Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*5764457251*

**BIOLOGY** **9700/43**

Paper 4 A Level Structured Questions **May/June 2021**

**2 hours**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Section A: answer **all** questions.
- Section B: answer **one** question.
- 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 **24** pages. Any blank pages are indicated.


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## Section A

Answer **all** questions.

**1** **(a)** Fig. 1.1 is a diagram of a part of a sarcomere in striated muscle.

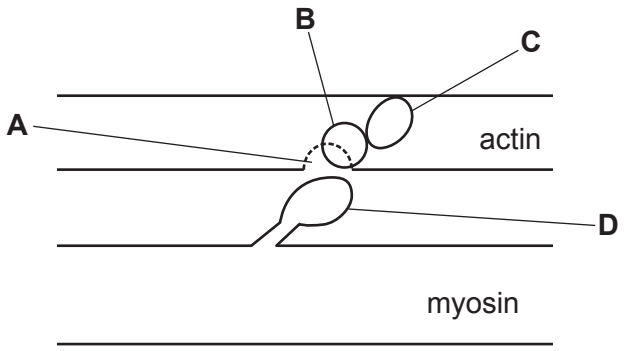



**Fig. 1.1**

With reference to Fig. 1.1, name **A**, **B**, **C** and **D**.

**A** .....

**B** .....

**C** .....

**D** .....

[4]

**(b)** When a muscle cell is stimulated, calcium ions are released from the sarcoplasmic reticulum.

With reference to Fig. 1.1, describe the role of calcium ions in the contraction of the sarcomere.

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..... [4]

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**(c)** When a mammal dies, aerobic respiration stops. The striated muscles contract and remain contracted for a few hours after death.

Suggest why the muscles remain contracted for a few hours.

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..... [2]

[Total: 10]

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**2** **(a)** During respiration, respiratory substrates such as glucose are used as a source of energy to produce ATP molecules.

**(i)** Cells can maintain a different concentration of ions within the cell compared with the extracellular environment.

It is estimated that animals may use 50% of ATP made from respiration to maintain higher concentrations of some ions inside cells.

Name the mechanism that can maintain a higher concentration of ions inside a cell.

..... [1]

**(ii)** Only a proportion of energy released by the respiration of glucose is used to make ATP.

- The energy yield from the respiration of glucose in aerobic conditions is 2870 kJ $mol^{-1}$.
- When ATP is hydrolysed to ADP, it releases 30.5 kJ $mol^{-1}$ of energy.
- It is estimated that 31 moles of ATP are made per mole of glucose respired.

Calculate the percentage efficiency of glucose respiration.

Show your working.

..... % [2]

**(iii)** The energy that is **not** converted to ATP during respiration is released as heat energy.

State **one** homeostatic use of this heat energy in mammals.

..... [1]

**(iv)** State the term used to describe the reaction that results in the production of ATP during the Krebs cycle.

..... [1]

**(b)** When a person exercises, power is generated.

Power is measured in joules per second ($J\,s^{-1}$).

The power generated when a person exercises will vary depending on the type and intensity of exercise. More power is generated when the intensity of exercise increases.

An experiment was carried out to determine whether increasing the intensity of exercise in a healthy human male caused a change in the value of the respiratory quotient (RQ).

- The man had a balanced diet.
- The RQ was calculated at rest.
- He carried out exercise for the same length of time on four separate days.
- The intensity of exercise was increased over the four days, generating different powers.
- The RQ was calculated for the four different powers generated.

The results are shown in Fig. 2.1.

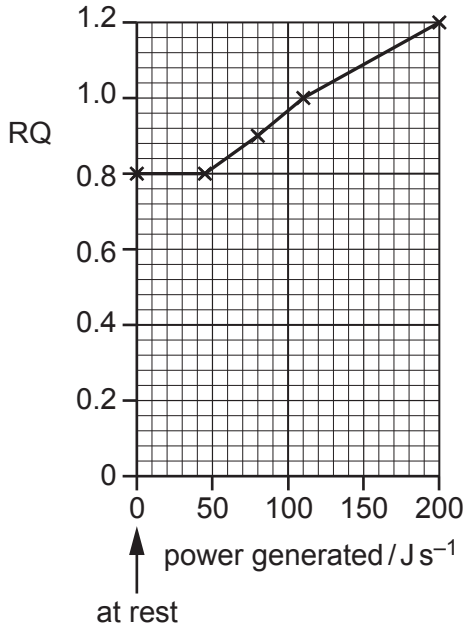



**Fig. 2.1**

With reference to Fig. 2.1, suggest what can be deduced from:

the RQ at rest

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the RQ when the power generated is $110\,J\,s^{-1}$

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the RQ when the power generated is $200\,J\,s^{-1}$.

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[4]

**(c)** Explain why a person continues to breathe deeply and at a higher rate for some time after the person has stopped exercising.

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..... [3]

[Total: 12]

**3** Fruit flies of the genus *Bactrocera* are pests that damage fruit crops.

Table 3.1 gives the names and geographical ranges of *Bactrocera* fruit flies that were classified as four separate species.

**Table 3.1**

| name | geographical range |
|---|---|
| *B. dorsalis* | China, India, Thailand |
| *B. invadens* | Africa, India |
| *B. papayae* | Indonesia, Malaysia |
| *B. philippinensis* | Philippine Islands, Borneo |

In 2014, the classification of these flies was changed. All four species were recognised as belonging to a single species, *B. dorsalis*.

**(a) (i)** Suggest reasons why the four species were originally classified as separate species.

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..... [2]

**(ii)** Some students decided to investigate whether the flies were members of one species or four separate species.

Suggest a simple investigation that the students could carry out.

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..... [2]

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**(b)** Female *B. dorsalis* lay their eggs in different types of fruits, such as avocados, bananas, mangos and papayas. The eggs hatch into larvae that eat the fruit. The actions of the female flies and larvae allow microorganisms to enter the fruit. The microorganisms feed by secreting extracellular enzymes, causing the fruit to rot.

Name **two** kingdoms that include organisms that could spoil fruit by secreting extracellular enzymes.

1 .....

2 .....

[2]

Before the four *Bactrocera* species were reclassified as a single species in 2014, some governments in Asia banned fruit imports from African countries to avoid introducing *B. invadens* as an alien species.

**(c)** Explain why the introduction of alien species should be avoided.

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..... [4]

**(d)** Suggest how reclassifying *B. invadens* as *B. dorsalis* will benefit fruit-producing countries in Africa.

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..... [2]

[Total: 12]

**4** **(a)** Bt maize has been genetically engineered to resist insect attack. In 2019, Bt maize formed 83% of the maize grown in the USA.

Outline how the genetic engineering process produced Bt maize plants with resistance to insect attack.

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..... [5]

**(b)** A proposed conservation benefit of Bt maize is that, unlike chemical insecticide sprays, it should not harm non-target insects.

When Bt maize was first grown in the USA, scientists were concerned that maize pollen containing the Bt toxin might be deposited by the wind on wild plants such as milkweeds, *Asclepias* spp. Milkweed leaves are the food source of caterpillars (larvae) of the monarch butterfly, *Danaus plexippus*.

In 1999, a laboratory experiment tested the effects of feeding milkweed leaves treated in different ways to the caterpillars of monarch butterflies. Each group of caterpillars was provided with milkweed leaves to eat throughout the experiment. The three different treatments were:

- leaves with no pollen
- leaves dusted with pollen from non-Bt maize
- leaves dusted with pollen from Bt maize.

Fig. 4.1 shows the results of this laboratory experiment.

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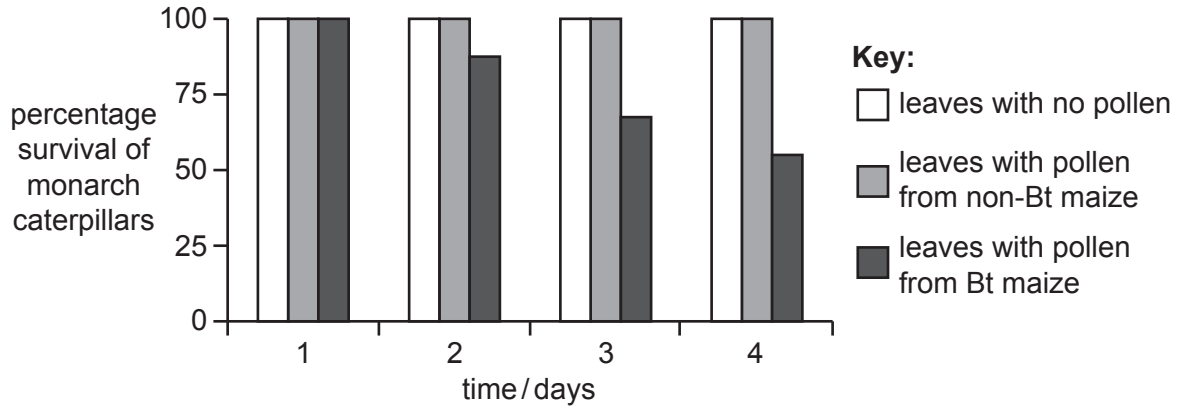



**Fig. 4.1**

**(i)** State what can be concluded from Fig. 4.1.

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..... [2]

**(ii)** Laboratory results are not always useful in predicting what will happen in real ecosystems.

- Some scientists predicted that increasing the area of Bt maize in the USA would decrease the number of monarch butterflies, based on the results in Fig. 4.1.
- More monarch butterflies were counted in 2019 than in 1999, even though the quantity of Bt maize grown more than tripled.

Suggest reasons why the predicted decrease in the number of monarch butterflies did not occur in the real ecosystem.

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..... [4]

[Total: 11]

**5** Photosynthesis is a process that results in the synthesis of complex organic molecules.

Respiration is a process that involves the breakdown of complex organic molecules.

**(a)** The light dependent stage of photosynthesis involves cyclic and non-cyclic photophosphorylation.

Describe **two** differences between cyclic and non-cyclic photophosphorylation.

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..... [2]

**(b)** Biochemical processes involving carbon dioxide change the external environment of the aquatic plant, *Elodea canadensis*, and the pond snail, *Lymnaea stagnalis*. Carbon dioxide dissolves in water to form carbonic acid.

A student set up 8 test-tubes. Each test-tube contained 30 $cm^3$ of distilled water containing a pH indicator, bromothymol blue.

Fig. 5.1 shows the experimental set up for these 8 test-tubes.

The test-tubes were left for 12 hours.

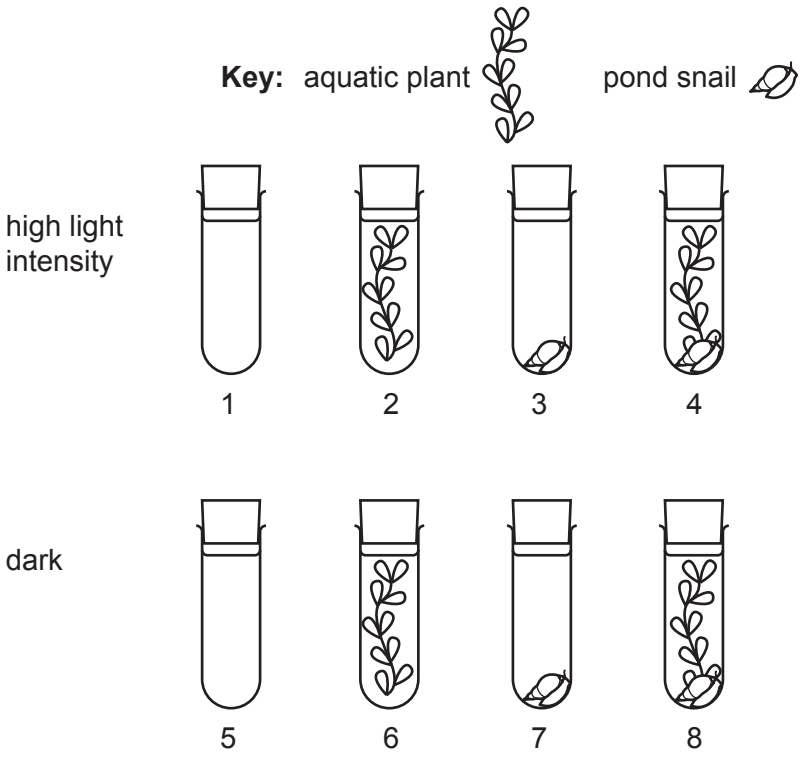



**Fig. 5.1**

Fig. 5.2 shows how the colour of bromothymol blue changes with pH.

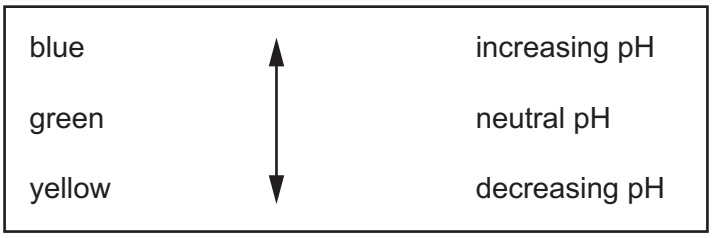



**Fig. 5.2**

All tubes were green at the start of the experiment.

The results of the experiment are shown in Table 5.1.

**Table 5.1**

| test-tube | colour after 12 hours |
|---|---|
| 1 | green |
| 2 | blue |
| 3 | yellow |
| 4 | green |
| 5 | green |
| 6 | yellow-green |
| 7 | yellow |
| 8 | yellow |

**(i)** Explain the purpose of test-tube 1 and test-tube 5.

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..... [1]

**(ii)** Explain the results of test-tubes 2, 3 and 4.

test-tube 2 .....

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test-tube 3 .....

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test-tube 4 .....

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[5]

**(iii)** Explain the colour change in test-tube 6.

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..... [3]

[Total: 11]

**6** **(a)** The bottlenose dolphin, *Tursiops truncatus*, is an aquatic mammal. It has adaptations to conserve heat when swimming in cold water.

Fig. 6.1 shows a bottlenose dolphin.

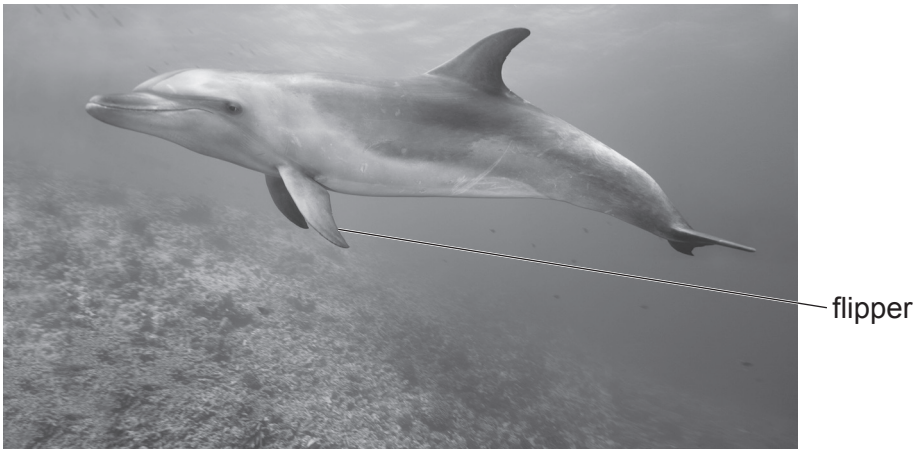



**Fig. 6.1**

**(i)** The arteries in the bottlenose dolphin that carry blood to the flippers are surrounded by veins bringing blood back to the rest of the body.

Outline how this arrangement of blood vessels is an adaptation to conserve body heat.

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..... [1]

**(ii)** When a dolphin has exercised for a long time, it may need to lose excess heat. Unlike humans, dolphins do **not** produce sweat.

Suggest how a dolphin may lose excess heat.

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..... [1]

**(b)** The control of blood glucose concentration in dolphins is the same as in most mammals.

A study was carried out to investigate the concentration of insulin in the blood of dolphins that were provided with a diet of fish, supplemented with glucose.

- One group of dolphins ate fish with 3 g of glucose for every kg of fish.
- Another group ate fish with 11 g of glucose for every kg of fish.

The concentration of insulin in the blood was measured 60 minutes before being fed, at the time of being fed and at regular intervals afterwards.

Measurements were also taken for a third group of dolphins, at the same time intervals, that were not fed any fish (fasting).

The results of the study are shown in Fig. 6.2.

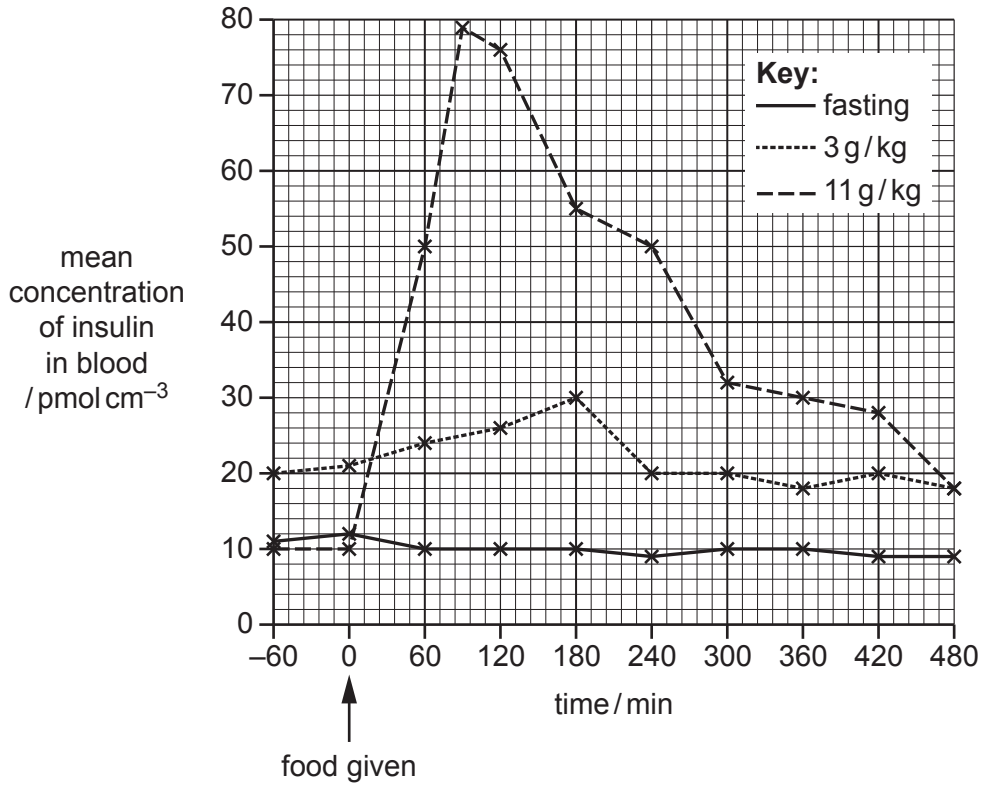



**Fig. 6.2**

**(i)** Describe the trends shown in Fig. 6.2.

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..... [4]

**(ii)** The mean concentration of insulin in the blood changes over time for the dolphins that were fed fish with 11 g of glucose per kg of fish.

Calculate the rate of change in the mean concentration of insulin in this group of dolphins from the time of being fed until the concentration reaches its maximum.

Show your working.

..... $pmol\,cm^{-3}\,min^{-1}$ [2]

**(c)** Blood glucose concentration is regulated by negative feedback.

Explain what is meant by negative feedback.

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..... [3]

[Total: 11]

**7** **(a)** Haemoglobin is made of two $\alpha$-globin chains and two $\beta$-globin chains.

A person may have a mutation in the gene coding for $\beta$-globin. This is due to a base substitution and leads to the production of abnormal $\beta$-globin and therefore abnormal haemoglobin.

A person who is homozygous for the mutant allele will have a condition called sickle cell anaemia.

Outline the phenotypic effects of having abnormal haemoglobin in a person with sickle cell anaemia.

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..... [4]

**(b)** $\mathbf{Hb^A}$ is the allele coding for normal $\beta$-globin.

$\mathbf{Hb^S}$ is the allele coding for abnormal $\beta$-globin.

The alleles are codominant.

**(i)** Explain what is meant by the alleles being codominant.

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..... [1]

**(ii)** A person who is heterozygous will have sickle cell trait but may not experience the symptoms of sickle cell anaemia.

Suggest why a person with sickle cell trait may not show the symptoms of sickle cell anaemia.

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..... [1]

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**(iii)** Construct a genetic diagram to show the possible offspring for a man and a woman who both have sickle cell trait.

| | | | |
|---|---|---|---|
| parental phenotype | sickle cell trait | × | sickle cell trait |
| parental genotype | | | |
| gametes | | | |
| offspring genotypes | | | |
| offspring phenotypes | | | |

[3]

[Total: 9]

**8** **(a)** Explain what is meant by stabilising selection.

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..... [3]

**(b)** Fig. 8.1 shows the distribution of fur colour in a population of mice.

The colour of the soil where the mice lived was mid-brown.

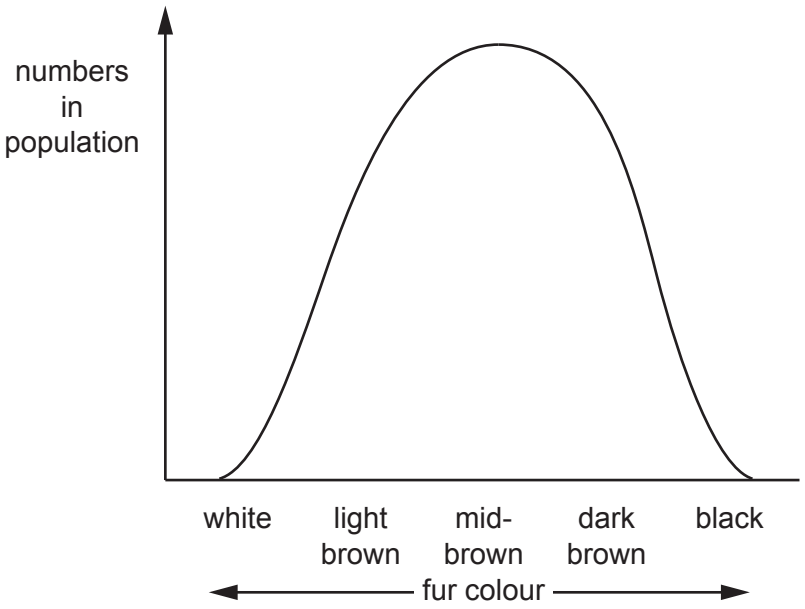



**Fig. 8.1**

**(i)** Suggest why mice with white fur and mice with black fur were present in the lowest numbers in Fig. 8.1.

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..... [2]

**(ii)** An environmental event caused the colour of the soil to change to dark brown.

On Fig. 8.1, sketch a curve to show the distribution of fur colour in the mouse population after many generations. [2]

**(c)** Explain what is meant by genetic drift.

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..... [2]

[Total: 9]

## Section B

Answer **one** question.

**9** **(a)** Explain the use of genes for fluorescence as markers in gene technology. [6]

**(b)** Discuss the **social** implications of using genetically modified organisms in food production. [9]

[Total: 15]

**10** **(a)** Describe the roles of sodium ions in selective reabsorption in the nephron **and** calcium ions in the functioning of a cholinergic synapse. [7]

**(b)** Compare the endocrine and nervous systems in control and co-ordination in mammals. [8]

[Total: 15]

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[Turn over

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