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CAMBRIDGE
International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5717680391

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **February/March 2026**

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. Do **not** use correction fluid or tape.
- 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.

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[Turn over

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1 *Batrachochytrium dendrobatidis* is a fungus that lives in a warm and damp environment, with optimal temperatures for growth of between 17 °C and 25 °C.

B. dendrobatidis causes a disease in the skin of frogs, which can be fatal in up to 100% of infected frogs. The disease is known as chytridiomycosis.

The mountain chicken frog, *Leptodactylus fallax*, is a large species of frog and is critically endangered. The frog is native to the Caribbean islands of Dominica and Montserrat.

Populations of *L. fallax* were believed to be in some decline in the years before 1995, but between 1995 and 2011 the total number of frogs decreased by more than 88%.

- In 1995, ash and acid rain from a volcanic eruption killed a large number of frogs on Montserrat.
- In 2002, chytridiomycosis arrived on Dominica where it caused a severe decrease in the number of frogs within 18 months.
- In 2009, chytridiomycosis arrived on Montserrat where it caused a severe decrease in the number of frogs within 12 months.

Figure 1.1 shows a mountain chicken frog.



Figure 1.1

(a) Suggest reasons that may have contributed to *L. fallax* becoming critically endangered, **other than** the volcanic eruption and the effects of chytridiomycosis.

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(b) Captive breeding was used to increase the number of *L. fallax* individuals. Releasing these frogs into the wild was **not** successful because *B. dendrobatidis* was still present on Dominica and Montserrat.

Conservationists have trialled the re-introduction of *L. fallax* into safer, semi-wild areas on Dominica and Montserrat. Here, conditions have been created that protect *L. fallax* from infection by *B. dendrobatidis* but still allow the frog to survive and reproduce.

Suggest measures that could have been taken in these areas to protect *L. fallax* from chytridiomycosis.

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(c) Outline the characteristic features of the kingdom Fungi.

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2 The Labrador retriever is a breed of dog that, as an adult, shows continuous variation in body mass.

Figure 2.1 shows a Labrador retriever.



Figure 2.1

(a) (i) Explain what is meant by continuous variation.

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(ii) Describe the causes of continuous variation in the body mass of adult mammals, such as Labrador retriever dogs.

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(b) Scientists have discovered that the gene *POMC* helps to regulate the body mass of Labrador retrievers.

Approximately 25% of Labrador retrievers have at least one mutant *POMC* allele.

Figure 2.2 shows the mean body mass of Labrador retrievers with each of the three possible genotypes for this gene:

- two normal *POMC* alleles (homozygous normal)
- one normal *POMC* allele and one mutant *POMC* allele (heterozygous)
- two mutant *POMC* alleles (homozygous mutant).

Each error bar shows the mean ±1 standard deviation.

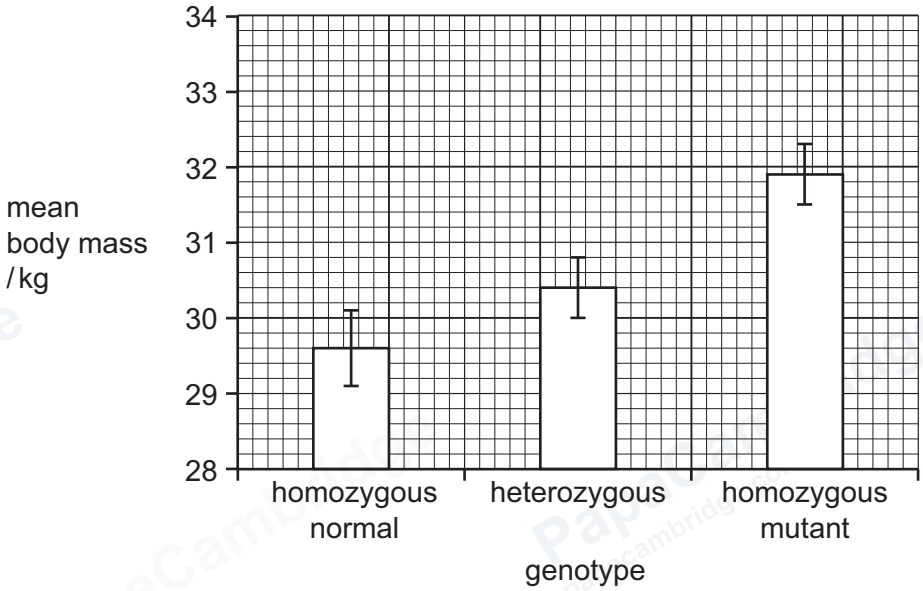

Figure 2.2

(i) With reference to Figure 2.2, describe the effect of the mutant *POMC* allele on the body mass of Labrador retrievers.

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(ii) Labrador retrievers with mutant *POMC* alleles have changes in behaviour that affect body mass.

Suggest a change in behaviour in Labrador retrievers with mutant *POMC* alleles that would affect body mass.

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3 Huntington's disease is caused by a mutation in a gene coding for a protein that has a number of cellular functions.

(a) Identify the gene and state the name of the protein that are affected by the mutation that causes Huntington's disease.

gene .....

protein .....

[2]

(b) In many countries, a genetic screening test for Huntington's disease is available.

Adults over the age of 18 years who are considered to be at risk of developing the disease are offered the genetic screening test.

(i) Suggest which adults are considered to be at risk of developing Huntington's disease.

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(ii) Suggest **and** explain why the genetic screening test for Huntington's disease is only offered to adults who are at least 18 years old.

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(c) Part of the gene associated with Huntington's disease has a repeated DNA triplet nucleotide sequence of CAG. There are 35 or fewer CAG repeats in the normal allele. Alleles with 40 or more CAG repeats are expected to result in the development of Huntington's disease.

The genetic screening test for Huntington's disease includes a polymerase chain reaction (PCR). This results in amplification of the gene that is associated with Huntington's disease.

The DNA fragments produced by PCR are then observed using agarose gel electrophoresis.

The genetic screening test results of four 18-year-old adults, **A**, **B**, **C** and **D**, who had no symptoms of Huntington's disease are shown in Figure 3.1. Control DNA containing the fragments from amplification of alleles with 35 and 40 CAG repeats is also shown.

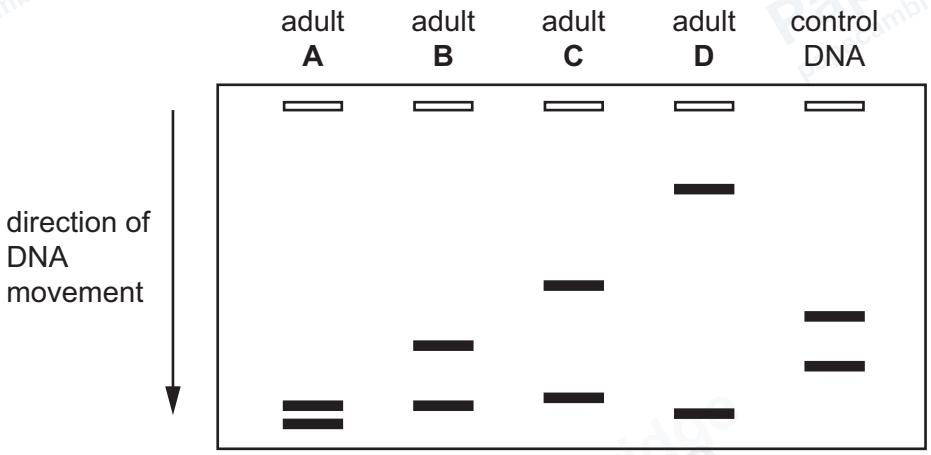

Figure 3.1

The results of the tests were used to make predictions.

- Adult **A** will **not** develop Huntington's disease.
- Adult **B** may or may **not** develop Huntington's disease.
- Adult **C** and adult **D** will develop Huntington's disease.
- Adult **D** will develop Huntington's disease before adult **C**.

Explain how the results of gel electrophoresis shown in Figure 3.1 support the predictions.

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(d) Some genetic diseases, such as severe combined immunodeficiency (SCID), can be treated by gene therapy.

Explain why Huntington's disease **cannot** be treated using the type of gene therapy used to treat SCID.

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4 **(a)** Outline the theory of evolution.

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(b) Approximately 95% of bird species living today belong to an evolutionary group known as Neoaves.

Bird species in the Neoaves group are believed to have evolved from a common ancestor that existed around 67 million years ago. The Neoaves that exist today can be divided into four groups:

- Mirandornithes, referred to as group 1
- Columbimorphae, referred to as group 2
- Otidimorphae, referred to as group 3
- all other Neoaves, referred to as group 4.

In 2014, scientists used DNA sequence data from 48 bird species to produce an evolutionary (phylogenetic) tree for the Neoaves. This is shown in Figure 4.1. The evolutionary tree shows possible evolutionary relationships between the four groups of species within the Neoaves.

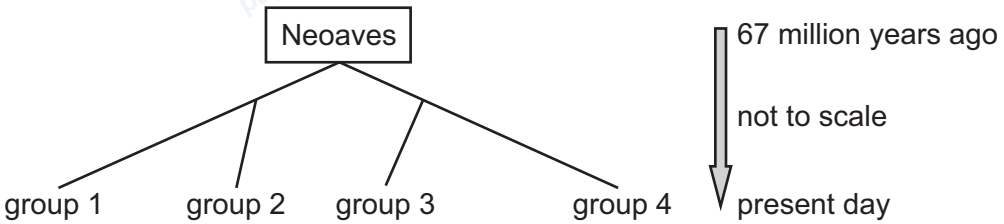

Figure 4.1

In 2024, scientists used DNA sequence data from 363 bird species to produce a new evolutionary tree for the four groups of species within the Neoaves. This is shown in Figure 4.2.

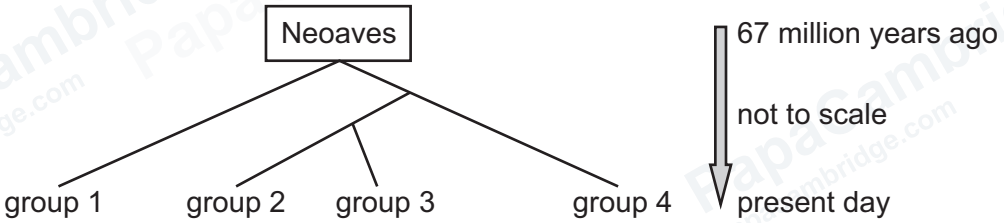

Figure 4.2

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(i) Describe the similarities and differences between the evolutionary relationships shown in Figure 4.1 and Figure 4.2.

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(ii) Explain how DNA sequence data can be used to produce evolutionary trees such as those shown in Figure 4.1 and Figure 4.2.

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(iii) State why Figure 4.2 is expected to be a more accurate representation of the evolutionary relationships of birds than Figure 4.1.

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(c) During the evolution of some Neoaves species, crossing over during meiosis did **not** occur in a large section of one chromosome for several million years.

State **and** explain the effect on genetic diversity of an absence of crossing over.

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5 **(a)** The sarcomere is composed of many structures and is the functional unit in the contraction of striated muscle.

Complete Table 5.1 to match each description with the correct region of the sarcomere.

Table 5.1

region of sarcomere	description
.....	only myosin present
.....	actin and myosin present
.....	only actin present
.....	attachment for myosin
.....	attachment for actin

[5]

(b) Hypocalcaemia is a condition where the blood calcium ion concentration is below the normal range.

Explain the effect of a low blood calcium ion concentration on the functioning of the sarcomeres of striated muscle fibres.

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[Total: 9]

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6 **(a)** Protein production in a prokaryote can be genetically controlled.

One example of the control of protein production in a prokaryote is the *lac* operon. The *lac* operon is functional when glucose is absent and lactose is present.

Complete Table 6.1, which shows information about the four genes associated with the *lac* operon.

Table 6.1

name of gene	type of gene	name of protein produced	function of protein produced
lacI	.....	repressor protein	binds to operator to prevent RNA polymerase from binding to the promoter
lacZ	structural	β-galactosidase	....
.....	structural	lactose permease	membrane transport protein to increase cellular uptake of lactose
lacA	structural	transacetylase	acetylates galactoside sugar residues to detoxify the cell

[3]

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(b) Insulin can be produced as a recombinant human protein using genetically engineered *Escherichia coli* bacteria. Recombinant insulin can be used to treat type 1 diabetes.

Describe the advantages of using recombinant insulin, instead of insulin from animal sources, to treat type 1 diabetes.

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7 **(a)** The process of ultrafiltration occurs in the Bowman's capsule region of a kidney nephron.

Figure 7.1 is a diagram representing part of a Bowman's capsule.

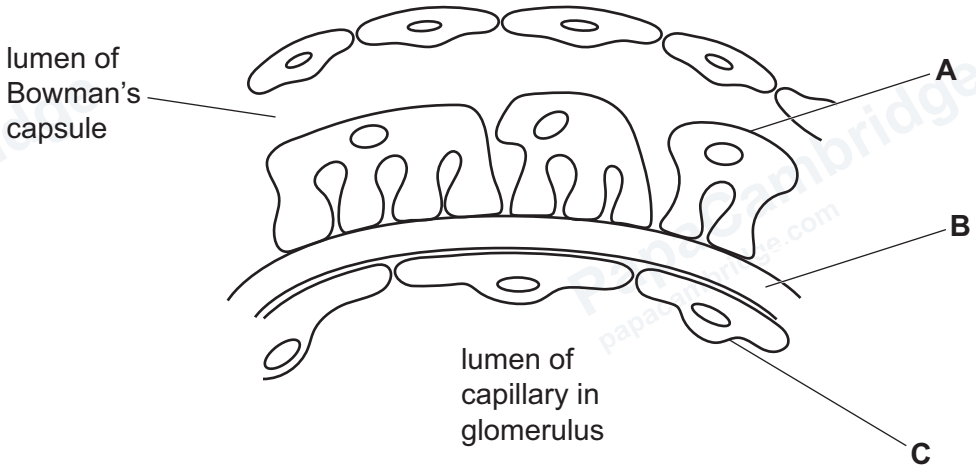

Figure 7.1

State the name of cell **A**, structure **B** and cell **C**.

A .....

B .....

C .....

[3]

(b) The kidney function of a person can be assessed by measuring the glomerular filtration rate (GFR). The GFR is the rate at which fluid filters from the blood in the glomerulus into the Bowman's capsule.

Suggest factors that are likely to decrease the GFR.

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(c) The kidney has an important role in homeostasis.

Explain what is meant by the term homeostasis **and** describe the principles of homeostasis in mammals.

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8 **(a)** Figure 8.1 shows three processes that require energy in living organisms.

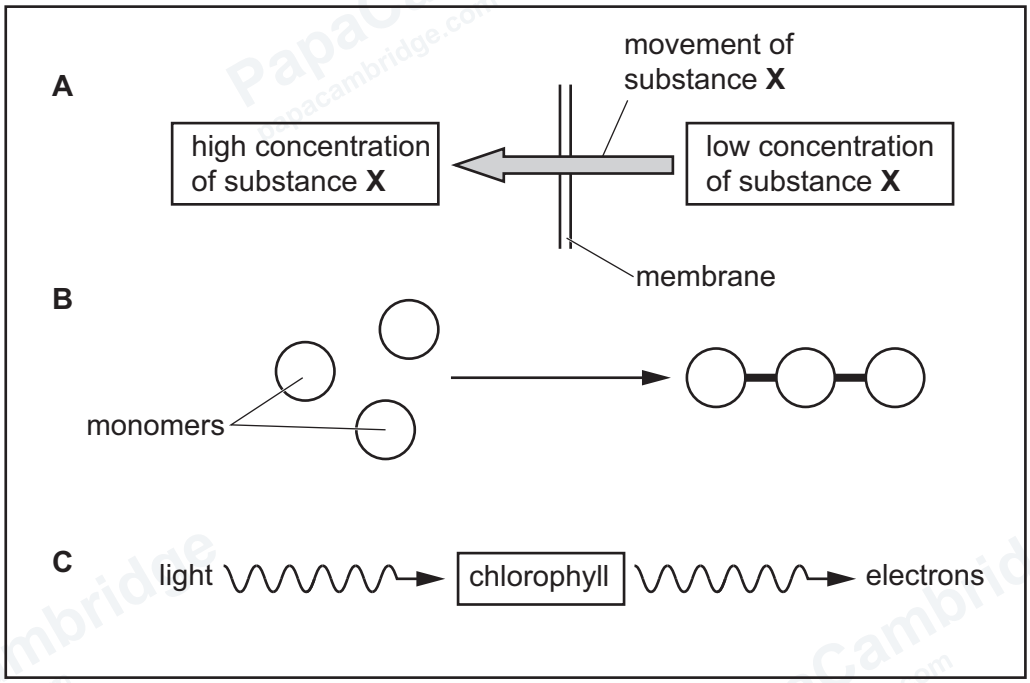

Figure 8.1

State the name of each type of process shown in **A**, **B** and **C**.

A .....

B .....

C .....

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(b) ATP is produced in mitochondria by a process called chemiosmosis.

Outline the process of chemiosmosis in mitochondria.

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(c) Different respiratory substrates have different energy values.

Table 8.1 shows the approximate energy values of carbohydrate and lipid.

Table 8.1

respiratory substrate	approximate energy value / kJ g^{-1}
carbohydrate	17.0
lipid	37.8

Calculate the mass of carbohydrate needed to release the same quantity of energy as 100 g of lipid.

Give your answer to one decimal place.

mass = ... g [2]

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9 **(a)** Nitric oxide is a cell-signalling molecule that has a role in a number of physiological processes in the body. It is also used as a therapeutic drug. Nitric oxide is known to have harmful effects in body cells if conditions are **not** controlled.

Scientists investigated the effect of nitric oxide on the use of oxygen by kidney cells grown in a culture medium.

The scientists recorded the oxygen concentration in the culture medium over a period of 24 minutes. During this 24-minute period, a small volume of nitric oxide was added to the culture medium on three occasions.

The results are shown in Figure 9.1.

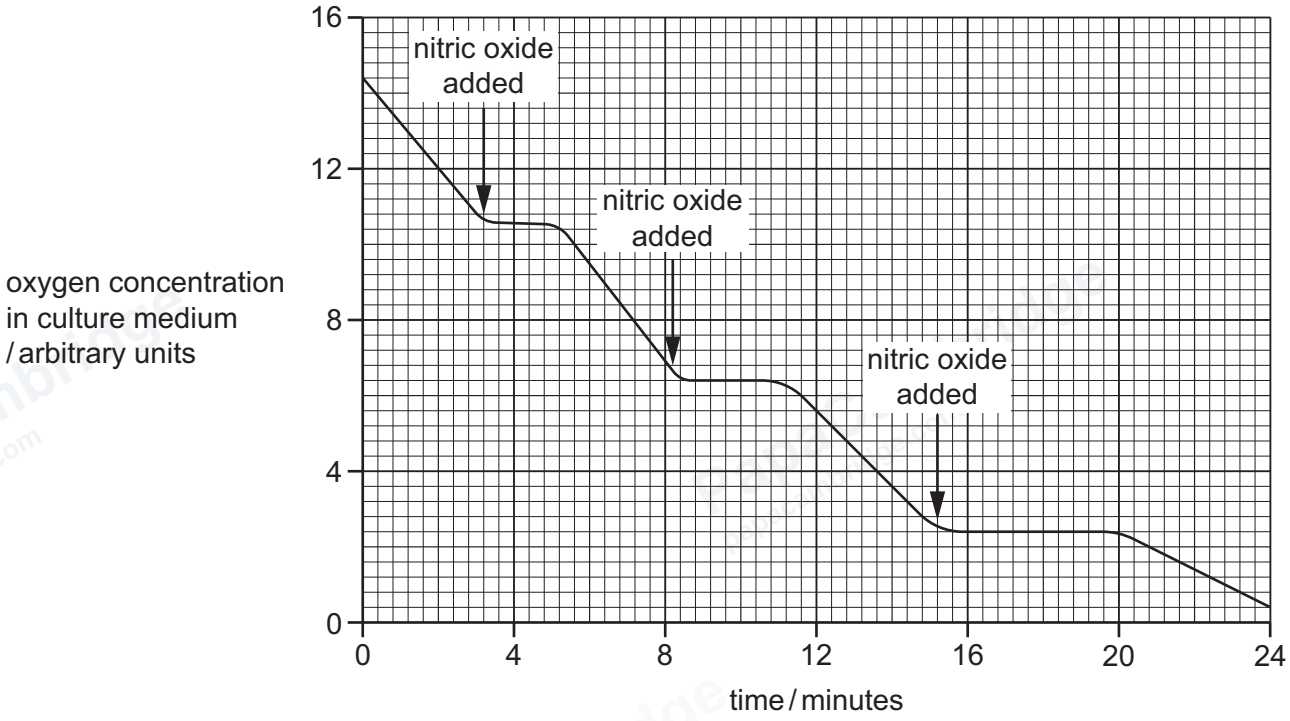

Figure 9.1

Describe the results of the investigation **and** suggest an explanation for these results.

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(b) Some organisms are able to carry out respiration in anaerobic conditions.

Describe the differences in respiration in anaerobic conditions between mammalian muscle cells and yeast cells.

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(c) Rice plants are adapted to grow in flooded fields.

Figure 9.2 shows rice plants growing in a flooded field.



Figure 9.2

Explain **three** adaptations of rice plants that allow the rice plants to grow in flooded fields.

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10 (a) Stomata have an important role in photosynthesis and transpiration.

Figure 10.1 shows the formula for calculating the stomatal index for an area of leaf.

$$\text{stomatal index} = \frac{\text{number of stomata}}{\text{number of stomata + number of epidermal cells}} \times 100$$

Figure 10.1

(i) Table 10.1 shows the stomatal index of the lower epidermis of the leaves of some crop plants.

Complete Table 10.1 for cotton and tomato using the formula shown in Figure 10.1.

Table 10.1

crop	number of stomata per unit area	number of epidermal cells per unit area	stomatal index
cotton	6	.....	15.8
groundnut	9	36	20.0
mung bean	5	12	29.4
sorghum	8	20	28.6
tomato	7	25	.....

[2]

(ii) The Russian wormwood, *Artemisia gmelinii*, has a stomatal index of 13.8 for its lower leaf surface and 1.7 for its upper leaf surface.

Explain the advantages to the plant for this difference in stomatal index values.

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(b) Figure 10.2 is a graph showing changes over a 24-hour period in the carbon dioxide concentration of the air in a glasshouse containing plants. The glasshouse did **not** have artificial lighting so the only source of light for the plants was sunlight.

The carbon dioxide concentration in the external atmosphere over the 24-hour period is also shown.

The air in the glasshouse was **not** completely sealed off from the external atmosphere so any difference in the carbon dioxide concentration between the glasshouse and external atmosphere will gradually decrease unless there are processes to maintain the difference.

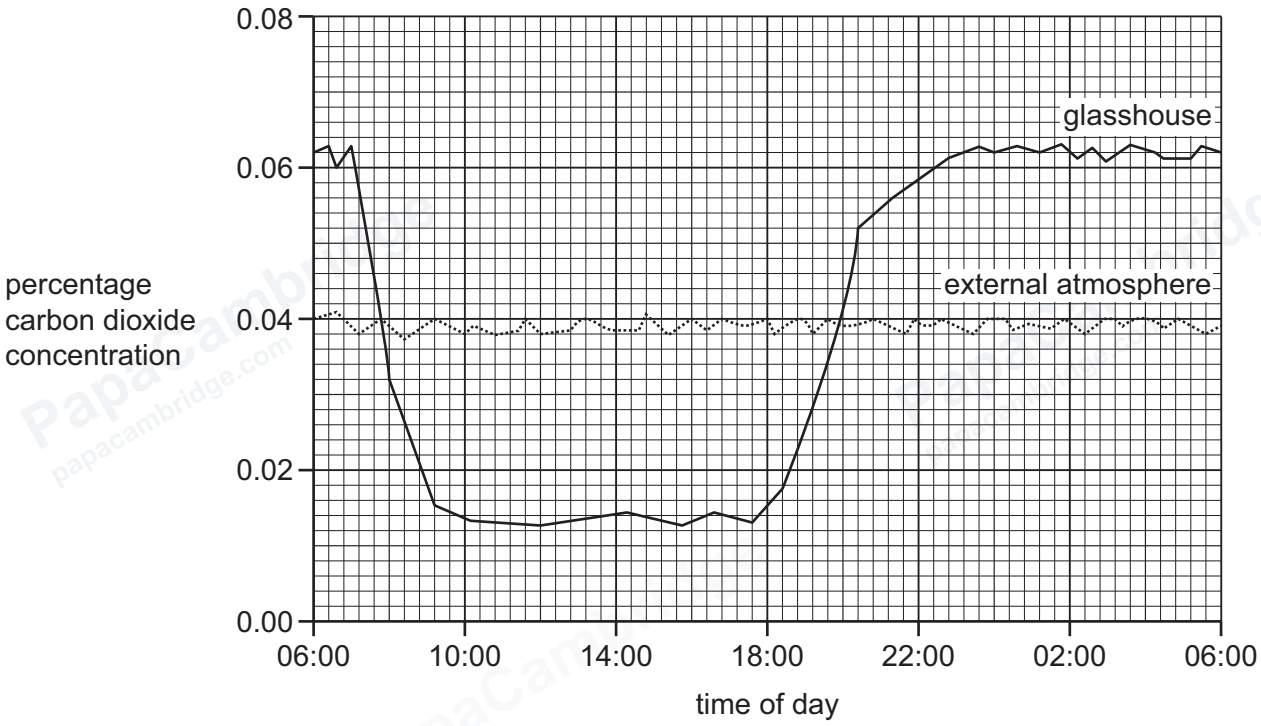

Figure 10.2

Suggest how different limiting factors affect the rate of photosynthesis of the plants in the glasshouse over the 24-hour period shown in Figure 10.2.

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(c) ATP and reduced NADP are products of the light-dependent stage of photosynthesis.

State where, in the chloroplasts, ATP and reduced NADP are produced **and** describe the roles of ATP and reduced NADP in the light-independent stage of photosynthesis.

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