Rewarding Learning

ADVANCED
General Certificate of Education
2025

Centre Number

Candidate Number

Biology

Assessment Unit A2 1

assessing

Physiology, Coordination and Control, and Ecosystems

[ABY11]

ABY11

MONDAY 2 JUNE, AFTERNOON

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 questions in black ink and use a dark HB pencil for drawings and graphs.
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 may use a scientific calculator.
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 Plant growth substances (hormones) have a role in stem elongation.

(a) Identify the role of the following hormones:

- gibberellins

_____

_____

- cytokinins

_____

_____ [2]

(b) Phytochromes are pigments which control flowering in some plants. Two interchangeable forms of phytochrome have been identified in flowering plants.

(i) Name these **two** forms of phytochrome.

_____ [1]

(ii) Using your knowledge of phytochrome conversions, explain the effect on a short-day plant of interrupting the middle of a 12-hour period of darkness with 15 minutes of light.

_____

_____

_____

_____

_____ [2]

2 A banded pattern is visible in voluntary muscle when viewed with an electron microscope. Structures called sarcomeres have Z-lines at each end. Myosin and actin are the main components of a sarcomere.

(a) **(i)** State **one** structural similarity between myosin and actin filaments.

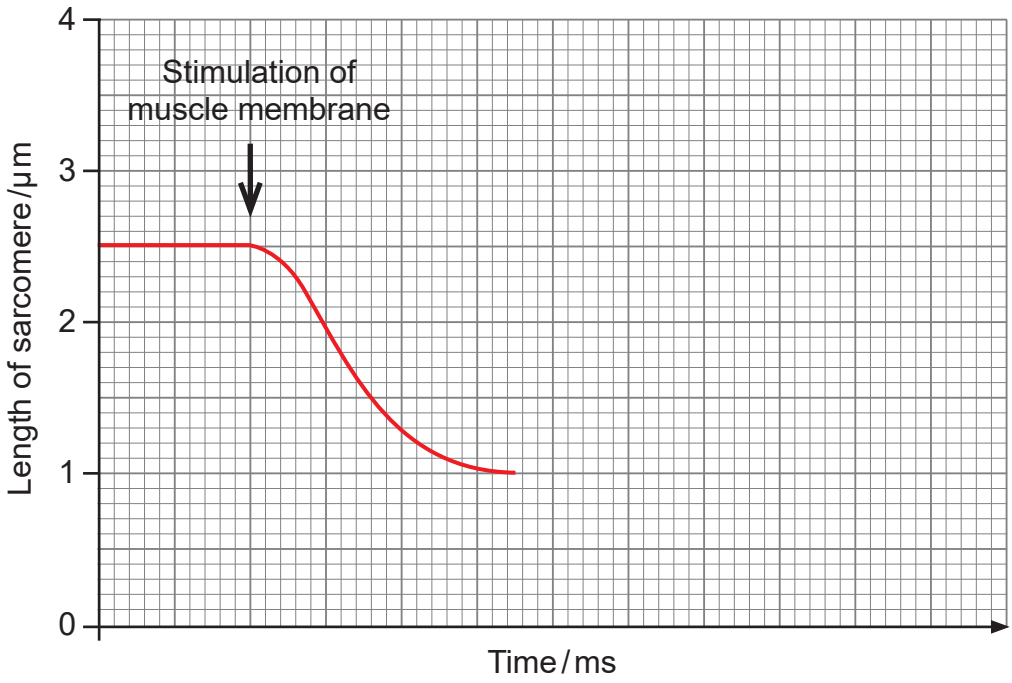
_____

_____ [1]

(ii) Name the region of a sarcomere which consists of actin filaments only.

_____ [1]

(b) The graph below shows the length of a sarcomere before and during muscle contraction.



(i) Complete the graph to show how the length of the sarcomere changes as the muscle relaxes. [1]

(ii) Describe and explain how myosin and actin filaments bring about the decrease in sarcomere length during muscle contraction.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

The graph shows that during contraction a sarcomere only shortens by approximately 1.5 μm.

(iii) Explain how a muscle fibre can contract by several centimetres when stimulated.

_____

_____

_____ [1]

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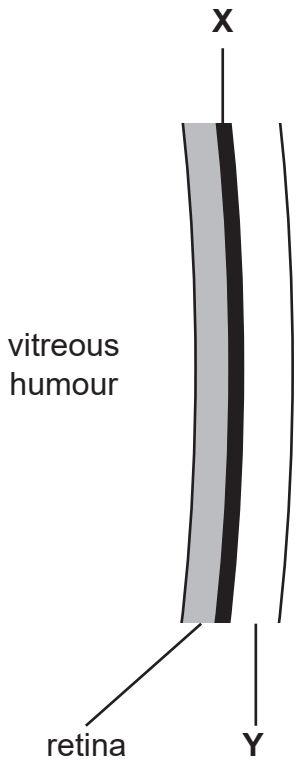
3 **(a)** The diagram below represents a small cross-section of the back of the human eye.



(i) Identify the structures labelled **X** and **Y**.

X _____

Y _____ [1]

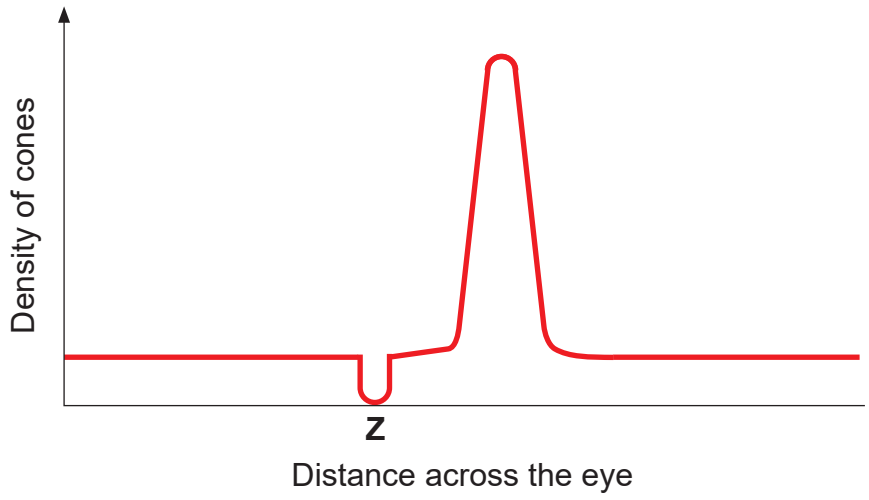
(ii) State **one** function of **X**.

_____

_____ [1]

[Turn over

(b) The graph below shows the distribution of cones across the retina. Cones are the photoreceptors responsible for visual acuity.



(i) Using your knowledge and the graph, explain how the distribution of cones, as well as their relationship with other neurones, results in high visual acuity.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) Describe and explain the density of cones at position **Z**.

_____

_____

_____

_____ [2]

(c) Describe what is meant by depth perception and explain how this is achieved in humans.

_____

_____

_____

_____

_____ [2]

4 **(a)** Deciduous woodlands contain trees such as oak and ash which lose their leaves in autumn. In these woodlands, a layer of these dead leaves ('leaf litter') covers the soil.

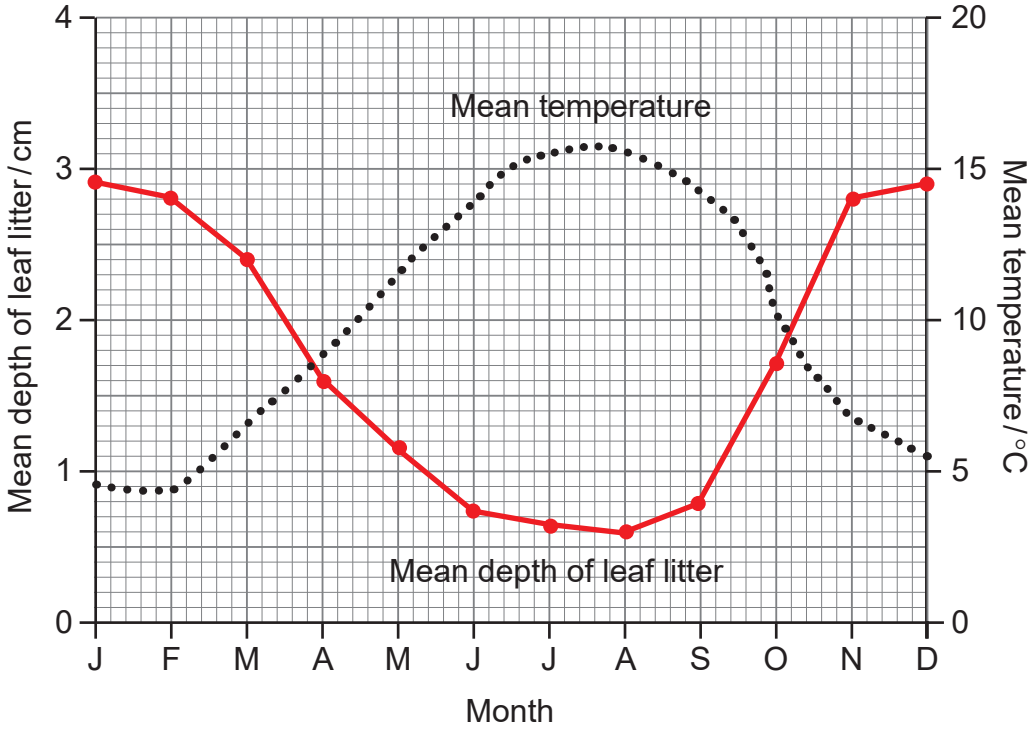
Scientists investigated how the amount of leaf litter in a deciduous woodland changed throughout the year, by recording the mean depth of leaf litter over a 12-month period.

(i) Suggest **one** advantage of recording leaf litter depth rather than dry mass of leaf litter.

_____

_____ [1]

The results of the investigation are shown in the graph below. Mean monthly temperatures are also included.



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(ii) Using the graph and your knowledge, explain the changes in mean depth of leaf litter from:

September – November

_____

_____

_____

March – June

_____

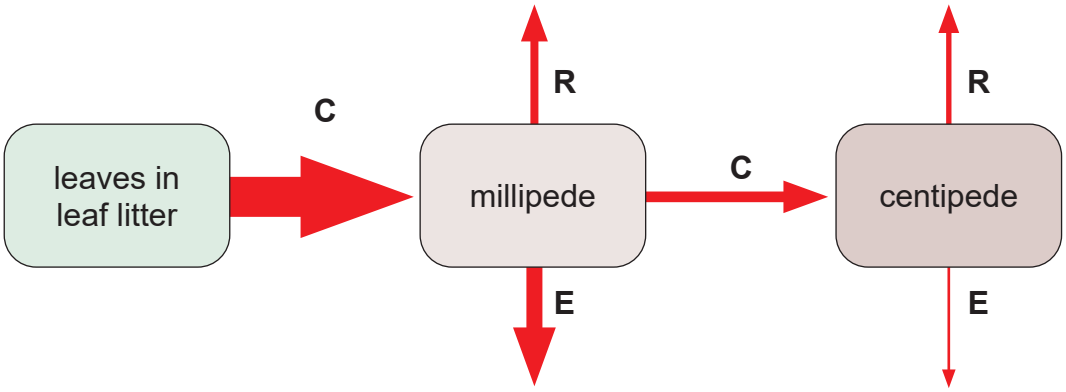
_____

_____

_____

_____ [3]

The diagram below represents part of a food chain in a deciduous woodland. Relative energy flow is represented by arrow thickness. Only consumption, respiration and egestion are shown.



C = consumption **R** = respiration **E** = egestion

(b) Describe the differences in relative energy flow for millipedes and centipedes and suggest reasons for these differences.

[4]

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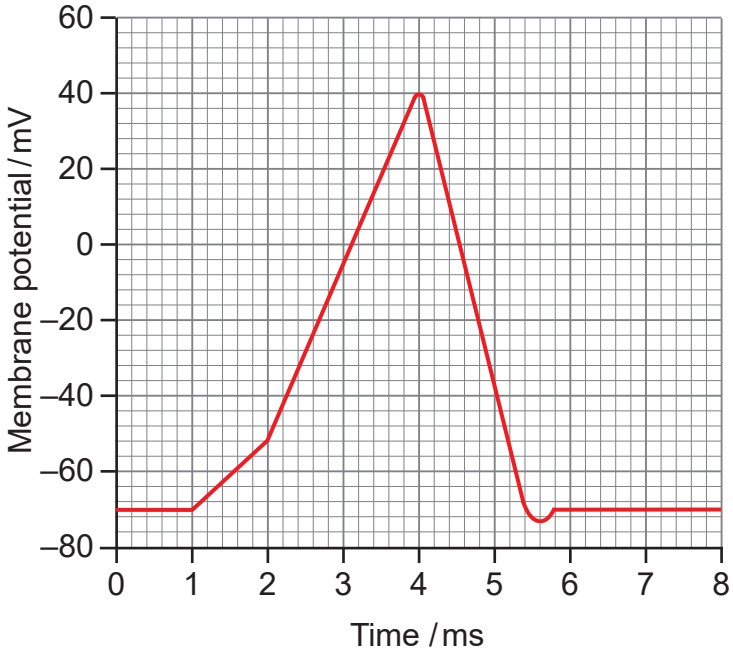
(Questions continue overleaf)

5 **(a)** The graph below represents changes in membrane potential during the generation of an action potential in a neurone.



(i) Calculate the total length of time the neurone was **not** at resting potential during the period shown.

_____ ms [1]

(ii) Suggest what caused the rapid increase in membrane potential at 2 ms.

_____

_____ [1]

(iii) Describe and explain the changes in membrane potential between 4 and 5.5 ms.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(b) Synapses are junctions between neurones.

(i) Suggest **one** reason why synapses are important in nervous communication.

_____

_____ [1]

The speed of synaptic transmission across a synaptic cleft of 40 nm is 0.50 ms^{-1}.

(ii) Calculate the time taken for a neurotransmitter to cross the synapse. (1 nm = 1×10^{-9} m.)

Show your working out.

_____ s [2]

(iii) Describe and explain the role of acetylcholinesterase in synaptic transmission.

_____

_____

_____

_____

_____

_____ [2]

Short-sightedness is a condition in which individuals see close-up objects clearly, but distant objects appear blurred. This can be a consequence of the ciliary muscles remaining (partially) contracted when viewing distant objects, leading to the light rays being focused in front of the retina, rather than on the photoreceptor cells.

Atropine is a chemical which acts by blocking acetylcholine receptors. Atropine can be used to treat short-sightedness, resulting in improved focus on distant objects.

(c) Using the information provided, suggest and explain how atropine can help improve distant vision in individuals with short-sightedness.

_____

_____

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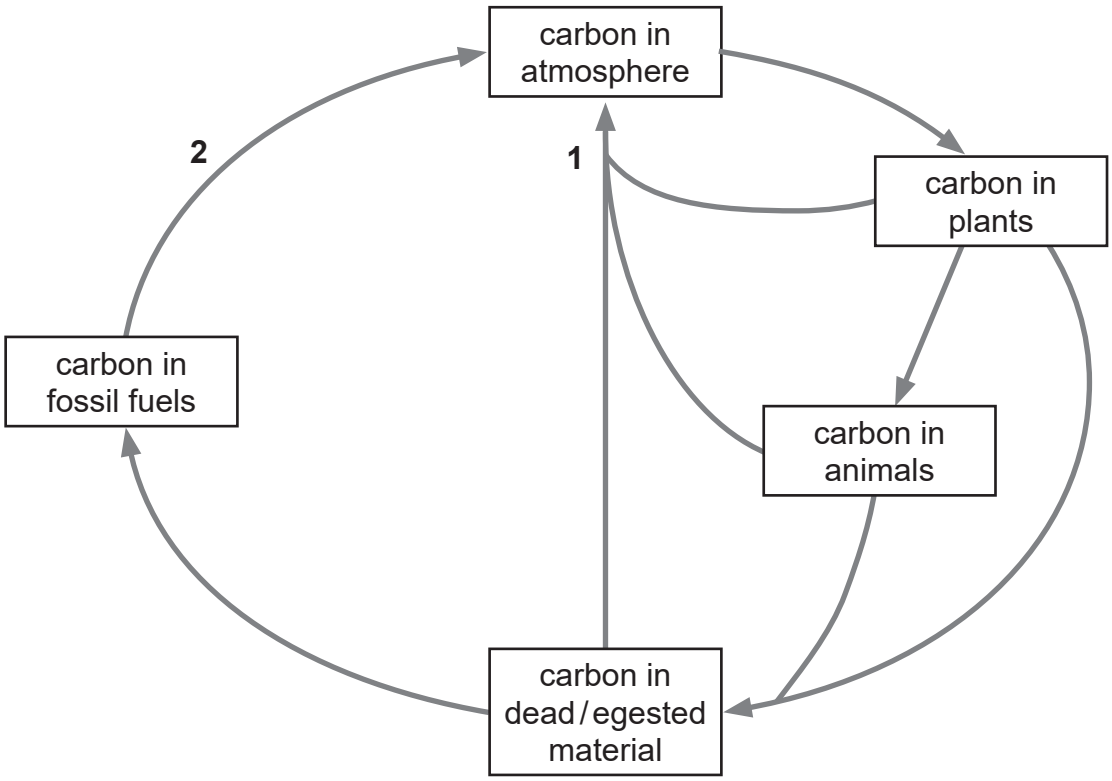
_____

_____

_____ [3]

6 **(a)** The carbon cycle is represented by the diagram below.



(i) Identify the processes labelled **1** and **2**.

1 _____

2 _____ [1]

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Peatlands are habitats which are typically waterlogged and acidic. Decomposition of dead organisms and organic compounds cannot occur in these soils, partially due to low oxygen levels in waterlogged conditions.

Peat consists of the remains of dead moss that has accumulated over centuries because of lack of decay and decomposition. In 'healthy' peatlands, the moss continues to grow as a thin living layer on top of the peat.

(ii) Using the information provided and your knowledge, suggest and explain the environmental benefit of healthy peatlands.

_____

_____

_____

_____

_____ [2]

Drainage of peatlands has a significant effect on carbon cycling.

(iii) Suggest and explain the effect of peatland drainage on carbon cycling.

_____

_____

_____

_____

_____

_____ [2]

(b) The nitrogen cycle is also significantly affected by conditions found in peatlands.

(i) Name a major group of biological molecules which always contain nitrogen in their structure.

_____ [1]

(ii) Using the information provided and your knowledge, describe and explain the effects of waterlogged conditions on nitrification and denitrification.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(c) Sundews are plants which live in waterlogged habitats. They have small, round leaves as shown in the photograph below. The leaves produce a sticky liquid on their surface. Sundews use the liquid to trap small insects which then die and are digested with enzymes.

Source: James Napier

(i) Using the information provided and your knowledge, suggest how sundews are adapted to maximise their growth in waterlogged habitats.

_____

_____

_____

_____

_____ [2]

[Turn over

Sundews can also gain nutrients through photosynthesis. However, rates of photosynthesis are lower in sundews than in many other plant species.

(ii) Using the information provided and your knowledge, suggest **two** reasons for this.

1. _____

_____

2. _____

_____ [2]

(iii) Explain why it is difficult to assign sundews to a particular trophic level in a food chain.

_____

_____

_____ [1]

7 Cell-mediated immune responses involve the sensitisation of T-lymphocytes. Following sensitisation, T-lymphocytes clone and produce a range of cells including killer T-cells and helper T-cells.

(a) Distinguish between the roles of killer T-cells and helper T-cells in immune responses.

_____

_____

_____

_____

_____ [2]

(b) Rejection of organ transplants between individuals is a consequence of cell-mediated immunity.

(i) Explain how a cell-mediated immune response brings about transplant rejection.

_____

_____

_____

_____

_____ [2]

A range of treatments can be used to reduce the possibility of transplant rejection. These include the use of drugs to inhibit DNA replication.

(ii) Explain how the use of these drugs reduces the possibility of transplant rejection.

_____

_____

_____

_____

_____ [2]

(iii) State **one** other method of reducing the possibility of transplant rejection.

_____

_____ [1]

(c) Blood transfusions between individuals can also provoke an immune response.

(i) Explain precisely why an individual with blood group O should not be given a transfusion of blood group AB.

_____

_____

_____

_____

_____ [2]

Blood group compatibility is important for organ transplants as well as blood transfusions. In addition to tissue matching, this also affects the availability of suitable transplants.

Consequently, the probability of individuals with rarer blood groups having a suitable donor match is less than for those with a more common blood group.

Scientists are currently researching the possibility of treating potential transplant organs with enzymes that mask the blood group antigens.

(ii) Describe and explain the advantage of being able to do this.

_____

_____

_____

_____

_____ [2]

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8 Himalayan Balsam (*Impatiens glandulifera*) grows in many natural habitats in the UK and Ireland. It was brought here from Asia about two hundred years ago as an ornamental garden plant. It then spread from gardens to natural habitats, its population increasing rapidly, often reaching its biotic potential.

(a) Define the term 'biotic potential'.

_____

_____

_____ [1]

Himalayan Balsam growing on a riverbank

Source: James Napier

Himalayan Balsam is a large plant, growing up to two metres in height in a few weeks. It typically grows on riverbanks, lake edges and surrounding areas. Seeds spread via an 'explosive' method of dispersal. When seed pods are ripe, they burst, ejecting large numbers of seeds several metres away from the parent plant. The seeds are also able to float.

(b) Himalayan Balsam typically forms large populations on riverbanks and lake edges.

Using the information provided, explain why.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(c) Once established as part of a community, Himalayan Balsam interacts with other populations living in the same habitat.

One type of interaction is with insect populations. As with many other flowering plants, Himalayan Balsam requires transfer of pollen for reproduction, and many insect species carry out this process of pollination.

An adaptation often shown in flowering plants is the production of nectar on which pollinating insects feed.

Bumblebee entering a Himalayan Balsam flower in search of nectar

Source: James Napier

Himalayan Balsam is a very valuable source of nectar for many insect species. It can produce up to 0.30 mg h^{-1} of nectar per flower.

(i) Calculate the mass of nectar which an individual plant with 20 flowers can produce in 24 hours.

Show your working out.

_____ mg [2]

[Turn over

Another type of interaction is competition with other plant populations.

Himalayan Balsam can flower from July to October – later than most other nectar-producing plants. Its large open flowers allow access to a wide range of insects including bumblebees, honeybees and wasps.

Scientists investigated whether the ground area covered by Himalayan Balsam affected pollination rates in three native plant species (Species **A**–**C**), usually found in the same habitat.

Several riverbank habitats of 30 m^2 were investigated. The results are shown in the table below.

Ground area covered by Himalayan Balsam in habitat / m^2	**Flowers pollinated / %**		
	Species A	**Species B**	**Species C**
0 (no Himalayan Balsam in habitat)	48	71	87
5	44	62	82
10	41	52	94
20+	38	33	88

(A pollination rate of 100% means that all the flowers in all the plants of that species in the sampled habitat were pollinated.)

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

_____ [4]

Many scientists express concern over the effect of Himalayan Balsam on native habitats. However, some scientists argue that there is a benefit in allowing some of its plants to survive in the wild.

(d) Using the information provided, suggest reasons for this.

_____ [2]

(e) Using the information provided, suggest why it is difficult to define Himalayan Balsam as either a K-selected or r-selected species.

_____

_____

_____

_____ [2]

Section B

In this question you will be assessed on the quality of your written communication skills including the use of specialist scientific terms.

9 The kidney is an organ involved in excretion and osmoregulation.

(a) Describe how the kidney allows excretion of the waste products of metabolism, yet ensures that useful substances are retained. [12]

(b) The loop of Henle and the collecting ducts are parts of the kidney important in osmoregulation.

Describe and explain their roles in osmoregulation in the kidney. [6]

(a) Describe how the kidney allows excretion of the waste products of metabolism, yet ensures that useful substances are retained.

15886

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(b) The loop of Henle and the collecting ducts are parts of the kidney important in osmoregulation.

Describe and explain their roles in osmoregulation in the kidney.

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Question Number	Marks
1	
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Total Marks	

Examiner Number

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