Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

5003427588

BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **May/June 2014**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the number of the Section B question you have answered in the grid below.

Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **22** printed pages and **2** lined pages.

CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 is an electron micrograph of a chloroplast from a maize leaf cell.

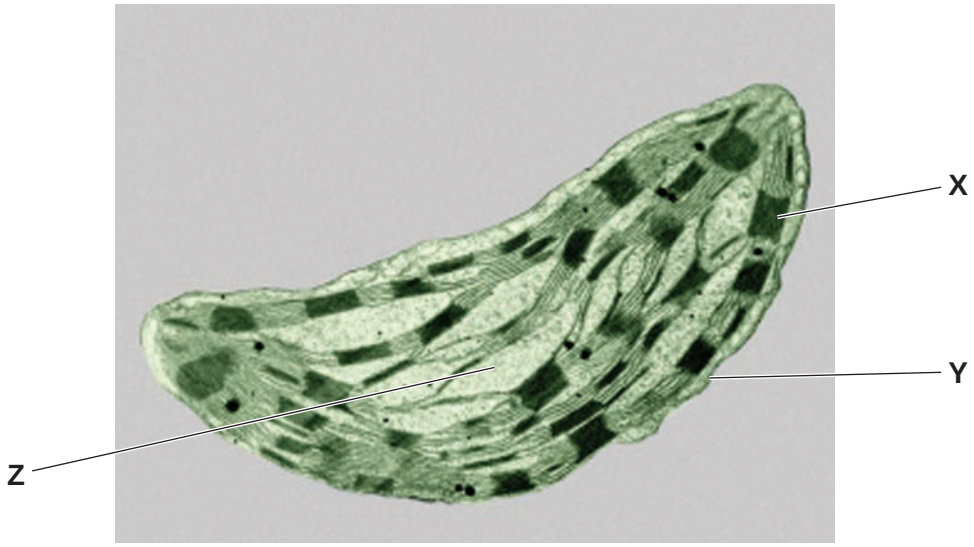

Fig. 1.1

Indicate below which of **X**, **Y** or **Z** contains:

transport proteins .....

pigments ..... [2]

(b) A chloroplast also contains DNA.

Suggest the functions of DNA in **this** organelle.

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.....[2]

(c) Changes in the atmospheric carbon dioxide concentration, light intensity and temperature alter the rate of photosynthesis. These three factors directly affect different stages of photosynthesis.

Complete the table below using a tick (✓) if the factor **directly** affects the stage or a cross (✗) if it does not affect the stage.

factor	**stage**	✓ or ✗
carbon dioxide concentration	Calvin cycle	.....
	photolysis	.....
light intensity	Calvin cycle	.....
	photolysis	.....
temperature	Calvin cycle	.....
	photolysis	.....

[3]

[Total: 7]

2 Myostatin is a protein that is produced in mammalian skeletal muscle cells. It circulates in the blood and acts on muscle tissue to slow down further differentiation and growth.

In thoroughbred racehorses, a mutation involving the substitution of a single nucleotide has been identified in the *MSTN* gene which codes for myostatin. At the site of this mutation, the DNA nucleotide has either a cytosine (C) base or a thymine (T) base, giving race horses three possible genotypes for this mutation: CC, CT or TT.

(a) At two years of age, racehorses with the *MSTN* CC genotype have greater muscle mass than those with the TT genotype.

Suggest an explanation for this difference.

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.....[2]

(b) Racehorses that had won races of different distances were tested to determine their *MSTN* genotype.

The results are shown in Fig. 2.1.

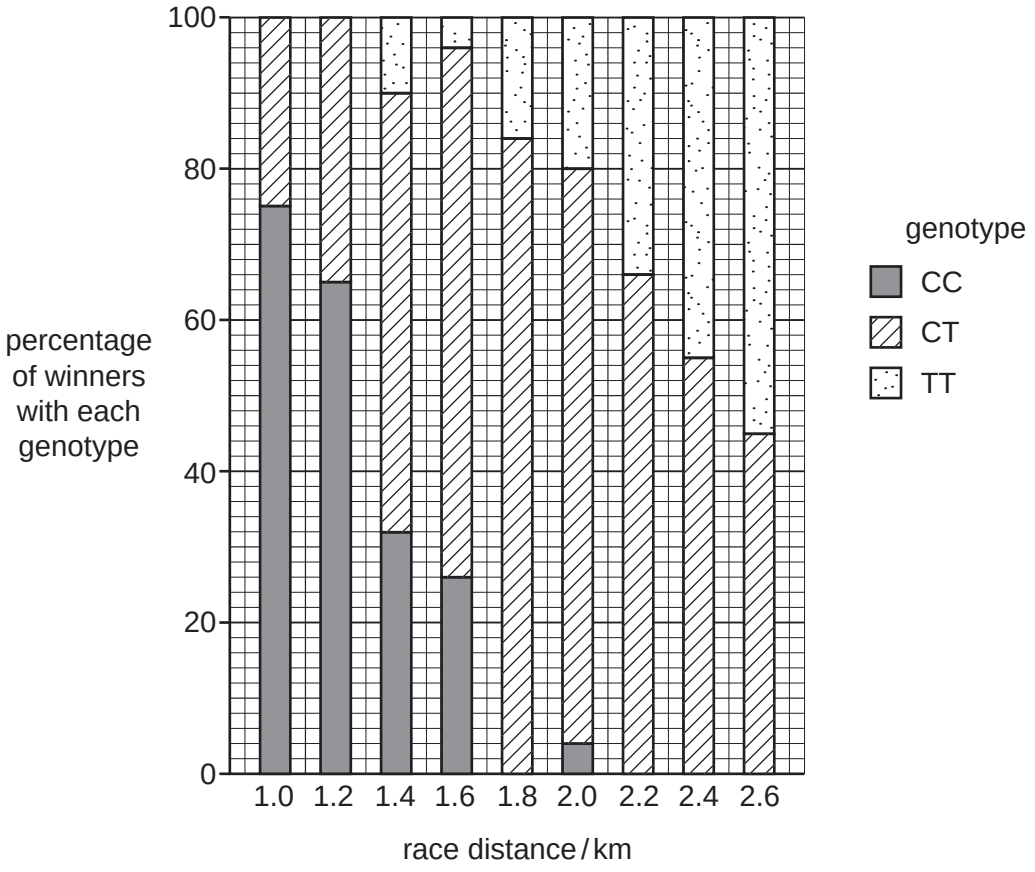

Fig. 2.1

With reference to Fig. 2.1, describe the effect of the *MSTN* genotype on the ability of racehorses to win races of different lengths.

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(c) Modern thoroughbred racehorses are the result of many years of artificial selection.

Explain:

(i) what is meant by *artificial selection*

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(ii) how genetic tests for the *MSTN* genotype can help in the selective breeding of racehorses.

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[Total: 10]

3 A group of membrane proteins which transport sugars out of cells have been identified and called SWEETs. They are found in the cell surface membranes of both animal and plant cells, including mammalian liver cells and rice mesophyll cells.

Each SWEET is a protein with seven coiled regions which together make a pore through a membrane bilayer as shown in Fig. 3.1.

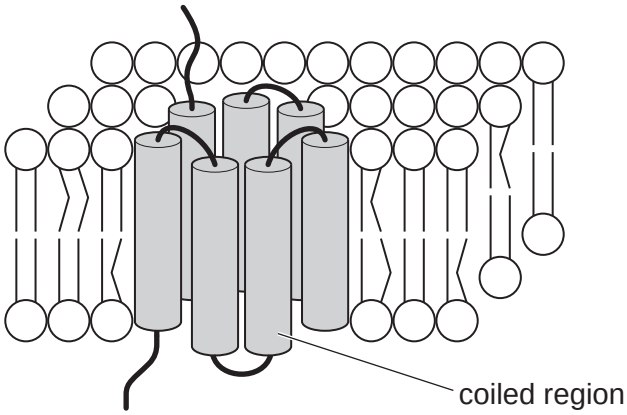

Fig. 3.1

(a) (i) Explain why, to enter or leave a cell, sugars need molecules such as SWEETS.

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(ii) Suggest how a SWEET is held within the membrane bilayer.

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(b) The bacterium, *Xanthomonas oryzae* (Xoo), causes the disease known as bacterial leaf blight in rice plants. It infects the intercellular spaces of the leaves of the host plant. Then, by switching on *SWEET* genes in the mesophyll cells, it stimulates the secretion of glucose into the intercellular spaces.

Several different **recessive** alleles have been found, in rice plants from different countries, which give resistance to bacterial leaf blight. All these alleles have a mutation in the promoter of the *SWEET* gene.

The effect of Xoo on wild type and resistant rice plants is compared in Fig. 3.2.

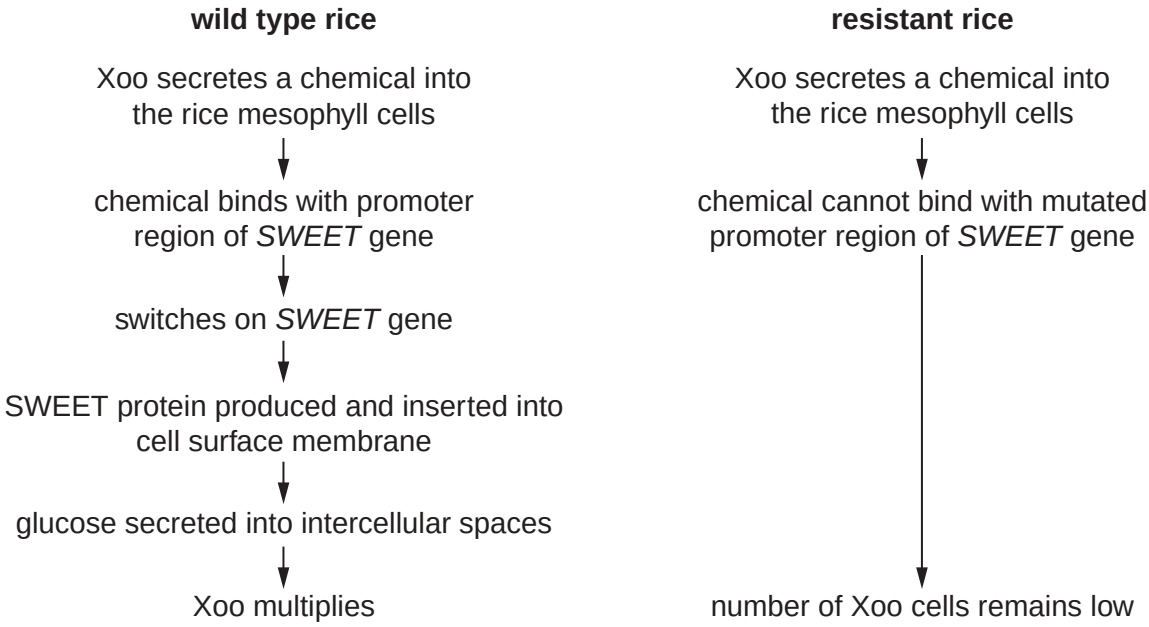

Fig. 3.2

(i) Using the information in Fig. 3.2, explain this resistance of rice plants to Xoo.

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(ii) Explain why it would be difficult to transfer this resistance into susceptible rice plants by genetic engineering.

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(iii) Explain why the presence of large numbers of Xoo in the intercellular air spaces of rice plants affects the ability of the plants to grow with their roots submerged in water.

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[Total: 14]

4 Collared lizards, *Crotaphytus collaris*, show variation in body length and running speed. Fig. 4.1 shows a collared lizard.

Fig. 4.1

An investigation was carried out to find out whether body length and running speed affected the number of offspring that a male lizard sired (fathered). The lizards reproduce sexually, and females lay eggs after mating with males.

A large number of male lizards was captured during the breeding season.

For each lizard:

- body length was measured
- it was chased down a small race track and its fastest running speed over 1 m recorded
- a blood sample was taken and DNA sequences at 10 different loci were analysed.

The lizards were then released back into the place where they were captured, to allow mating to occur.

Several weeks later, after the lizards' eggs had hatched, as many young hatchlings as possible were captured. DNA testing was carried out on each hatchling to determine which male was the father. The results were used to determine the number of offspring sired by each of the male lizards in the first sample.

(a) Outline how DNA analysis can be carried out and then used to establish which male lizard sired each hatchling.

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(b) Fig. 4.2 shows the number of offspring sired plotted against the body length of the adult male lizards.

Fig. 4.3 shows the number of offspring sired plotted against the fastest running speed (sprint speed) of the adult male lizards.

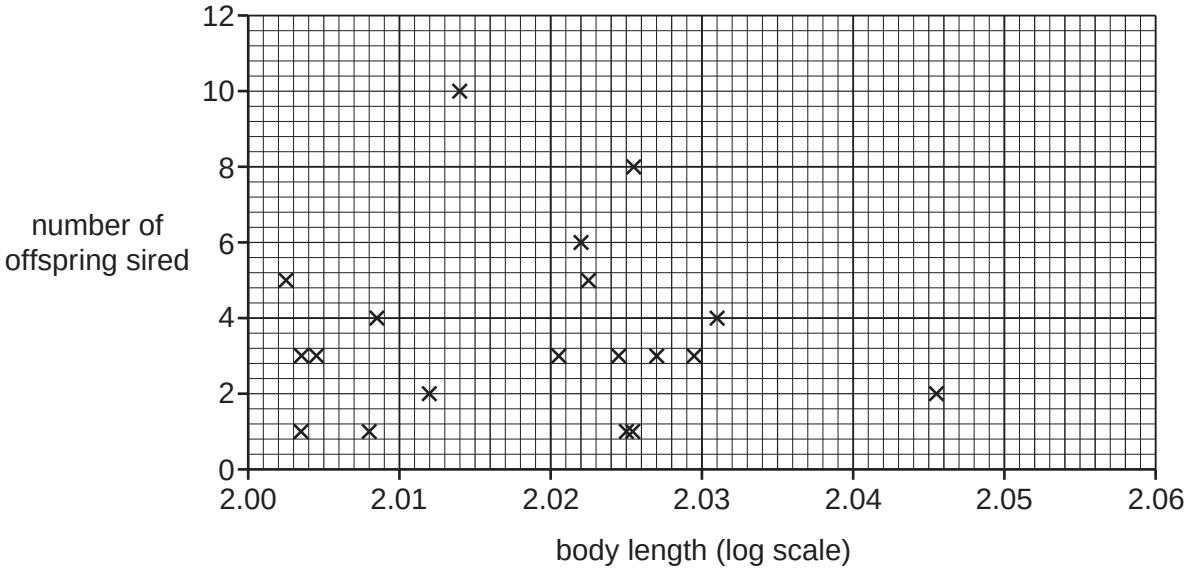

Fig. 4.2

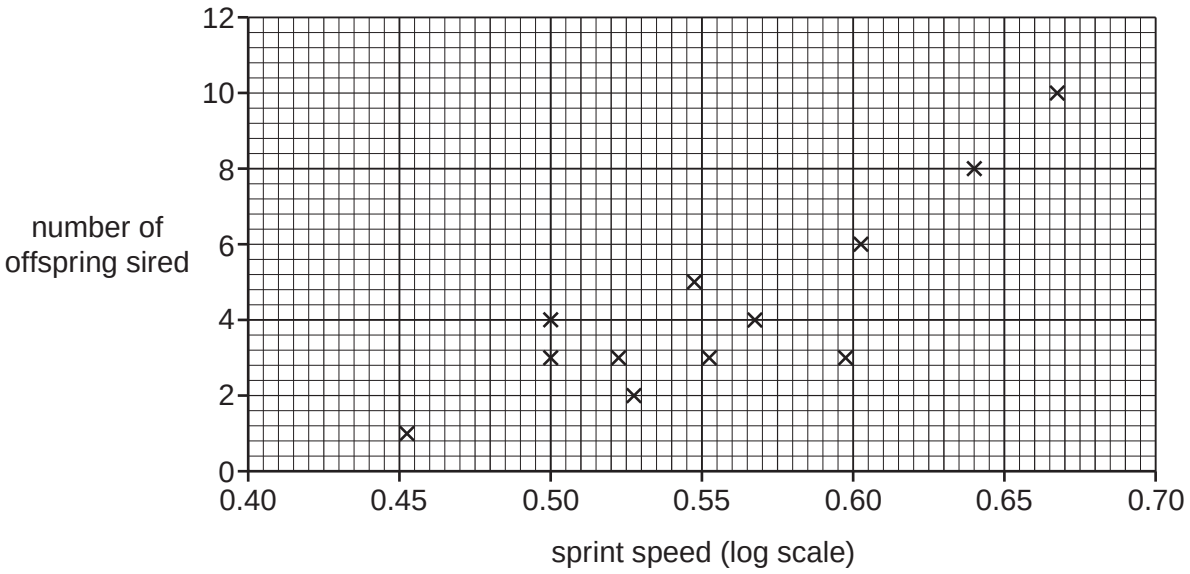

Fig. 4.3

(i) With reference to Fig. 4.2 and Fig. 4.3, describe the relationships between
- body length and the number of offspring produced
- sprint speed and the number of offspring produced.

body length .....

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sprint speed .....

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.....[4]

(ii) Research has also shown that, in a population of collared lizards with varying leg lengths, those with longer hind legs are able to run faster.

With reference to the results shown in Fig. 4.3, explain how, over time, this could lead to a change in the mean hind leg length in a population of collared lizards.

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[Turn over

(c) Small islands often contain species of lizards that are not found on other islands or on the mainland.

Explain how a population of collared lizards that became isolated on an island could evolve to form a new species.

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[Total: 15]

Question 5 starts on page 14

5 The hormone FSH (follicle stimulating hormone) plays important roles in the reproductive cycles of mammals.

(a) State the precise site of secretion of FSH.

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(b) Certain cells in the ovaries and testes have receptors for FSH in their cell surface membranes. FSH can bind with these receptors, which triggers the cells to respond to the hormone.

Mice were genetically modified so that they lacked functioning alleles of the gene that codes for the production of FSH receptors.

(i) Female mice without FSH receptors were sterile. They were found to have normal primary and secondary follicles in their ovaries, but no Graafian (ovarian) follicles or corpora lutea.

Explain these observations.

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(ii) Spermatozoa were collected from male mice with and without FSH receptors. The mean number of spermatozoa per mouse was estimated. The percentage of spermatozoa that could swim actively was calculated. Table 5.1 shows the results.

Table 5.1

	male mice with FSH receptors	**male mice without FSH receptors**
mean number of spermatozoa per mouse	5.6×10^6	3.6×10^6
percentage of spermatozoa that could swim actively	62	47

Discuss what these results suggest about the role of FSH in the development of spermatozoa in male mice.

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[Total: 8]

6 **(a)** In mammals, the water potential of the blood is constantly monitored by osmoreceptor cells in the hypothalamus of the brain. When the water potential of the blood decreases, ADH (antidiuretic hormone) is produced by cells in the hypothalamus and released into the blood via an endocrine gland.

(i) Explain what is meant by the term *water potential*.

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(ii) Describe the effect on water potential of adding solute to a solution.

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(iii) State precisely where ADH is released into the blood.

.....[1]

(iv) The decrease in the water potential of the blood is sometimes due to the loss of water from the body of a mammal.

List **two** ways by which water may be lost from the body.

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(b) Describe the action of ADH on the kidney.

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(c) Diabetes insipidus is a condition caused by an inability to produce ADH or by the kidneys being unable to respond to ADH.

Suggest symptoms that may be experienced by a person who has diabetes insipidus.

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[Total: 11]

7 Neurofibromatosis (NF) is a genetically inherited condition in humans where tumours grow in the nervous tissue. One symptom, which can develop around the age of 20 years, is loss of sight due to tumours on the optic nerve.

(a) If one parent has NF, there is at least a 50% chance that his or her children will develop the condition, even if the other parent is unaffected.

Complete the genetic diagram below to show how NF may be transmitted from parent to child.

key to symbols

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parental phenotypes	parent with NF	unaffected parent
parental genotypes		
gametes		
offspring genotypes		
offspring phenotypes		

[3]

(b) Suggest how a person may develop NF when there is no family history of the condition.

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.....[2]

(c) Suggest how a tumour on the optic nerve could prevent the transmission of nerve impulses to the brain.

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[Total: 8]

8 Adipose tissue is specialised connective tissue that functions as the major storage site for fat in the form of triglycerides.
The human body contains two types of adipose tissue:
white adipose tissue (WAT) and brown adipose tissue (BAT).

- WAT is more common and is found under the skin and around some internal organs.
- BAT is found in infants around the back and shoulders.
- BAT is also found in adults but in relatively smaller quantities.
- BAT cells contains more mitochondria than WAT cells.
- BAT is involved in the maintenance of a constant blood temperature when the external environment is cold.

(a) (i) Blood temperature in humans is maintained by a process called homeostasis.

With reference to blood temperature, outline the main principles of homeostasis.

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(ii) Suggest why infants have relatively more BAT than adults.

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(b) Mitochondria in BAT cells function differently from those in other cells during periods of cold environmental conditions.

Fig. 8.1 shows part of a mitochondrion in a BAT cell.

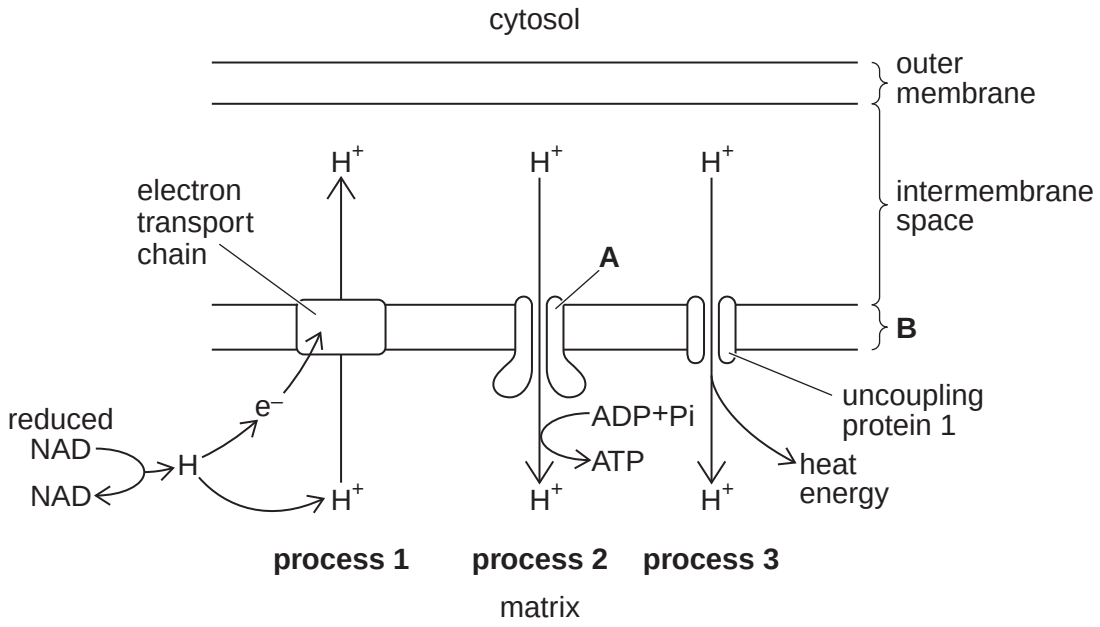

Fig. 8.1

(i) Name structures **A** and **B**.

A .....

B ..... [2]

(ii) Draw an arrow on Fig. 8.1 to indicate the direction of the proton gradient that exists between the matrix and the intermembrane space. [1]

(iii) State the **two** processes, shown in Fig. 8.1, that will be more active during periods of cold external environmental conditions.

.....[1]

(iv) State the by-product that is obtained as a result of processes **1** and **2**.

.....[1]

(v) Suggest the main respiratory substrate for BAT cells.

.....[1]

[Total: 12]

Section B

Answer **one** question.

9 **(a)** Describe the main features of an organism belonging to the **plant** kingdom. [8]

(b) Describe the methods used to conserve endangered **animal** species. [7]

[Total: 15]

10 **(a)** Describe the production of penicillin using the batch culture method. [8]

(b) Mycoprotein is produced using a continuous culture method.

Describe the advantages of the batch culture method **and** the continuous culture method. [7]

[Total: 15]