Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3490479618

BIOLOGY **9700/41**

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

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Section A

Answer **all** questions.

1 (a) Fig. 1.1 is a diagram of a kidney nephron and some of its blood vessels.

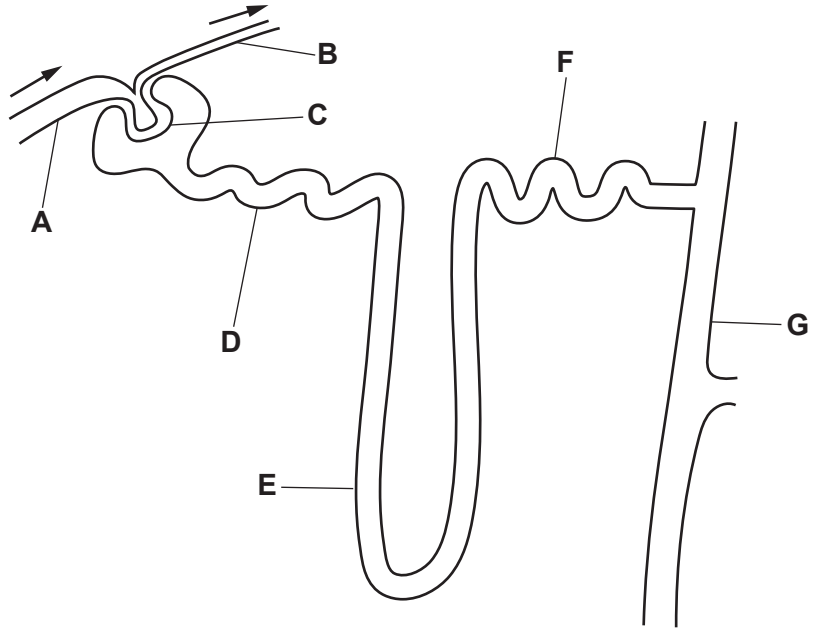


Fig. 1.1

With reference to Fig. 1.1, complete Table 1.1 using the letters **A** – **G**.

Each letter may be used once, more than once or not at all.

Table 1.1

description	letter
efferent blood vessel	.....
part of nephron containing cells that respond to ADH	.....
part of nephron where podocyte cells are located	.....
part of nephron containing cells that are located in the medulla	.....

[4]

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(b) Describe **and** explain how the cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

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..... [5]

(c) Fig. 1.2 shows the concentrations of ADH in the blood at different percentage changes in water potential of the blood.

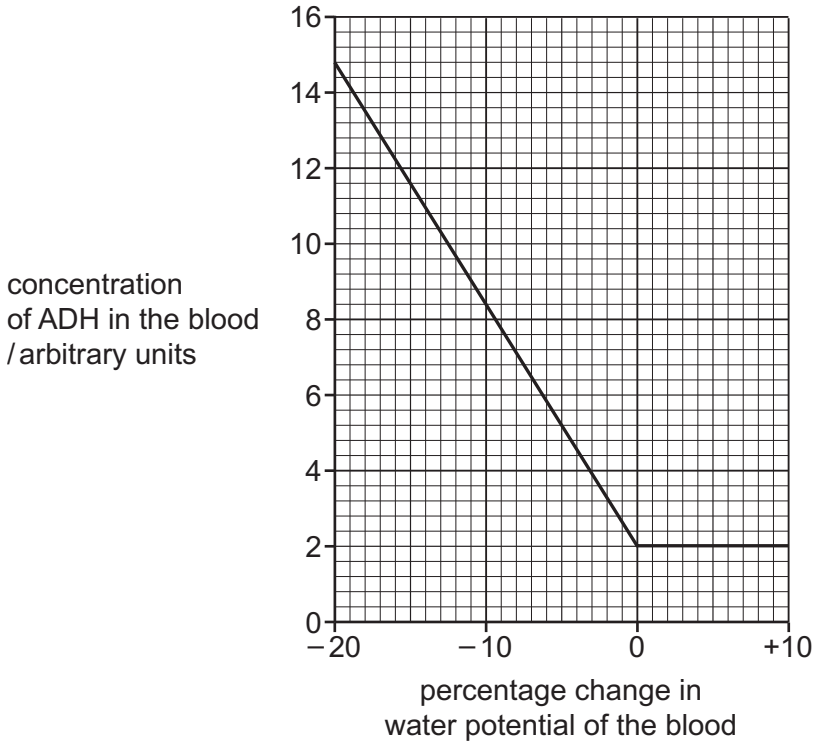


Fig. 1.2

(i) Describe the trend shown in Fig. 1.2.

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..... [2]

(ii) Sometimes a person will have a low concentration of ADH in the blood even though there is a change in the water potential.

Suggest **one** effect on the circulatory system of a low concentration of ADH in the blood.

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..... [1]

[Total: 12]

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Turn over for Question 2

2 **(a)** Cotton, *Gossypium hirsutum*, and false flax, *Camelina sativa*, are crop plants that are grown in different parts of the world.

Rubisco activase is an enzyme in the stroma of chloroplasts that is needed to maintain the activity of a second enzyme, rubisco.

Scientists measured the activity of rubisco activase in cotton and in false flax at a range of temperatures.

Fig. 2.1 shows the results.

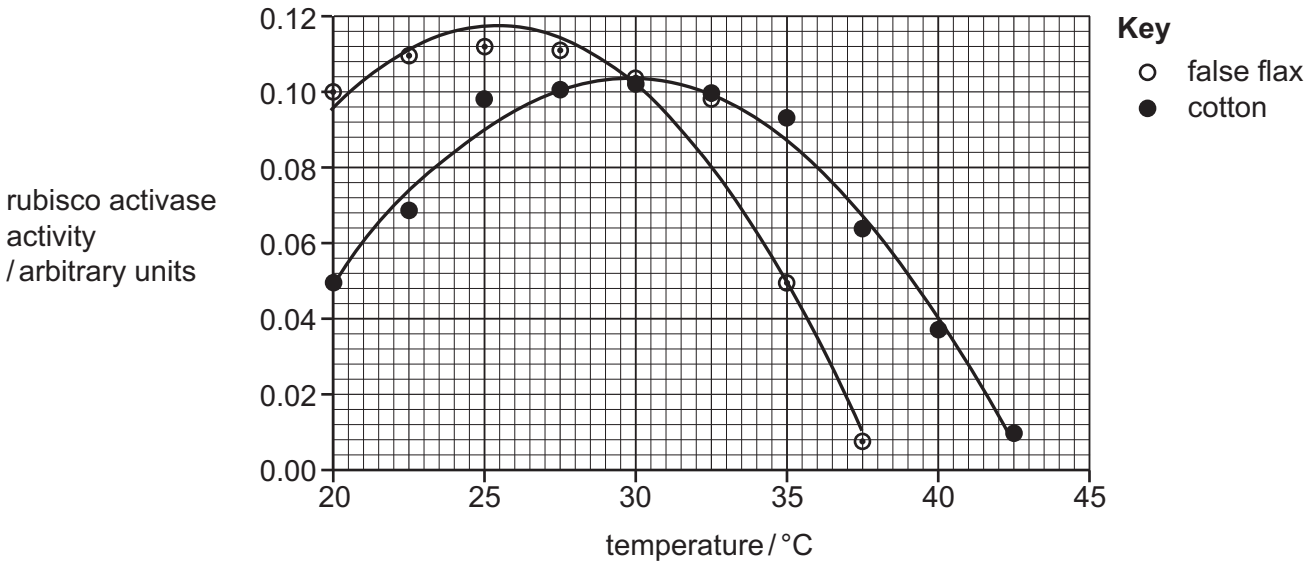


Fig. 2.1

(i) With reference to Fig. 2.1, compare the results obtained for cotton and false flax.

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(ii) Suggest reasons for the differences shown in Fig. 2.1.

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..... [3]

(b) Rubisco enzymes from cotton and false flax are active at temperatures up to 45 °C and will denature at 45 °C.

Explain how the Calvin cycle is affected when rubisco denatures.

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..... [3]

(c) One goal of genetic engineering is to make crops that are heat tolerant. This means that crops can grow and produce a good yield at high environmental temperatures.

Use the information given in Question 2 to suggest **and** explain a way to improve the tolerance of a crop to high temperatures.

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[Total: 12]

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[Turn over

3 Ecological surveys are conducted before conservation decisions are made. For example, surveys can be carried out before deciding whether to reintroduce a species to its former habitat.

(a) Outline how an ecological survey can measure the biodiversity of a terrestrial habitat.

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..... [4]

(b) Table 3.1 lists some mammal species that became extinct in Great Britain or were introduced into Great Britain in the last 12 400 years.

The reasons for each extinction or introduction and the time of each event are shown.

Table 3.1

species	number of years before present time	event	reason
arctic fox	12 400	extinction	climate change
sheep	5 400	introduction	farming
house mouse	3 500	introduction	accidental
lynx	1 500	extinction	hunting
fallow deer	900	introduction	food
South American coypu	86	introduction	fur
South American coypu	33	extinction	conservation culling

With reference to Table 3.1, state **and** explain the factors that have had a negative impact on biodiversity in Great Britain.

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..... [4]

(c) Non-governmental and government organisations are working together to reintroduce a lynx population to its former habitat in a remote part of Great Britain. Lynx are predatory big cats.

Fig. 3.1 shows a lynx.



Fig. 3.1

Suggest the factors that need to be considered by organisations to successfully reintroduce and restore a breeding population of lynx in Great Britain.

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..... [5]

[Total: 13]

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Turn over for Question 4

4 **(a)** In 1984, the geneticist Alec Jeffreys invented a DNA testing technique, known as DNA profiling, that produces a DNA banding pattern on a gel. The DNA banding pattern (profile) is unique to each individual.

DNA profiling can be used in police forensic work to catch criminals.

Since 1987, police in many countries have collected and stored DNA from crime scenes to create DNA profiles, which they try to match with the DNA profiles of criminal suspects.

(i) DNA at a crime scene may be obtained from hairs and traces of blood, semen and saliva.

Explain why PCR may be needed before DNA from a crime scene can be profiled.

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..... [2]

(ii) Explain why electrophoresis produces a DNA banding pattern on a gel.

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(b) GEDmatch is described as 'an open data personal genomics website'. It can be used by people who want to upload their DNA data to trace their ancestors and other relatives.

In 2018, police in the USA solved a large number of serious crimes. Some of these crimes had been unsolved for over thirty years. The police used GEDmatch to profile DNA taken from crime scenes and to look for matching DNA profiles. In many cases the police found partial matches to the relatives of criminals. This allowed the criminals to be identified and then charged on the basis of a complete DNA profile match.

(i) Suggest why the police strategy of comparing crime scene DNA with the GEDmatch database was so successful.

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..... [2]

(ii) Explain why GEDmatch is an example of bioinformatics.

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..... [2]

(iii) The first successful conviction resulting from the use of GEDmatch by the police was widely reported.

Some journalists and broadcasters thought that the GEDmatch website should not have been used by the police in this way.

In the days following the news, the number of citizens choosing to upload their DNA data to GEDmatch increased from 1500 to 5000 a day.

Comment on the social **and** ethical issues raised by this first successful conviction.

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..... [2]

[Total: 10]

5 **(a)** Gibberellin is a plant growth regulator involved in barley seed germination. Production of gibberellin is stimulated by the uptake of water.

State the location of gibberellin synthesis in a barley seed during germination.

..... [1]

(b) Barley seeds germinate when placed on blotting (absorbent) paper soaked in water.

The germination of barley seeds placed on blotting paper soaked in solutions of different water potential was investigated.

The success of germination was measured as a germination index for:

- barley seeds placed on blotting paper soaked in water
- barley seeds placed on blotting paper soaked in 5 solutions of different water potential.

The results are shown in Fig. 5.1.

The higher the germination index value, the more successful the germination of the barley seeds.

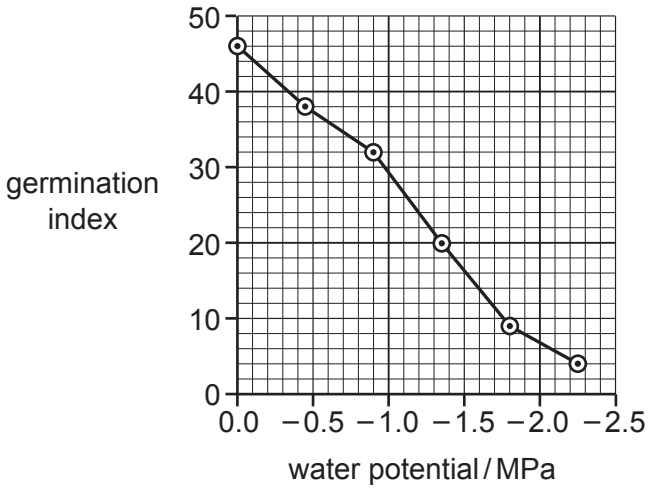


Fig. 5.1

(i) With reference to Fig. 5.1, describe the relationship between the germination index of barley seeds and water potential.

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..... [2]

(ii) Suggest explanations for the relationship shown in Fig. 5.1.

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..... [3]

(c) During barley seed germination, gibberellin stimulates the synthesis of enzymes.

State the name of one of these enzymes **and** the precise location of its synthesis.

enzyme .....

location .....
[2]

(d) Some plants are grown commercially for their flowers. Many of these plants are varieties that have short stems.

Two factors that affect the height of stems are:
- gibberellin
- the *Le*/*le* gene.

The *Le*/*le* gene has two alleles, Le and le.

(i) Suggest an advantage of growing a short-stemmed variety of a flowering plant.

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..... [1]

(ii) Explain how the *Le*/*le* gene and gibberellin are involved in affecting the height of plant stems.

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..... [3]

[Total: 12]

6 Fig. 6.1 outlines the first three stages of respiration in aerobic conditions.

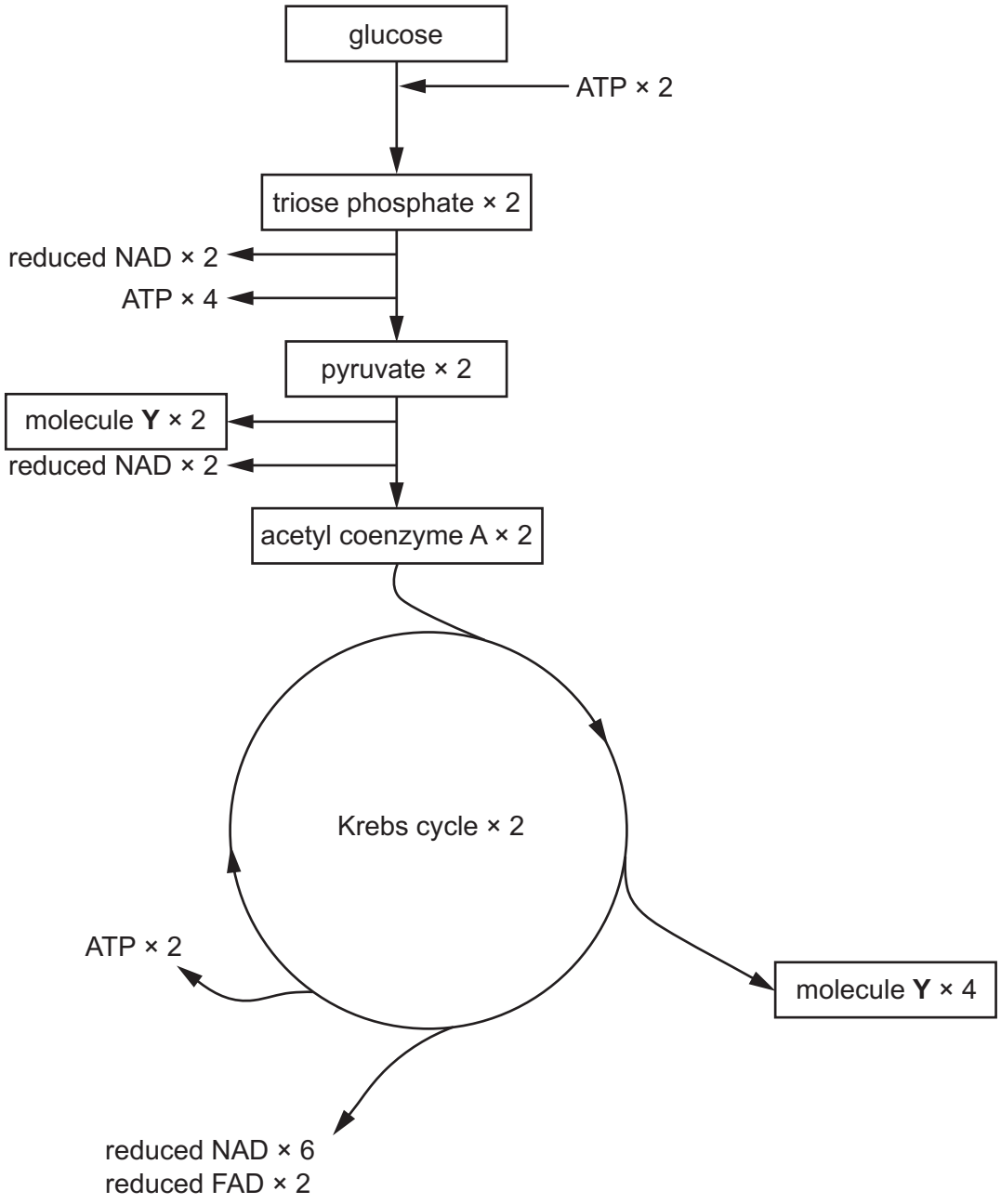


Fig. 6.1

(a) Name molecule **Y** in Fig. 6.1.

..... [1]

(b) Explain how Fig. 6.1 shows that glycolysis involves oxidation.

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..... [1]

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(c) At one time it was thought that the oxidative phosphorylation of:

- one molecule of reduced NAD results in the synthesis of 3 ATP molecules
- one molecule of reduced FAD results in the synthesis of 2 ATP molecules.

Using Fig. 6.1, a theoretical value for the net number of ATP molecules that are synthesised for each molecule of glucose can be calculated.

Modern research has shown that the actual net number of ATP molecules synthesised for each glucose molecule respired is much lower than this theoretical value.

(i) Using Fig. 6.1, calculate the theoretical value for the net number of ATP molecules that are synthesised for each molecule of glucose respired in **all** phosphorylation reactions.

Show your working.

answer = ... [2]

(ii) Suggest **two** reasons why the actual net number of ATP molecules synthesised is less than the theoretical number.

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..... [2]

(d) Outline the roles of NAD and FAD in aerobic respiration.

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(e) Rotenone is used as an insecticide. Rotenone kills insects by inhibiting the transfer of electrons in the electron transport chain of the mitochondrion.

Explain how rotenone affects ATP synthesis in the mitochondrion.

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..... [3]

[Total: 12]

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7 **(a)** The function of the enzyme iduronate 2-sulfatase is to break down certain complex molecules.

Hunter syndrome is a rare, inherited condition in humans, caused by iduronate 2-sulfatase not functioning properly or by iduronate 2-sulfatase not being produced. This will cause the complex molecules to build up, leading to progressive damage to many organs.

Explain how a gene mutation can lead to iduronate 2-sulfatase not functioning properly or not being produced.

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..... [4]

(b) Hunter syndrome is caused by a recessive allele located on the **X** chromosome.

Using appropriate symbols, draw a genetic diagram to show the probability of a normal male and a heterozygous normal female having a child with Hunter syndrome.

key

parental phenotype	normal male	×	normal female
parental genotype			
gametes			
offspring genotypes			
offspring phenotypes			

probability ..... [5]

[Total: 9]

8 California salamanders are terrestrial amphibians.

An original population of California salamanders occupied an area of forest in northern California. Approximately 10 million years ago, two separate populations, **A** and **B**, started to migrate from the original population.

- Population **A** travelled along the coast of California, to the west of the Great Central Valley.
- Population **B** travelled east of the Great Central Valley.

The two populations now live close to each other in southern California.

Fig. 8.1 outlines the migratory routes of populations **A** and **B**.

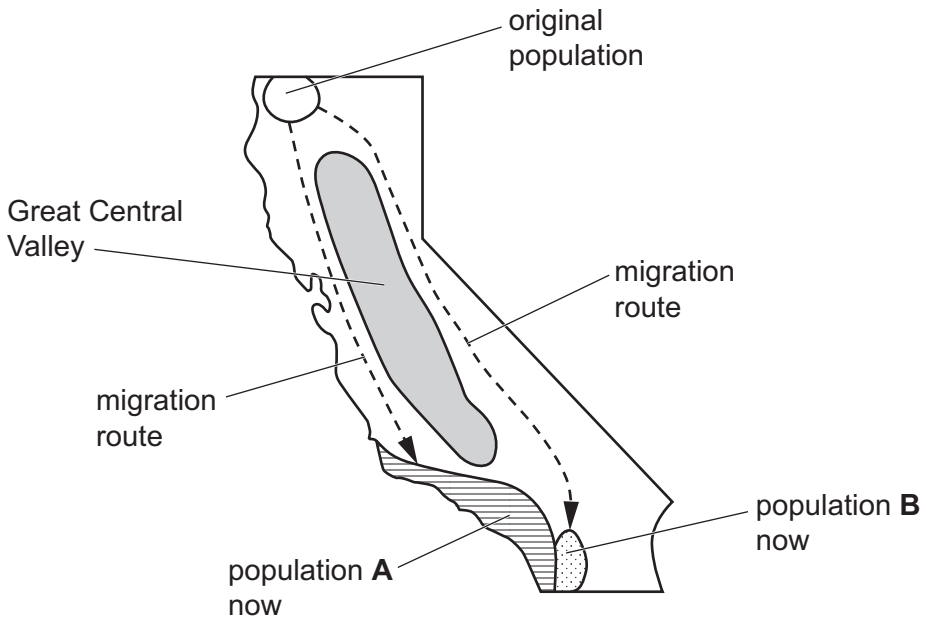


Fig. 8.1

Salamanders from population **A** rarely interbreed with salamanders of population **B**. If they do interbreed, the offspring are infertile.

Suggest **and** explain the sequence of events that have resulted in these two populations becoming reproductively isolated from each other.

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[Total: 5]

Section B

Answer **one** question.

9 **(a)** Describe **and** explain the mechanism by which guard cells open stomata. [7]

(b) Explain how the anatomy **and** physiology of the leaves of maize or sorghum are able to maximise carbon dioxide fixation at high temperatures. [8]

[Total: 15]

10 **(a)** Describe **and** explain the transmission of an action potential in a myelinated neurone. [9]

(b) Explain what is meant by homeostasis in a mammal **and** explain why it is important to maintain body temperature, blood glucose concentration and the water potential of blood. [6]

[Total: 15]

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[Turn over

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