

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Education
January 2003
Advanced Level Examination



BIOLOGY (SPECIFICATION A)
Unit 6 Physiology and the Environment

BYA6

Thursday 23 January 2003 Morning Session

No additional materials are required. You may use a calculator.
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Time allowed: 1 hour 30 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- You are reminded that this test requires you to use your knowledge of Modules 1, 2, 4 and 5 as well as Module 6 in answering synoptic questions. These questions are indicated by the letter **S**.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
9			
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

- 1** **Figure 1** shows a section through a human eye. **Figure 2** shows the distribution of rods and cones in the retina of the human eye.

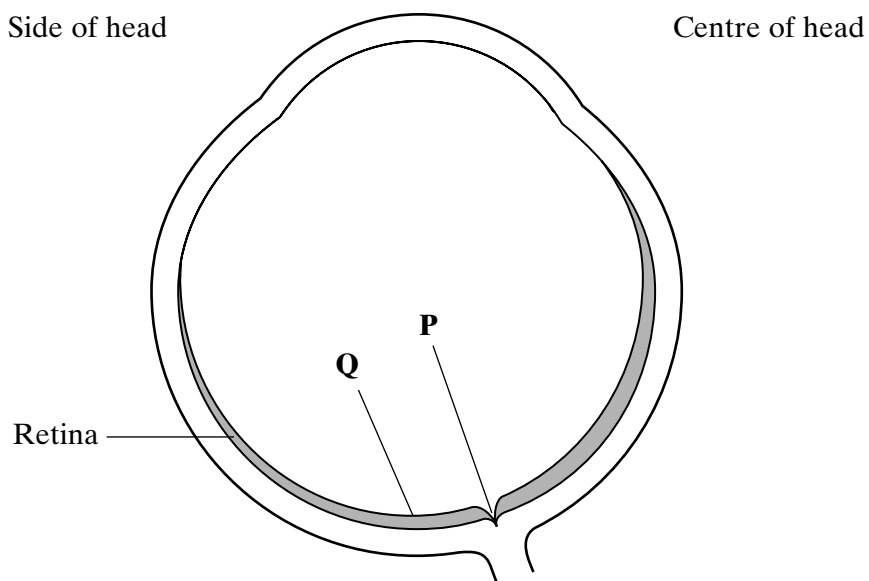


Figure 1

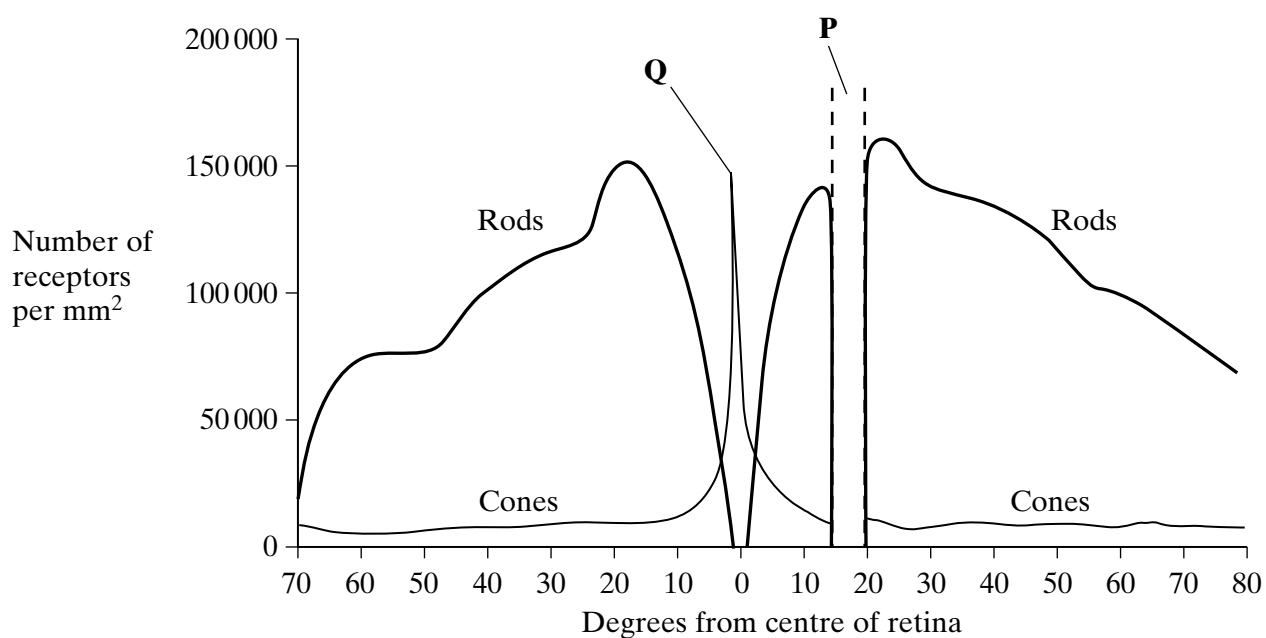


Figure 2

(a) Use **Figures 1** and **2** to explain why

(i) no image is perceived when rays of light strike the retina at the point marked **P**;

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(1 mark)

(ii) most detail is perceived when rays of light strike the part of the retina labelled **Q**.

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(1 mark)

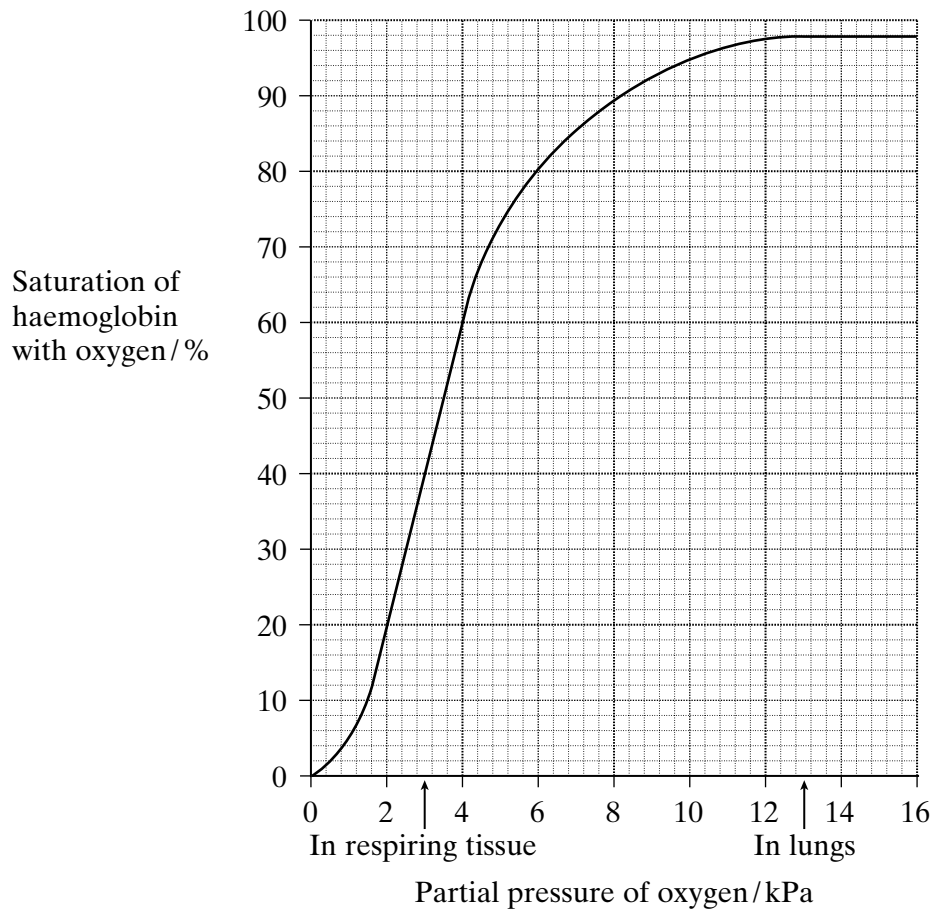
(b) Rod cells allow us to see objects in dim light. Explain how the connections of rod cells to neurones in the retina make this possible.

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(3 marks)

5

TURN OVER FOR THE NEXT QUESTION

2 The graph shows the dissociation curve for adult human haemoglobin.



(a) What is the percentage saturation of haemoglobin at the partial pressure of oxygen found in

(i) the lungs;

.....

(ii) respiring tissue?

.....

(1 mark)

- (b) 1 dm^3 blood leaving the lungs carries 200 cm^3 oxygen. Use the graph to calculate the amount of oxygen that this volume of blood will unload to the respiring tissue. Show your working.

Answer cm^3
(2 marks)

- S (c) A mutation in one of the genes coding for the production of haemoglobin could lead to a decrease in the oxygen-carrying capacity of the blood. Explain how.

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(2 marks)

5

TURN OVER FOR THE NEXT QUESTION

3 Some students investigated the distribution of woodlice. They classified the places where the woodlice were found as light and dry, light and humid, dark and dry, or dark and humid. Woodlice are small animals that absorb oxygen through their body surface.

S (a) Woodlice belong to the class Crustacea. Which **two other** levels of classification do woodlice share with all other crustaceans?

1

2

(1 mark)

(b) The students found the woodlice to be distributed as shown in the table.

Type of location	Number of woodlice found
Dark and humid	36
Dark and dry	12
Light and humid	24
Light and dry	3

S (i) They analysed their results statistically and found them to be significant at the 0.001 level. What does this tell the students about their results?

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(2 marks)

(ii) How does the distribution of woodlice increase their chances of survival?

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(2 marks)

- 4 The table shows the diet of the large white butterfly and the enzymes it produces at different stages of its life cycle.

Stage in life cycle	Diet	Enzymes secreted by	
		salivary glands	mid-gut
Larva	Leaves	None	Amylase Maltase Proteases Lipase
Adult	Nectar	Sucrase	Sucrase

- (a) The larva and adult of the large white butterfly occupy different ecological niches. Explain how the diets and enzymes secreted are related to the demands of these stages of the life cycle.

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(3 marks)

- S (b) Leaves contain little glucose, yet large amounts of glucose can be found in the midgut of the larva of the large white butterfly. Explain why.

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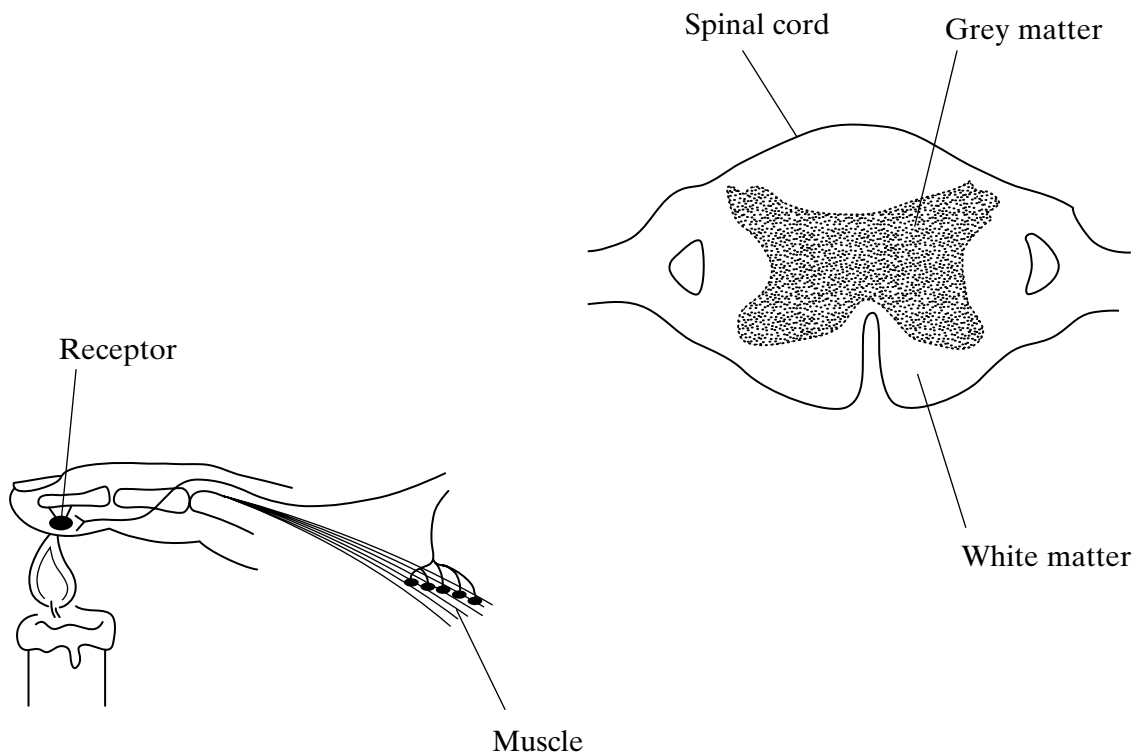
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(2 marks)

- 5 The diagram shows part of a simple reflex arc containing three neurones.



- (a) Complete the diagram by drawing and labelling the structures that conduct impulses into, through, and out of the spinal cord. (3 marks)
- (b) Explain how synapses ensure that a nerve impulse is transmitted in only one direction.

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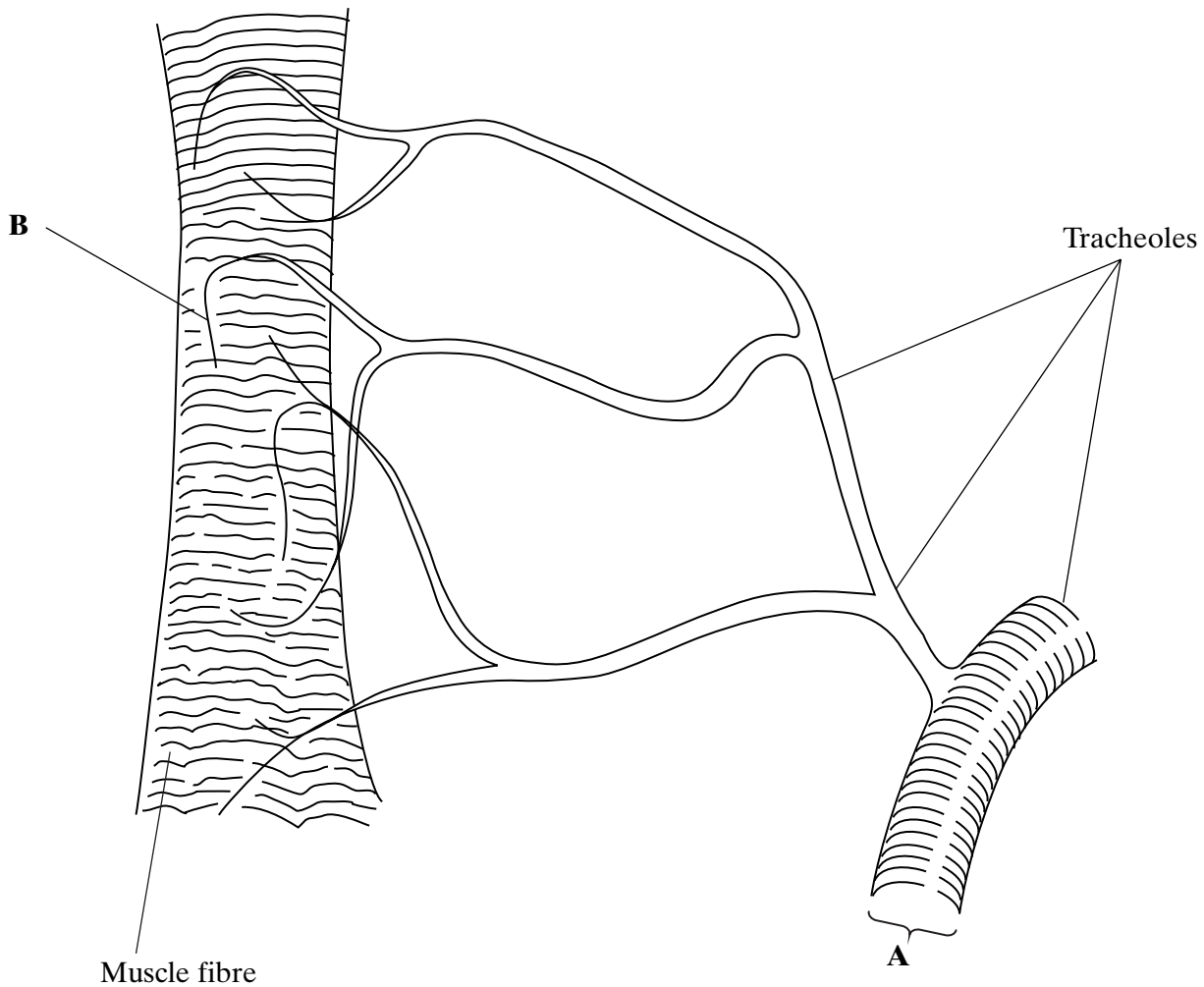
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(2 marks)

- 6 The drawing shows some tracheoles that carry air to a muscle fibre in an insect.



- (a) (i) Explain how the structure of the gas exchange system of an insect ensures that there is a large surface area for gas exchange.

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.....
(1 mark)

- (ii) Describe **one** way in which the transport of oxygen to a muscle in an insect is different from that in a fish.

.....
.....
(1 mark)

- S** (b) The diameter of the tracheole at point **A** is $20\mu\text{m}$. Calculate the magnification of the drawing. Show your working.

Answer: magnification =
(2 marks)

- S** (c) Breathing movements can bring about the mass flow of air as far as point **B**. What causes the diffusion of oxygen molecules from **B** into a muscle fibre?

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(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

7 Most nitrogenous waste material comes from surplus protein in the diet.

(a) **Figure 1** shows some of the important steps in the formation of urea in mammals.

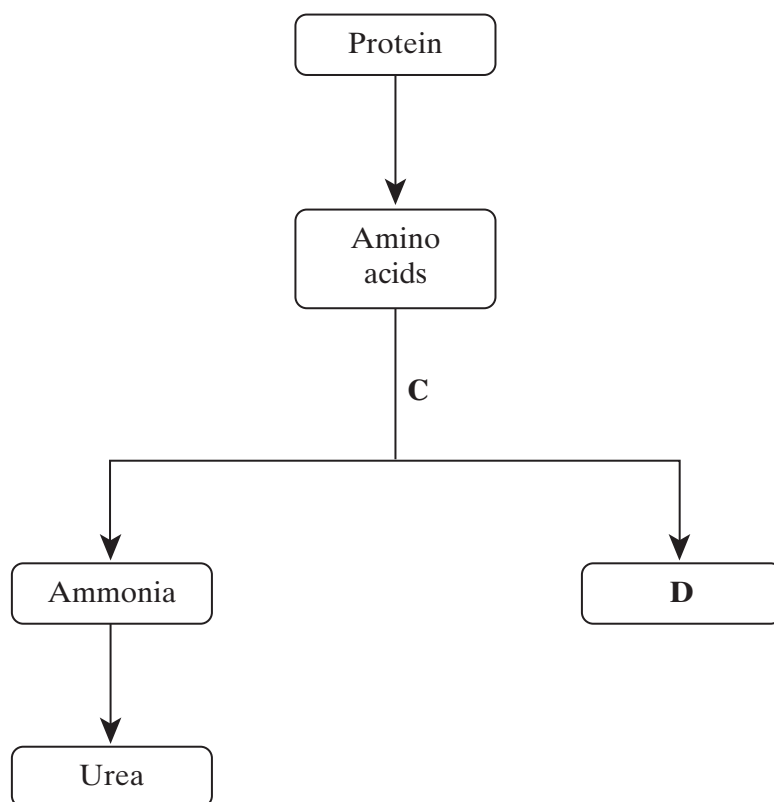


Figure 1

S (i) Why are protein molecules considered to be polymers?

.....

 (1 mark)

(ii) Name process **C**. (1 mark)

S (iii) Describe what happens to the part of the amino acid molecule labelled **D**.

.....

 (2 marks)

- (b) Tadpoles of the common frog live in freshwater ponds. Over a period of weeks, they undergo metamorphosis as they develop into adult frogs and move onto land. **Figure 2** shows the proportions of nitrogenous waste excreted as ammonia and as urea during the time after the tadpole hatches from the egg.

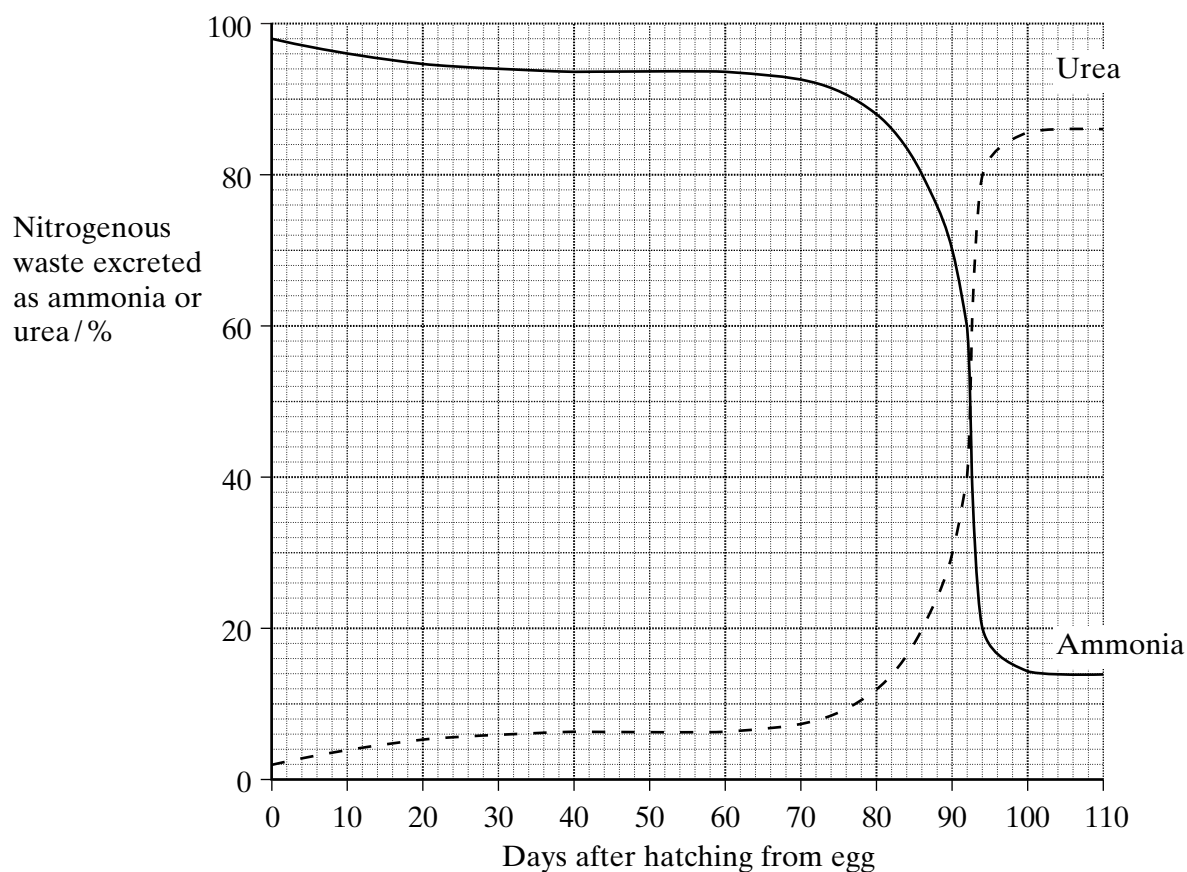


Figure 2

- (i) Describe the changes in proportions of the two excretory products over the period shown.

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(2 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

- (ii) Suggest an explanation for the changes in the proportions of ammonia and urea excreted.

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(4 marks)

- S (c) In the first convoluted tubule of a human nephron, sodium ions, glucose molecules and water molecules are reabsorbed into the blood plasma. **Figure 3** illustrates how these substances are reabsorbed.

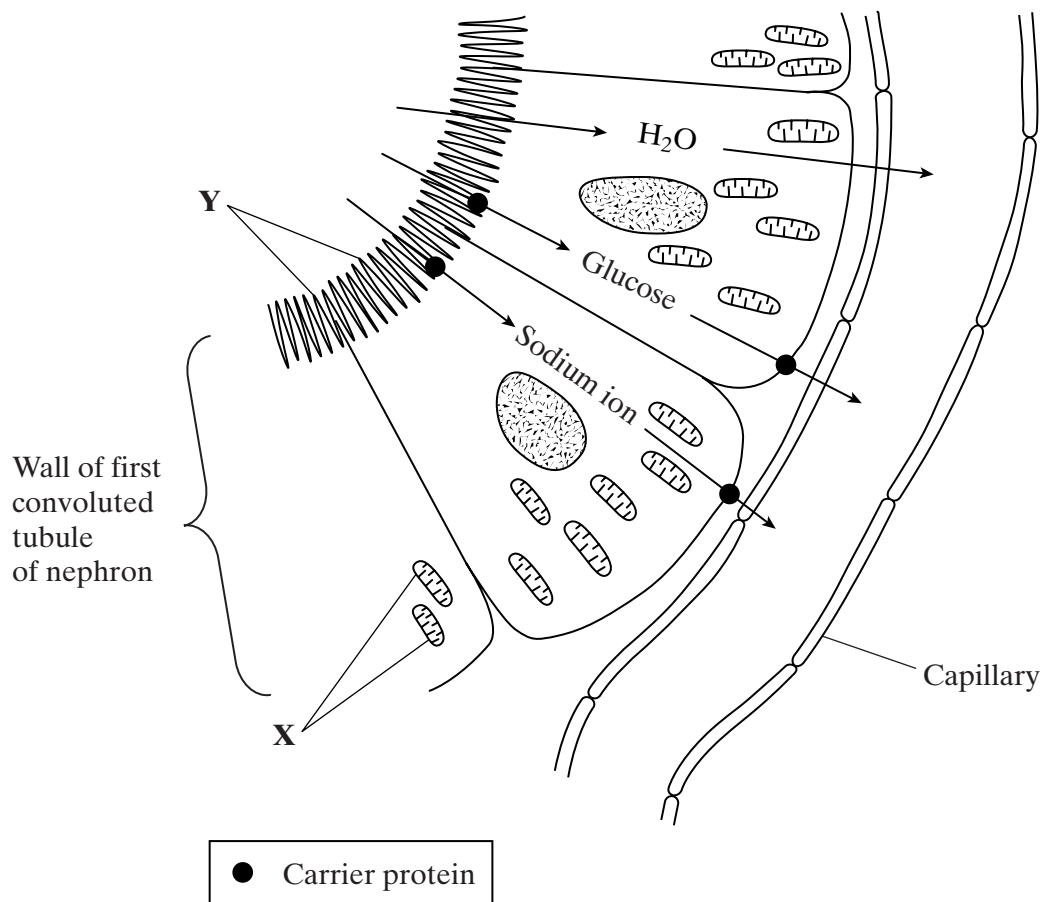


Figure 3

- (i) Explain the large number of the organelles labelled **X** in these cells.

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(2 marks)

- (ii) Give **two** differences between the process by which water enters the capillary from the epithelial cell and that by which glucose and sodium leave the epithelial cell.

1

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2

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(2 marks)

- (iii) Explain the importance of the structures labelled **Y** on the epithelial cells.

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(1 mark)

TURN OVER FOR THE NEXT QUESTION

- 8 (a) The graphs in **Figure 1** show the relationship between the membrane potential of an axon membrane and the numbers of Na^+ (sodium ion) channels and K^+ (potassium ion) channels that are open.

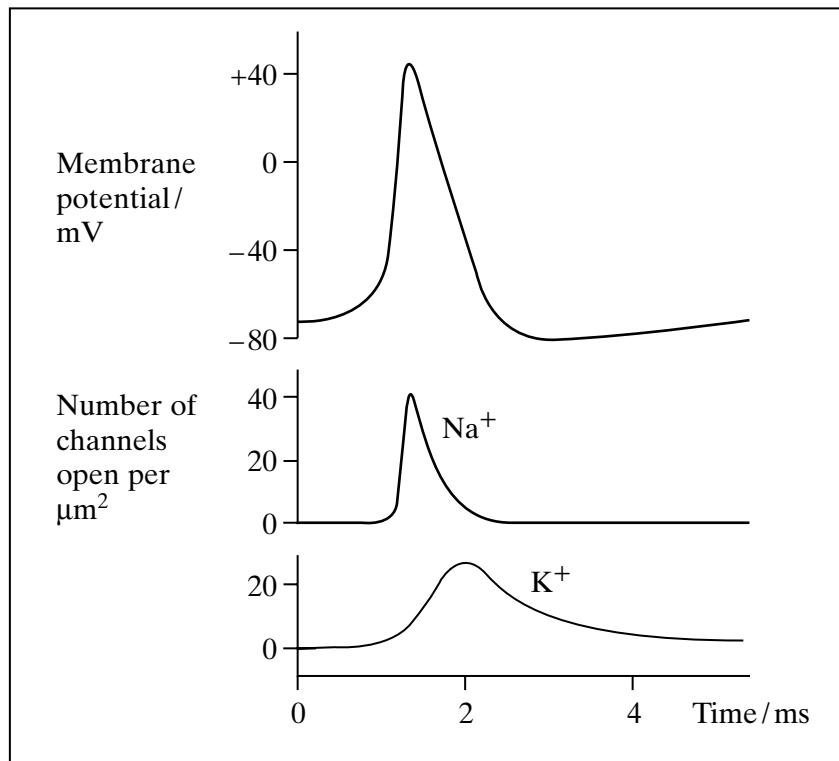


Figure 1

Using the information in the graphs, explain how

- (i) the action potential is generated;

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(2 marks)

- (ii) the axon membrane is repolarised.

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(2 marks)

- (b) The secretion of gastric juice by the stomach is stimulated by nerves and by hormones. **Figure 2** shows the volume of gastric juice secreted following nervous stimulation and hormonal stimulation.

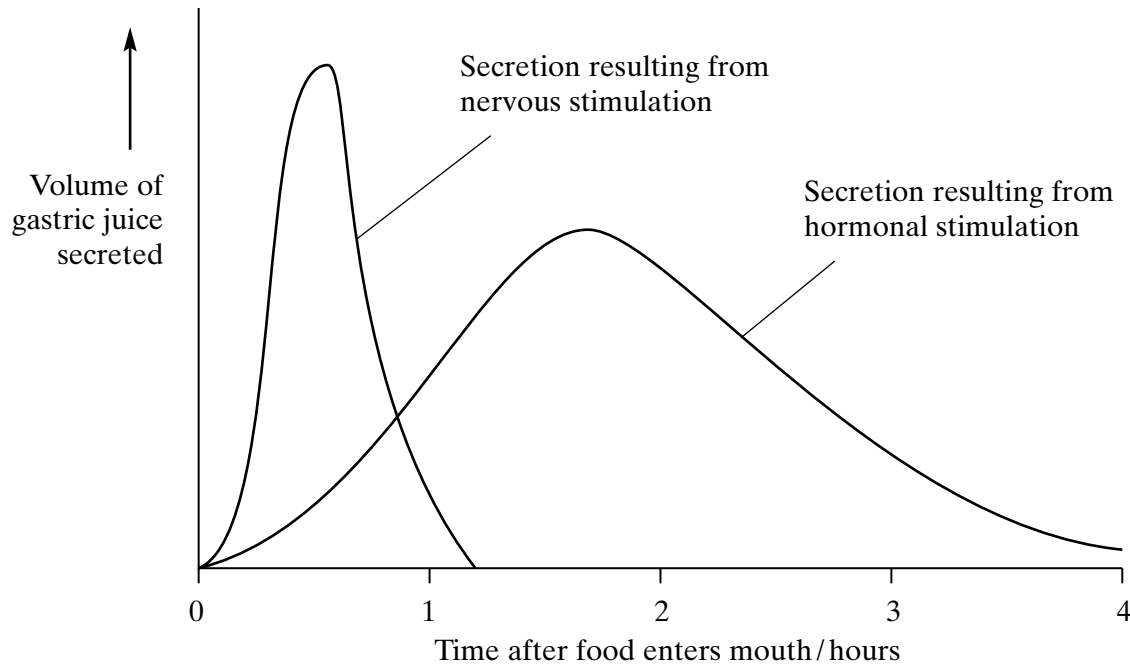


Figure 2

Give **two** differences between the nervous and hormonal control of the secretion of gastric juice. Use information in the graph to illustrate your answer.

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2

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(2 marks)

- (c) Gastric juice contains pepsin.

- (i) Pepsin is produced as inactive pepsinogen. What is the advantage of this?

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(ii) Pepsin is an endopeptidase. What is an *endopeptidase*?

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(1 mark)

(iii) What is the advantage in endopeptidases acting on proteins before exopeptidases do?

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(2 marks)

S (d) When pepsin leaves the stomach it enters the small intestine. Explain how pepsin is inactivated by the high pH in the small intestine.

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(4 marks)

9 Some organisms are adapted for living in hot, dry environments.

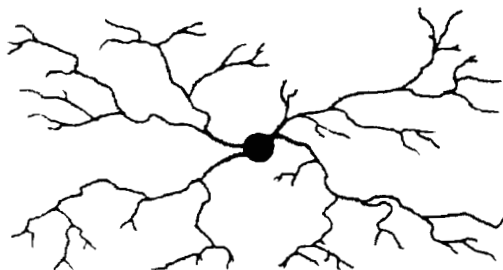
(a) The drawing shows a cactus, which is a xerophytic plant.

A Extensive
root system

Root system seen
from the side

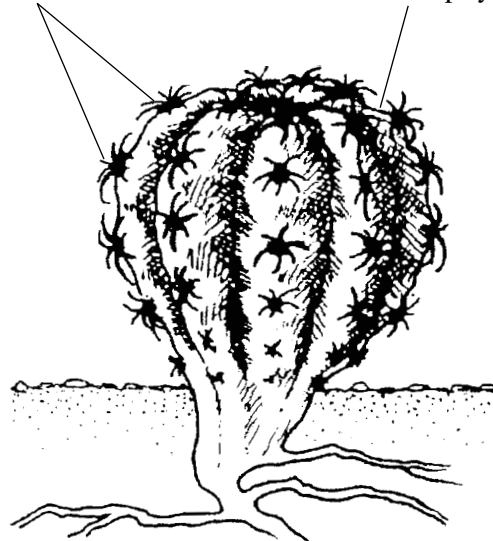
Soil surface

Root system seen
from above



B Leaves reduced
to spines

C Cells in epidermis of stem
contain chlorophyll



(i) Explain how each of the features, **A**, **B** and **C**, adapt this cactus to life in a hot desert.

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(6 marks)

QUESTION 9 CONTINUES ON THE NEXT PAGE

- S** (ii) Explain how feature **B** could have evolved to be present in all plants of this species.

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(4 marks)

- (b) Explain what causes the activity of reptiles living in a desert to vary greatly over a twenty-four hour period.

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(5 marks)

END OF QUESTIONS