



## **GCE Biology**

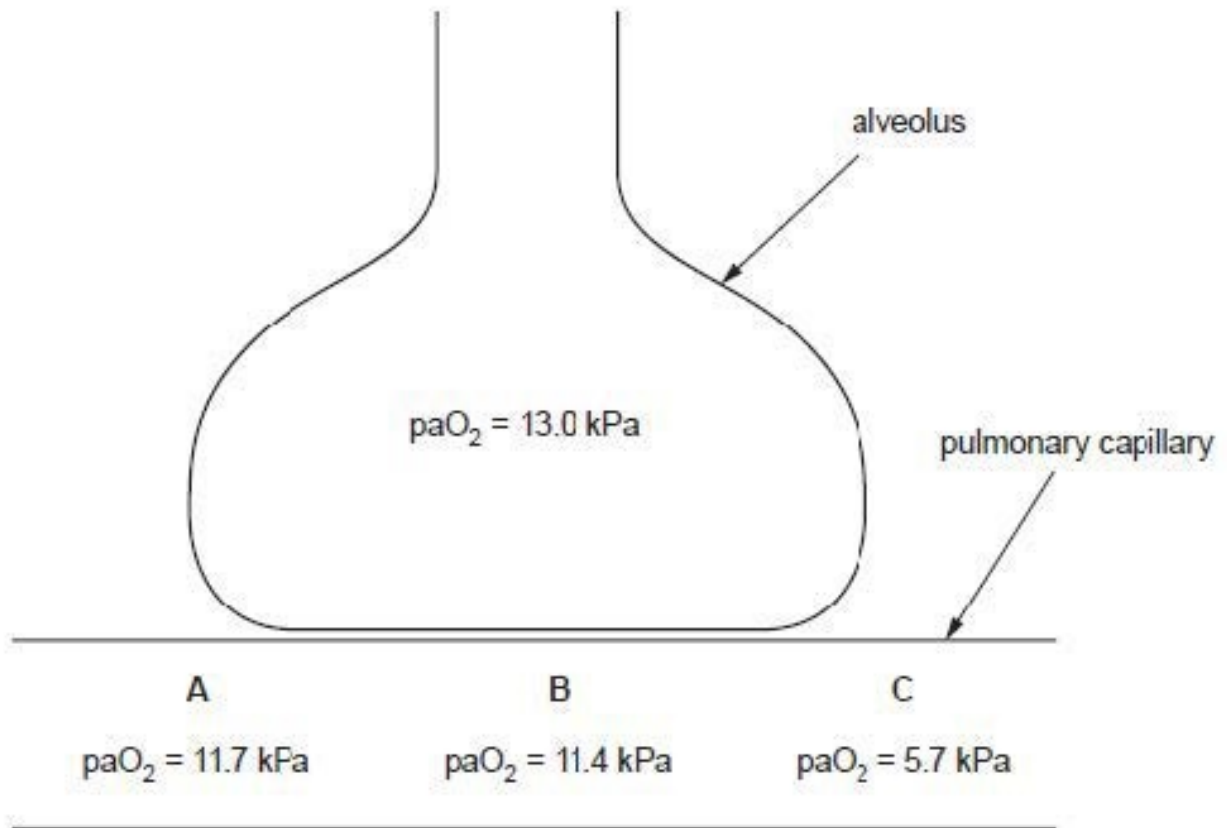
S21-A400U30-1

### **Assessment Resource 19**

Requirements for Life Resource H

Answer all questions.

1. Gas exchange in the alveoli relies on maintaining a concentration gradient between the air in the alveoli and the blood. The diagram below shows the oxygen levels ( $paO_2$ ) in the alveoli and at three points along a pulmonary capillary.



- (a) (i) Describe two ways that an oxygen concentration gradient is maintained between alveolar air and blood. [2]

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- (ii) Explain how the information in the diagram shows that A is the venous end of the pulmonary capillary. [1]

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- (iii) The haemoglobin in blood leaving the lungs is not fully saturated with oxygen but in most healthy people reaches a value of 98 to 99%. Suggest two reasons for this. [2]

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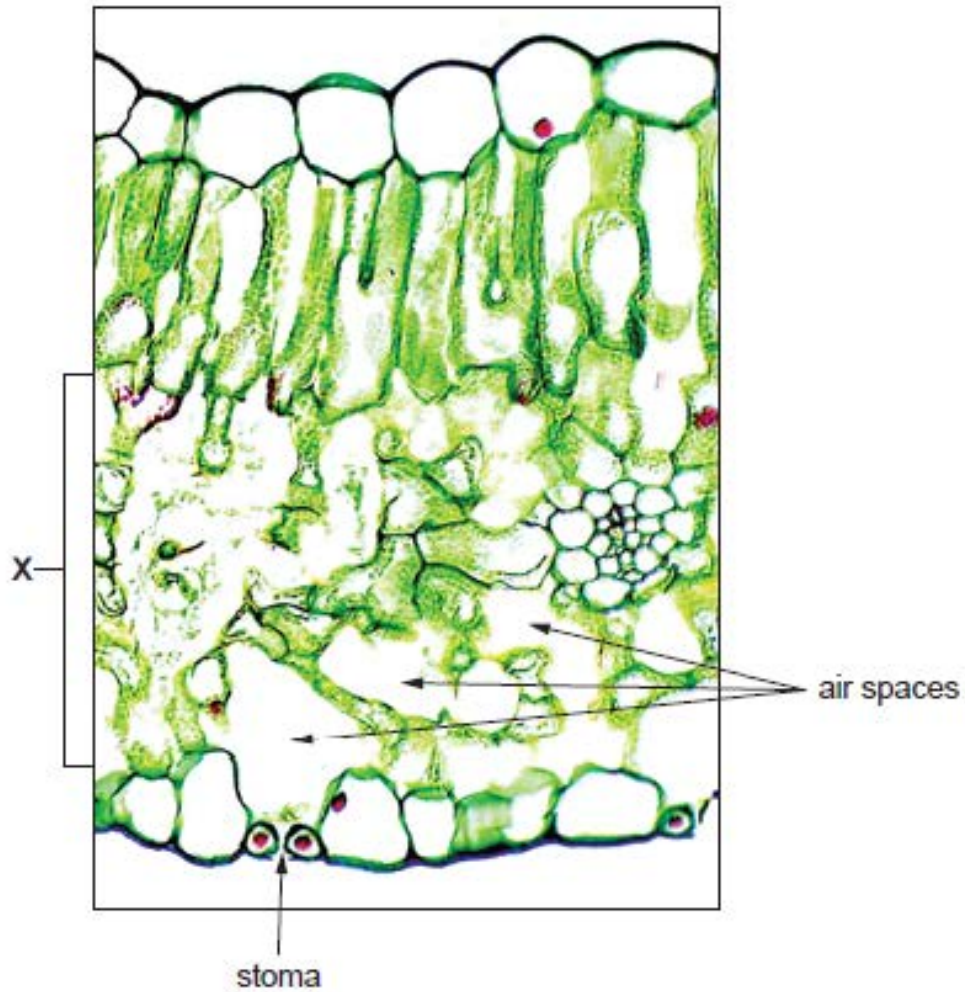
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- (iv) One function of the lungs is the excretion of carbon dioxide. State two forms in which carbon dioxide is transported to the lungs for excretion. [2]

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- (b) In plants, gas exchange takes place directly between the cells and the air in the air spaces in the tissues. Exchange between the air in the air spaces and the atmosphere is through stomata.  
The photomicrograph below shows a section through part of a lily leaf (*Lilium sp.*).



- (i) Name the tissue labelled X on the diagram. [1]

- (ii) Explain why the rate of gas exchange between the air spaces of the leaf and the leaf tissues is lower than between the alveoli and the blood of a mammal. [3]

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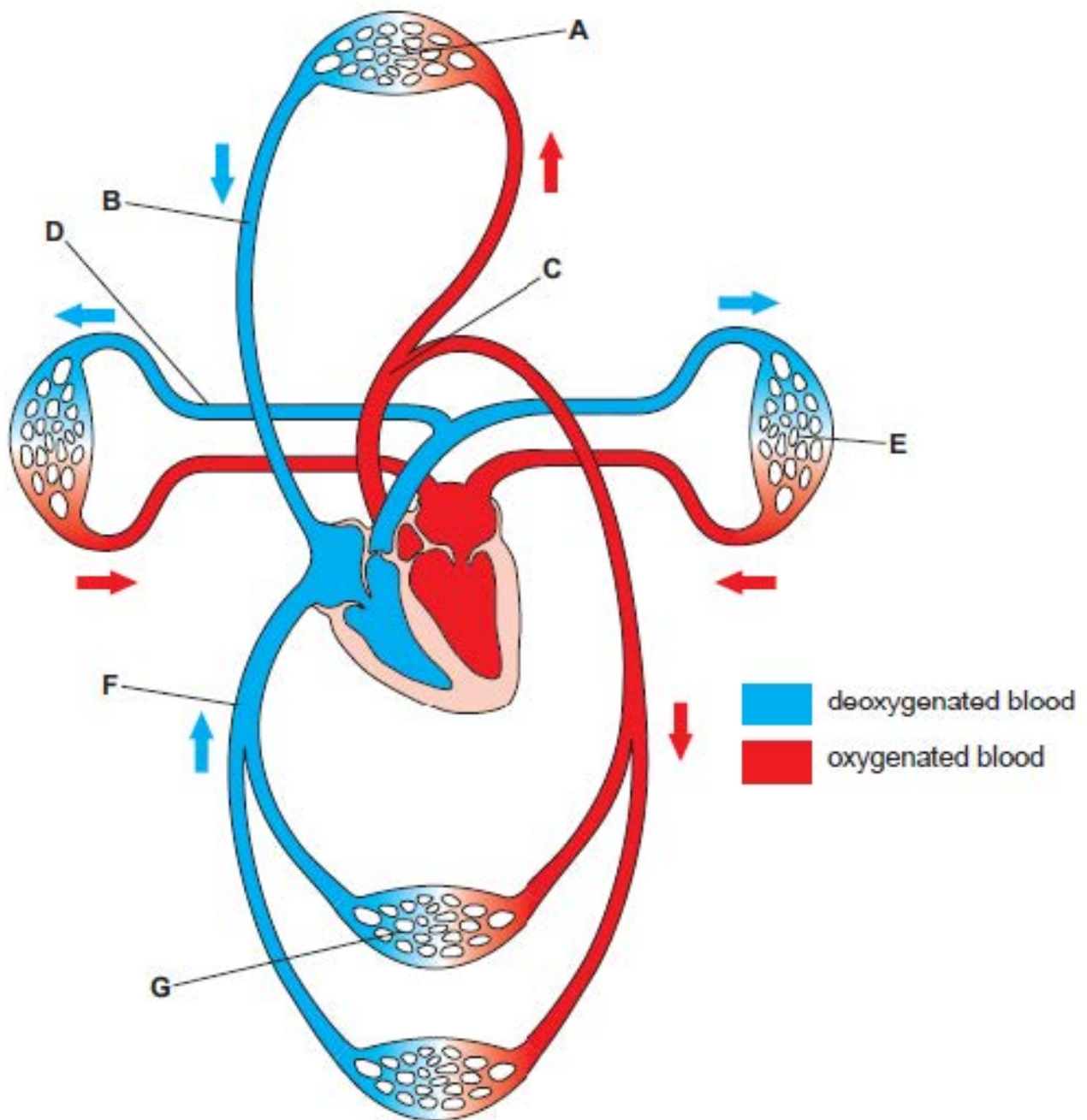
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2. Mammals have a double circulatory system as shown in the diagram below. The arrows show the direction of blood flow.



- (a) Using only the letters A to G from the diagram, identify the following (letters may be used once, more than once or not at all): [3]
- (i) parts of the pulmonary circulation ..... [3]
  - (ii) blood pressure is maintained by elastic recoil ..... [3]
  - (iii) blood flow is maintained by contraction of skeletal muscle and breathing movements ..... [3]

(b) Use the information provided in the table below to answer the questions that follow.

|                      | Total number of vessels | Mean length / cm | Mean diameter / cm | Total cross-sectional area / cm <sup>2</sup> | Total blood volume / cm <sup>3</sup> | Rate of blood flow / cm <sup>3</sup> s <sup>-1</sup> |
|----------------------|-------------------------|------------------|--------------------|--|--------------------------------------|--|
| aorta                | 1                       | 40               | 1.0                | 0.8  | 32                                   | 28   |
| other large arteries | 40                      | 20               | 0.3                | 3  | 60                                   | 7.8  |
| arterioles           | $4 \times 10^7$         | 0.2              | 0.002              | 124  | 25                                   | 1.18   |
| capillaries          | $1.2 \times 10^9$       | 0.1              | 0.0008             | .....  | 60                                   | 0.036  |

- (i) Using the formula below calculate the total cross-sectional area of the capillaries. Express your answer to three significant figures. [3]

$$\text{cross-sectional area} = \pi r^2$$

$$(\pi = 3.142)$$

Total cross-sectional area = ..... cm<sup>2</sup>

- (ii) Explain why a low protein diet would result in fluid retention in the tissues. [4]

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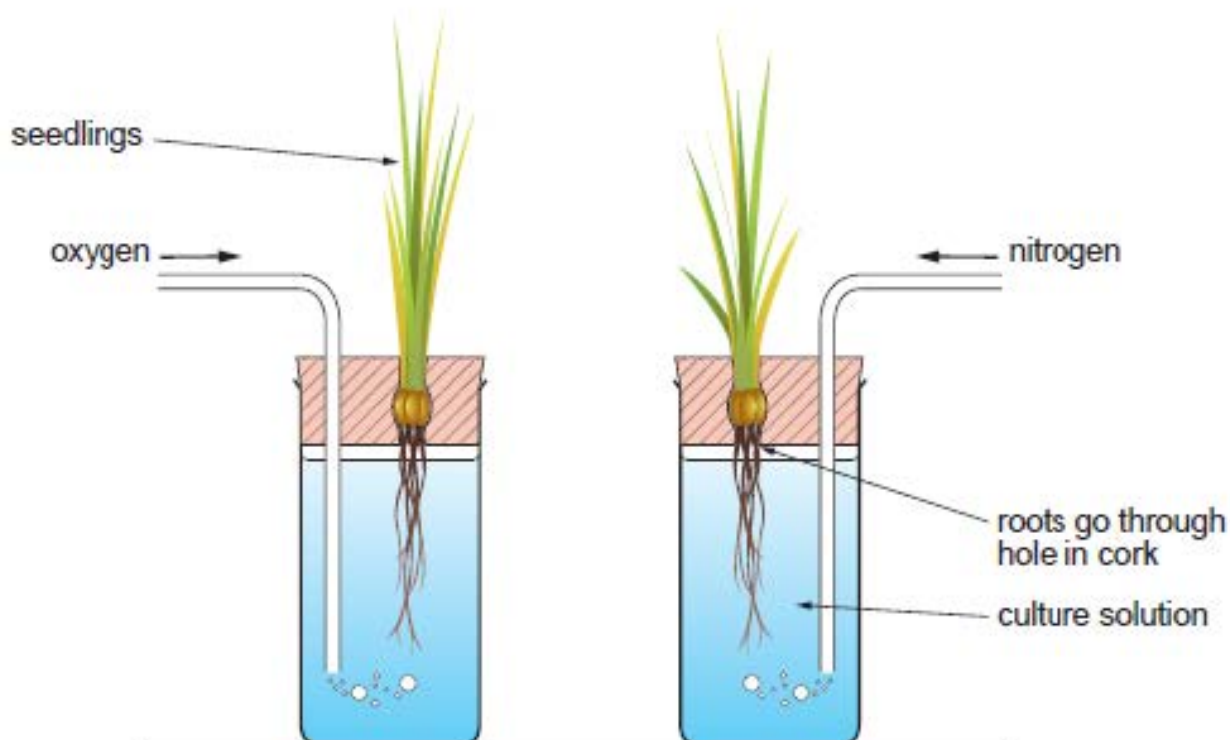
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3. Barley seedlings were grown as shown in the diagram below, each in the same volume of culture medium. The culture medium contained known concentrations of all the ions needed for plant growth. Oxygen was bubbled through the culture medium of one experimental set up and nitrogen was bubbled through the other.



The concentration of phosphate ions in each culture solution was measured every four hours for 24 hours. It was assumed that the decrease in the concentration of phosphate ions was due to uptake of phosphate ions by the plant roots.

- (a) (i) Identify the variables in this investigation: [2]

Independent variable

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Dependent variable

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(ii) Identify and justify two variables that should have been controlled in this experiment. [2]

Controlled variable I. ....

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Controlled variable II. ....

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(b) The results of the investigation are shown in the table below.

| Time/hours | Concentration of phosphate in culture solution /mmol dm <sup>-3</sup> |               |
|------------|---|---------------|
|            | with oxygen   | with nitrogen |
| 0          | 100.0   | 100.0         |
| 4          | 51.5  | 00.2          |
| 8          | 26.3  | 55.1          |
| 12         | 12.2  | 38.4          |
| 16         | 6.3   | 14.1          |
| 20         | 0.4   | 6.0           |
| 24         | 0.2   | 5.2           |

It was concluded that uptake of phosphate ions can occur by both active transport and diffusion. Explain how the evidence supports this conclusion. [2]

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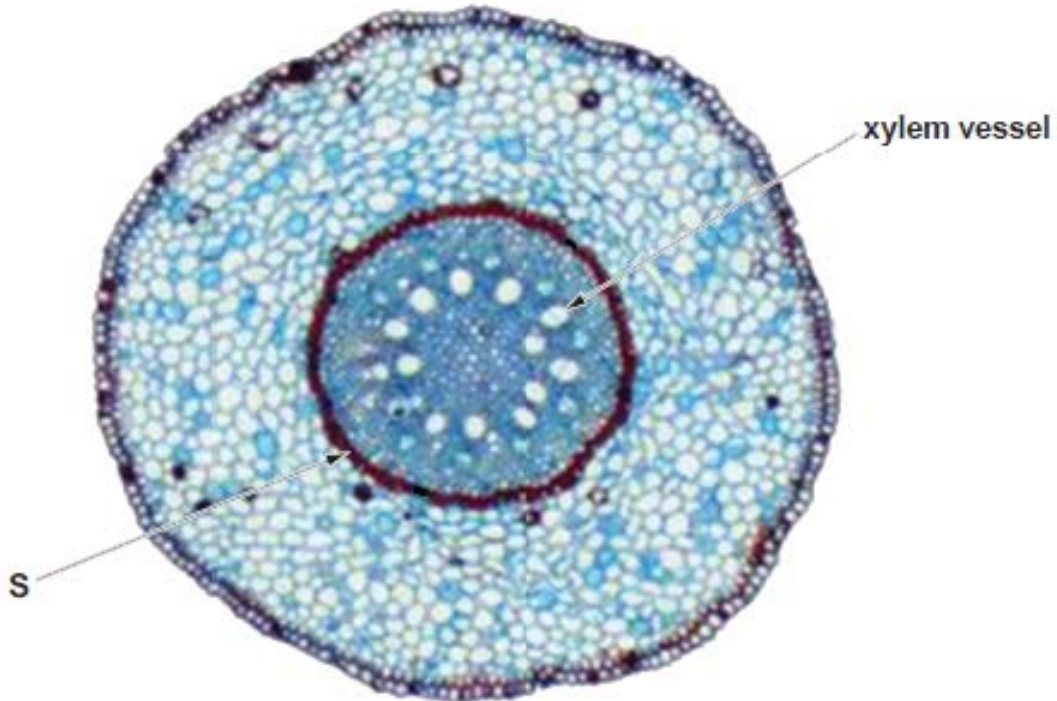
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- (c) In a different experiment, phosphate ions labelled with a radioactive isotope of phosphorus were found to move through the tissue layer labelled **S** on the image of T.S. root shown below.

It was found that radioactive phosphate ions were only found in the xylem when oxygen was bubbled through the culture solution.



- (i) Name tissue **S**. [1]

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- (ii) Explain how a feature of the cells found in tissue **S** means that oxygen is needed for the phosphate ions to pass into the xylem. [2]

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4. A study was carried out to investigate the changes to the digestive system of snakes when not fed for extended periods.

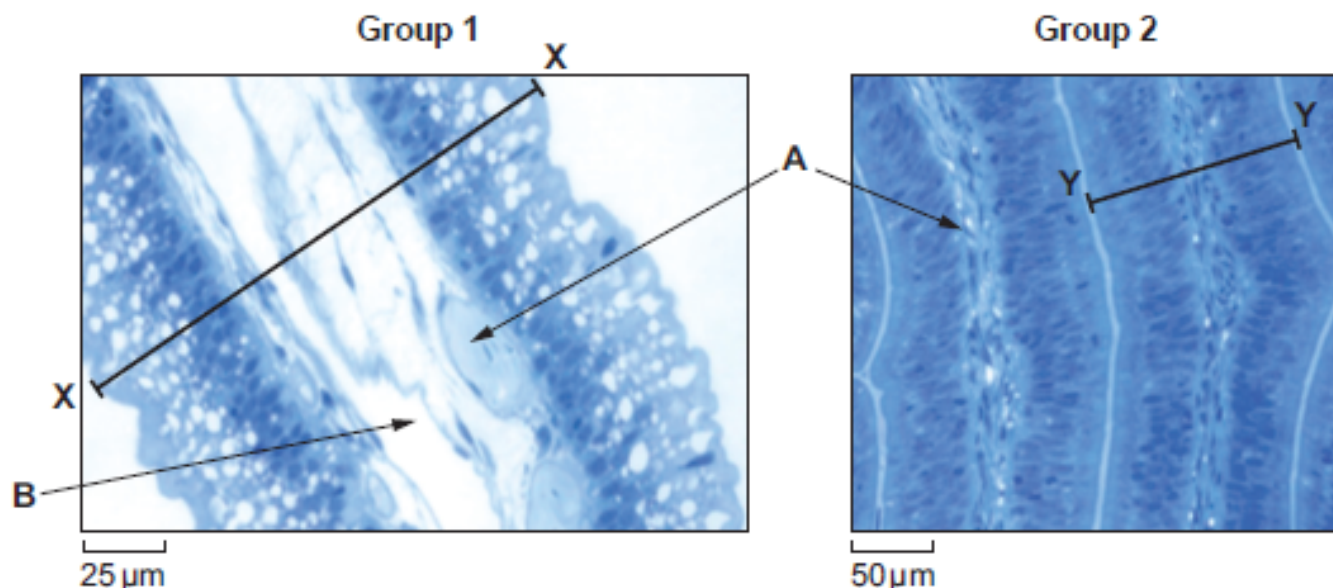
Burmese pythons (*Python molurus bivittatus*) are a species of snake that hide and wait for their prey to come close enough to catch and eat. Their prey is ingested whole and can weigh up to 25% of the snake's body mass. Digestion takes from 10 to 14 days. They can go without food for up to one year.

Two groups of snakes were fed for a four-week period as follows:

- Group 1      fed every third day  
Group 2      not fed during the period of the study

At the end of the study, snakes from each group were killed and the structure of the ileum examined using light and electron microscopy.

- (a) The images below show sections through villi from the ileum of a snake from each group.



- (i) The width of the villus shown by X-X in the Group 1 snake was 140  $\mu\text{m}$  and the width of the villus in the Group 2 snake at Y-Y was 96  $\mu\text{m}$ . Calculate the percentage decrease in the width of the villus when deprived of food. [2]

Percentage decrease in width = .....

(ii) Structure A absorbs glucose and structure B absorbs lipids following digestion. Name these structures. [1]

A .....

B .....

(iii) After four weeks, the following observations were made:

- structure B was not present in the villi of the snakes from Group 2
- structure A was always present in the villi of snakes from both groups

Explain why structure B was not needed in Group 2 snakes whereas structure A was essential for all snakes. [2]

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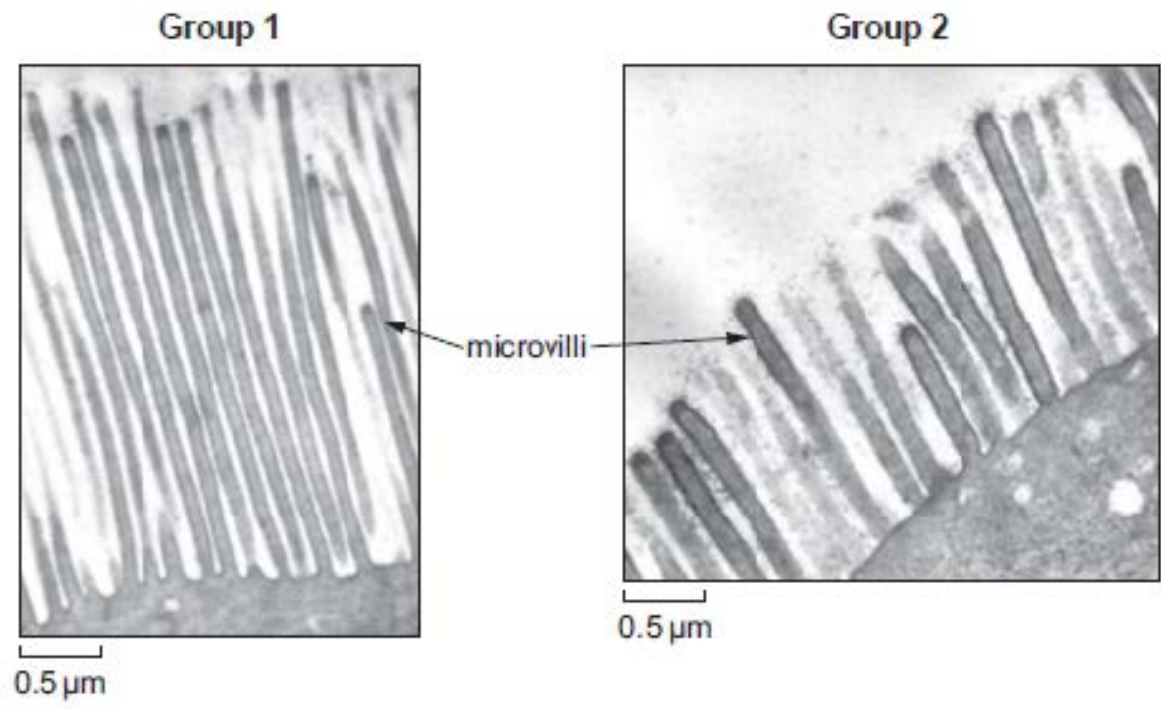
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(b) The electron photomicrographs below show high magnification images of the surface of the epithelial cells covering the villi of a snake from each of Groups 1 and 2.



Describe and explain the differences in the length and width of the microvilli seen in Group 1 compared to Group 2. [3]

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- (c) Electron microscopy also showed that the epithelial cells from the snakes in Group 1 had the following differences compared to those from Group 2.

| Group 1                          | Group 2                          |
|----------------------------------|----------------------------------|
| large number of mitochondria     | few mitochondria                 |
| cells arranged in a single layer | cells arranged in several layers |

Explain the observations that were made for Group 1.

[2]

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- (d) Not feeding animals might be considered unethical and cruel. Explain why not feeding these snakes for four weeks would not be considered an ethical issue, but there may be other ethical issues involved with this study. [2]

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