



Rewarding Learning

ADVANCED
General Certificate of Education
2019

Centre Number

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Candidate Number

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Biology

Assessment Unit A2 1

assessing

Physiology, Coordination and
Control, and Ecosystems

MV18

[ABY11]

THURSDAY 6 JUNE, MORNING

Time

2 hours 15 minutes, plus your additional time allowance.

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 on blank pages.

Complete in black ink only.

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 at the end of each question 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.

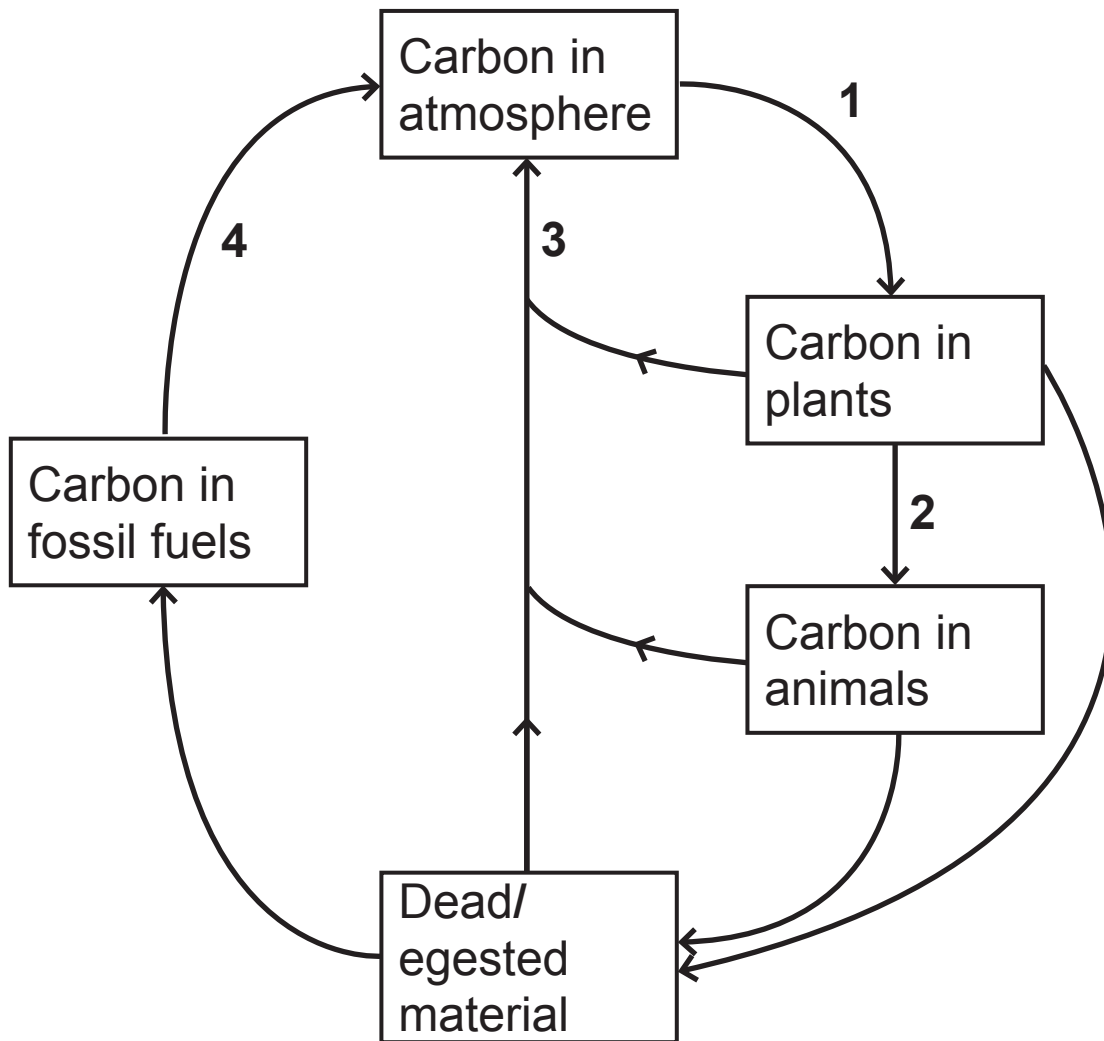
You are expected to answer Section B in continuous prose.

Quality of written communication will be assessed in Section B.

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(Questions start overleaf)

Section A

1 The carbon cycle is represented in the diagram below.



(a) Identify the processes labelled 1–4. [2 marks]

- 1 _____
- 2 _____
- 3 _____
- 4 _____

(b) State **one** way in which carbon may be stored within the cycle for a very long period of time. [1 mark]

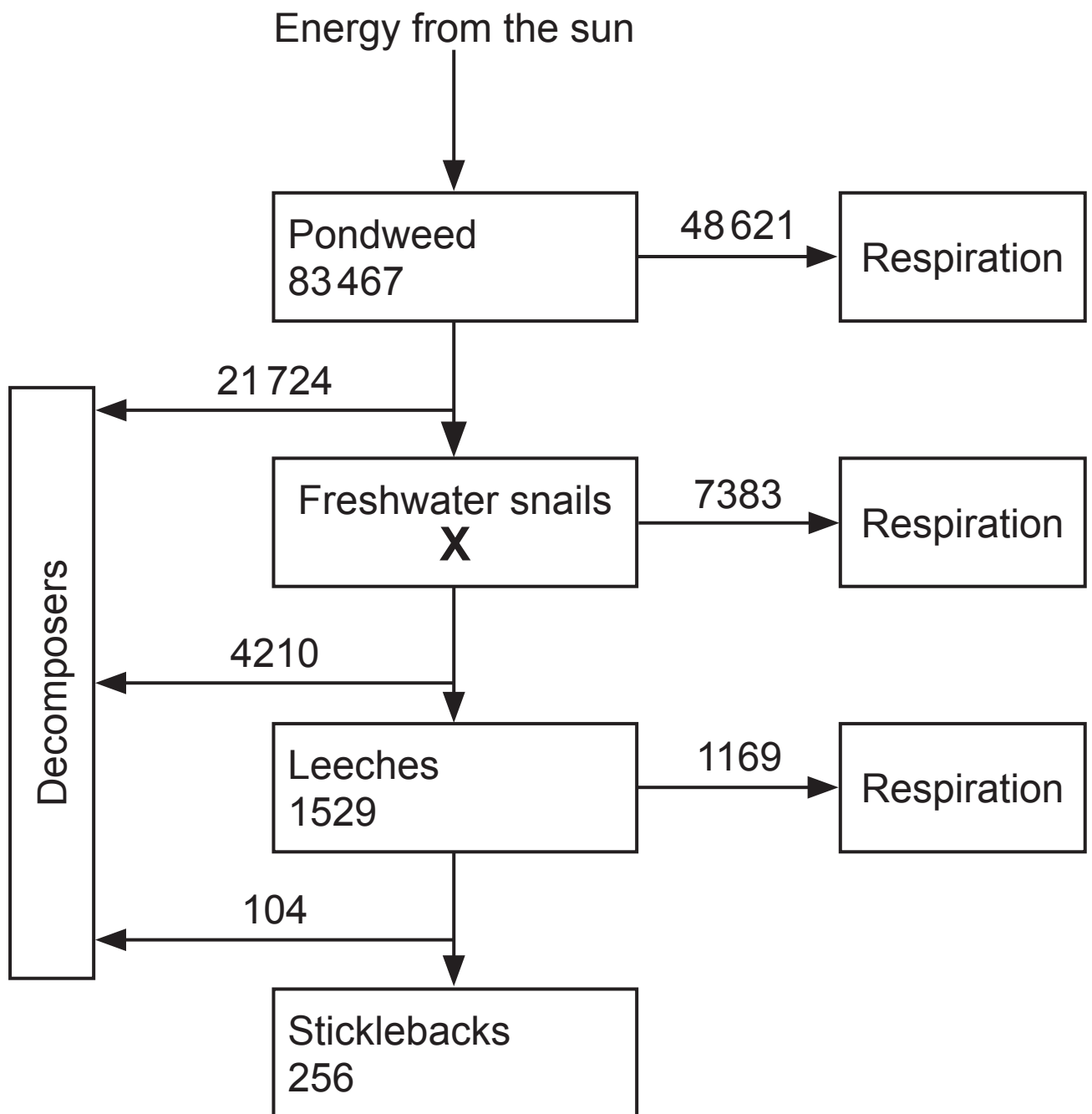
(c) Reducing deforestation and fossil fuel use are strategies used to limit the rate of increase of atmospheric carbon dioxide.

(i) Many scientists argue that reduced use of fossil fuels should be the greater priority.

Suggest **one** reason why. [1 mark]

(ii) Suggest **one** argument for making reduced deforestation the higher priority. [1 mark]

- 2 (a) The energy flow through a freshwater food chain is shown below. Units are $\text{kJ m}^{-2} \text{ year}^{-1}$.



- (i) Identify the primary consumer in this food chain.
[1 mark]
-

- (ii) Calculate the energy (**X**) which passes to the freshwater snails. [1 mark]
(Show your working.)

_____ $\text{kJ m}^{-2} \text{year}^{-1}$

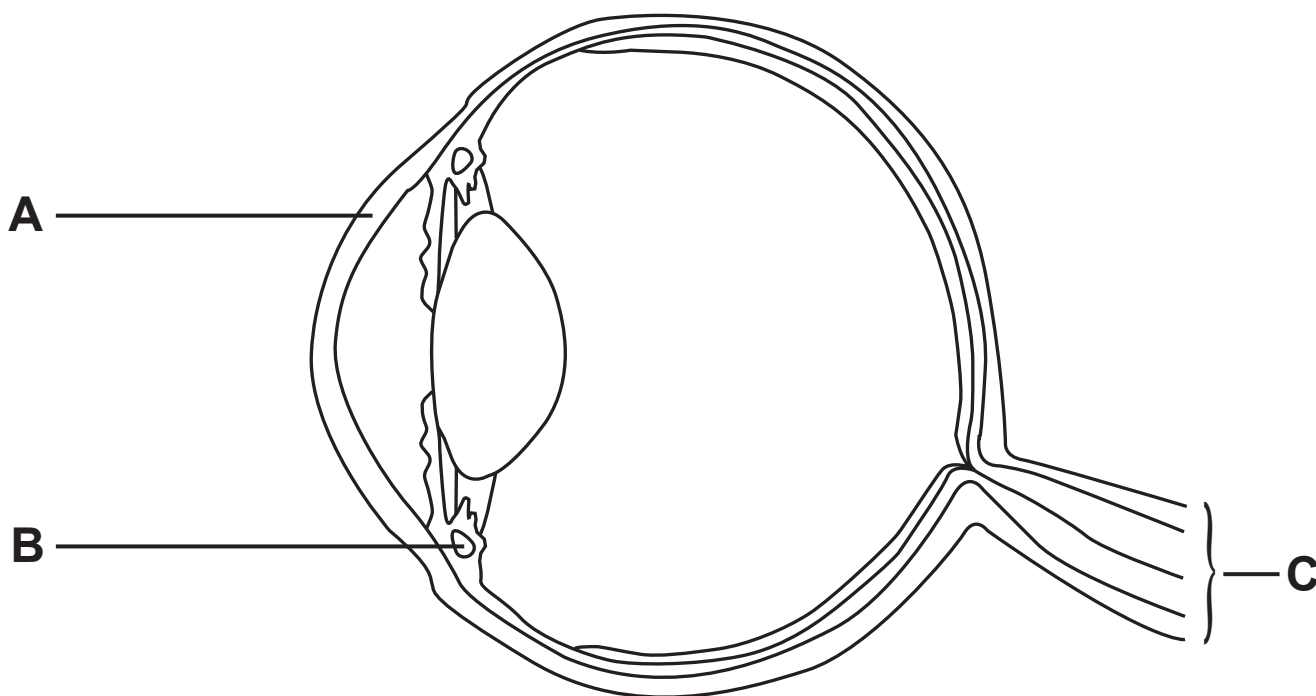
- (iii) Calculate the percentage efficiency of energy transfer between leeches and sticklebacks. [2 marks]
(Show your working.)

_____ %

(b) When a bird is consumed by a mammal, the efficiency of energy transfer is typically lower than that from a leech to a stickleback. Suggest reasons for this.
[3 marks]

3 A longitudinal section through the mammalian eye is shown in the diagram below.

(a) Identify the structures labelled **A**, **B** and **C**. [3 marks]

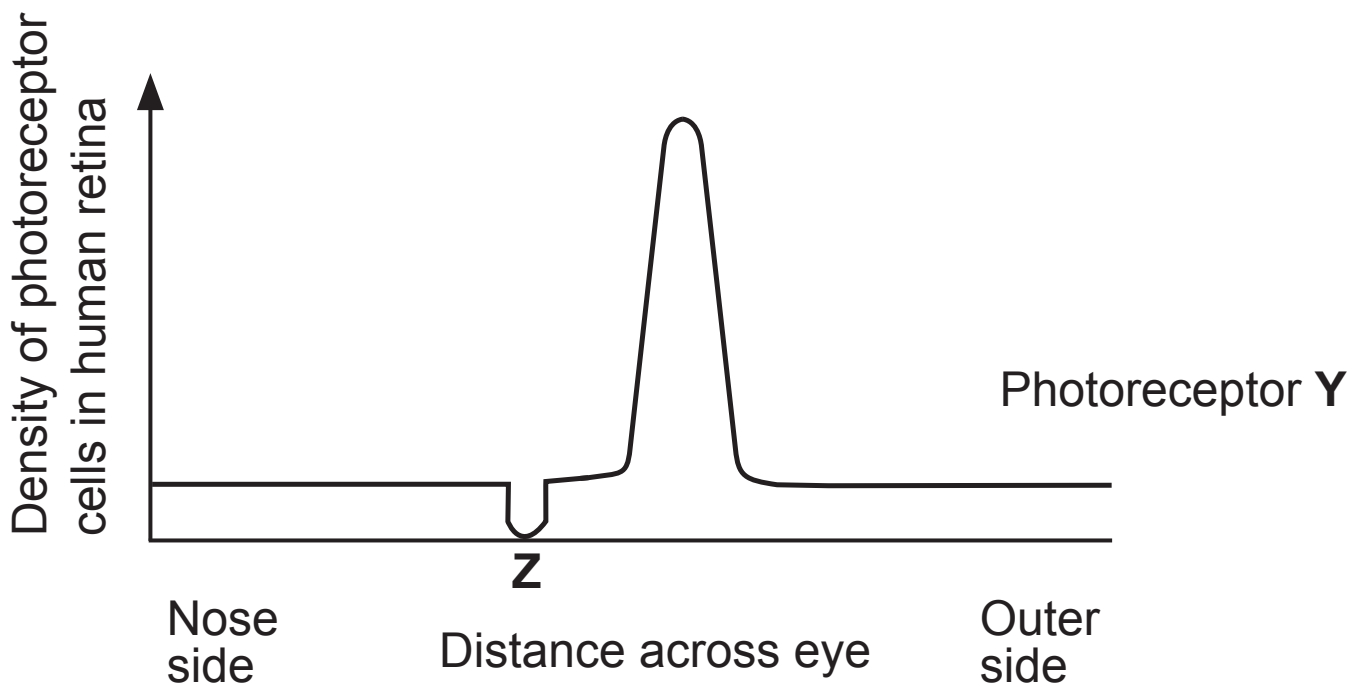
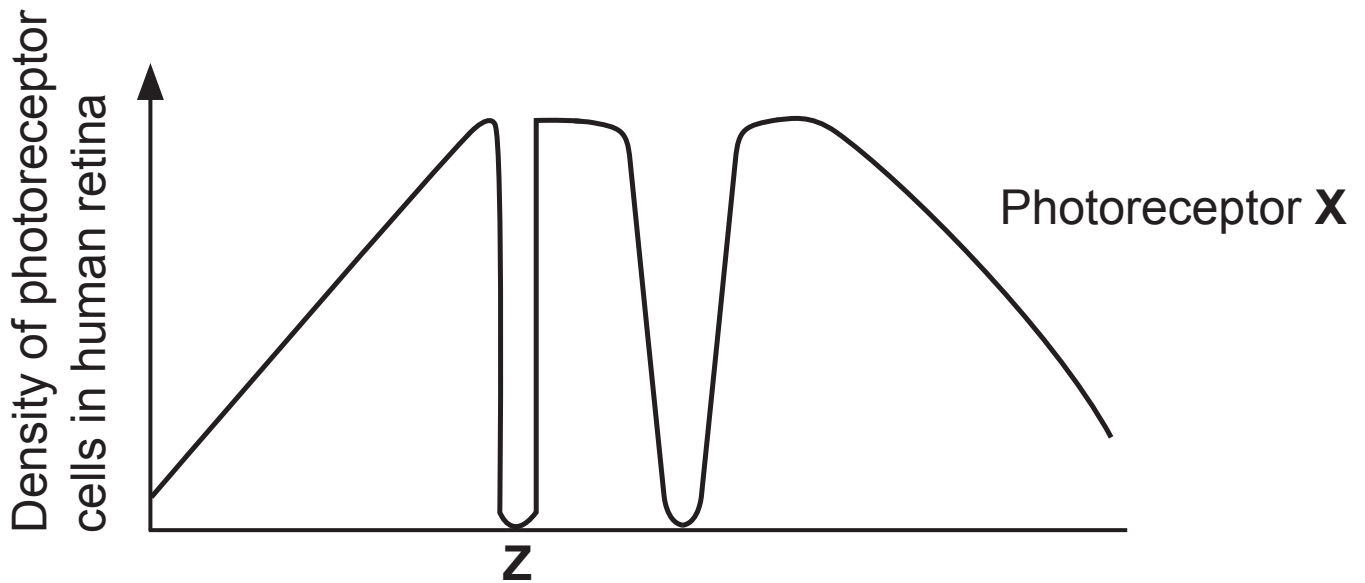


A _____

B _____

C _____

(b) The two types of photoreceptor cells (**X** and **Y**) are not distributed evenly across the retina. The graphs below show the distribution of each of the two types of photoreceptor cells across the retina of the human eye.



(i) Identify the photoreceptor cells **X** and **Y**. [1 mark]

X _____

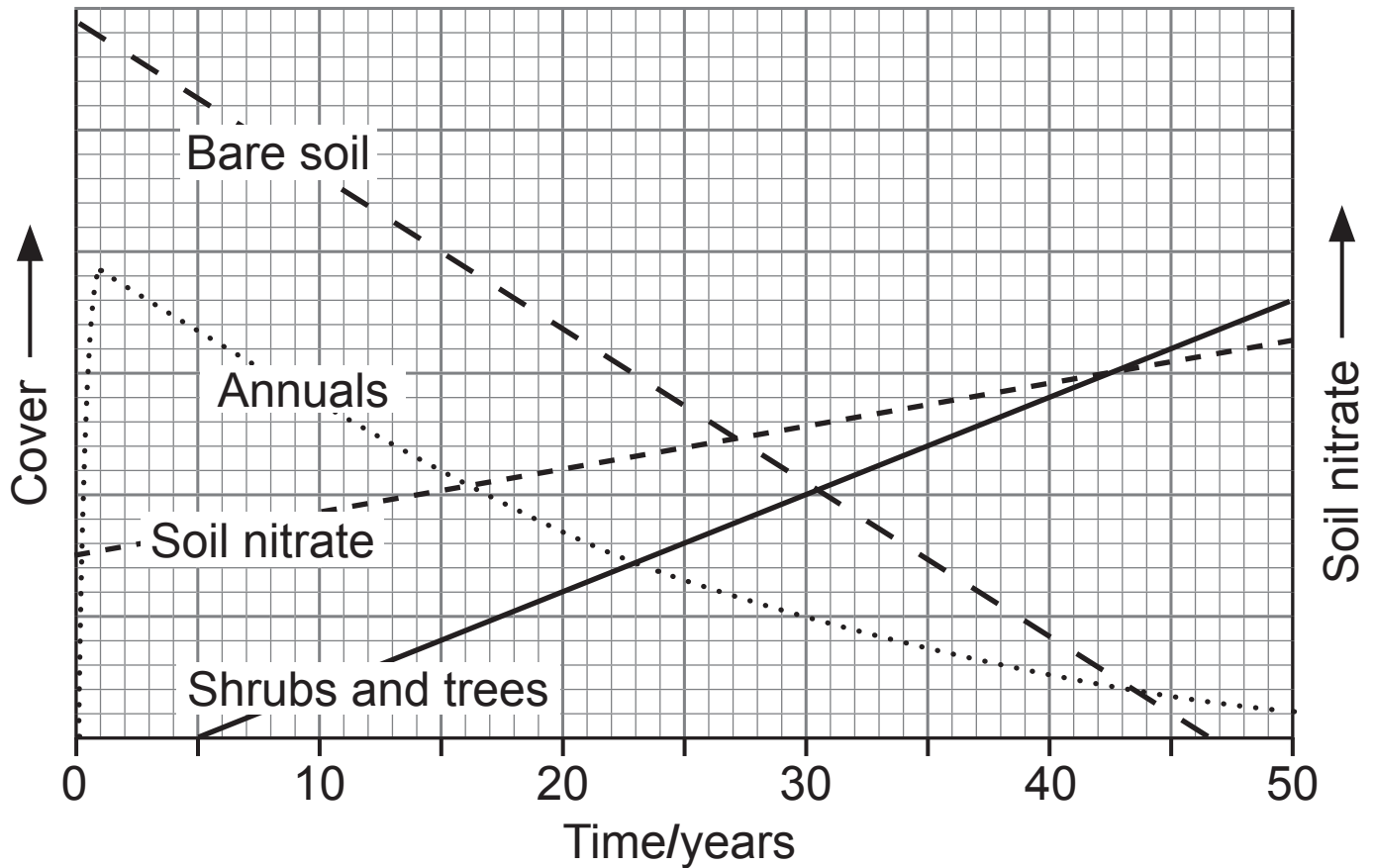
Y _____

(ii) Explain the absence of both types of photoreceptor cells at position **Z**. [2 marks]

(iii) In a dimly-lit room, people may find it easier to see an object by looking to one side of it, rather than looking directly at it.

Using the information provided and your knowledge of photoreceptor cells, suggest an explanation for this. [3 marks]

- 4 The graph below shows how the cover of bare soil and some types of plants changed in a field that was ploughed then abandoned over a 50-year period. Annuals are plants that live for only one year. Soil nitrate is also shown.



- (a) (i) State the type of succession that would occur in an abandoned crop field. [1 mark]
-

(ii) Many of the annual plants have root nodules containing nitrogen-fixing bacteria. Describe and explain the advantage of this adaptation in the early years of this succession. [2 marks]

(iii) Using your knowledge of the nitrogen cycle, explain the increase in soil nitrate concentration during the 50-year period. [2 marks]

(c) Explain how the introduction of sheep to the field after ten years would change the pattern of succession.
[3 marks]

- 5 The Galapagos Islands provide unique ecosystems for plants and animals. However, tourism has resulted in the introduction of non-native species.

One example, identified in 1982, is the cottony cushion scale insect (***Icerya purchasi***). Having both male and female reproductive organs, this organism had the potential of becoming a significant pest when introduced.



Adults lay eggs which hatch and then develop through several stages. One of the early stages is referred to as the 'crawler' stage, since the individuals can move easily during this stage. The insects tend to move much less during other stages of the life cycle.

The adult insects use piercing, sucking mouthparts to feed on the phloem sap of plants. The insects egest a sticky, sugary substance called honeydew, which is known to attract their natural predators, including ladybirds.

The phloem sap of some plants can contain high concentrations of molecules called alkaloids. If a cottony cushion scale insect feeds on these plants, the alkaloids

are present in its honeydew. The alkaloids have been shown to greatly increase the time taken for a ladybird egg to hatch and develop into an adult.

(a) (i) Define the term 'pest'. [1 mark]

(ii) Suggest how possessing both male and female reproductive organs can allow rapid population growth in new habitats. [2 marks]

(iii) Explain how the 'crawler' stage in the insect's life cycle represents an adaptation for survival. [2 marks]

(iv) Explain how the production of honeydew may affect the adult cottony cushion scale population in the short term. [2 marks]

(v) When cottony cushion scale insects feed on plants containing alkaloids, the ladybird population may be affected. Describe and explain how it may be affected. [2 marks]

(c) This example of biological control was first used in California where the insect was damaging citrus fruit crops. Before the 1940s, pesticides were not widely available. The changes in population density of the cottony cushion scale over a period of time after the introduction of **R. cardinalis** are shown in the graph below.

Image removed due to copyright.

(i) Explain what is meant by the term 'economic threshold' as shown on the graph.
[1 mark]

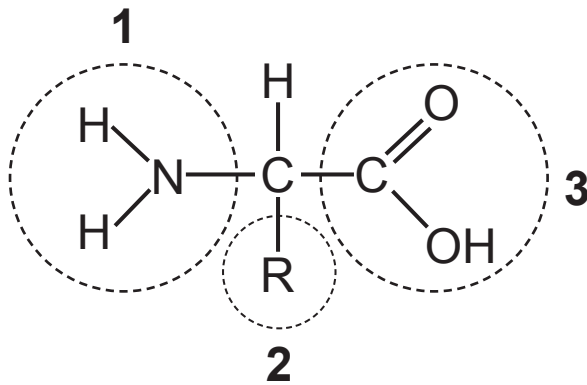
(ii) Suggest **two** reasons why the pest population did not decline immediately upon the introduction of ladybirds. [2 marks]

1. _____

2. _____

(iii) Suggest and explain a reason for the resurgence of the pest after 1947. [2 marks]

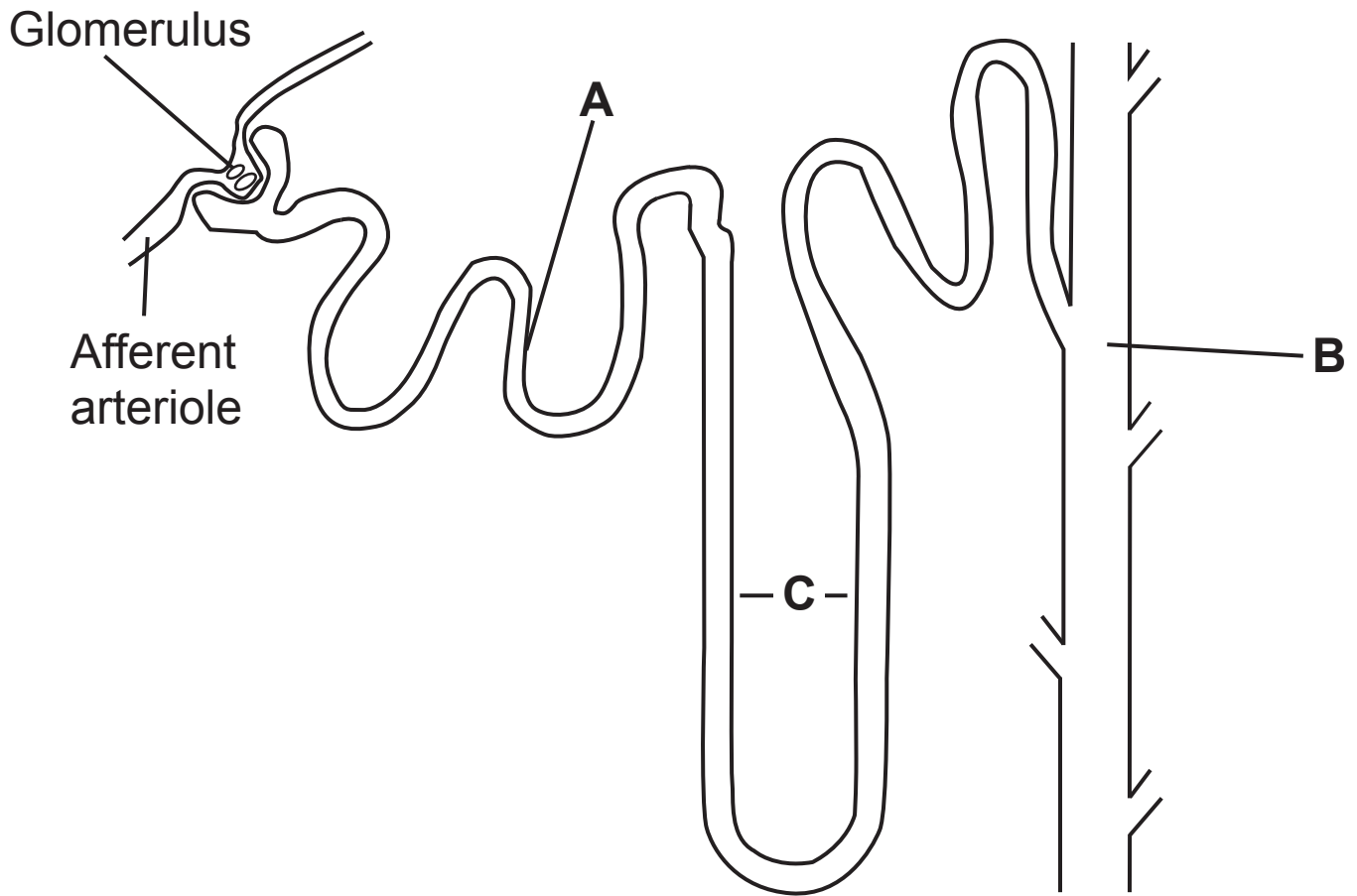
- 6 (a) Excess amino acids cannot be stored by mammals. These molecules are broken down and the products are excreted or further metabolised. The diagram below represents the general structure of an amino acid.



- (i) Identify the part of the amino acid molecule (1, 2 or 3) used to make urea. [1 mark]

- (ii) Urea is removed by the kidneys. Name another excretory product removed by the kidney in mammals. [1 mark]

(b) A nephron from a human kidney is represented in the diagram below.



(i) State the **functions** of the regions labelled **A**, **B** and **C**. [3 marks]

A _____

B _____

C _____

(ii) Explain the term 'ultrafiltration'. [1 mark]

(iii) State **two** ways in which the glomerulus is adapted to carry out the process of ultrafiltration. [2 marks]

1. _____

2. _____

(iv) Name **one** substance present in the blood in the afferent arteriole that will normally not be found in region **A**. Explain your answer. [2 marks]

(c) The properties of some excretory products from different animals are summarised in the table below.

Animal	Excretory product	Toxicity	Solubility	Volume of water required for removal of excretory product
Freshwater fish	Ammonia	High	High	High
Human	Urea	Moderate	Moderate	Moderate
Bird	Uric acid	Low	Low	Low

(i) Describe the relationship between the toxicity of the excretory product and the volume of water required for its removal from the body and suggest an explanation for this relationship. [2 marks]

(ii) The lower the toxicity of the excretory product, the less risk of damage to the animal. Use the table on the previous page to suggest **one** other advantage of making a less toxic excretory product. Explain your answer. [2 marks]

(d) Sharks are fish which live in salt water and produce some urea as well as ammonia. Some of the urea is stored in the blood and this ultimately aids the removal of ammonia. This dissolved urea causes the blood to be hypertonic to (more concentrated than) seawater.

(i) State the effect of dissolved urea on the water potential of the shark's blood. [1 mark]

- (ii) As the shark's blood flows through the capillaries of its gills, exchange can take place between the blood and sea water.

Using the information provided, explain how the presence of the urea in the shark's blood indirectly aids the removal of ammonia. [2 marks]

7 Many diseases are the result of viral infection. Measles is a highly infectious childhood disease that may have serious effects on the individual. Vaccination protects individuals from measles.

If a population is to be protected from measles, a high proportion of the population must be vaccinated. This contributes to 'herd' immunity, where even individuals who are not vaccinated are protected from the viral illness due to the general immunity of the 'herd'.

(a) (i) Define the term 'vaccine'. [2 marks]

(ii) Suggest **two economic** benefits of vaccination programmes. [2 marks]

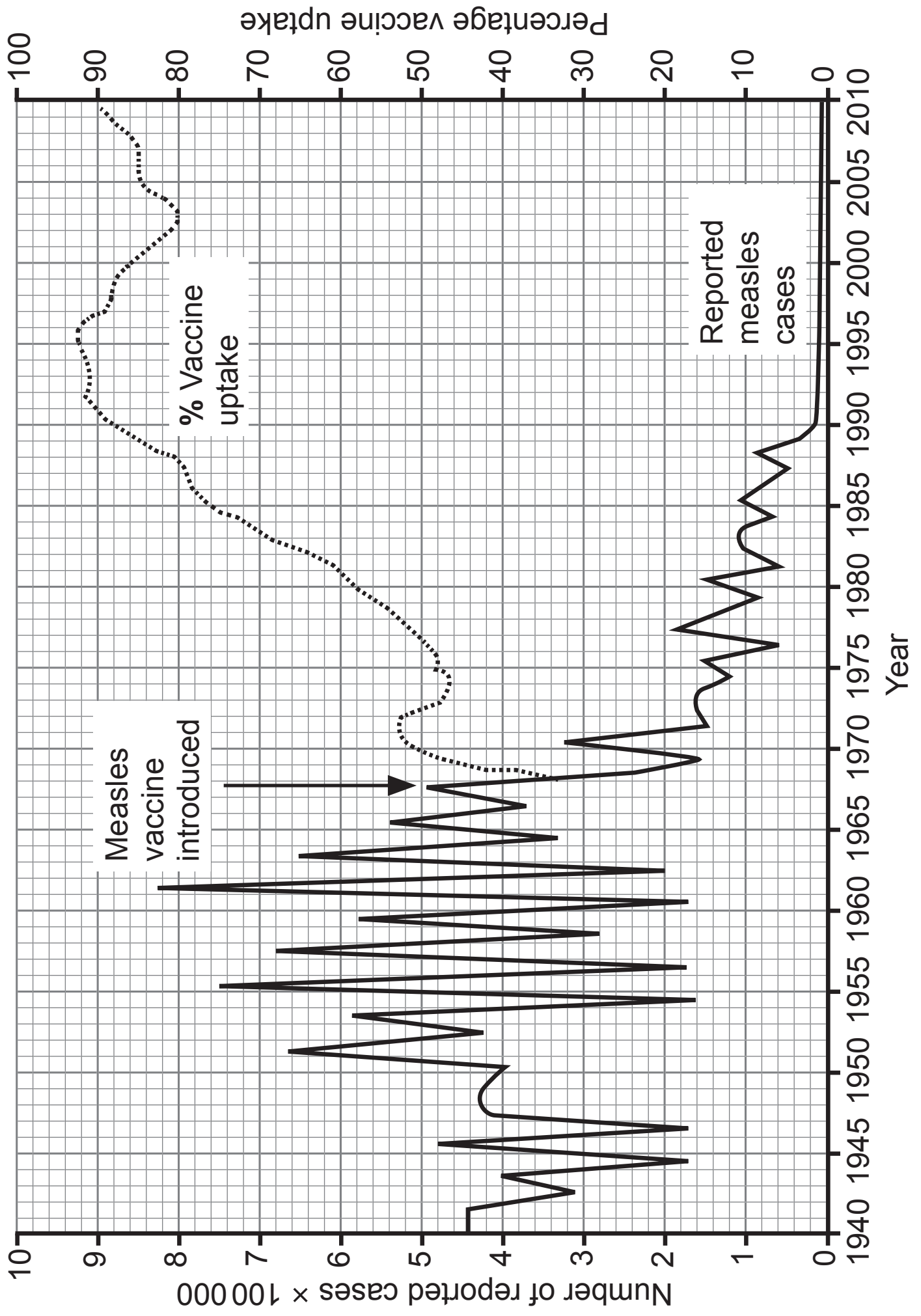
1. _____

2. _____

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The number of reported cases of measles and the percentage uptake of the measles vaccine in England and Wales is shown in the graph opposite for the period 1940–2010.

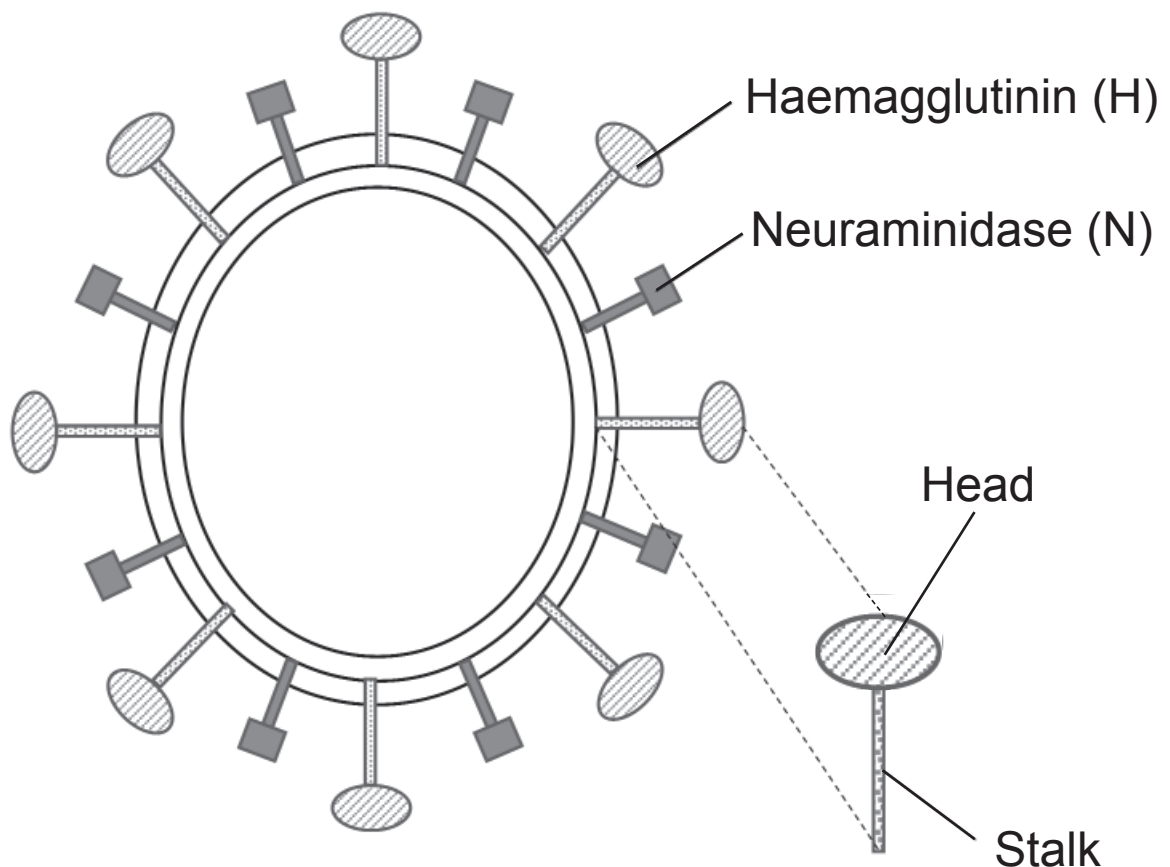
(b) Explain how the data from 1990–2010 provides evidence of the effectiveness of ‘herd’ immunity.
[2 marks]



(c) 'Seasonal flu' is a condition caused by infection with one strain of the influenza virus. Two of the main coat proteins (antigens) on the virus are haemagglutinin (H) and neuraminidase (N); both are directly involved in the ability of the virus to infect host cells.

Many strains of the flu virus are named depending on the particular types of coat proteins they have, e.g. Spanish Flu (1918) was identified as H1N1.

The diagram below represents the arrangement of H and N coat proteins on a strain of flu virus.



The H coat protein consists of a head region and a stalk region as shown. The head region is the region which differs between H1, H2, etc. while the stalk region remains the same.

Currently, flu vaccines are based on the head region of the H protein.

(i) Identify and describe the type of immunity caused by vaccination. [2 marks]

(ii) Suggest why it is difficult to produce a 'universal' vaccine which is effective against all strains of the flu virus. [2 marks]

(iii) The stalk region of the H protein is described as 'highly conserved'. Using your knowledge of protein structure, suggest a possible meaning for the term 'highly conserved' in this context. [1 mark]

(iv) Using the information provided, suggest and explain how a flu vaccine could be designed which provides protection against several strains of the flu virus.
[3 marks]

SOURCES

Q3(a) . . . Source: *Principal examiner*

Q5 Source: *Nigel Cattlin, Science Photo Library*

Q6(a) . . . Source: *Principal examiner*

Q6(b) . . . Source: *Principal examiner*

Q7(b) . . . Data source: Public Health England, Measles notifications and deaths in England and Wales, 1940-2013
(http://webarchive.nationalarchives.gov.uk/2014505192926/http://www.hpa.org.uk/HPAweb&HPAwebStandard/HPAweb_C/1195733835814) Compiled by @visualvaccines

Q7(c) . . . Source: *Principal examiner*

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Question Number	Marks
1	
2	
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Total Marks	
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Examiner Number

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