Rewarding Learning

ADVANCED
General Certificate of Education
2023

Centre Number

Candidate Number

Biology

Assessment Unit A2 1

assessing

Physiology, Coordination and Control, and Ecosystems

[ABY11]

ABY11

THURSDAY 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 eight** 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 The statements below relate to the structure of muscles.

State the most appropriate word defined by each statement:

- the protein which forms the thin filaments in a myofibril

  _____

- the region of a myofibril between adjacent Z-lines

  _____

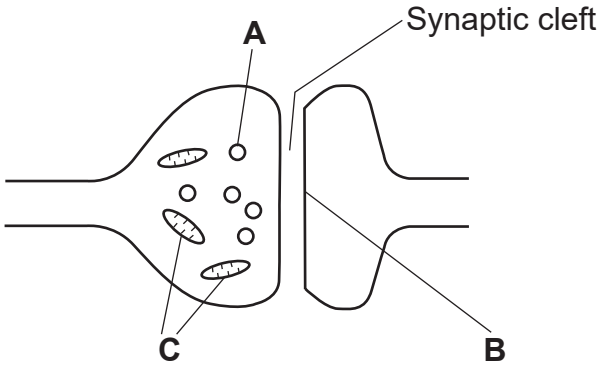
- the zone or band which does **not** change in length as a myofibril contracts

  _____

- the ions released which stimulate muscle contraction.

  _____ [4]

2 **(a)** The diagram below shows parts of two adjacent neurones at a synapse.



Source: Chief Examiner

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

A _____

B _____ [2]

(ii) Describe precisely the function of structures **C**.

_____

_____

_____ [1]

(iii) In some species, synapses involved in reflex and other defensive actions have narrower synaptic clefts compared to other synapses.

Suggest the advantage of narrower synaptic clefts. Explain your answer.

_____

_____

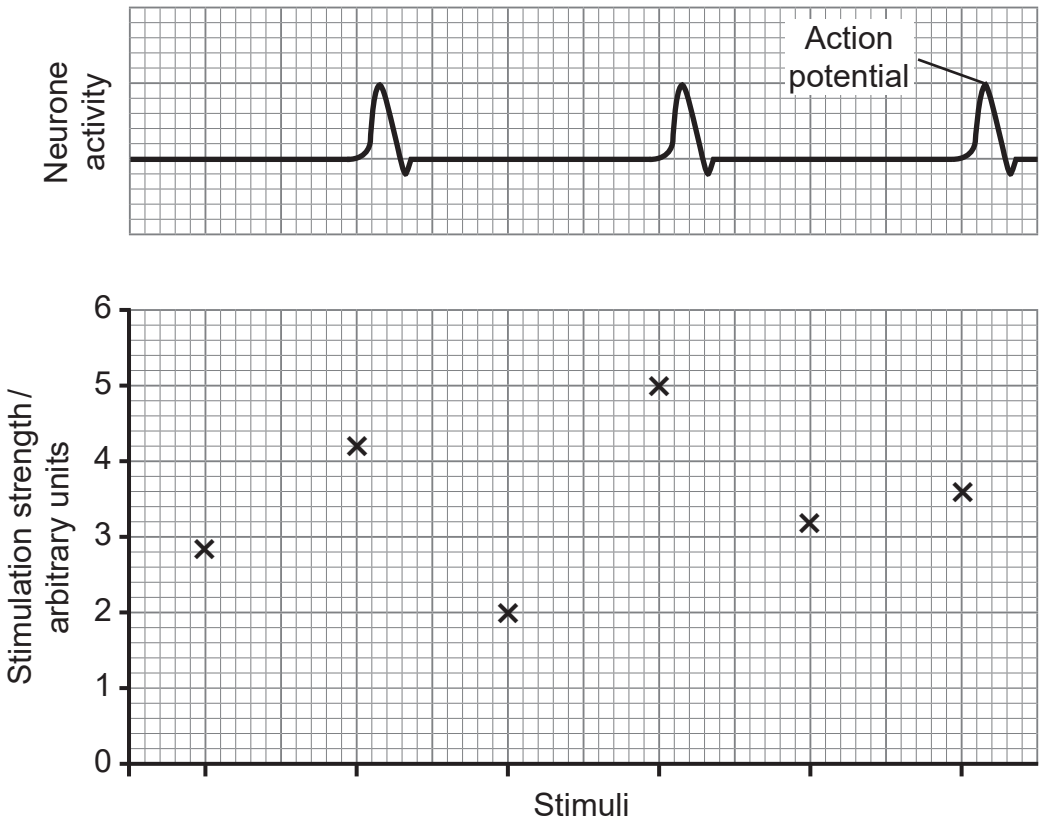
_____

_____

_____ [2]

[Turn over

(b) A study investigated the relationship between stimulus strength and the generation of action potentials in a neurone. The results for six stimuli of different strengths are shown in the graph below.



(i) From the results shown, estimate the stimulus threshold value.

_____ [1]

(ii) Explain how the results demonstrate the 'all-or-nothing' law.

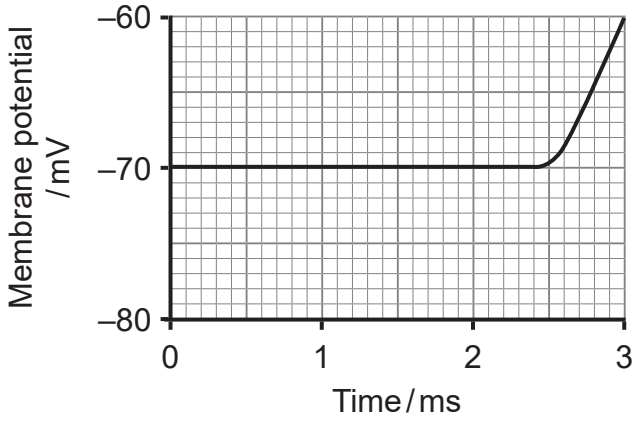
_____

_____

_____

_____ [2]

The graph below represents the membrane potential of a neurone immediately before and at the start of an action potential.



(c) Explain fully the membrane potential between 2 and 3 ms.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

[Turn over

3 The kidney is both an excretory and an osmoregulatory organ.

(a) Urine is the mixture of substances excreted from the body following kidney filtration. Name the three parts of the excretory system that urine passes through after leaving the kidney until its removal from the body. List these parts in the correct order.

_____ _____ _____ [1]

(b) The proximal convoluted tubule (PCT) is the part of a nephron where selective reabsorption of glucose and amino acids takes place. The cells lining PCTs are highly adapted for the selective reabsorption of these substances. For example, they have large numbers of mitochondria to produce the ATP required for active transport.

(i) Describe and explain one **other** way in which the cells lining the PCT are adapted for selective reabsorption.

_____

_____

_____

_____

_____ [2]

(ii) Explain how selective reabsorption of glucose and amino acids from the PCT facilitates the reabsorption of water.

_____

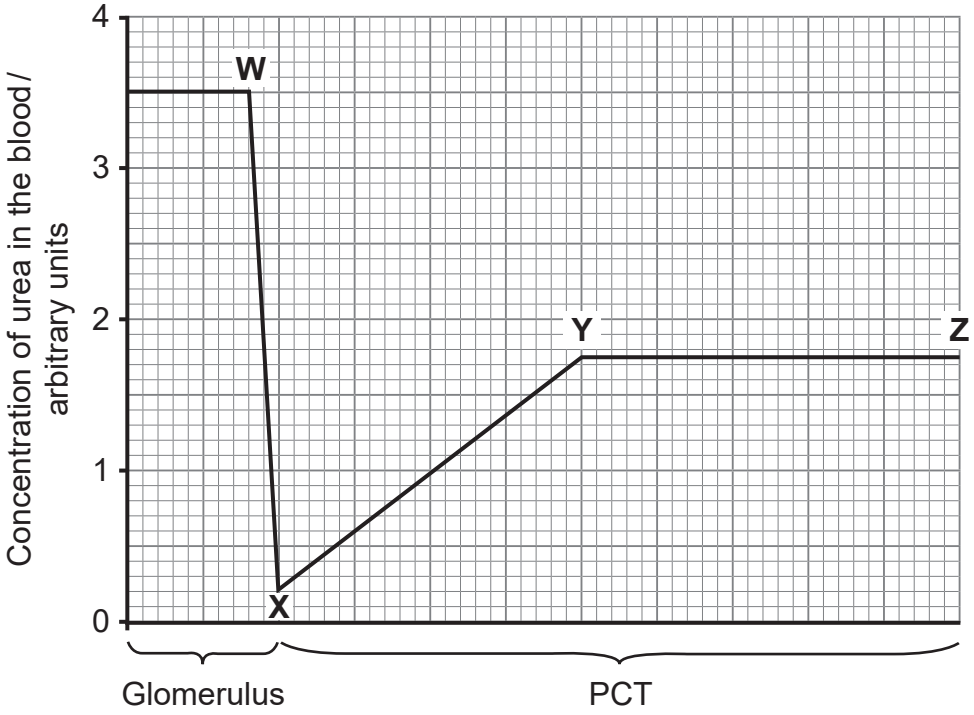
_____

_____

_____

_____ [2]

(c) The diagram below shows how the concentration of urea **in the blood** changes as it passes through the blood vessels in certain parts of the kidney.



(i) Name the process which occurs between **W** and **X**. Explain how this process causes the concentration of urea in the blood to decrease.

_____

_____

_____

_____ [2]

(ii) Explain the increase in concentration of urea in the blood between **X** and **Y**.

_____

_____ [1]

[Turn over

(iii) Explain why the concentration of urea in the blood remains constant between **Y** and **Z**.

_____

_____

_____ [1]

The diagram below summarises the osmoregulatory role of the kidney when blood solute potential decreases (becomes more negative).

Osmoreceptors detect a decrease in blood solute potential

↓

Corrective action

↓

Normal blood solute potential restored

(d) Describe and explain the corrective action which restores the normal blood solute potential in this situation.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

4 A range of substances are involved in promoting plant growth.

(a) Write the most appropriate word(s) into the blank spaces to complete the passage below.

The elongation of internodal regions in stems is promoted by the substance

_____, whereas cytokinin acts by

promoting _____ . [2]

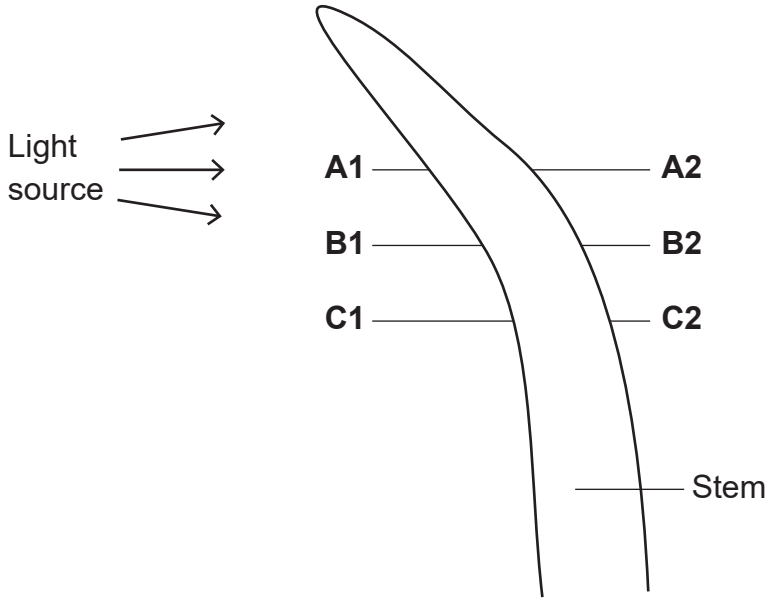
(b) Auxin is a plant growth substance produced in the stem tip. It is translocated down the stem to the regions in which it acts.

Historically, scientists developed two hypotheses to explain auxin distribution and phototropism (the growth of a stem in the direction of a light source).

1. Auxin is destroyed on the illuminated side (with the auxin concentration on the shaded side unaffected).

2. Auxin is moved from the illuminated to the shaded side.

In an investigation, mean auxin concentrations in three sections of a plant stem (**A**, **B** and **C**) were measured on each of the illuminated (**1**) and the shaded (**2**) sides. The stem was displaying a phototropic response, as shown below.



The mean auxin concentrations for each area are shown in the table below.

Section of plant stem	Mean auxin concentration / arbitrary units
A1	275
A2	304
B1	201
B2	380
C1	167
C2	409

(i) Summarise the results and explain how the evidence supports hypothesis **2**, and not hypothesis **1**.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) Explain the role of auxin in phototropism.

_____

_____

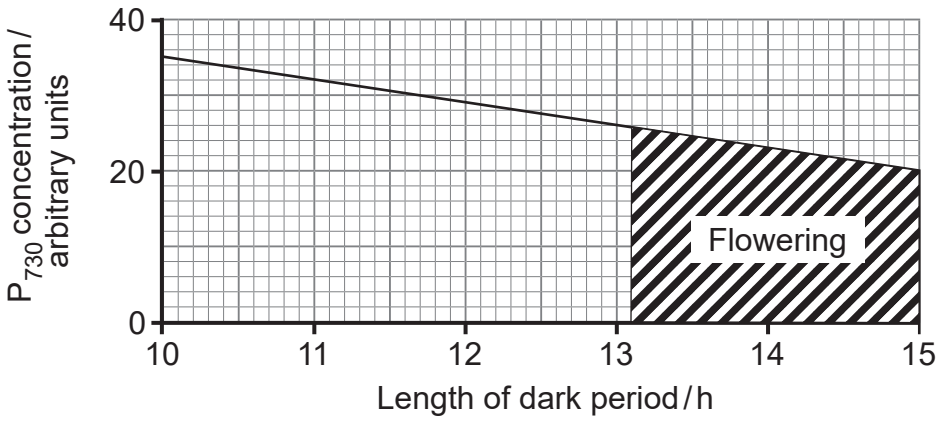
_____

_____

_____ [2]

(c) Phytochrome is a plant pigment which is important in the control of flowering. It exists in two interchangeable forms, P_{660} and P_{730}.

The graph below shows how length of night (dark period) and P_{730} concentration affects the initiation of flowering in a species.



(i) Identify precisely the critical length of the dark period required to initiate flowering.

_____ [1]

(ii) With reference to phytochrome conversions, explain the effect of changing the length of the dark period on flowering in this species.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

5 Growth of plants can be affected by interactions, both positive and negative, with other organisms.

(a) Define the term 'biotic potential'.

_____

_____

_____ [1]

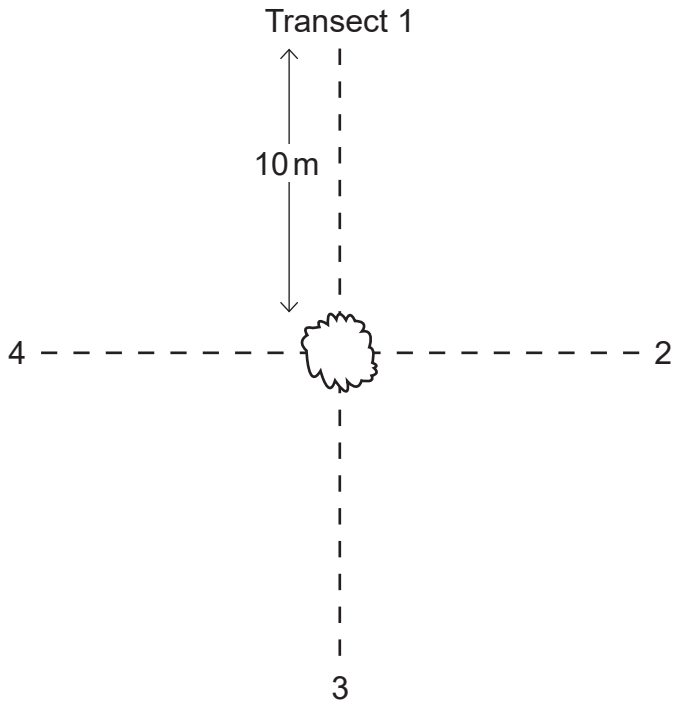
(b) In Lime trees, dispersal of seeds is aided by the presence of a leaf-like 'parachute'. Dispersal assists colonisation of new areas and reduces competition with the parent tree and other seedlings.

Source: Chief Examiner

An investigation was carried out on seed dispersal from a Lime tree. Initially, the mean number of seeds per square metre found up to 10 m away from the tree was recorded.

Subsequently, the number of seedlings surviving two years and then five years following dispersal was recorded.

The method involved four transects taken in straight lines away from the base of the tree trunk (with the second transect being at a right angle to the first and so on), as shown in the diagram below.



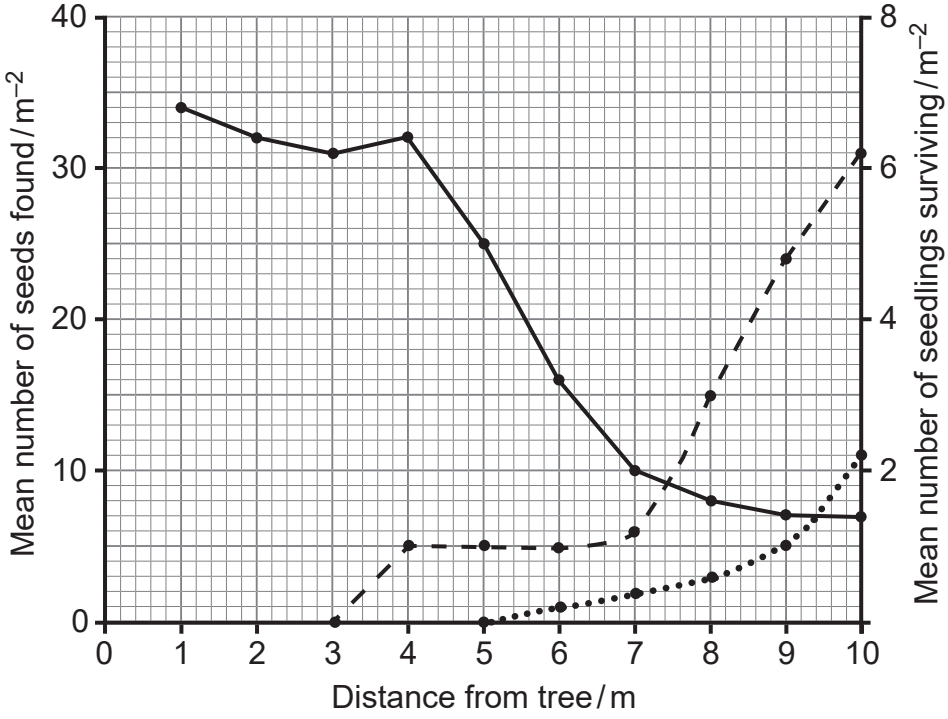
(i) In this investigation, a single mature Lime tree in an isolated field was chosen, rather than a tree within a woodland. Suggest **one** reason for this.

_____

_____ [1]

[Turn over

The results are shown in the graph below.



(ii) Calculate the percentage of seeds found at a distance of 10 metres which survive as seedlings for at least two years.

(Show your working.)

_____ % [2]

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(iii) Describe the results for seeds **found**.

_____

_____

_____

_____

_____

_____ [2]

(iv) Explain the results for seedling **survival** after each of two and five years.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

[Turn over

(c) Mycorrhiza are soil fungi which form mutualistic associations with many species of tree and other plants.

In woodland, the fungi penetrate tree roots and their hyphae extend between the cells of the root cortex. Water and minerals absorbed by the fungi can pass into the trees. The mycorrhizal association thus extends the effective distance over which the trees can absorb water and minerals.

(i) Suggest how this mutualistic association benefits the fungi.

_____

_____ [1]

The importance of mycorrhizal fungi was investigated as follows.

Seeds of one species of tree were planted in pots of woodland soil. Half of the pots contained untreated woodland soil and the other half contained woodland soil which had been heated at 100°C for 24 hours. The pots were then all placed in identical environmental conditions and the development of seedlings was monitored.

At the end of the investigation, it was observed that all the seeds placed in untreated soil had germinated to produce healthy seedlings. However, in the soil which had been heated, less than 20% of the seeds had developed into seedlings. The seedlings which had developed weighed less than half of the weight of the seedlings in untreated soil.

(ii) Using the information provided, outline the conclusions which can be drawn from this investigation. Explain your answer.

_____

_____

_____

_____

_____

_____ [2]

(d) Environmental agencies are trying to increase the percentage of land in Northern Ireland covered by woodland. Increasing biodiversity is a goal, as is reducing the rate of carbon dioxide increase in the atmosphere.

Both coniferous and deciduous plantations are used as part of this strategy. Conifers are evergreen and retain their leaves over winter, casting a dense shade under their canopy. Deciduous trees shed their leaves every winter and grow new leaves each spring.

Using the information provided, answer the questions below.

(i) Suggest and explain **one** reason why conifers may be more effective than deciduous trees at reducing the rate of increase of carbon dioxide in the atmosphere.

_____

_____

_____

_____

_____ [2]

(ii) Most scientists agree that deciduous trees are more beneficial to biodiversity than conifers. Suggest **one** reason for this.

_____

_____

_____ [1]

6 Antibody-mediated immunity involves the production of specific antibodies in response to the presence of foreign antigens.

(a) **(i)** Outline briefly the steps involved between the introduction of a foreign antigen into the body for the first time and antibody production.

_____

_____

_____

_____

_____ [2]

Secondary immune responses, following vaccination or previous infection, often involve antibodies being produced faster and in greater numbers.

(ii) Explain why there is:

faster antibody production _____

_____

_____

greater antibody production _____

_____

_____ [2]

(b) Part of the reason why people can become ill very quickly after infection is that bacteria can divide rapidly.

Assuming that bacteria divide every 20 minutes, calculate the number present after four hours following infection by a single bacterium.

_____ [1]

(c) Antibiotic resistance in bacteria has developed in many ways. For example, some species (or strains) of bacteria have evolved relatively impermeable cell walls, whereas others have developed the ability to remove the antibiotic chemicals once they enter the cells.

The development of resistance involves a considerable energy cost to the bacteria.

In a study of antibiotic resistance, a bacterial sample was cultured on agar jelly in Petri dishes in a laboratory. During the study an antibiotic was added to the growth medium on day 3.

The results are shown in the table below.

Day	Percentage of bacteria which were resistant to antibiotic
1	3
2	2
3	2
4	81
5	97
6	100
7	100

(i) Using the information provided and your understanding, describe and explain the results shown in the table.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

Further research has been carried out on the effects of low concentrations of antibiotics on bacteria.

Studies have shown that in these circumstances, some bacteria can ‘switch off’ the cellular processes that check and correct mistakes in DNA replication.

(ii) Suggest and explain the possible benefit to these bacteria of switching off these processes.

_____

_____

_____

_____

_____

_____ [2]

7 Grasslands are ecosystems dominated by grass species with few, if any, shrubs or trees. There is a wide range of grassland types, usually determined by soil characteristics. Examples include damp meadow grasslands and dry coastal grasslands.

(a) Define the term 'ecosystem'.

_____

_____

_____ [1]

(b) Meadow grasslands are often characterised by having deep fertile soils. If not grazed by cattle, the grass is usually cut late in the summer. This is necessary to conserve them as grasslands.

(i) Using your understanding of succession, suggest why grazing or cutting is necessary to maintain meadow grassland.

_____

_____

_____ [1]

The table below shows the estimated mean number of organisms in a meadow grassland.

Trophic level	Estimated mean organisms / m^{-2}
producers	3350
primary consumers	240
secondary consumers	33
tertiary consumers	0.02

(ii) Calculate the percentage of organisms in the grassland which are tertiary consumers.

(Show your working.)

_____% [2]

(iii) In the space below, draw and label a pyramid of numbers for this grassland.

[2]

[Turn over

(c) Unlike meadow grasslands, coastal grasslands often have shallow sandy soils which drain rapidly.

(i) Suggest why coastal grasslands remain as grasslands, without the need for grazing or mowing each year.

_____

_____

_____ [1]

Common Bird's-foot-trefoil (*Lotus corniculatus*) is a common plant of coastal grasslands. It is a species which is able to fix nitrogen.

Source: Chief Examiner

(ii) Describe what is meant by 'nitrogen fixation' and explain the advantage of this in coastal grasslands.

_____

_____

_____

_____

_____ [2]

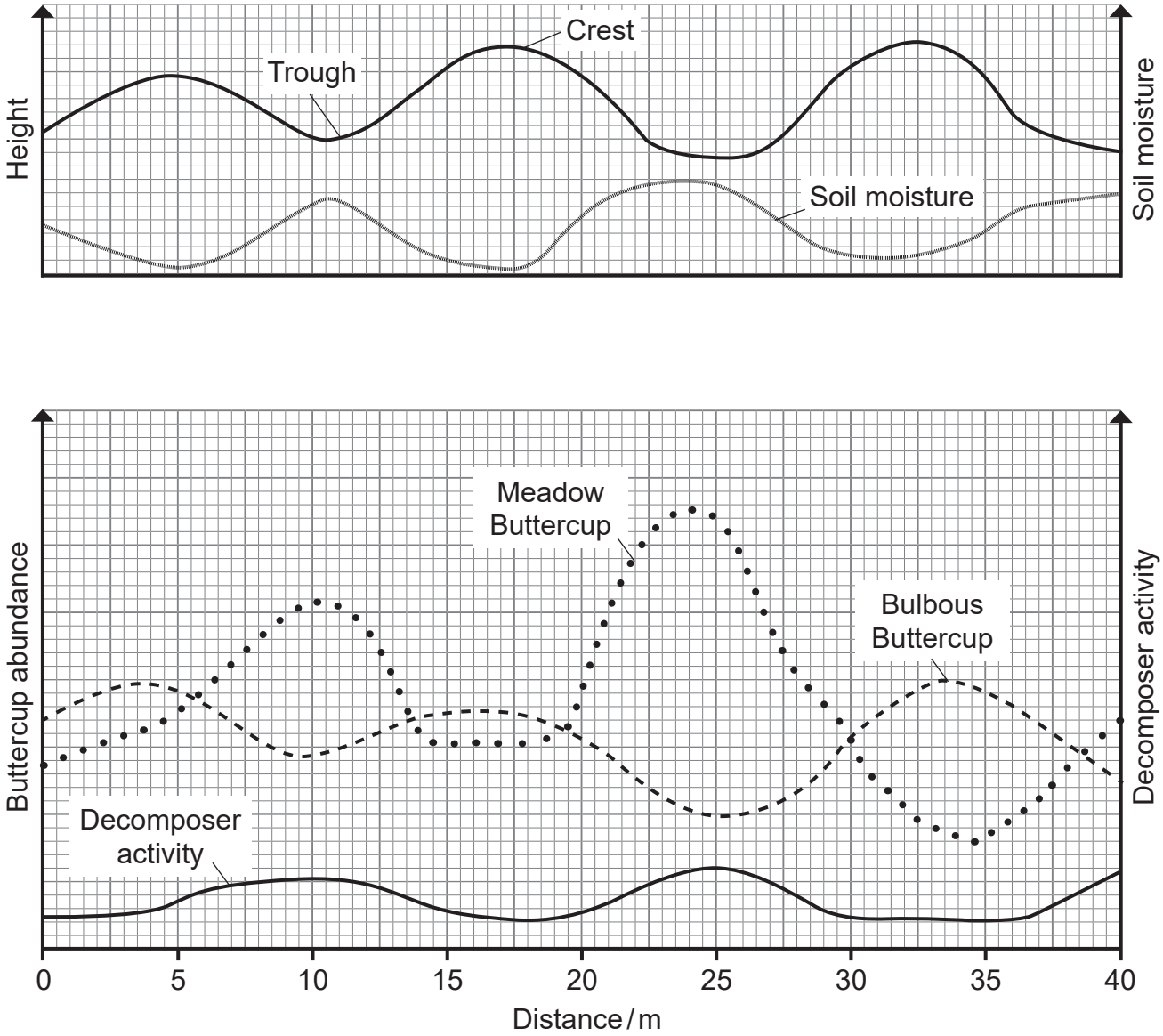
(d) Meadow Buttercup (*Ranunculus acris*) and Bulbous Buttercup (*Ranunculus bulbosus*) are also common in coastal grasslands.

(i) State precisely what can be determined about the classification of *R. acris* and *R. bulbosus* from their binomial names.

_____

_____ [1]

In a study, the distribution and abundance of these two buttercup species and the activity of decomposers was investigated. The ground in the study area was undulating (consisting of a series of crests and troughs). The results of the investigation are summarised in the graphs below.



(ii) Describe and suggest explanations for the results shown.

_____ [5]

(e) Rabbits can be harmful to grasslands, because they graze the grasses very close to the ground and dig burrows.

Around 60 years ago, some rabbit populations were deliberately infected with a virus which caused myxomatosis, a disease fatal to rabbits. This was done to try to reduce damage to agricultural grasslands.

(i) State the term used to describe this method of reducing the numbers of a pest species.

_____ [1]

(ii) The use of a virus in this role caused some concern in the scientific community.

Suggest **one** reason for this.

_____

_____ [1]

Section B

Quality of written communication will be assessed in this section.

8 The mammalian eye is adapted to focus light rays on to photoreceptors in the retina.

Rods and cones are the photoreceptors in the retina.

(a) Describe the structure of rods and outline how the structure of cones differs from that of rods. [6]

(b) The arrangement and distribution of rods, cones, and associated neurones in the retina enable the eye to achieve high levels of both visual sensitivity and visual acuity. Describe how high visual sensitivity and high visual acuity are achieved.

[12]

(a) Describe the structure of rods and outline how the structure of cones differs from that of rods.

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(b) The arrangement and distribution of rods, cones, and associated neurones in the retina enable the eye to achieve high levels of both visual sensitivity and visual acuity. Describe how high visual sensitivity and high visual acuity are achieved.

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THIS IS THE END OF THE QUESTION PAPER

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Question Number	Marks
1	
2	
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Total Marks	

Examiner Number

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