1. Nov/2022/Paper_41/No.3

(a) The results of investigations carried out on mitochondria show how the structure of a mitochondrion is related to its role in aerobic respiration.

- Intact mitochondria (not damaged) were removed from cells.
- A technique was used to remove the outer mitochondrial membrane, leaving the inner membrane intact.
- The inner mitochondrial membrane was separated from the contents of the matrix so that both could be analysed.

(i) The removal of the outer membranes of mitochondria involves placing the organelles in pure water. This results in the rupture (bursting) of the outer membrane. The inner mitochondrial membrane does not rupture and remains intact.

Suggest **and** explain why the inner membrane of a mitochondrion remains intact when the organelle is placed in pure water.

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(ii) Name **three** molecules, other than coenzymes, that are found in the mitochondrial matrix **and** explain their role in aerobic respiration.

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(iii) The inner membrane contains a very high proportion of the molecule cardiolipin. Cardiolipin makes the membrane impermeable to some ions.

Suggest why the inner membrane contains a very high proportion of cardiolipin.

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(b) In further experiments it was found that, in an intact mitochondrion:

- there is a membrane potential across the inner mitochondrial membrane, with the matrix having a negative charge
- the transport of ATP, ADP and inorganic phosphate (P_i) is driven by the membrane potential across the inner membrane.

Fig. 3.1 shows the location of some inner membrane carrier proteins.

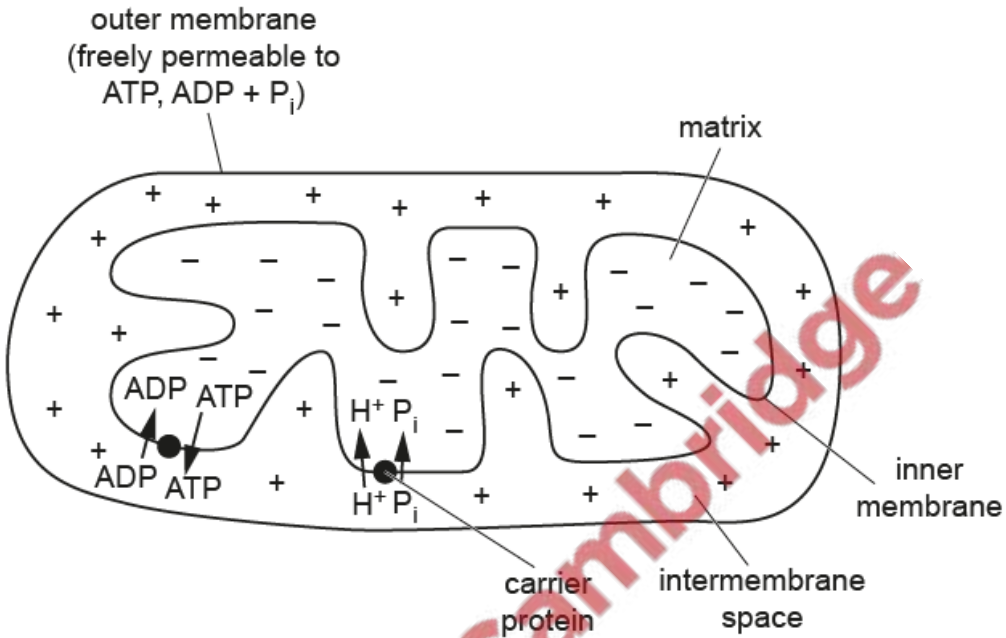

Fig. 3.1

(i) Reduced NAD and reduced FAD transfer hydrogen atoms to carriers located in the inner mitochondrial membrane.

Explain how hydrogen atoms from reduced NAD and reduced FAD lead to a membrane potential forming across the inner mitochondrial membrane during oxidative phosphorylation.

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(ii) Suggest **and** explain how P_i is transported across the inner membrane of the mitochondrion into the matrix.

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(iii) Suggest the advantages of linking ATP transport to ADP transport across the inner membrane of the mitochondrion.

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[Total: 14]

2. Nov/2022/Paper_42/No.2

Yeast cells can respire in anaerobic conditions.

(a) (i) Outline how yeast carries out respiration in anaerobic conditions.

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(ii) Explain why respiration in anaerobic conditions is an advantage to yeast.

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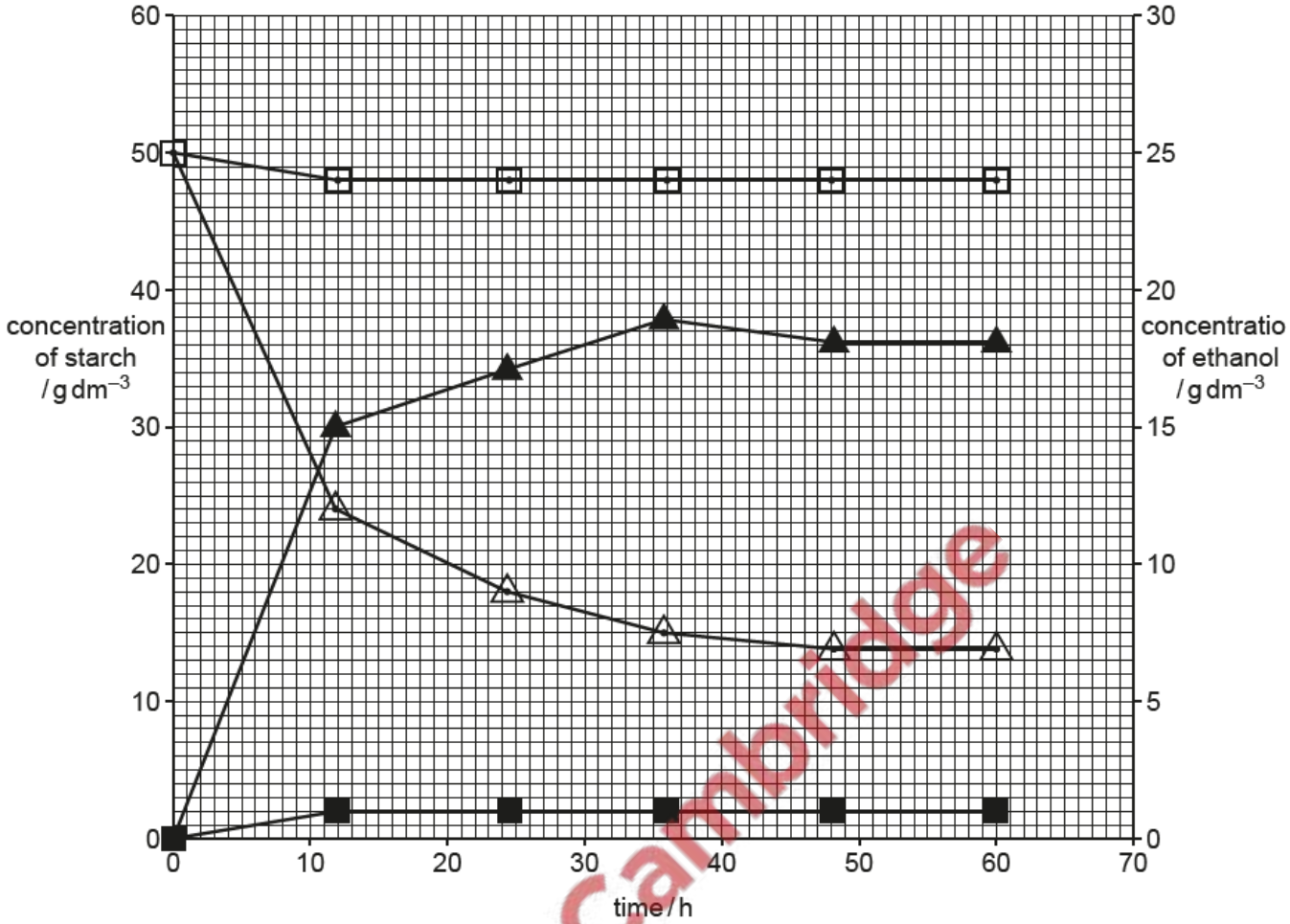
Bioethanol is a type of biofuel produced from maize starch on an industrial scale. In the high temperature method, heating to 120 °C is used to break apart starch molecules. The enzymes α-amylase and glucoamylase are added to the resulting starch suspension once it has cooled down. These enzymes hydrolyse the starch to glucose. Yeast cells are then added and maintained in anaerobic conditions to produce ethanol.

The high temperature method is expensive to carry out, so a new method has been developed which heats starch to a lower temperature of 80 °C.

In the lower temperature method, enzymes catalysing the hydrolysis of starch do **not** need to be added to the starch suspension. A genetically modified (GM) strain of the same yeast species is used. The GM strain of yeast has genes that allow the cell to produce α-amylase and glucoamylase and to attach these enzymes to the external surface of the cell surface membrane. The GM yeast cells are added to the starch that was heated to 80 °C and are maintained in anaerobic conditions to produce ethanol.

(b) An investigation was carried out to compare the GM strain of yeast with the yeast that had **not** been genetically modified (non-GM strain).
In this investigation, the starch suspension produced after heating to 80 °C was allowed to cool to 30 °C before adding yeast cells.

The results are shown in Fig. 2.1.



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

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[Total: 11]

(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.

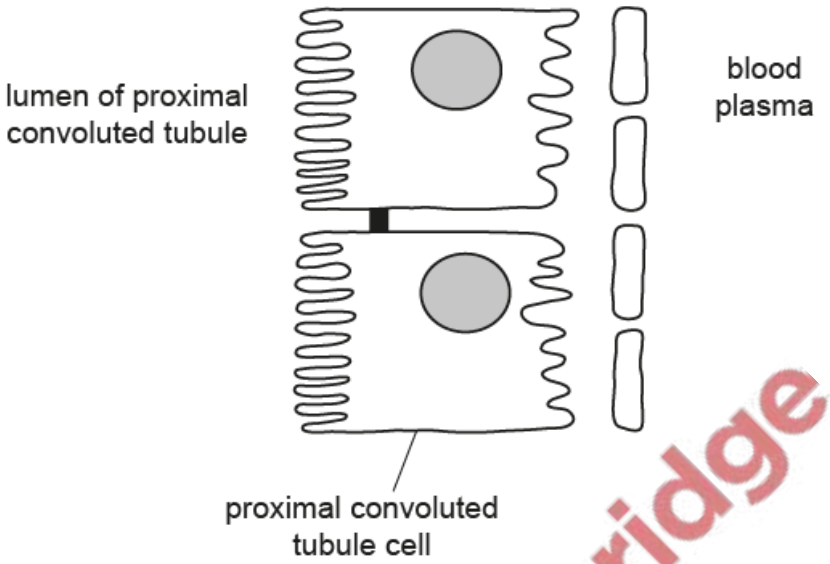

Fig. 8.1

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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(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]