Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED
General Certificate of Education
2013

Biology

Assessment Unit A2 1

assessing

Physiology and Ecosystems

[AB211]

AB211

TUESDAY 21 MAY, AFTERNOON

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
There is an extra lined page at the end of the paper if required.
Answer **all nine** questions.
You are provided with **Photograph 1.4** for use with Question 4 in this paper.
Do not write your answers on this photograph.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.
Section A carries 72 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**, and awarded a maximum of 2 marks.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total Marks	

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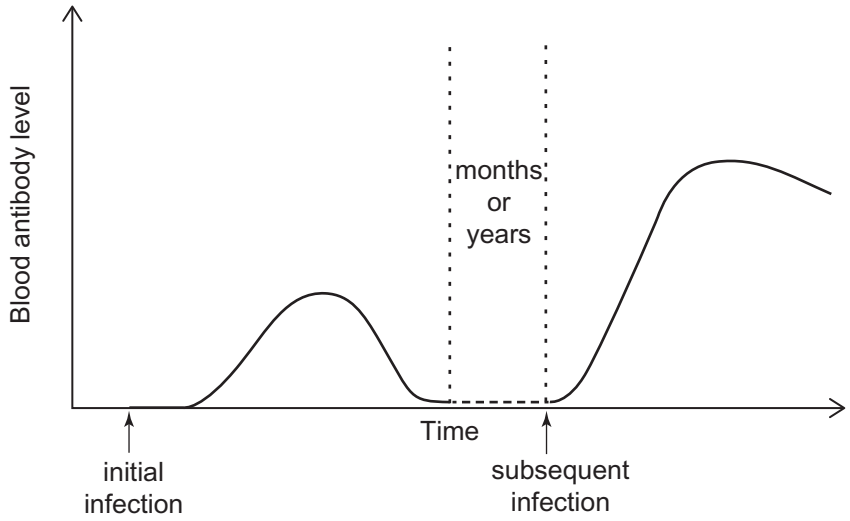
Section A

Examiner Only	
Marks	Remark

1 Antibodies are produced during an initial infection by a pathogen (e.g. a bacterium) and then again if a subsequent infection occurs. The levels of antibody produced during initial and subsequent infections are shown in the graph below.

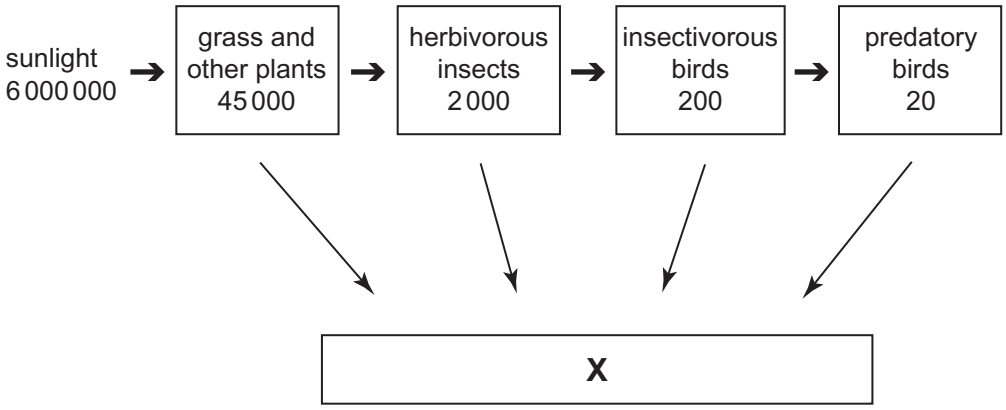


Complete the passage below describing antibody production in the graph.

Following initial infection there is a delay in antibody production due to the time involved in activating _____ and producing the _____ cells that make the antibodies. The rapid secondary response is due to the retention of _____ cells by the body. [3]

Examiner Only	
Marks	Remark

2 **(a)** The diagram below shows the flow of energy through part of a food web in a grassland ecosystem. The figures are in kJ m^{-2} $year^{-1}$.



(i) Name the group of organisms represented by **X** in the box above.

_____ [1]

(ii) State **one** reason why only a very small percentage of energy reaching the leaf surface of the grass is utilised by the plants in photosynthesis.

_____

_____ [1]

(iii) The efficiency of energy transfer between the grass and the herbivorous insects is less than that in subsequent stages of the food web. Explain the reason for this.

_____

_____

_____

_____ [2]

(b) Many countries with very high populations do not use meat products as a significant human food source. For example, in much of Asia, a diet consisting largely of rice is common and seldom contains meat from birds or mammals.

In terms of energy transfer through trophic levels, explain the reason for this.

_____

_____

_____

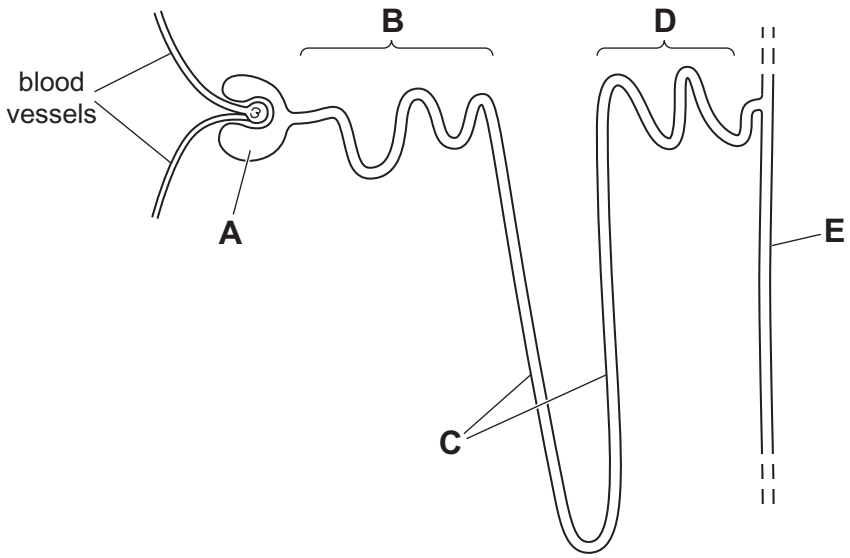
_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 The diagram below is of a mammalian nephron and associated structures.



(a) (i) Identify the parts labelled **D** and **E**.

D _____

E _____ [2]

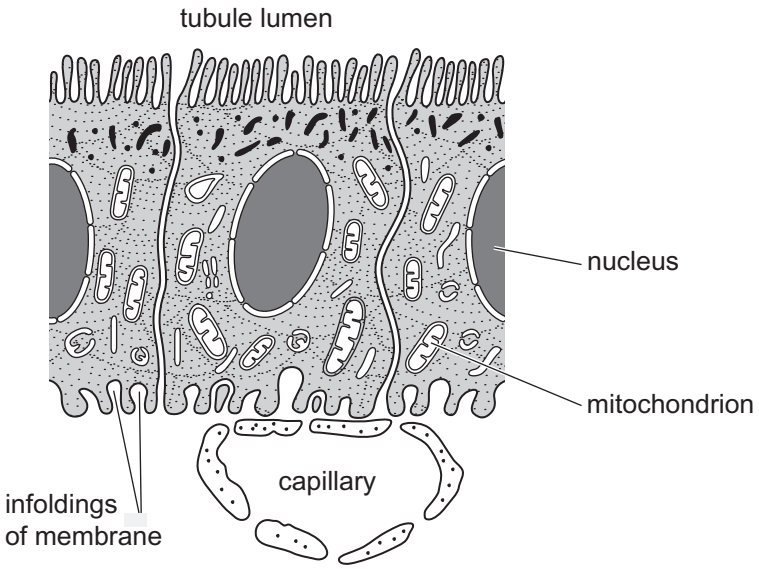
Reabsorption of substances takes place along the regions labelled **B**–**E**.

(ii) Which **two** letters correspond to the regions in which most water is absorbed?

_____ and _____ [1]

Examiner Only	
Marks	Remark

(b) The proximal tubule is the main site of reabsorption of solutes. The diagram below represents the cells lining the proximal convoluted tubule.



Adapted from: © CCEA A2 Biology: Unit 1: Physiology and Ecosystems by John Campton, page 15, published by Philip Allan, 2010. ISBN 1444112546. "Reproduced by permission of Philip Allan (for Hodder Education)"

(i) Describe and explain **two** distinct ways in which the cells of the proximal tubule are adapted for the function of selective reabsorption.

1. _____

_____

2. _____

_____ [2]

The table below summarises differences in the concentration of some substances in the blood plasma and the renal filtrate at the end of the proximal convoluted tubule.

Substance	Concentration in blood plasma/ arbitrary units	Concentration in renal filtrate at end of proximal tubule/ arbitrary units
Large proteins	12	0
Glucose	0.15	0
Urea	0.04	0.09

(ii) Explain these results.

[3]

(c) In mammals, there is a strong positive correlation between the length of the loop of Henlé and the degree of aridity (dryness) of the environment that a mammal, such as the desert rat, inhabits. Explain this relationship.

[2]

Examiner Only

Marks	Remark

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

4 **(a)** **Photograph 1.4** is an electronmicrograph of the junction between two neurones in the brain.

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

A _____

B _____ [2]

(ii) **X** and **Y** are separate neurones. Neurones are highly specialised, elongated cells with long axons.

Suggest why the axons are not visible in the electronmicrograph.

_____

_____ [1]

(b) The synaptic cleft between neurones is typically 20 nm wide. If it takes a neurotransmitter 1×10^{-6} seconds to cross the synapse, calculate the speed of synaptic transmission in metres per second. (Show your working.)

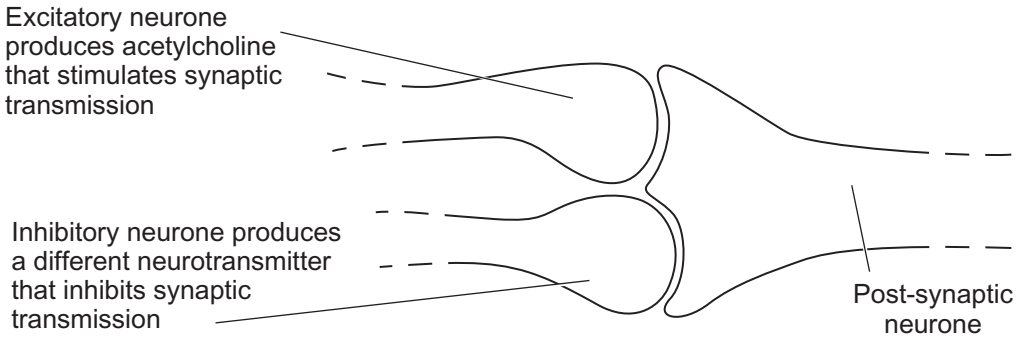
_____ $m\,s^{-1}$ [2]

Examiner Only	
Marks	Remark

(c) Typical synapses are described as excitatory – their function is to produce an action potential in adjacent neurones.

In inhibitory synapses, the pre-synaptic neurone releases transmitters whose function is to reduce the possibility of an action potential occurring in the post-synaptic neurone. They act as a 'brake' on nervous communication in some circumstances.

An excitatory neurone and an inhibitory neurone synapsing with a post-synaptic neurone are shown in the diagram below.



(i) Suggest how an inhibitory synapse can prevent an excitatory synapse producing an action potential in a post-synaptic neurone.

[2]

A deficit of the neurotransmitter serotonin, found in some inhibitory synapses, can create states of anxiety and panic in individuals.

(ii) The drug Prozac can be used to alleviate the symptoms caused by a shortage of serotonin. Using the information provided, suggest how Prozac affects synaptic transmission.

[2]

Examiner Only	
Marks	Remark

5 The growth of a population depends on various factors which influence birth and death rates. The population will grow until it reaches carrying capacity.

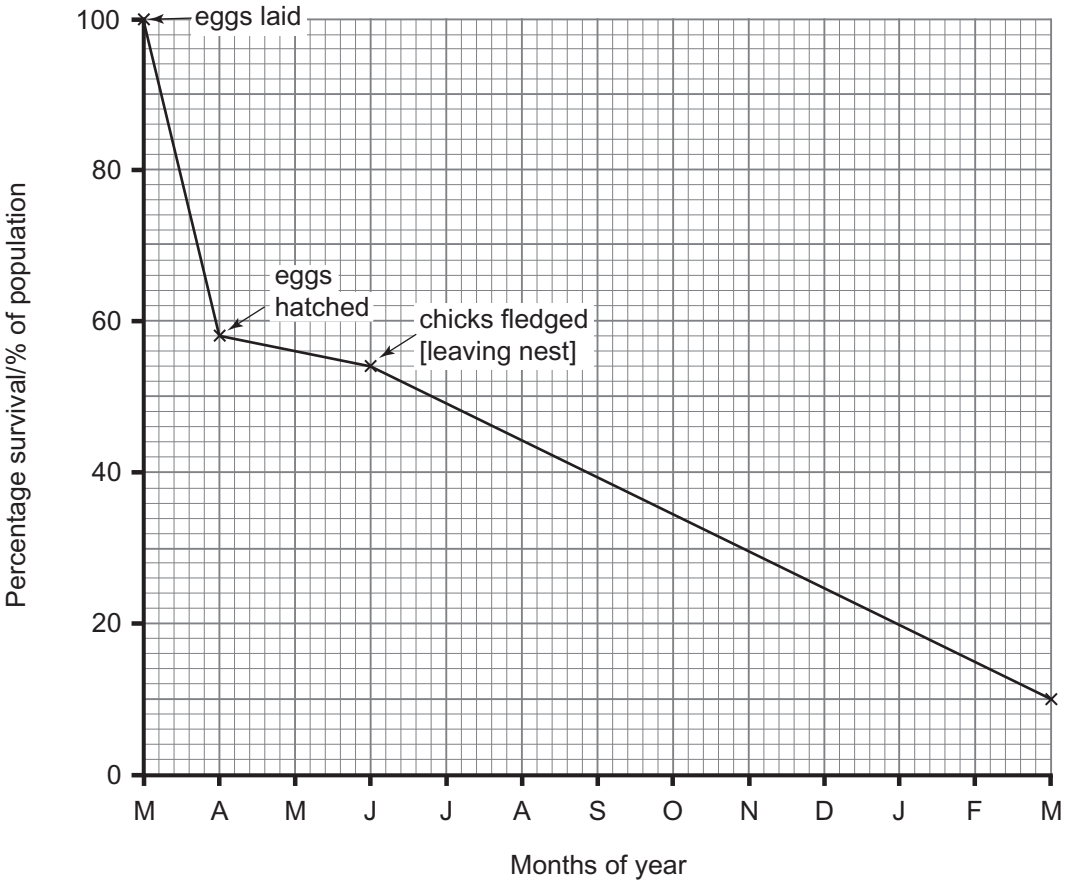
(a) Define what is meant by the term 'carrying capacity'.

_____

_____

_____ [1]

(b) Owls are highly-skilled, predatory hunters that feed on mice, shrews and other small mammals. The following graph represents survivorship data for the owls in a large woodland from when the eggs are laid in March until the birds are one year old.



(i) At which stage is there the highest rate of mortality (death)?

_____ [1]

(ii) Suggest **one** cause of death in the months immediately after fledging.

_____

_____ [1]

(c) Describe a suitable procedure that could be used to produce a reliable estimate of owl numbers in the woodland. (You do not need to describe techniques involved in sampling or trapping owls.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

Examiner Only	
Marks	Remark

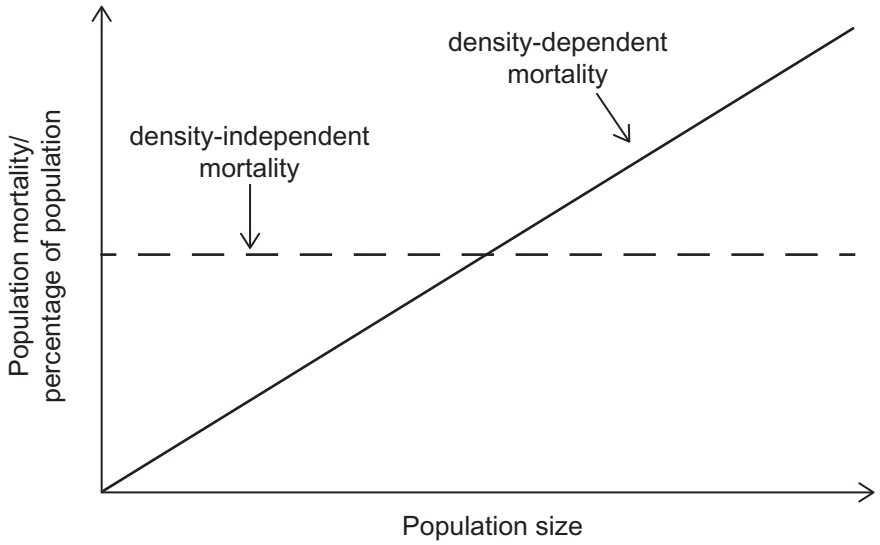
Examiner Only	
Marks	Remark

(d) In owls, as in most other species, mortality rates are very high during the first year of life. Mortality can be due to density-independent or density-dependent factors.

- **Density-independent** factors reduce the population by the same proportion regardless of the size of the population, e.g. in insect populations cold weather may cause up to a third of the population to die, whether the population is large or small.

- **Density-dependent** factors reduce the population to a greater extent as the population increases in size, e.g. competition for a resource will become greater as the population increases in size.

The graph below shows the effect of population size on each of density-independent and density-dependent mortality.



(i) Density-dependent mortality tends to result in population size becoming stable. Suggest which type of population strategy maintains stable population numbers through density-dependent factors.

_____ [1]

(ii) Using the information available, suggest how a **named** density-dependent factor is important in regulating owl numbers and keeping population numbers stable.

[3]

Examiner Only	
Marks	Remark

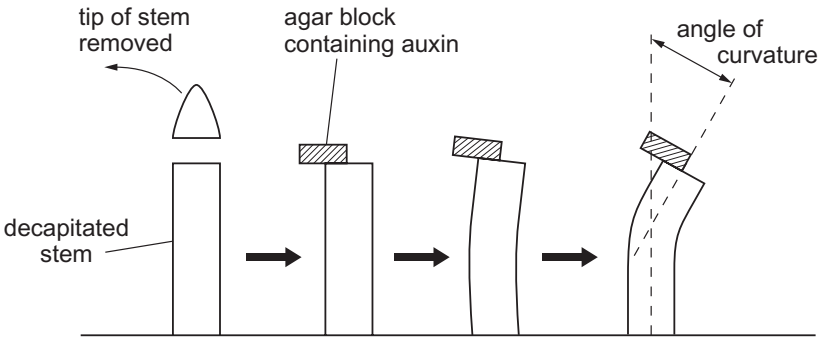
Examiner Only	
Marks	Remark

6 Auxins are a group of plant growth substances produced in the apical meristems (tips) of plant stems. They are involved in a number of growth responses including phototropism.

(a) Auxins act by loosening the linkages between the cellulose microfibrils in cell walls. Using this information, explain how auxin promotes cell elongation.

[2]

(b) In an early experiment investigating phototropism, tips of young stems were removed and replaced by agar blocks containing auxin as shown. Following the initial set-up of the experiment, the investigation was completed in darkness.

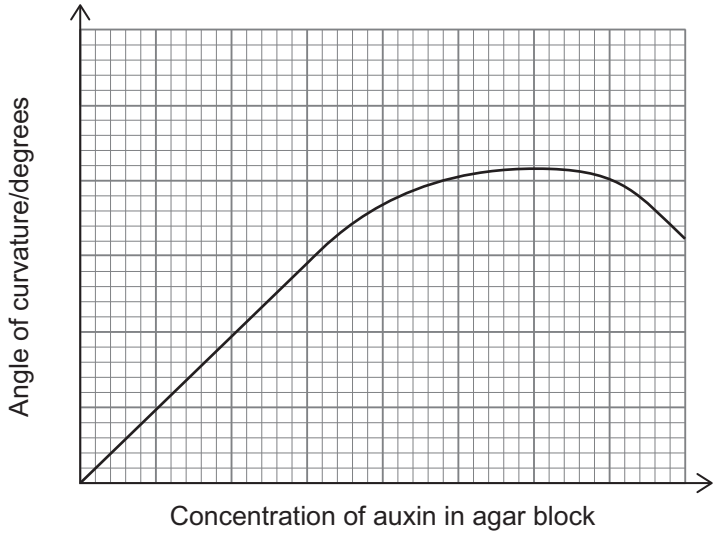


(i) Explain precisely why the investigation was completed in darkness.

[1]

Examiner Only	
Marks	Remark

(ii) The investigation was repeated a number of times using different concentrations of auxin in the agar block each time. The graph below shows the relationship between the concentration of auxin in the agar block and the angle of curvature produced in decapitated stems.

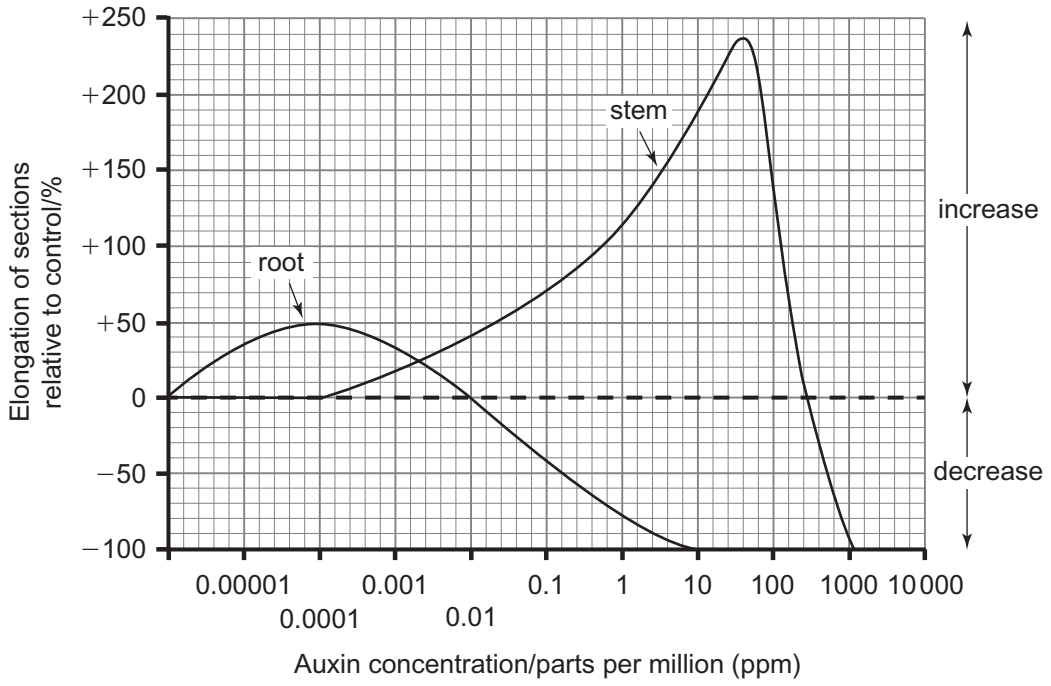


Describe and explain the results shown.

[3]

Examiner Only	
Marks	Remark

(c) The following graph shows the effect of auxin concentration on stem and root elongation. The results illustrated are in relation to the growth of control stem and root sections (with no auxin added).



(i) What is the effect of an auxin concentration of 1 ppm on the stem and the root?

Stem _____

_____

Root _____

_____ [2]

(ii) Explain how the graph provides evidence that auxin is produced in the apical meristem of plant stems and travels down through the plant.

_____

_____

_____

_____

_____ [2]

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

7 Lough Neagh is the most highly eutrophic lake in Ireland, enriched with high levels of nitrate and phosphate.

(a) The following table shows the sources of phosphate entering Lough Neagh in the year 2000.

Source	Phosphate entering Lough Neagh		Additional notes
	tonnes	%	
Towns	129	25.4	value decreasing
Industry	6.8	1.3	value relatively static
Septic tanks	62	12.2	consequence of large number of rural farms with septic tanks and inefficient soakaway systems
Agriculture	310.7	61.1	proportion increasing as other sources decrease or remain static

(i) Suggest how phosphate (and nitrate) pollution from septic tanks can be decreased.

_____

_____ [1]

(ii) Much of the agricultural contribution to phosphate (and nitrate) pollution comes from the inappropriate use or overuse of artificial fertiliser.

Describe how the use of artificial fertiliser can lead to pollution of waterways and a subsequent reduction in aquatic life.

_____

_____

_____

_____

_____

_____

_____ [3]

(iii) Describe **two** distinct ways in which farmers can reduce the level of water pollution caused by artificial fertiliser.

1. _____

_____

_____

2. _____

_____

_____ [2]

(b) In Lough Neagh one of the species that was found in high numbers is *Anabaena,* a blue-green alga that is capable of fixing nitrogen.

Using this information, suggest why phosphate, rather than nitrate, is thought to have been mainly responsible for the problems in Lough Neagh.

_____

_____

_____

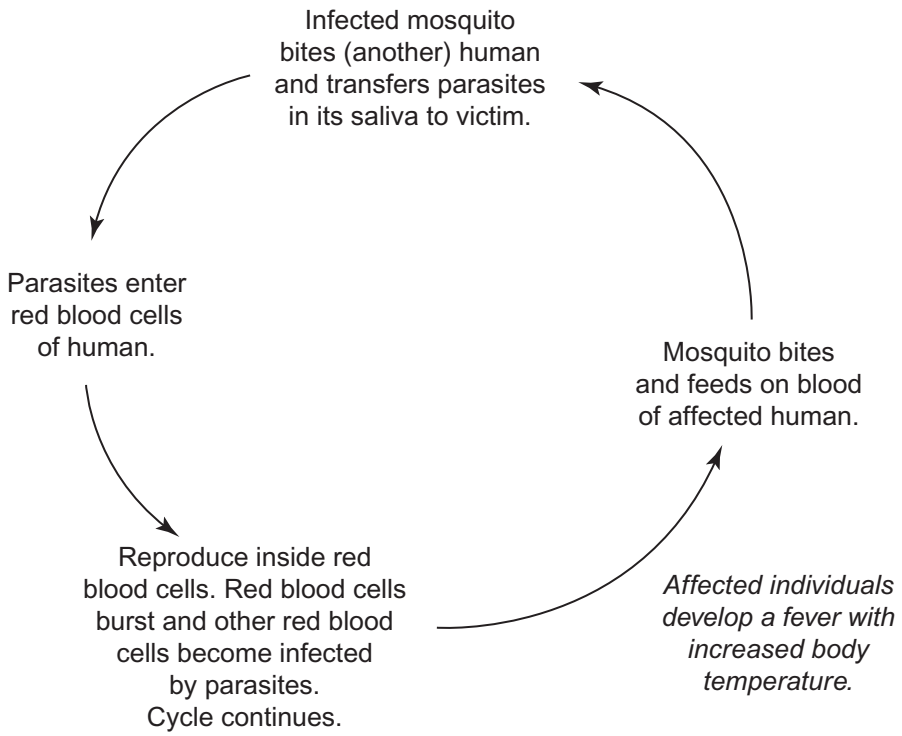
_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

8 Malaria is a harmful, often fatal, disease affecting millions of people. It is caused by a protoctistan parasite, *Plasmodium*, that spends part of its lifecycle in mosquitoes and part of its lifecycle in humans, as shown in the diagram below.



(a) (i) Suggest why *Plasmodium* is described as a parasite.

_____

_____

_____ [1]

(ii) Using the information provided, explain why individuals affected with malaria are lethargic and suffer from a shortage of energy.

_____

_____

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

(iii) Malaria is spread by the female mosquito that feeds on blood. Mosquitoes feed at night and are attracted by the heat of warm blooded mammals. Research suggests that when presented with a choice of human victims, the mosquitoes are more likely to bite individuals with raised blood temperatures.

Explain why this behaviour increases the spread of the *Plasmodium* parasite.

_____

_____

_____

_____

_____ [2]

(b) One way of restricting the spread of malaria is to disrupt the parasite's life cycle by reducing the number of mosquitoes. For many decades, the insecticide DDT has been used to control mosquito numbers in affected areas. However, while DDT is a very effective general insecticide, it can do great ecological harm.

(i) Suggest why it is regarded as ethically appropriate to use the ecologically harmful DDT to destroy mosquitoes in malaria-affected countries.

_____

_____

_____ [1]

(ii) However, there is a worldwide ban on the use of DDT for agricultural purposes. Suggest **two** ways in which DDT could cause ecological harm.

1. _____

_____

_____

2. _____

_____

_____ [2]

Examiner Only	
Marks	Remark

(c) Another method of reducing the incidence of malaria is to use nets to prevent the mosquitoes from biting humans. In an investigation in rural Africa analysing the effectiveness of nets, the bed of one child in each household was covered with a mosquito net for a period of three nights. As a further variable, approximately half the nets were sprayed with an insecticide.

Immediately before and immediately after the trial, the children in the trial and a control group, were monitored for the presence of mosquito bites. The results are shown in the table below.

Group	Number of children	Number of fresh mosquito bites
Control group	266	189
Nets (without insecticide spray)	197	94
Nets (sprayed with insecticide)	203	33

(i) Summarise the results of the investigation.

_____

_____

_____

_____

_____ [2]

There are many variables that could have affected this investigation of the incidence of mosquito bites in African children. Consequently it was necessary to have large sample sizes to increase reliability.

(ii) Suggest **two** factors that might have contributed to the variability in this investigation.

1. _____

_____

_____

2. _____

_____

_____ [2]

(iii) Suggest how the control group would have been selected. Explain your answer.

_____

_____

_____

_____

_____ [2]

(iv) Suggest **one** reason why the incidence of mosquito bites was used in the trial rather than recording infection with malaria.

_____

_____

_____ [1]

Examiner Only	
Marks	Remark

Section B

Examiner Only	
Marks	Remark

Quality of written communication is awarded a maximum of 2 marks in this section.

9 The mammalian eye is highly adaptable: capable of accommodating images of objects which are close-up or far-away; providing detailed colour images during daytime when the light intensity is high; and yet able to perceive images when the light intensity is low. Some species of nocturnal mammals have eyes that are highly specialised to function only in the very low light intensities during the night.

(a) Describe and explain how the typical mammalian eye provides a detailed colour image of close-up objects in high light intensities. [10]

(b) Explain how the eye is adapted to provide vision in low light intensities, and suggest how the eyes of nocturnal mammals are specialised. [6]

Quality of written communication [2]

(a) Describe and explain how the typical mammalian eye provides a detailed colour image of close-up objects in high light intensities.

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(b) Explain how the eye is adapted to provide vision in low light intensities, and suggest how the eyes of nocturnal mammals are specialised.

Examiner Only	
Marks	Remark

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Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

113162

GCE Biology Advanced (A2)
Assessment Unit A2 1
Physiology and Ecosystems
Summer 2013

Photograph 1.4
(for use with Question 4)