



Cambridge International AS & A Level

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BIOLOGY

9700/42

Paper 4 A Level Structured Questions

October/November 2022

2 hours

You must answer on the question paper.

No additional materials are needed.

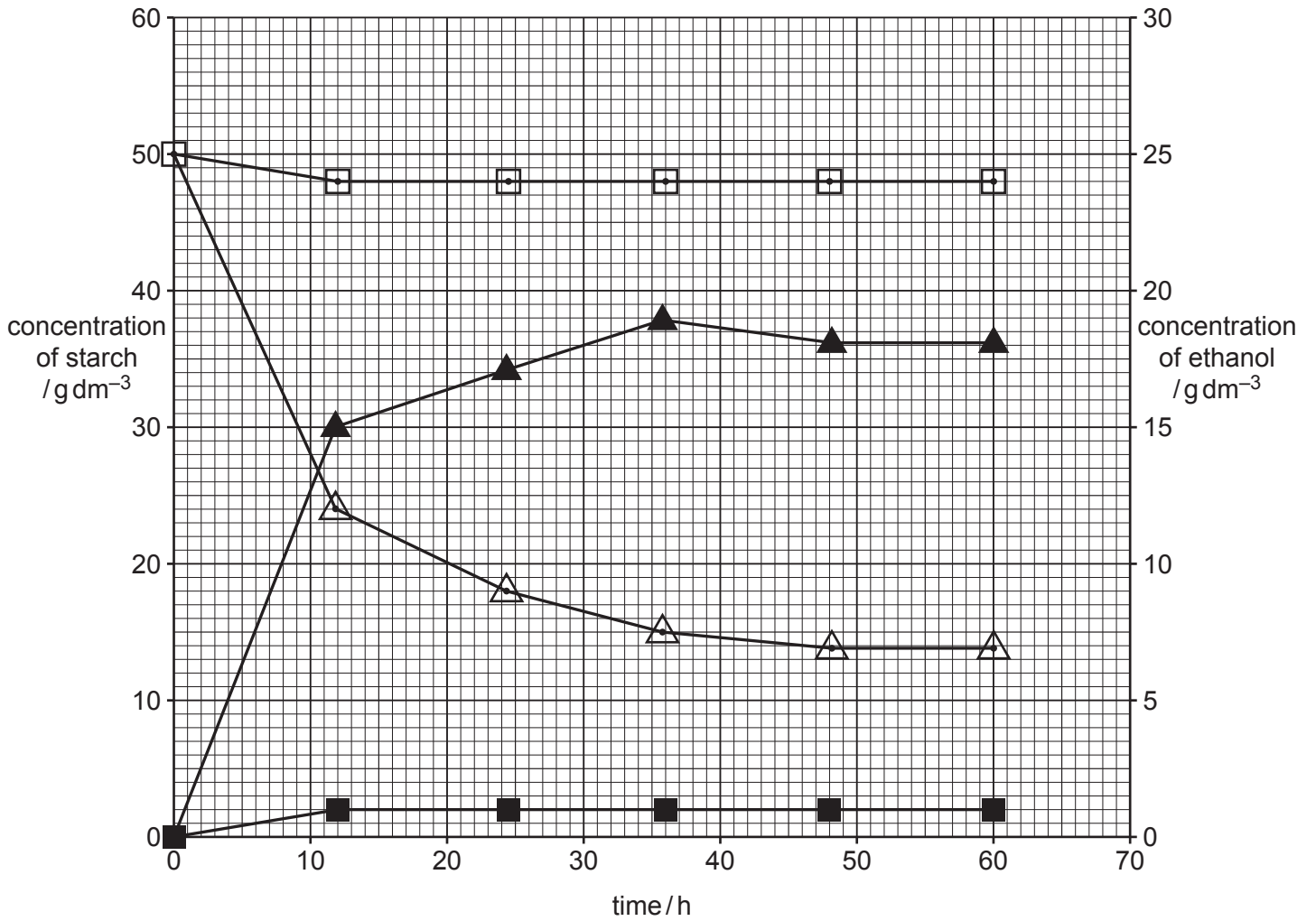
INSTRUCTIONS

- 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.



Key
 ■ ethanol concentration using non-GM strain
 □ starch concentration using non-GM strain
 ▲ ethanol concentration using GM strain
 △ starch concentration using GM strain

Fig. 2.1

With reference to Fig. 2.1, describe the trends in the data for **ethanol** production by the GM strain compared to the non-GM strain.

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..... [2]

- (c) The rate of ethanol production is similar for the lower temperature method and the higher temperature method.

Suggest why using the lower temperature method has a similar rate of production of ethanol to the higher temperature method.

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..... [2]

- (d) Suggest **one** reason why the high temperature method is expensive to carry out.

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..... [1]

[Total: 11]

3 (a) Photosynthesis is an energy transfer process that takes place in chloroplasts of plant cells.

(i) Fig. 3.1 shows a diagram of a chloroplast.

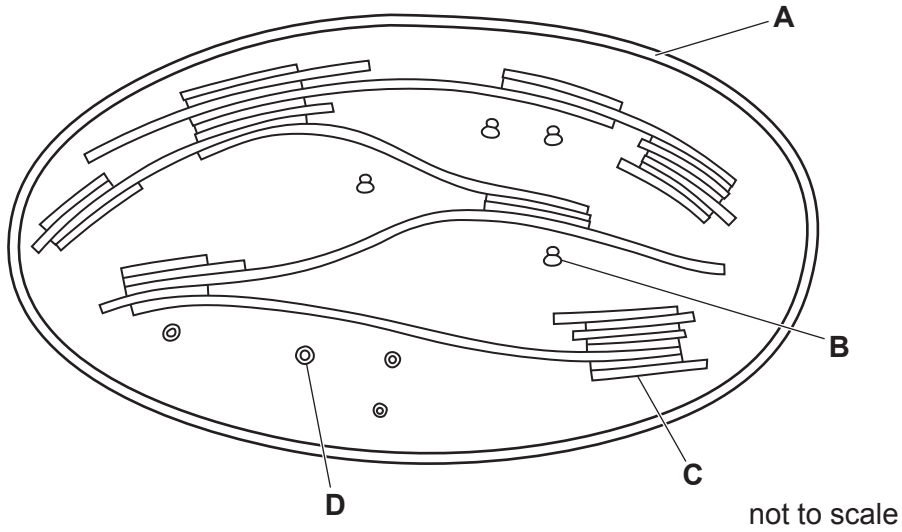


Fig. 3.1

Using the letters **A**, **B**, **C** or **D**, identify the structure that:

- contains genes that code for some of the enzymes used in photosynthesis

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- is the site of synthesis of some of the enzymes used in photosynthesis.

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[2]

(ii) Explain how grana are adapted for their specific role in photosynthesis.

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[4]

(ii) Discuss how the results in Fig. 3.2 support that chemiosmosis occurs during photophosphorylation.

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..... [3]

[Total: 12]

(b) Scientists are working towards a goal of treating haemophilia by gene therapy. They plan to use a common, harmless virus to introduce the functional gene. The virus has a genome that is 4.7 kilobase pairs long.

- (i) With reference to Table 4.1 and the introduction to (a), assess:
- which form of haemophilia, A or B, scientists should try to treat first
 - whether they should attempt to treat haemophilia with gene therapy at all.

Explain your reasoning.

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..... [3]

- (ii) In gene therapy trials to treat haemophilia, the gene coding for the clotting factor needs to be introduced together with a promoter.

Explain why a promoter has to be introduced as well as the desired gene.

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..... [2]

- (iii) Some individuals taking part in gene therapy trials have been naturally exposed to the virus carrying the functional gene, so that their blood already contains antibodies to the virus.

Predict how this will affect the success of the gene therapy treatment.

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..... [2]

- (c) Gene editing is a newer technique for modifying DNA. Some scientists are researching the use of gene editing, instead of introducing a functional gene, to treat haemophilia.

State **two** possible advantages of using gene editing as a method of treating haemophilia.

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..... [2]

[Total: 13]

5 *Myosotis* is a genus of small flowering plants. Many different *Myosotis* species grow on the islands of New Zealand, which are an important site of *Myosotis* evolution. Lowland *Myosotis* species grow at low altitude while alpine *Myosotis* species grow at high altitude at the tops of mountains.

(a) Scientists wanted to obtain molecular data to determine the evolutionary relationships of New Zealand's *Myosotis* species. They extracted DNA from individuals of *Myosotis* species collected from three different islands in New Zealand.

To carry out a polymerase chain reaction before DNA sequencing, the DNA samples were mixed with primers, deoxynucleotides and *Taq* polymerase and put through 35 cycles of treatment. Each treatment cycle involved one minute at 95°C, followed by one minute at 50°C and then four minutes at 72°C.

Describe what happened to the DNA at each temperature.

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..... [3]

(b) Fig. 5.1 shows the three largest New Zealand islands.

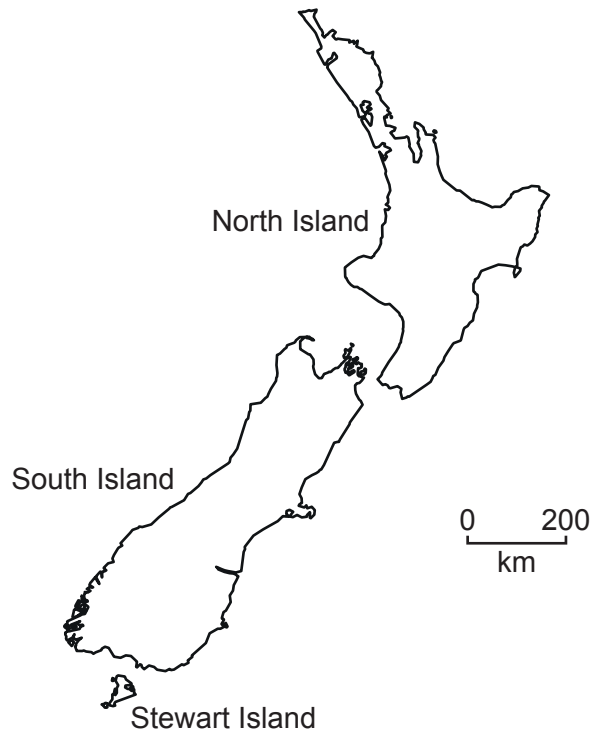


Fig. 5.1

North Island has mostly lowland habitat. South Island and Stewart Island have mountains with alpine habitats that are above the tree line.

DNA sequence data for three *Myosotis* species were compared. The results are described in the bullet points.

- In the alpine species *M. pygmaea*, individuals on South Island showed genetic differences from individuals of *M. pygmaea* on Stewart Island.
- In the alpine species *M. pulvinaris*, individuals from different mountains on South Island showed genetic differences.
- In the lowland species *M. pottsiana*, individuals from different areas of North Island showed overall genetic similarity.

(ii) Suggest why structural genes in operons are transcribed together.

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..... [1]

(iii) *trpA* is an example of a structural gene and *trpR* is an example of a regulatory gene.
Describe the differences between the functions of structural genes and regulatory genes.

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..... [2]

(iv) *trpA* codes for the enzyme tryptophan synthase.
Tryptophan synthase catalyses the formation of the amino acid tryptophan.
Explain why tryptophan synthase is an example of a repressible enzyme.

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..... [2]

(b) Control of gene expression in eukaryotes is more complex than in prokaryotes.

In plants, the control of gene expression can involve plant hormones, such as gibberellin, and proteins known as JAZ and MYC.

(i) Describe how gibberellin activates genes in plant cells.

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(ii) Transcription of some plant genes is prevented when JAZ proteins bind to other proteins known as MYC.

When JAZ proteins are broken down, MYC proteins are free to bind to DNA. This allows transcription to begin.

State the term that is used to describe proteins such as MYC proteins.

..... [1]

[Total: 13]

Turn over for Question 7.

- 7 The determination of sex in domestic turkeys is different from that in humans. The sex chromosomes in turkeys are named **Z** and **W**. Male turkeys are **ZZ** and female turkeys are **ZW**.

The gene for feather colour is located only on the **Z** chromosome.

- The dominant allele codes for bronze feathers.
- The recessive allele codes for brown feathers.

(a) Define the terms dominant and recessive.

dominant

.....

recessive

.....

[2]

(b) Using suitable symbols, construct a genetic diagram to show the results of a cross between a heterozygous bronze male turkey and a brown female turkey.

symbols

parent phenotypes

bronze male

brown female

parent genotypes

gametes

offspring genotypes

offspring phenotypes

[5]

(c) Explain how you would carry out a test cross to determine the genotype of a bronze male turkey.

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..... [3]

[Total: 10]

- 8 (a) Selective reabsorption takes place in the proximal convoluted tubule of a kidney nephron.

Fig. 8.1 is a diagram of two cells of the proximal convoluted tubule and part of the adjacent blood capillary.

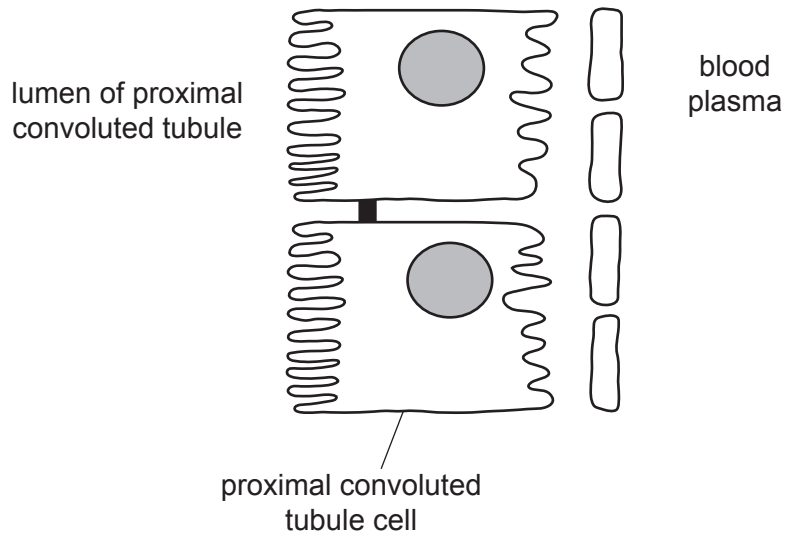


Fig. 8.1

The cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

On Fig. 8.1, use label lines and letters to indicate:

- **C**, where cotransporter proteins are located
- **P**, where sodium-potassium pumps are located. [2]

- (b) Explain how the cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

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..... [5]

(c) The plasma, the glomerular filtrate and urine are composed of various substances.

Table 8.1 shows the percentage composition of plasma, the glomerular filtrate and urine.

Table 8.1

substance	percentage composition		
	plasma	glomerular filtrate	urine
water	90.00	90.00	94.00
glucose	0.10	0.10	0.00
amino acids	0.05	0.05	0.00
plasma proteins	8.00	0.00	0.00
urea	0.03	0.03	2.00
other substances	1.82	9.82	4.00

As a result of the action of the cells of the proximal convoluted tubule, glucose and amino acids have been reabsorbed by the blood, whereas only some of the urea has been reabsorbed.

Calculate how many times the percentage composition of urea has increased in the urine compared with the glomerular filtrate.

Show your working and give your answer to the nearest whole number.

answer [2]

[Total: 9]

9 (a) Voltage-gated channels are involved in the generation of an action potential.

Fig. 9.1 is a diagram of the voltage-gated channels of sodium ions and potassium ions in the membrane of an axon. The channels are shown in three different states, 1, 2 and 3.

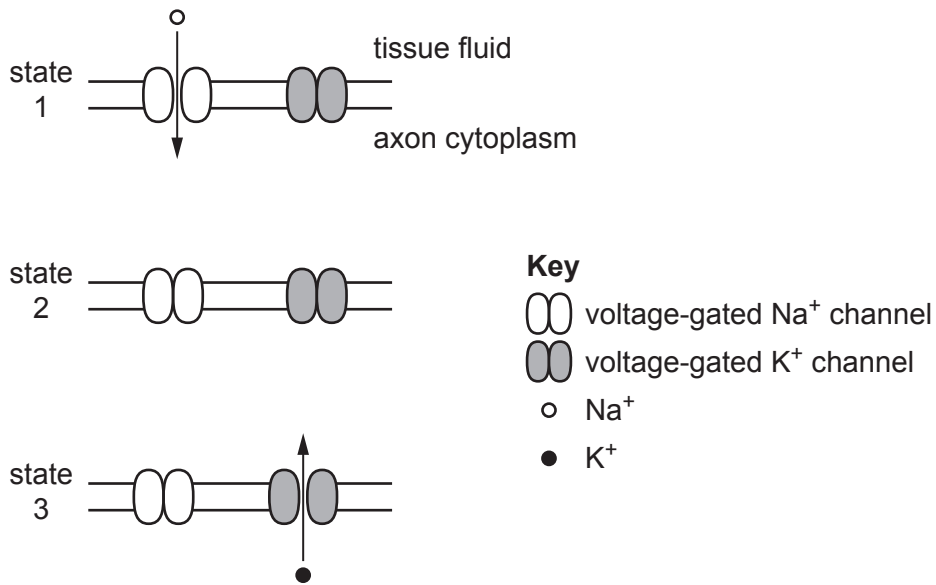


Fig. 9.1

Fig. 9.2 is a diagram of different phases of an action potential in an axon. The phases are labelled A, B, C, D, E, F and G.

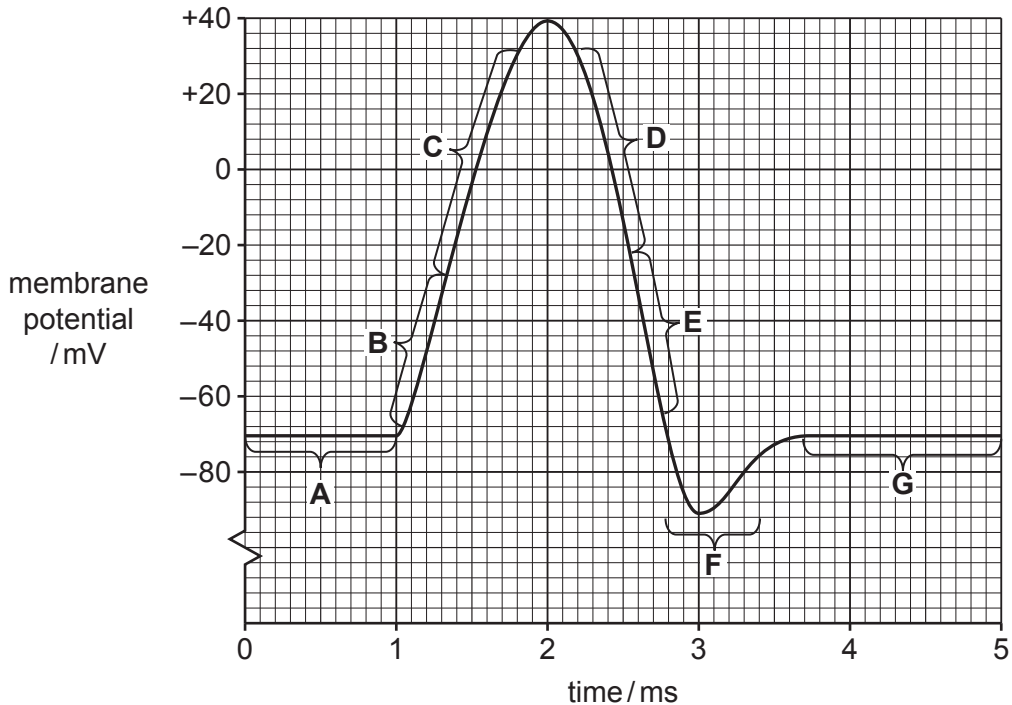


Fig. 9.2

(b) The passage below outlines cell signalling.

Complete the passage by using the most appropriate scientific terms.

Cells need to interact with their environment and other cells around them. This is called cell signalling. Cells in mammals are involved in a complex system of communication with each other. For example, liver cells detect signals using receptors in their cell surface membranes. Glucagon binds to the receptors because its shape is

This binding activates a, leading to stimulation of the enzyme

[3]

[Total: 7]

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