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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2176246435

BIOLOGY **9700/44**

Paper 4 A Level Structured Questions **October/November 2025**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **28** pages. Any blank pages are indicated.

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1 **(a)** Fig. 1.1 is a diagram of a sensory neurone.

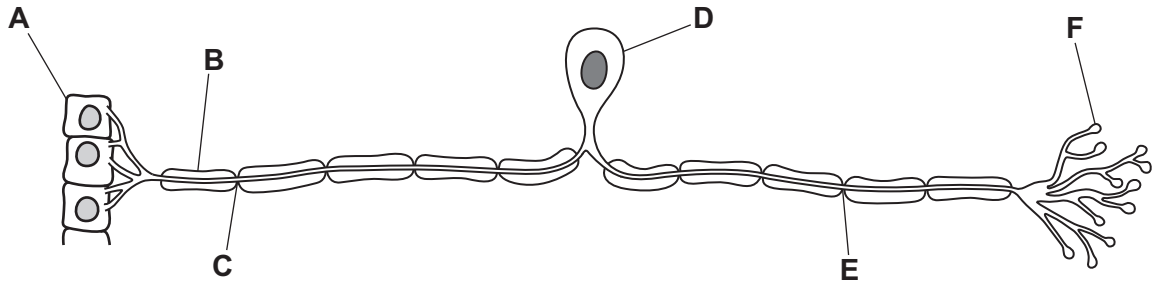


Fig. 1.1

Use the letters **A**–**F** in Fig. 1.1 to identify:

a receptor cell .....

an area where dendron membrane depolarisation occurs .....

a structure that forms a synapse with an intermediate neurone .....

a structure that allows rapid transmission of impulses .....

[4]

(b) Opioid drugs can bind to opioid receptors in the presynaptic membrane of a cholinergic synapse.

Fig. 1.2 is a diagram of a presynaptic membrane with an opioid receptor.

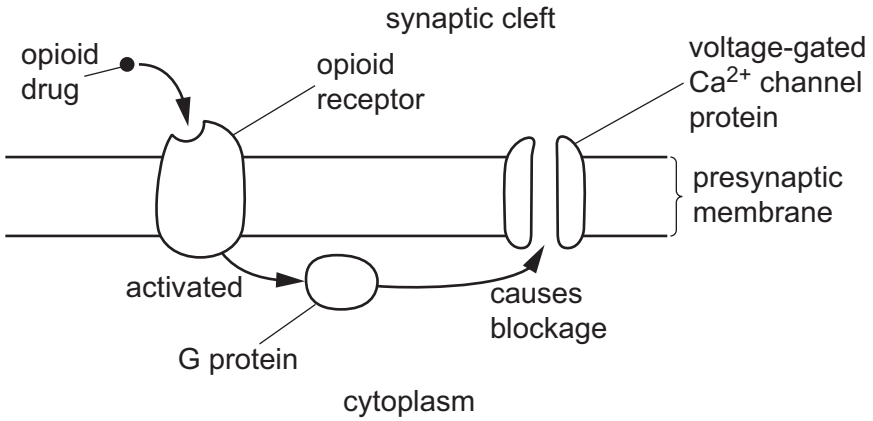


Fig. 1.2

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Opioid drugs have an effect on the normal events that occur at a cholinergic synapse.

Suggest **and** explain the effect that an opioid drug will have on the normal events that occur at a cholinergic synapse.

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[Total: 8]

2 **(a)** Meiosis and cytokinesis occur in the male reproductive organs (anthers) of plants to make pollen grains. Cells which carry out meiosis are known as pollen mother cells.

Fig. 2.1 shows five stages of meiosis in a pollen mother cell.

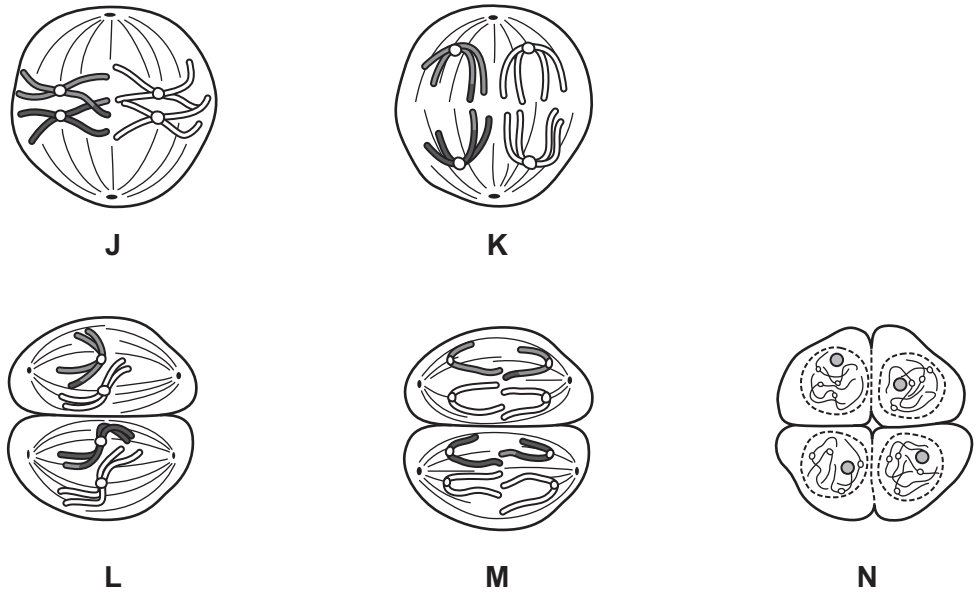


Fig. 2.1

Use the letters **J**–**N** in Fig. 2.1 to state **all** the stages that show:

anaphase .....

cells containing pairs of homologous chromosomes .....

crossing over .....

haploid cells .....

[4]

(b) Maize plants have male and female reproductive organs on the same plant. The male anthers are located on structures known as tassels. When selective breeding is carried out to create an F1 hybrid, the tassels are removed.

Suggest why the tassels are removed when selective breeding is carried out to create an F1 hybrid.

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(c) Outline how selective breeding is used to produce vigorous, uniform varieties of maize.

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3 **(a)** Genetic engineering is a modern method for producing crop plants with improved characteristics.

One example of a crop plant with improved characteristics is soybean, *Glycine max*, which has been genetically modified to make it resistant to a herbicide. This genetically modified soybean is called GM soybean.

To create GM soybean, a bacterial gene and a section of regulatory DNA were introduced into soybean cells.

Outline the roles of enzymes and a section of regulatory DNA in the creation of genetically modified organisms such as GM soybean.

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(b) In 2018, an area of 123.5 million hectares was used to grow soybean crops worldwide. GM soybean was grown in 73% of this area.

In 2018, soybeans accounted for 50% of the total GM crop area worldwide.

Calculate the total area used to grow GM crops worldwide in 2018.

Show your working.

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(c) Discuss the social implications of growing GM crops.

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4 Alleles are alternative forms of a gene. For example, there may be a dominant allele, **T**, and a recessive allele, **t**, at the same gene locus.

The relative frequency of each allele of a gene in a population can change over time due to factors such as selection, genetic drift and the bottleneck effect.

(a) Fig. 4.1 shows the relative frequency of the **T** allele in a population of 50 individuals over 20 generations.

At generation 0, the number of **T** alleles and the number of **t** alleles in the population was equal, so the relative frequency of each allele was 0.5. The relative frequencies of the two alleles of the gene add up to 1.

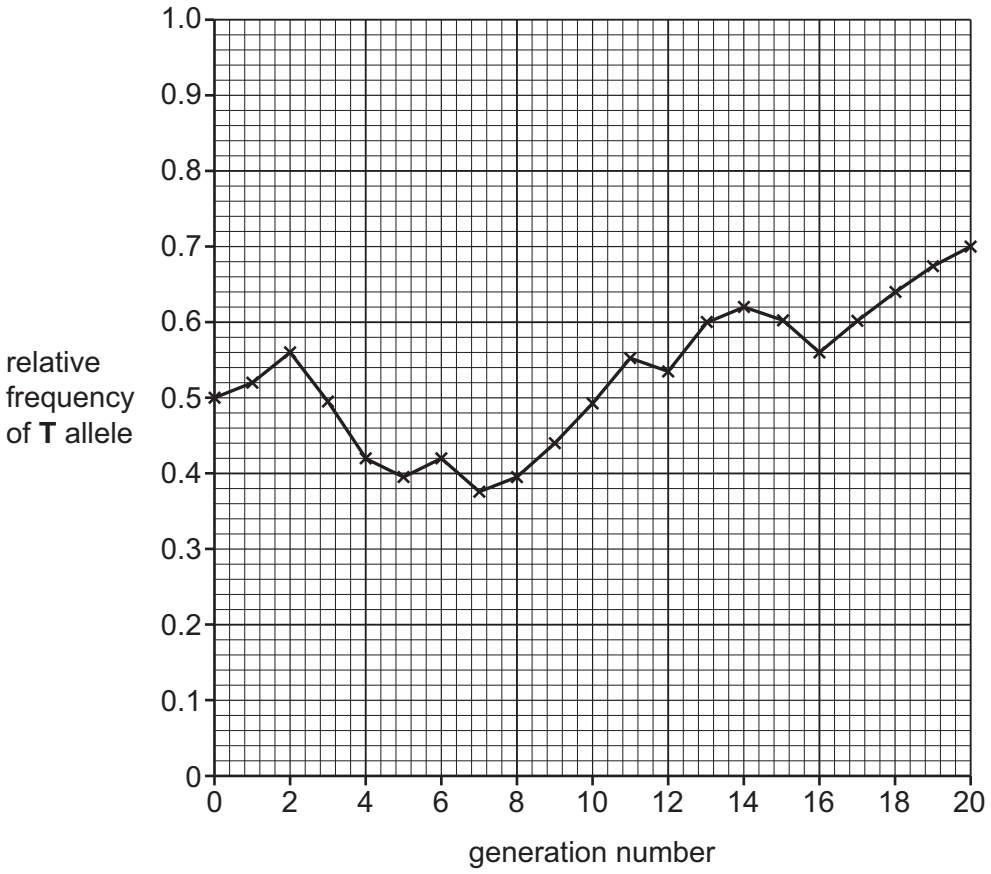


Fig. 4.1

(i) With reference to Fig. 4.1, state the relative frequency of the **t** allele after 20 generations.

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(ii) Suggest possible explanations for the change in the relative frequency of the **T** allele between generation 0 and generation 13.

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(b) The relative frequency of the **T** allele in a population of only 10 individuals was determined over 20 generations. The environmental conditions remained the same throughout the experiment.

Fig. 4.2 shows the results.

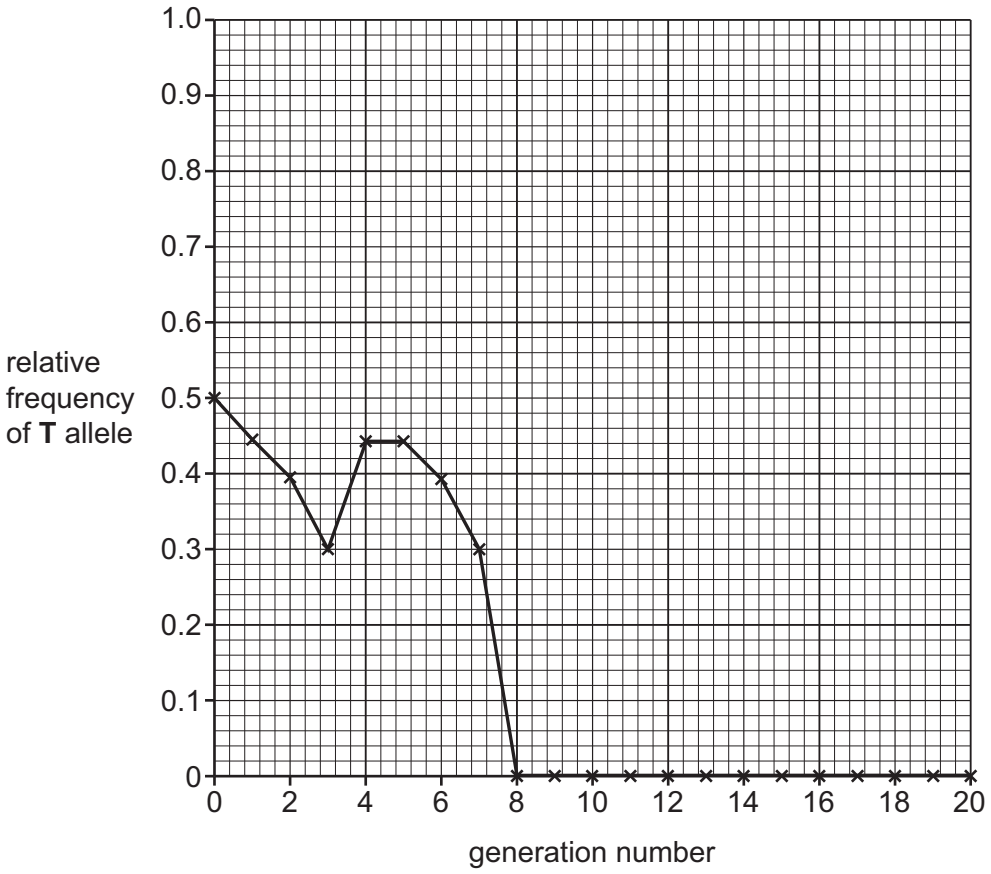


Fig. 4.2

Explain why Fig. 4.2 shows a different result from Fig. 4.1.

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(c) State the name of the principle that can be used to calculate relative frequencies of two alleles by counting the numbers of organisms in the population showing dominant and recessive phenotypes.

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5 The fruit fly, *Drosophila melanogaster*, feeds on sugars found in damaged fruits.

A fruit fly with normal features is described as wild type. It has a grey body and its wings are longer than its abdomen. The genes for body colour and wing length are located on different chromosomes.

A fruit fly with mutations in these two genes has a black body and short wings.

Fig. 5.1 shows a wild type fruit fly and a mutant fruit fly.

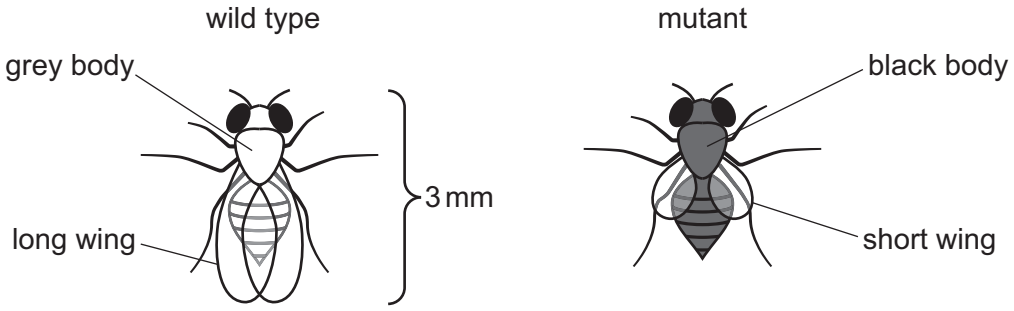


Fig. 5.1

(a) Fruit flies were first used for genetic crosses by Thomas Morgan in 1908. They are one of the most studied animals in current genetic research.

- Male fruit flies are easily distinguished from female fruit flies.
- Fruit flies have a short life cycle and a female can lay hundreds of eggs in a few days.
- Some genes for development and cell signalling in fruit flies are similar to those of humans.

Suggest why fruit flies are still used in genetic crosses.

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(b) When a wild type fruit fly was crossed with a mutant fruit fly with a black body and short wings, all the F1 offspring had grey bodies and long wings.

Using appropriate symbols, complete Fig. 5.2 to show the expected results of a cross between two of these **F1** fruit flies.

symbols:

F1 phenotypes: grey body long wing × grey body long wing

F1 genotypes:

Punnett square

offspring phenotypes:

phenotypic ratio .....

Fig. 5.2

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(c) Describe how you would determine the genotype of an F2 fruit fly with a grey body and long wings.

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6 Some people can develop a condition called type 2 diabetes. In people with type 2 diabetes, glucose uptake from the blood is decreased. In some cases, the pancreas cannot make enough insulin to keep blood glucose concentration within a healthy range.

(a) A person with type 2 diabetes and a person without type 2 diabetes were given a glucose drink. The blood glucose concentration of each person was measured at regular intervals for 120 minutes.

The results are shown in Fig. 6.1.

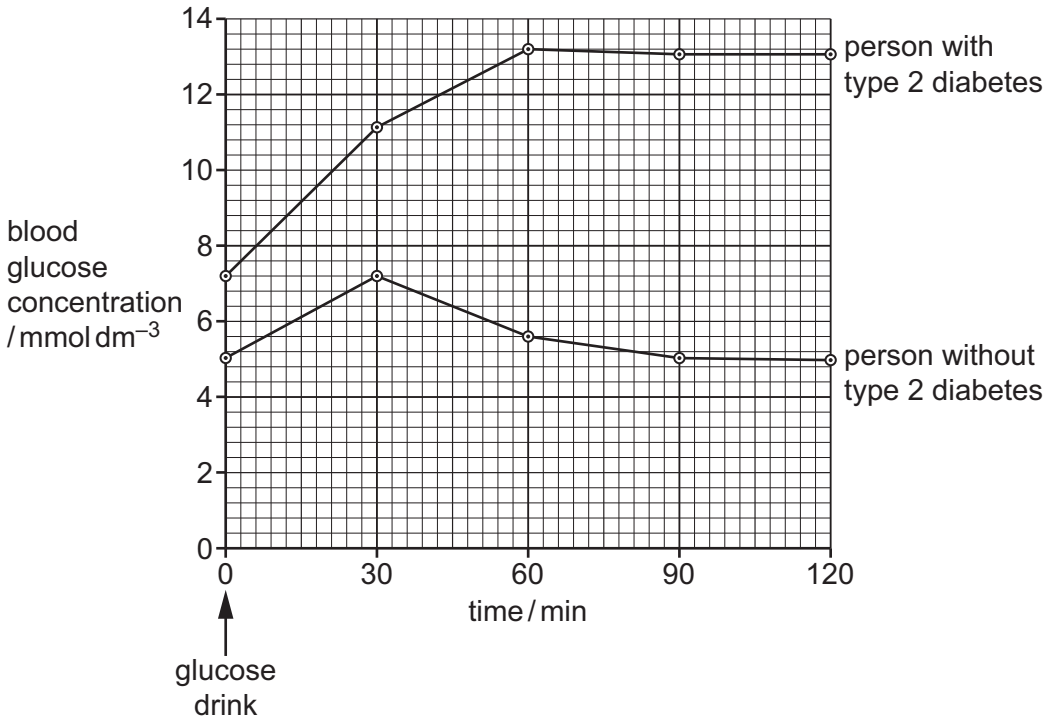


Fig. 6.1

(i) Describe the curve for the person **without** type 2 diabetes.

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(ii) Calculate the percentage increase in blood glucose concentration, between 0 and 60 minutes, for the person **with** type 2 diabetes.

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(iii) Suggest ways in which people with type 2 diabetes can help to control their condition.

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(b) Glucagon has a role in the control of blood glucose concentration.

Describe the cell signalling pathway involving glucagon, and describe how this pathway leads to a change in the blood glucose concentration.

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7 The kakapo, *Strigops habroptila*, is a species of large, nocturnal (active at night) parrot and is found only in New Zealand. The bird does not fly and lives on the ground.

The kakapo is classified as critically endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™.

Fig. 7.1 shows a kakapo.



Fig. 7.1

(a) Complete Table 7.1 to show the classification of the kakapo.

Table 7.1

taxonomic group	name
domain	Eukarya
kingdom	Animalia
.....	Chordata
class	Aves
.....	Psittaciformes
family	Strigopidae
genus	.....

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(b) The kakapo was widely distributed before humans arrived in New Zealand. The Kakapo Recovery Programme started in 1995. Birds were moved to protected areas. In 2024 they were only found in these protected areas.

This is shown in Fig. 7.2.

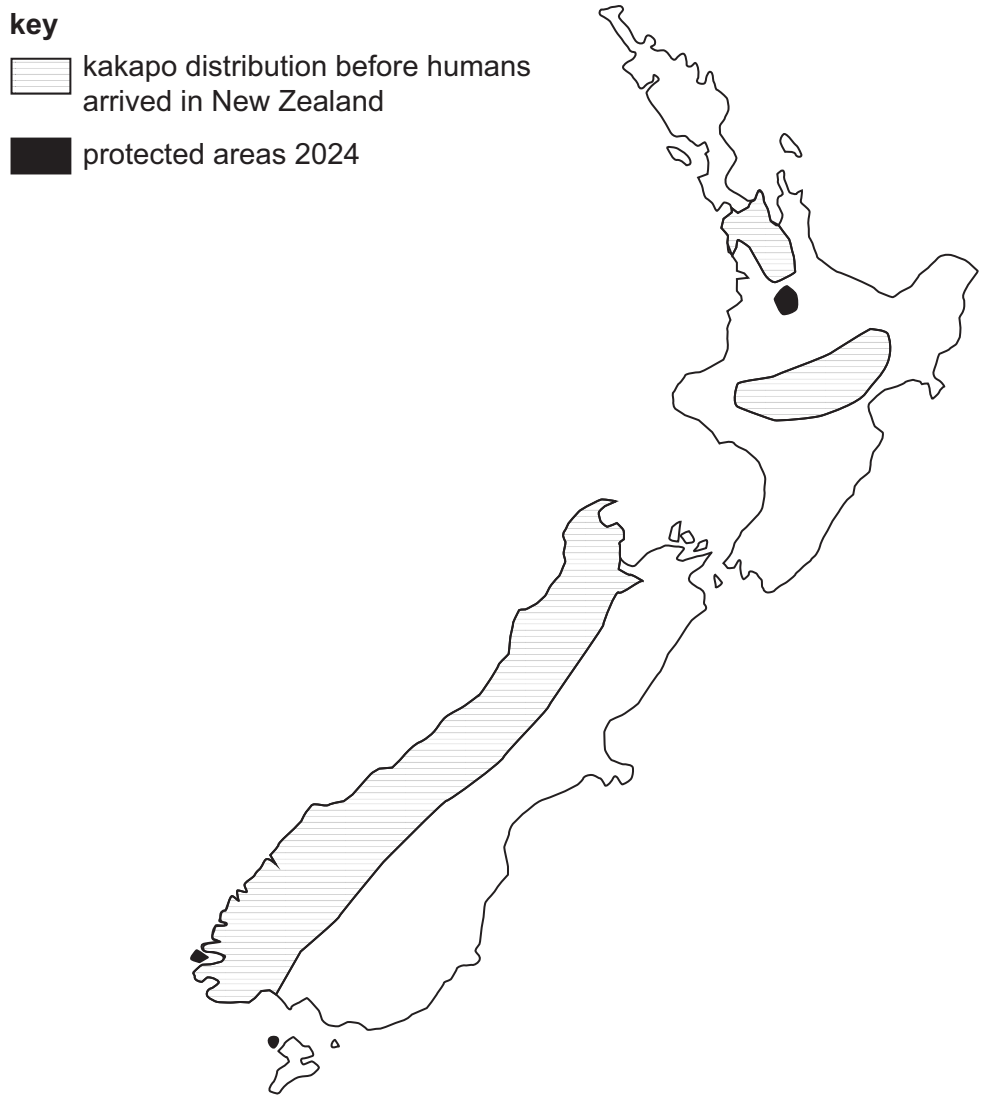


Fig. 7.2

Suggest the ideal features of a protected area for the kakapo.

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(c) DNA has shown that the kakapo population may have gone through one or more genetic bottlenecks after the arrival of humans in New Zealand.

Suggest the consequences of a genetic bottleneck to the kakapo population in New Zealand.

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8 **(a)** When the water supply to a plant is reduced, the concentration of abscisic acid (ABA) in the leaves increases.

ABA binds to receptors in the cell surface membranes of guard cells. This triggers a series of events in the cells, which results in stomatal closure.

Fig. 8.1 is a diagram of part of a guard cell showing some of the events that occur when ABA binds to its receptor.

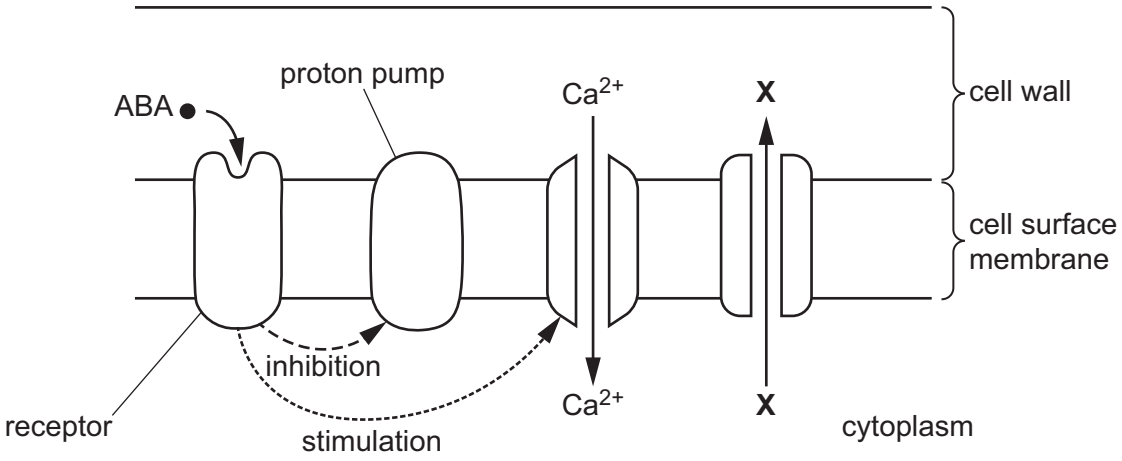


Fig. 8.1

Fig. 8.1 shows that calcium ions are involved in the events within a guard cell that result in stomatal closure.

Outline the role of calcium ions in the response of the guard cell to a reduced water supply **and** explain how this response results in stomatal closure.

Identify **X** in your answer.

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(b) Explain, using examples, why the homeostatic control involving the opening and closing of stomata is important for the efficient functioning of plants.

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9 **(a)** In aerobic conditions, pyruvate that has formed during glycolysis enters the mitochondrion and takes part in the link reaction.

Name the **two** coenzymes involved in the link reaction.

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[2]

(b) Enzymes play an important role in the functioning of the Krebs cycle.

The enzymes in the Krebs cycle can be affected by the presence of hydrogen peroxide. Hydrogen peroxide is a product of some of the reactions that occur within the mitochondrion.

An investigation was carried out to measure the effect of two different concentrations of hydrogen peroxide on an enzyme of the Krebs cycle. The activity of the enzyme was measured over 10 minutes when exposed to the two different concentrations of hydrogen peroxide.

The results are shown in Fig. 9.1.

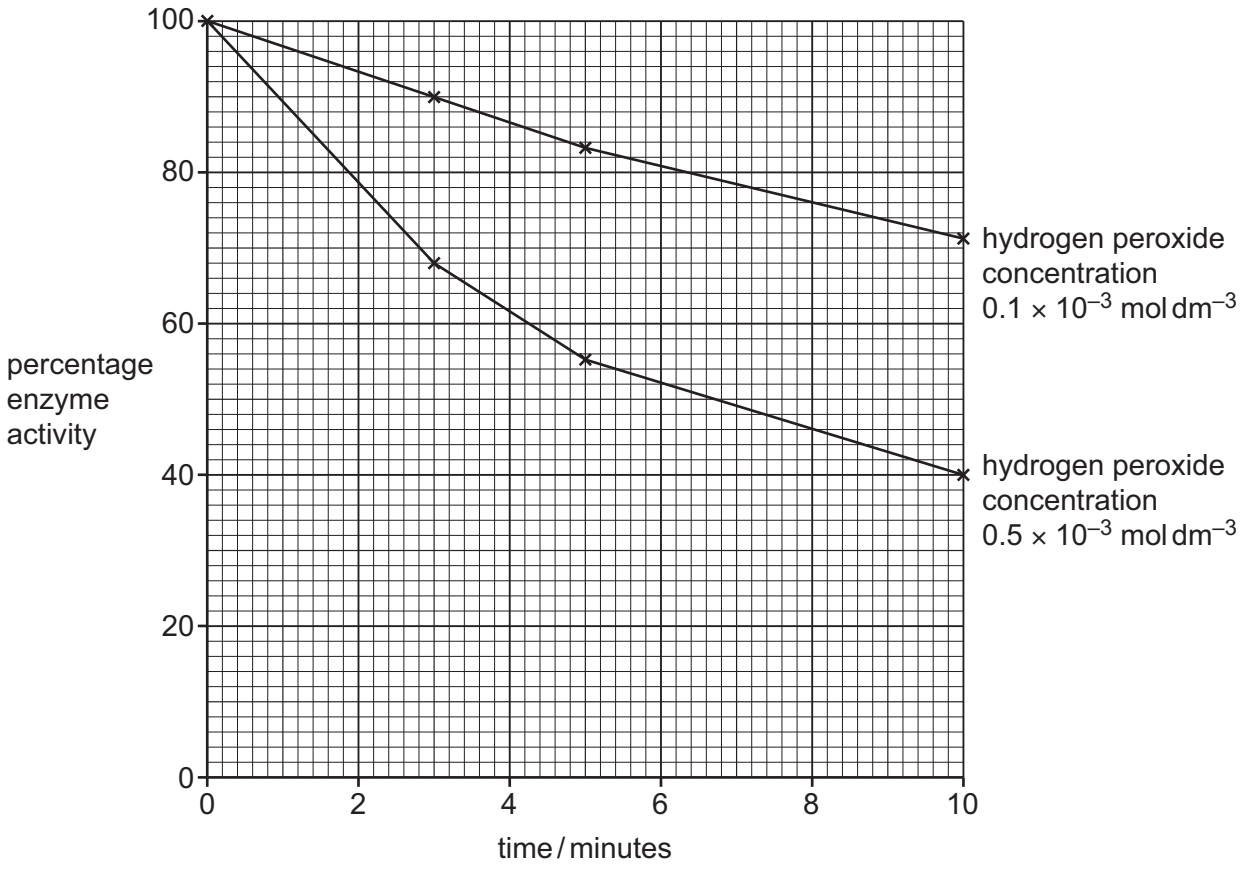


Fig. 9.1

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Describe the effect shown in Fig. 9.1 of hydrogen peroxide concentration on the activity of the Krebs cycle enzyme.

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(c) Reduced NAD and reduced FAD are produced during the Krebs cycle. They carry hydrogen to the inner mitochondrial membrane where oxidative phosphorylation occurs.

The first two steps in oxidative phosphorylation are:

1. Hydrogen atoms split into protons and electrons.
2. Electrons move along the electron transport chain, releasing energy.

Outline the steps that occur to complete oxidative phosphorylation.

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(d) Fig. 9.2 shows the oxygen consumption of a person who is carrying out a fast-running exercise.

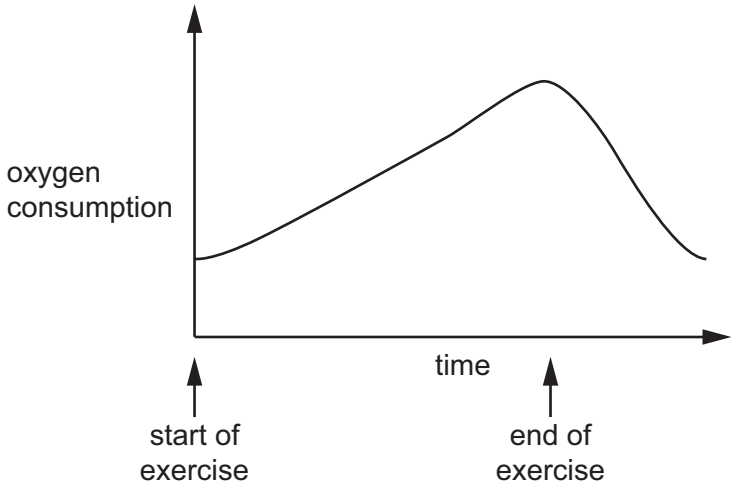


Fig. 9.2

Suggest why the oxygen consumption takes time to return to normal after exercise.

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10 (a) Cyclic photophosphorylation and non-cyclic photophosphorylation occur during the light-dependent stage of photosynthesis.

Outline the **differences** between cyclic photophosphorylation and non-cyclic photophosphorylation.

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(b) Complete the passage about the Calvin cycle using the most appropriate word or words.

A molecule of ..... combines with a five-carbon molecule, ribulose bisphosphate (RuBP), catalysed by the enzyme ..... . This reaction produces a six-carbon compound that splits into two molecules of a three-carbon compound, glycerate 3-phosphate (GP).

ATP and ..... are used to convert GP molecules into molecules of a three-carbon sugar, triose phosphate (TP).

Some TP molecules are used to make ....., while others are recycled to regenerate RuBP using ATP.

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