Rewarding Learning

**ADVANCED**
**General Certificate of Education**
**2022**

**Centre Number**

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**Candidate Number**

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# Biology

## Assessment Unit A2 1

*assessing*

Physiology, Coordination and Control, and Ecosystems

**[ABY11]**

*ABY11*

**WEDNESDAY 1 JUNE, MORNING**

**TIME**

2 hours 15 minutes.

**INSTRUCTIONS TO CANDIDATES**

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
**You must answer the questions in the spaces provided.**
**Do not write outside the boxed area on each page or on blank pages.**
Complete in black ink only. **Do not write with a gel pen.**
Answer **all nine** questions.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 100.
Section A carries 82 marks. Section B carries 18 marks.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You are reminded of the need for good English and clear presentation in your answers.
Use accurate scientific terminology in all answers.
You should spend approximately **25 minutes** on Section B.
You are expected to answer Section B in continuous prose.
**Quality of written communication** will be assessed in Section B.

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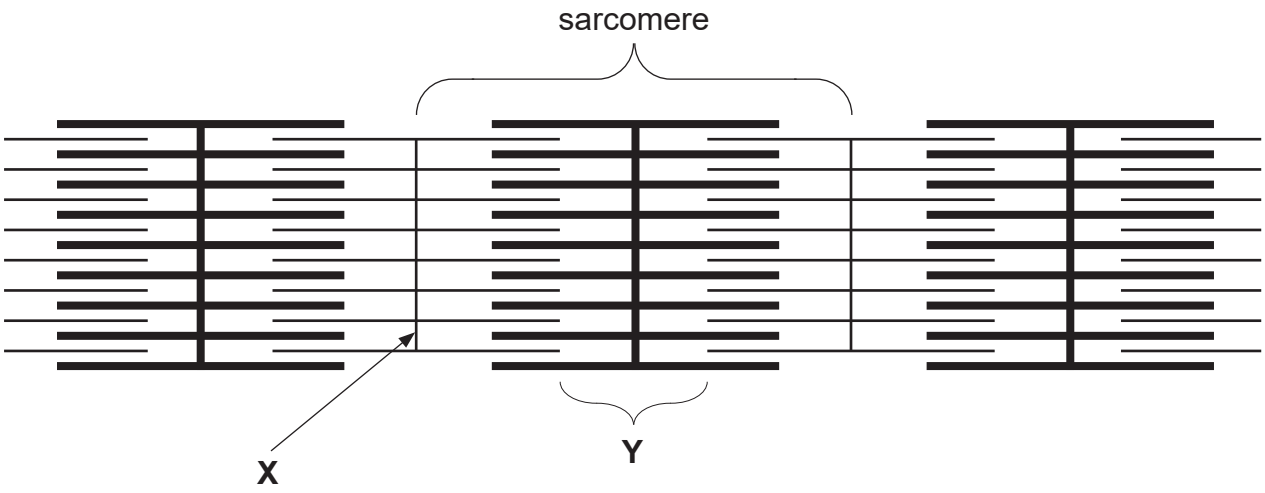
## Section A

**1** **(a)** The diagram below represents a section through a myofibril in skeletal muscle.




**(i)** Identify the sarcomere components labelled **X** and **Y**.

**X** _____

**Y** _____ [2]

**(ii)** The diagram represents the myofibril in a relaxed state. When contracted, the sarcomere will decrease in length. State **two** other changes that would be observed in the myofibril.

1. _____

2. _____ [2]

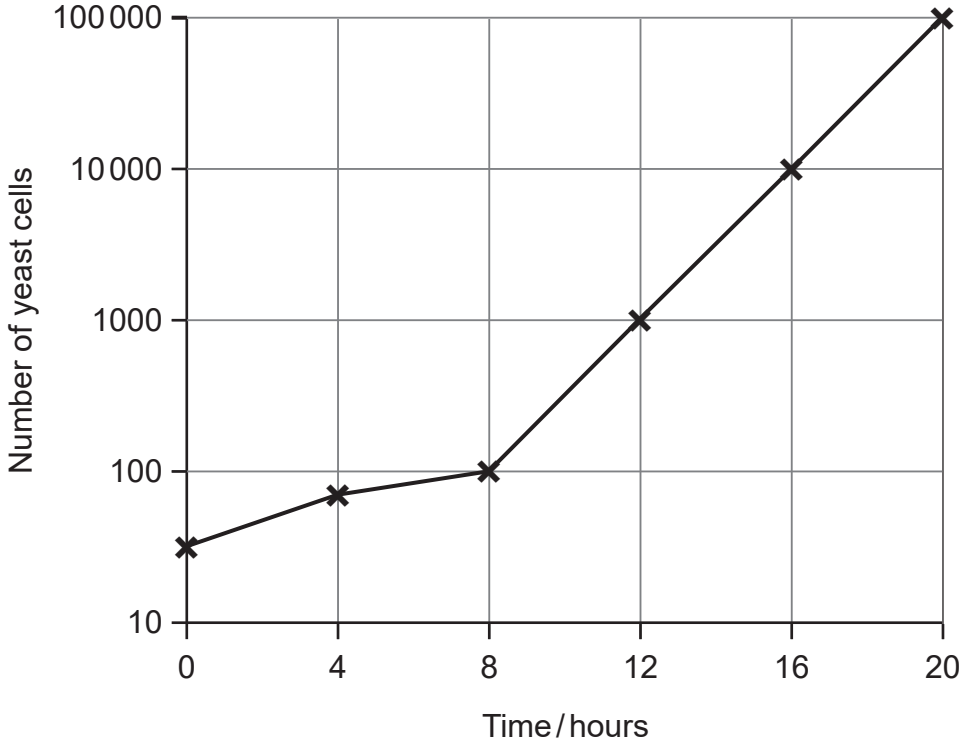
**(b)** Describe the role of calcium ions in muscle contraction.

_____

_____ [1]

**[Turn over**

**2** The graph below shows how yeast cell numbers changed after being added to a beaker containing a nutrient-rich solution.




**(a)** Name the population growth phase which occurred between 0 and 8 hours.

_____ [1]

**(b)** State the evidence which suggests that the carrying capacity of this culture had **not** been reached after 20 hours.

_____

_____ [1]

**(c)** Calculate the average rate of increase of yeast cells between 8 and 20 hours. (Show your working.)

_____ cells hour$^{-1}$ [2]

**(d)** Using your understanding of population growth, describe and explain the pattern shown in the graph.

_____

_____

_____

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_____ [4]

**[Turn over**

**3** Homeostasis is the maintenance of constant (steady state) conditions within the body. The kidneys control the body's water balance and are therefore important homeostatic organs.

Homeostatic systems have sensors which monitor the factor to be controlled.

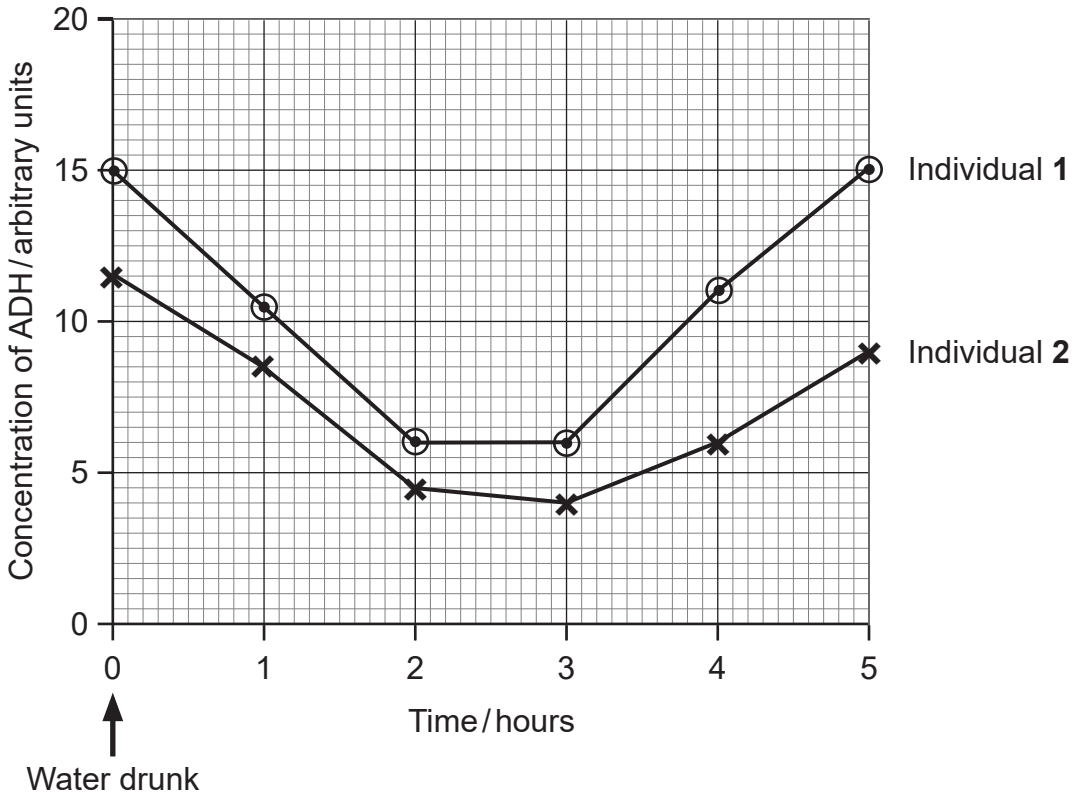
**(a)** State the precise location of the sensors which monitor the solute potential of the blood.

_____ [1]

**(b)** Antidiuretic hormone (ADH) is important in osmoregulation. It acts by controlling the amount of reabsorption of water from the collecting ducts of nephrons into surrounding blood vessels.

ADH binds to receptors on the plasma membrane of cells lining the collecting ducts. This binding causes the movement of aquaporins (water channel proteins) towards the plasma membrane. Aquaporins then become incorporated into the membrane.

The graph below shows the concentration of ADH in the blood of two individuals (**1** and **2**) over a five-hour period, after drinking 600 $cm^3$ of water.

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**(i)** Describe and explain the results shown for individual **1**.

_____ [5]

**(ii)** The ADH concentration of individual **1** was higher at the start of the investigation. Suggest what might have caused this.

_____ [1]

**(c)** Explain the term ‘negative feedback’ in the context of osmoregulation.

_____

_____

_____ [1]

The ADH receptors on the plasma membrane are proteins. Their shape may be distorted, for example as a result of mutation.

**(d)** Using the information provided, suggest and explain how the presence of distorted ADH receptors could affect the kidneys’ role in osmoregulation.

_____

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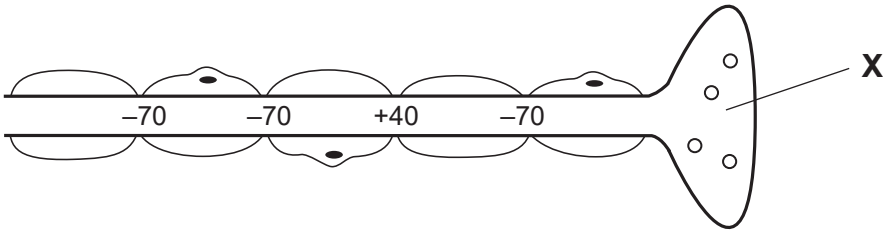
_____ [3]

**4** **(a)** The diagram below represents part of a myelinated neurone. The membrane potential (in mV) inside the axon membrane relative to the outside is shown at several positions along the axon.




**(i)** How many Schwann cells are shown in the diagram?

_____ [1]

**(ii)** Identify structure **X**.

_____ [1]

**(iii)** On the diagram, add an arrow to show the next part of the neurone which will become depolarised. [1]

**(iv)** Explain how the myelin sheath increases the speed of a nerve impulse.

_____

_____

_____

_____

_____

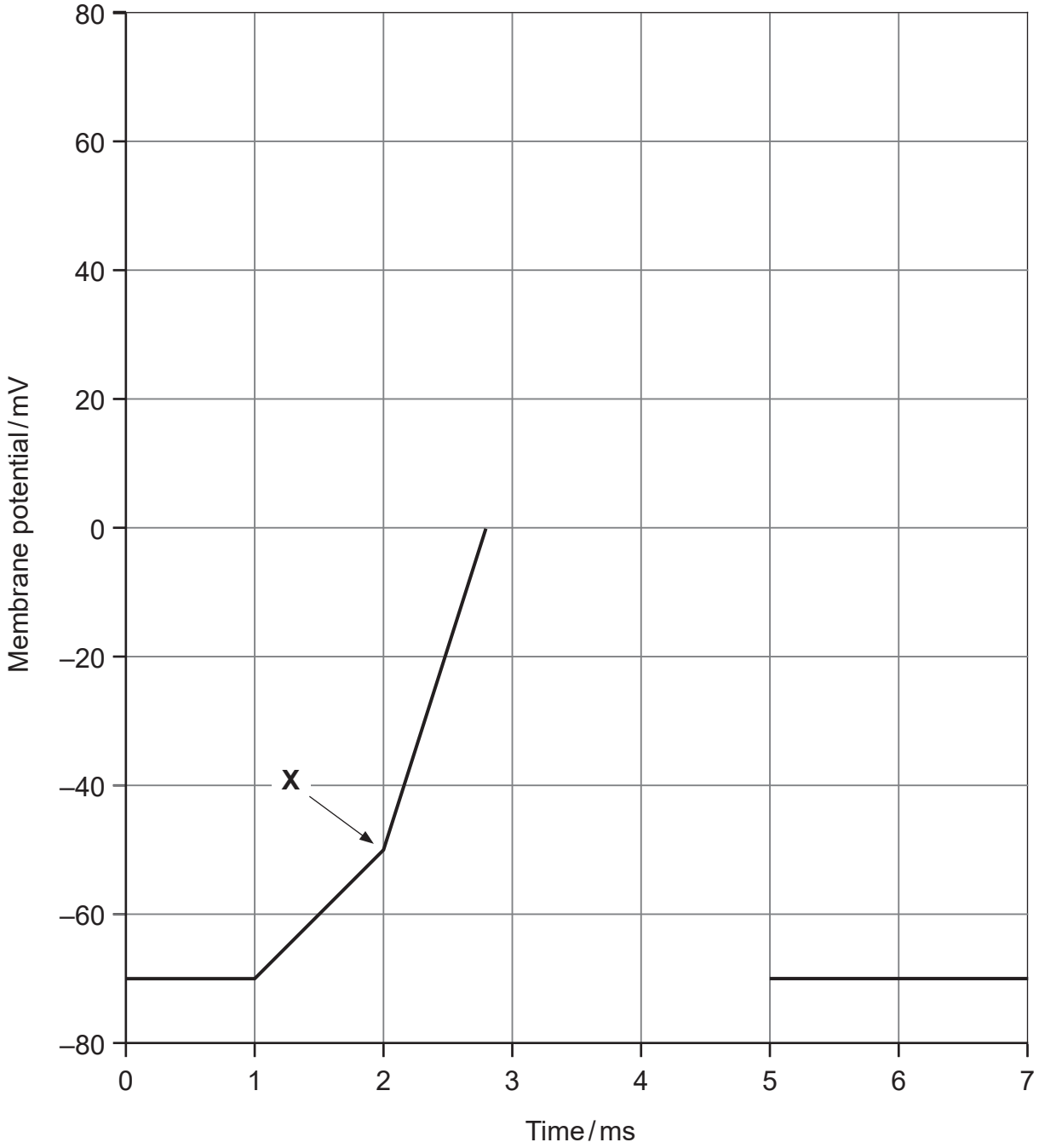
_____ [2]

**[Turn over**

**(v)** Apart from the presence of a myelin sheath, state **one** other factor that increases the speed of a nerve impulse.

_____ [1]

**(b)** The partially completed graph below shows changes in membrane potential as an action potential occurs.

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**(i)** Complete the graph to show the changes in membrane potential until the resting potential is restored. [2]

**(ii)** Suggest what causes the change in rate of depolarisation at position **X**.

_____

_____

_____ [1]

**(c)** A myelinated neurone is 740 mm long. This neurone is able to conduct nerve impulses at 90 m/s.

Calculate the length of time it takes for an impulse to pass along this neurone.

Give your answer in standard form.
(Show your working.)

_____ s [3]

**5** **(a)** Mistletoe (*Viscum album*) is a parasitic plant which grows on trees. The photograph below shows mistletoe growing on the branches of a tree in winter. The tree shown loses its leaves in winter (deciduous), while mistletoe does not (evergreen).

*Source: Chief Examiner*

Mistletoe grows in ball-like clumps, as shown in the photograph above. Each clump represents an individual plant. As a parasite, it gains at the expense of its host. The mistletoe plant produces special structures which can penetrate the outer layers of a branch and absorb nutrients and water from the tree.

**(i)** Apart from the presence of structures to obtain nutrients and water, and using the information provided, suggest and explain **one** adaptation of mistletoe.

_____

_____

_____

_____

_____

_____ [2]

**(ii)** Parasitism can be described as a +/– interaction. Name **one** other type of +/– interaction.

_____ [1]

**(b)** The photograph below shows ivy (*Hedera helix*) growing on trees.

*Source: Chief Examiner*

Like mistletoe, ivy is an evergreen plant that has leaves in winter. However, ivy is not classified as parasitic since it has roots that obtain minerals and water from the ground.

Based on the definition of parasitism as a +/– interaction, some scientists suggest that ivy should be classified as parasitic since it can harm the host tree.

**(i)** Using the information provided, suggest **two** ways ivy may cause harm to its host tree.

1. _____

_____

2. _____

_____ [2]

**[Turn over**

However, the presence of ivy on trees can benefit animal biodiversity in an area.

**(ii)** Suggest **one** way in which ivy may help benefit animal biodiversity.

_____

_____ [1]

**(c)** The zone of the Earth just south of the Arctic icecaps is known as tundra. In this zone, conditions are very cold and windy throughout the year and there is little rainfall. Lower layers of soil here are frozen all year and the top layers are frozen for part of the year.

Primary succession in tundra habitats can take over 3000 years to reach climax.

Pioneer species are mainly algae and lichen and these are followed by mosses. The stable end stage is usually low-growing shrubs (often evergreen) with lichens, algae and mosses often present. There are very few large animals in this biome (zone).

Using the information provided, answer the following questions.

**(i)** Name the type of climax community found in the tundra.

_____ [1]

**(ii)** Suggest **two** reasons why there are usually very few trees in the tundra.

1. _____

_____

2. _____

_____ [2]

**(iii)** Suggest **one** reason why many of the shrubs are 'evergreen'.

_____

_____

_____ [1]

**(iv)** Succession in the tundra takes much longer than successions in warmer regions, e.g. the British Isles. The main reason for this is the very low temperature in the tundra. Using your understanding of cellular metabolism, suggest an explanation for succession being so slow.

_____

_____

_____

_____

_____

_____ [2]

**6** **(a)** The structure and function of the mammalian eye allow light rays to be focused on photoreceptor cells in the retina.

**(i)** Describe and explain how the eye focuses on a **near** object.

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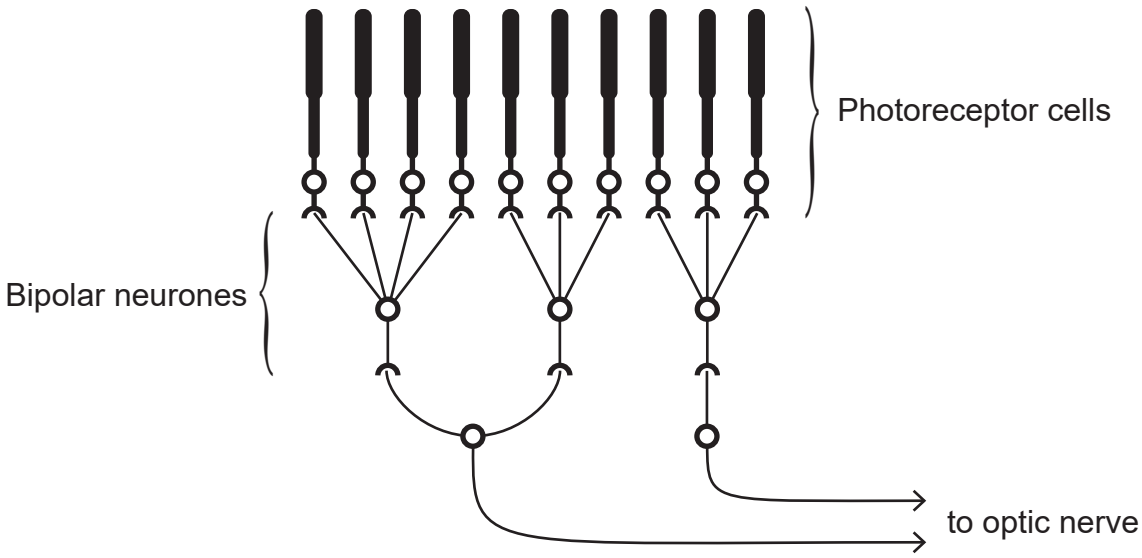
_____ [3]

The diagram below represents a small section of the retina. Photoreceptor cells are sensitive to visual stimuli.



**(ii)** Name the photoreceptor cells shown in the diagram.

_____ [1]

**(iii)** Using the diagram, describe what is meant by the term 'high visual sensitivity' and explain how high visual sensitivity is achieved.

_____

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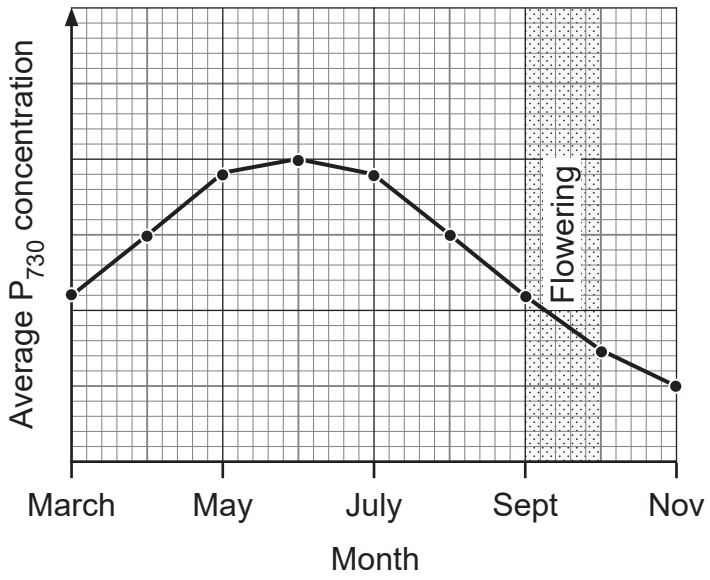
_____ [4]

**(b)** Phytochrome is a photoreceptor molecule involved in the flowering process in plants. The graph below shows how the average monthly concentration of the $P_{730}$ form of phytochrome changed between March and November in a particular plant.




**(i)** In terms of phytochrome conversions, explain the changes in concentration of $P_{730}$ between March and November.

_____

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_____ [3]

**(ii)** Using the graph, describe the evidence which suggests that this plant is a short-day plant.

_____

_____ [1]

**(iii)** The graph shows that flowering in this plant occurs in the autumn.
Suggest how the photoperiod could be manipulated to delay flowering until December. Explain your answer.

_____

_____

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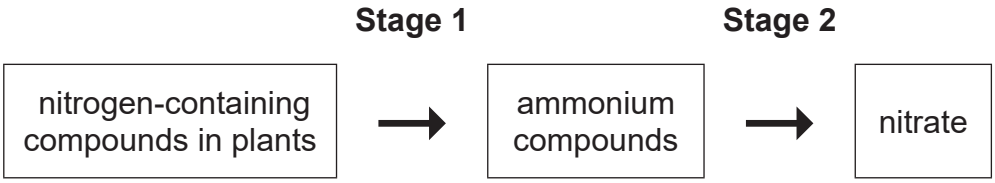
_____

_____ [2]

**7** **(a)** The flow diagram below summarises the cycling of nitrogen in nitrogen-containing compounds following the death of plants.




**(i)** State the general name given to the organisms involved in **Stage 1**.

_____ [1]

**(ii)** **Stage 2** takes place faster in non-compacted soil that is well drained. Using your knowledge of nitrification, suggest an explanation for this.

_____

_____

_____

_____

_____

_____ [2]

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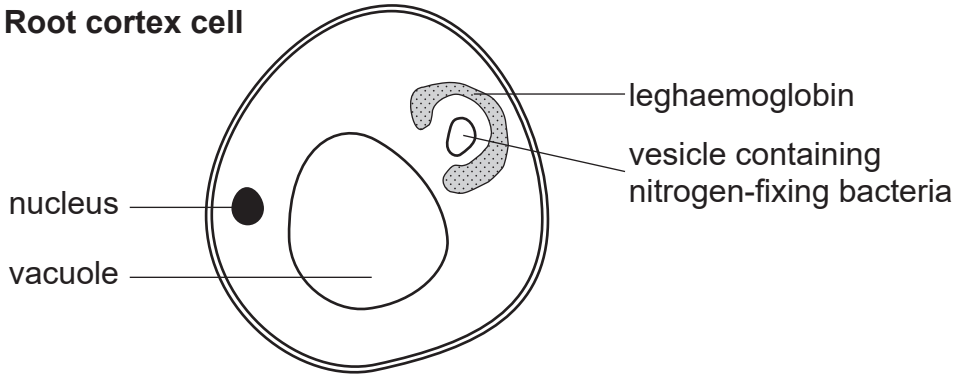
**(Questions continue overleaf)**

Legumes are plants which are able to fix nitrogen. In these species, nitrogen-fixing bacteria are usually found in cells of the root cortex (between the epidermis and the vascular tissue in the centre of the root).

These bacteria require some oxygen for respiration, but many of the enzymes involved in nitrogen-fixation work best in very low or oxygen-deficient environments.

In some species of legumes, a substance called leghaemoglobin is found in the cytoplasm of the root cortex cells containing the nitrogen-fixing bacteria. This is shown below. Leghaemoglobin is a form of haemoglobin, similar to human haemoglobin. It binds to oxygen if the partial pressure of oxygen reaches a high level.




**(b)** Using the information provided, suggest and explain the role of leghaemoglobin.

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_____ [3]

In contrast to nitrogen fixation, denitrification is the process in which nitrate is converted to nitrogen gas. The table below summarises denitrification activity over a range of soil depths in a marsh, an environment in which soil water levels are usually high.

| Soil depth / cm | Denitrification activity/ arbitrary units |
|---|---|
| 5 | 23 |
| 10 | 56 |
| 15 | 84 |
| 20 | 80 |
| 25 | 86 |

**(c)** Describe the trend shown and suggest an explanation.

_____

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_____ [3]

**8** The human immunodeficiency virus (HIV) is the virus that can lead to Acquired Immunodeficiency Syndrome (AIDS). AIDS is the term used to describe the characteristic range of 'opportunistic' infections and diseases that can develop in people who have been infected by HIV.

HIV is a retrovirus and is very closely related to the simian immunodeficiency virus (SIV), a virus frequently present in chimpanzees, although causing little harm. It is thought that HIV mutated from SIV and that the chimpanzee acted as a 'reservoir' for HIV before it passed to humans. Evidence indicates that the transfer of the virus between a chimpanzee and a human occurred in the forests of central Africa in a region where the chimpanzees and humans live in close proximity.

**(a) (i)** Define the term retrovirus.

_____

_____

_____ [1]

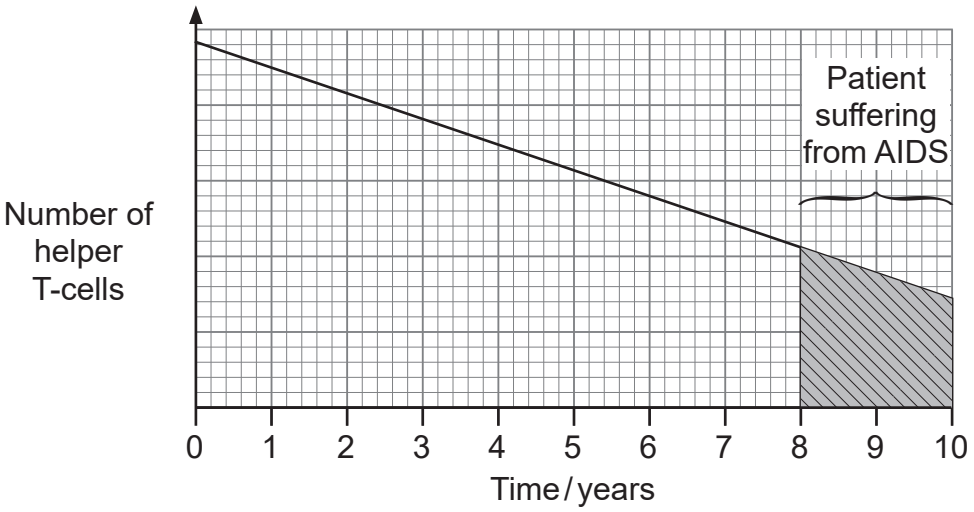
**(ii)** Suggest **one** way in which the HIV virus could have passed from chimpanzees to humans.

_____

_____ [1]

**(b)** The main target cell for HIV in humans is the helper T-cell.

The graph below shows how the number of helper T-cells changed over a ten-year period in an individual infected with HIV.




**(i)** Using the information provided and your understanding of immunity, suggest why people with AIDS suffer from a range of 'opportunistic' infections and diseases that seldom affect people who do not have AIDS.

_____

_____

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_____

_____

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_____

_____ [3]

**[Turn over**

Once in the body, HIV attaches to a specific receptor on the surface membrane of helper T-cells, known as the CD4 receptor.

**(ii)** When scientists were developing drugs to combat AIDS, there was a major focus on the CD4 receptor. Suggest how these drugs could work.

_____

_____

_____

_____

_____

_____ [2]

**(c)** T-cells are also involved in 'autoimmune' diseases, where cells of the immune system destroy the body's own cells. For example, in Type 1 diabetes, killer T-cells destroy the insulin-secreting cells of the pancreas.

Scientists suggest that autoimmune diseases can be a consequence of reduced production of suppressor T-cells.

**(i)** State the function of suppressor T-cells and explain how reduced production could lead to the development of Type 1 diabetes.

_____

_____

_____

_____

_____

_____ [2]

**(ii)** Type 1 diabetes often begins in childhood. In many cases, the onset of the condition occurs a few months after a child has suffered from an infectious viral disease such as chickenpox.

Using the information given, suggest an explanation for the link between having an infectious disease and the development of Type 1 diabetes.

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_____

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_____ [2]

## Section B

*Quality of written communication will be assessed in this section.*

**9** **(a)** Phytoplankton are single-celled, photosynthesising protoctistans that live in the surface layers of seas. They are the producers in many food chains. A typical example is shown below.

phytoplankton → herring (fish) → puffins (birds) → eagles (birds)

Explain why only a very small percentage of the solar energy reaching the sea surface is available for eagle growth in the above food chain. [12]

**(b)** Increasing efficiency of energy transfer is an important factor in intensive agriculture.

Explain the role of fertiliser, confinement and high-energy and high-protein foods in increasing efficiency in agriculture. [6]

**(a)** Phytoplankton are single-celled, photosynthesising protoctistans that live in the surface layers of seas. They are the producers in many food chains. A typical example is shown below.

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Explain why only a very small percentage of the solar energy reaching the sea surface is available for eagle growth in the above food chain.

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**(b)** Increasing efficiency of energy transfer is an important factor in intensive agriculture.

Explain the role of fertiliser, confinement and high-energy and high-protein foods in increasing efficiency in agriculture.

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|---|---|
| Question Number | Marks |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| Total Marks | |

Examiner Number

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