and again at 5, 10 and 20 minutes.

The results are shown in Fig. 4.2.

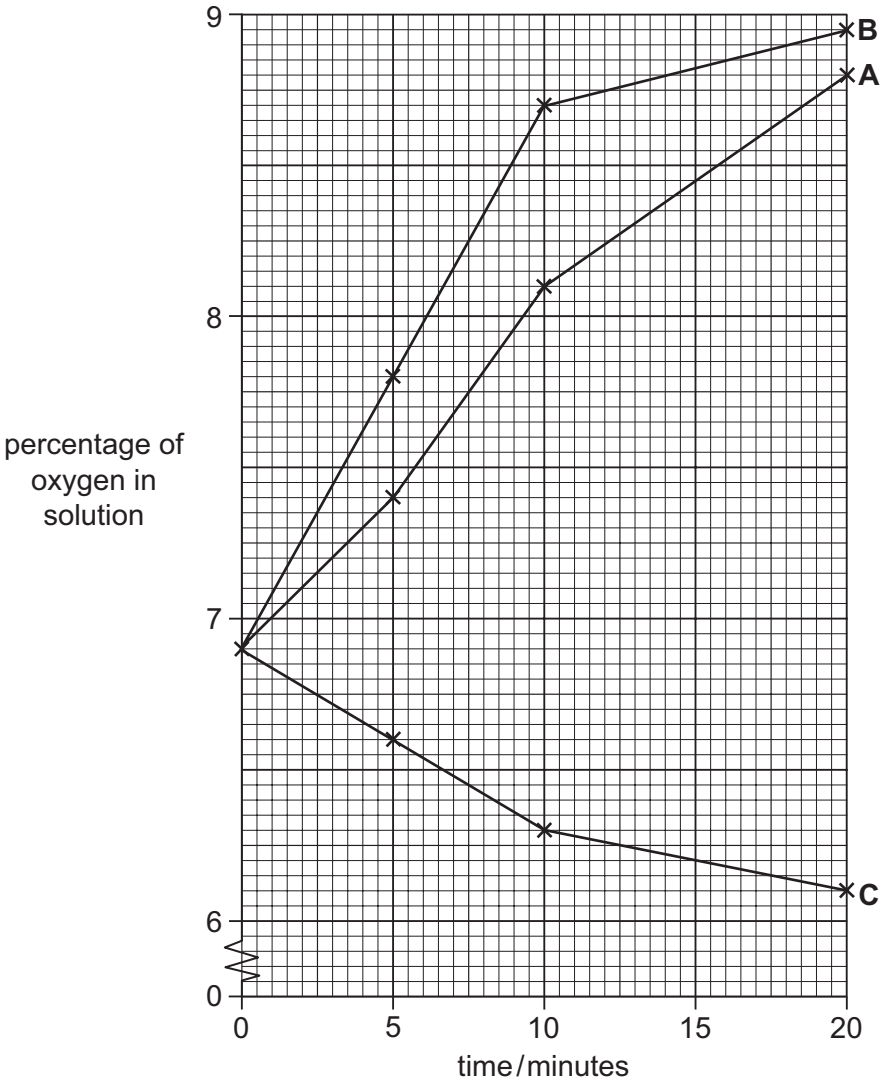

Fig. 4.2

(i) State why sodium hydrogencarbonate solution was used.

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..... [1]

(ii) Calculate the mean rate of oxygen production for tube **A** for the 20 minutes of the experiment.

Give your answer to two decimal places.
Show your working.

answer ..... [2]

(iii) Compare the results for tubes **A** and **B**.

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..... [2]

(iv) Explain the results for tube **C**.

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(v) Suggest what factor, which may have an effect on the rate of photosynthesis, was **not** taken into account in this experiment.

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(d) Fig. 4.3 shows the relationship between the light dependent and light independent reactions in a chloroplast.

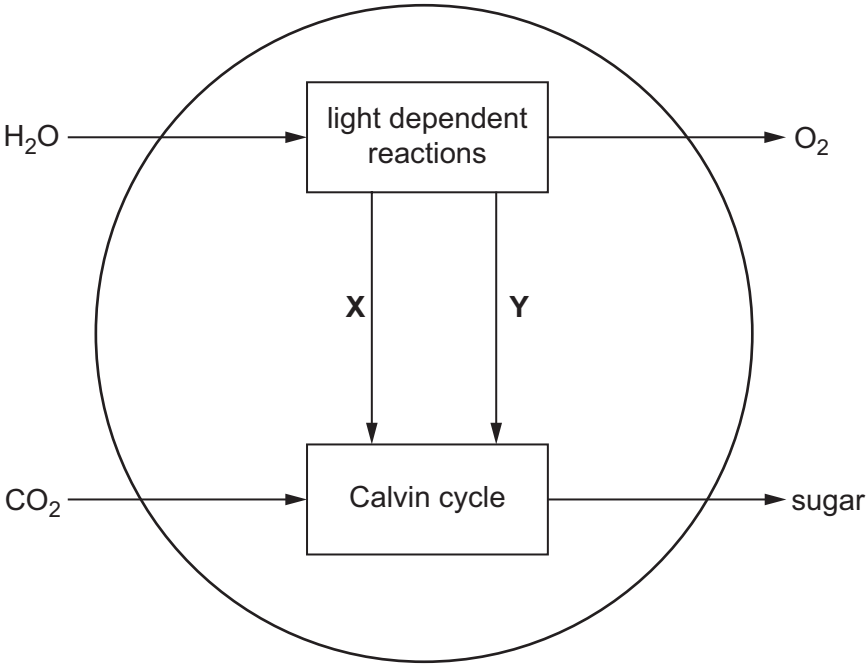

Fig. 4.3

Name substances **X** and **Y** in Fig. 4.3.

X .....

Y ..... [2]

[Total: 15]

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5 **(a)** Explain what is meant by the term *heterozygous genotype*.

heterozygous .....

.....

genotype .....

..... [2]

(b) The budgerigar, *Melopsittacus undulatus*, is a small type of parrot that is native to Australia.

Fig. 5.1 shows a budgerigar.

Fig. 5.1

A budgerigar can have blue, green, yellow or white feathers.

Two genes, **A**/**a** and **D**/**d**, are involved in the inheritance of feather colour in budgerigars.

- A bird which has at least one dominant allele **A** but is homozygous for **d** has blue feathers.
- A bird which has at least one dominant allele **D** but is homozygous for **a** has yellow feathers.
- A bird with at least one dominant **A** allele **and** one dominant **D** allele has green feathers.
- A bird that is homozygous for **a** and **d** has white feathers.

Two green-feathered budgerigars, heterozygous at both gene loci, were crossed.

Draw a genetic diagram of this cross to show the probability of producing offspring with yellow feathers.

[6]

[Total: 8]

6 The Death Valley region of Nevada in the USA used to have an extensive lake system. Approximately 20 000 years ago the lakes started to dry up and they now consist of isolated small pools. Four different species of the desert pupfish have been found living in these pools. Evidence indicates that over 20 000 years ago there was only one species of pupfish living in the lake system.

Fig. 6.1 shows a desert pupfish.

Fig. 6.1

(a) Explain how the change from an extensive lake system to just a few pools could have resulted in the evolution of four species of desert pupfish.

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(b) Suggest what may happen to the desert pupfish if water levels rise and the pools once more form an extensive lake system.

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[Total: 8]

7 The Venus fly trap, *Dionaea muscipula*, is a carnivorous plant. It has traps which catch insects.

Each trap consists of a pair of modified leaves joined by a midrib of hinge cells. The modified leaves have touch-sensitive hairs. If two hairs are touched within 20 seconds, or the same hair is touched twice in rapid succession, the trap closes.

(a) Explain how touching the hairs results in closure of the trap.

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(b) *D. muscipula* grows naturally in a small region in eastern USA. Fires that destroy much of the vegetation occur in this region. Three sites in this region where there had been fires were identified and investigated.

- Site 1 had experienced a fire 2 years before.
- Site 2 had experienced a fire 10 years before.
- Site 3 had experienced a fire 30 years before.

Preliminary observations suggested that over the course of time following a fire, the biodiversity of plants had increased. However, the abundance of Venus fly trap plants had decreased and so had the light intensity available to them. There was also a decrease in the nitrogen that the plants absorbed from insects as a proportion of all the nitrogen they obtained from their environment.

Name an ecological or statistical method to measure:

(i) the abundance of *D. muscipula* at each site

..... [1]

(ii) plant biodiversity at each site

..... [1]

(iii) the strength of the relationship between light intensity and the proportion of nitrogen absorbed from insects, after taking measurements from a large number of plants.

..... [1]

[Total: 8]

8 Fig. 8.1 shows the proportion of cotton, maize and soybeans grown in the USA that are genetically modified in two different ways:

- HT crops are modified to be resistant to the herbicide glyphosate
- Bt crops are modified to express the Bt toxin which kills insect pests.

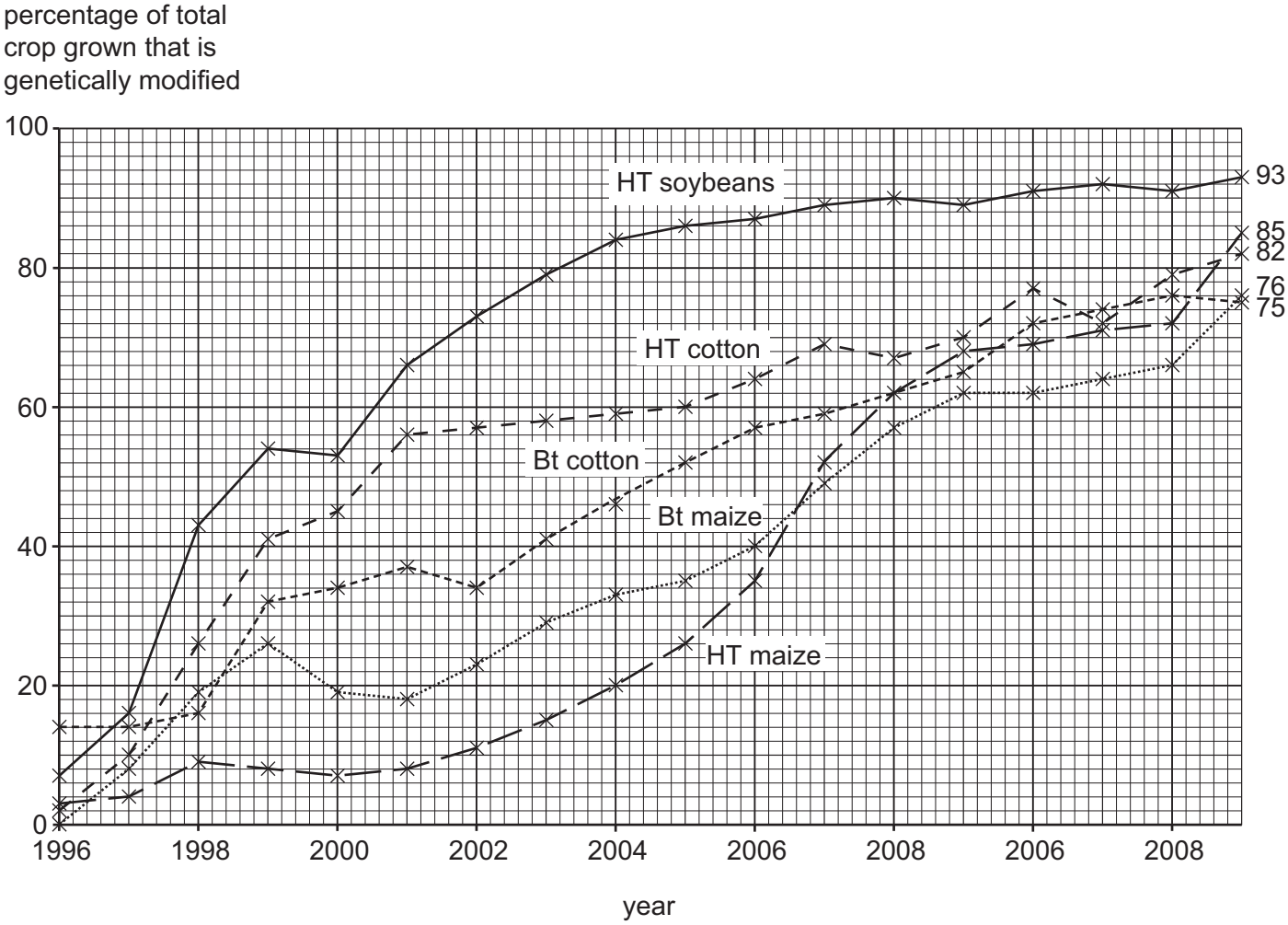

Fig. 8.1

(a) (i) With reference to Fig. 8.1, describe the change in the percentage of genetically modified cotton grown in the USA since 1996.

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(ii) Name a vector suitable for genetically modifying plant cells.

..... [1]

(iii) The HT crops received two new genes that gave resistance to glyphosate herbicide and also a marker gene called GUS. The parts of the plant that express the GUS gene turn blue when dipped into a colourless chemical substrate.

Explain why the GUS gene was also transferred to the genetically modified crops.

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(b) Fig. 8.2 shows the increase in the number of weed species resistant to glyphosate herbicide and triazine herbicides since 1970.

Crops have not been genetically modified to resist triazine herbicides.

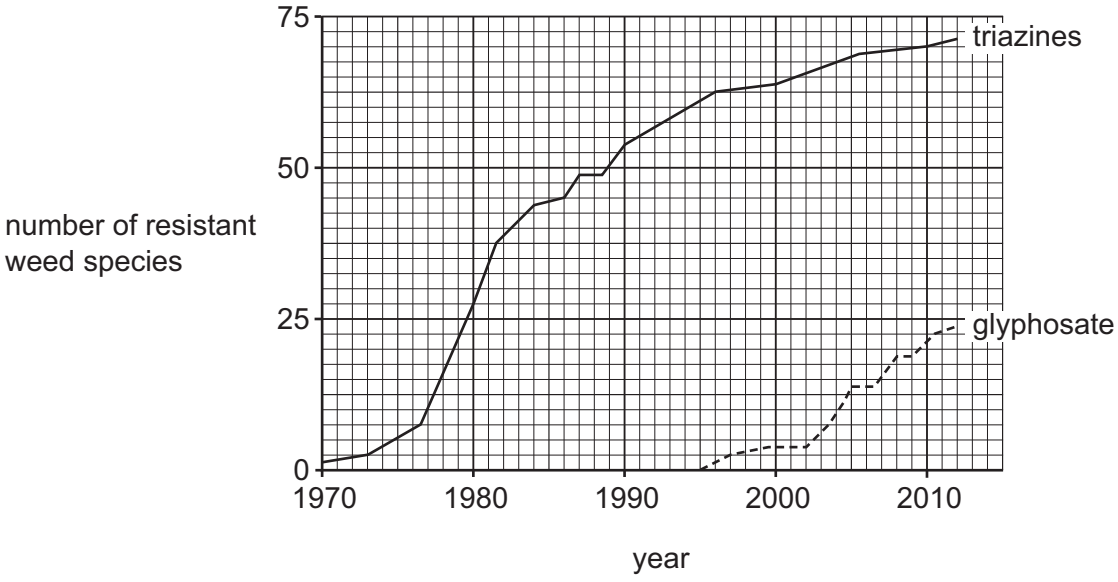

Fig. 8.2

(i) With reference to Fig. 8.1 and Fig. 8.2, justify the statement that the rise in glyphosate-resistant weeds has resulted from the introduction of genetically modified crops.

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(ii) Give **one** piece of evidence from Fig. 8.2 to support the idea that the development of weeds resistant to herbicides is **not** due to horizontal gene transfer from genetically modified crops.

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(iii) Outline how herbicide resistance in weeds arises and spreads without horizontal gene transfer.

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(c) Crops such as maize and cotton are genetically modified to produce Bt toxins to protect them against insect pests. When these GM crops first became available it was predicted that insect pests would develop resistance to these toxins.

The extent of Bt resistance in insect pest species was surveyed in 2005 and in 2011.

The level of resistance in each species was classified according to the highest percentage of resistant individuals recorded in any population anywhere in the world. Three levels of resistance were identified:

- <1%
- 1–6%
- >50%

There were no reports of populations of insect pests having between 6% and 50% of resistant individuals.

The results of the surveys are shown in Table 8.1.

Table 8.1

year	total number of insect pest species surveyed	number of insect pest species susceptible to Bt toxins	number of insect pest species with reported levels of resistance		
			<1%	1–6%	>50%
2005	9	8	0	0	1
2011	13	4	3	1	5

The results in the table show that levels of resistance to Bt toxins have increased between 2005 and 2011.

Suggest **two** other pieces of information that are needed to assess the significance of the results of the surveys.

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[Total: 15]

[Turn over

Section B

Answer **one** question.

9 **(a)** Describe the action of glucagon on liver cells in the regulation of blood glucose concentration. [9]

(b) Outline how a dip stick can measure the concentration of glucose **and** suggest advantages of using an electronic biosensor instead of a dip stick. [6]

[Total: 15]

10 **(a)** Explain how the *lac* operon is involved in the metabolism of lactose in *Escherichia coli*. [9]

(b) Describe the role of gibberellin in the germination of barley. [6]

[Total: 15]