Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL

2400U20-1

S19-2400U20-1

BIOLOGY – AS unit 2
Biodiversity and Physiology of Body Systems

FRIDAY, 24 MAY 2019 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**8**	
3.	**12**	
4.	**11**	
5.	**6**	
6.	**13**	
7.	**14**	
8.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **8**.

The quality of written communication will affect the awarding of marks.

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Answer **all** *questions.*

1. *(a)* All living organisms belong to one of three domains: Eubacteria, Archaea and Eukaryota.

(i) State which of these domains contain organisms with a prokaryotic cell structure. [1]

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(ii) Many members of the domain Archaea are extremophiles. Explain the meaning of the term "extremophile". [1]

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(iii) Members of the kingdom Animalia are classified in the domain Eukaryota. State the other kingdoms that are classified in the domain Eukaryota. [1]

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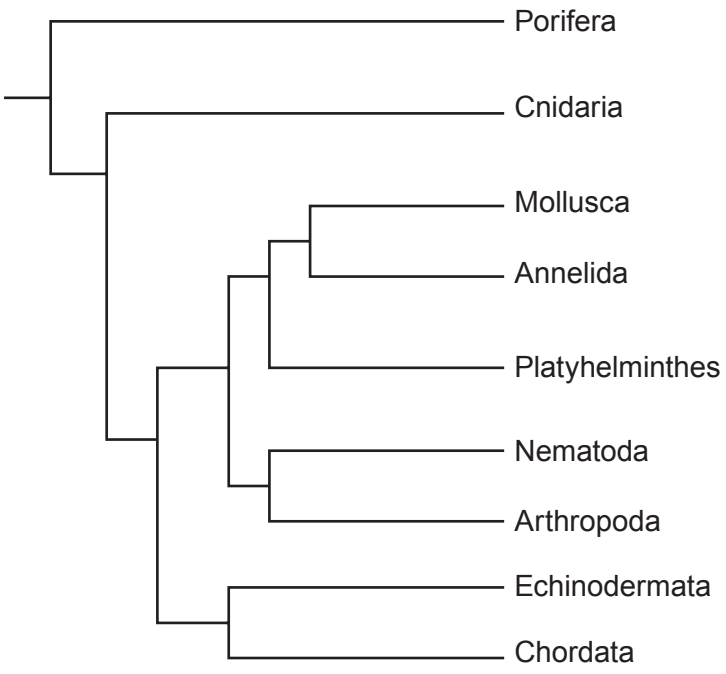
(b) The phylogenetic tree lists some of the various sub-groups of the kingdom Animalia.



(i) Name the taxonomic group to which these sub-groups belong. [1]

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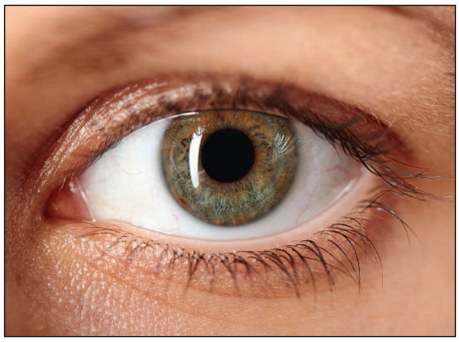
(ii) The photographs show the eye of an octopus and the eye of a human. Octopuses are molluscs and humans are chordates.

Octopus

Human



Using the phylogenetic tree opposite and your own knowledge, explain why the development of the eye in these species is an example of convergent evolution. [3]

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2. The table provides information about three animals.

	Annelid (e.g. earthworm)	Amphibian (e.g. adult frog)	Mammal (e.g. human)
Environmental conditions	Terrestrial (moist)	Terrestrial (moist)	Terrestrial
Gas exchange surface	Skin	Skin, buccal cavity and lungs	Lungs
Permeability of skin to gases	Permeable	Permeable	Impermeable
Mean skin surface area / mm^2		5×10^4	1.8×10^6
Mean body volume / mm^3	1.2×10^3	2.5×10^4	6×10^7
Mean surface area to volume ratio	3 : 1	2 : 1	0.03 : 1

(a) Calculate the mean skin surface area of the annelid. **Give your answer in standard form.** [2]

Surface area = ... mm^2

(b) The animals shown in the table have closed circulatory systems. Describe what is meant by a closed circulatory system and explain its role in these animals. [2]

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(c) The amphibian and the mammal possess mechanisms to ventilate their lungs.

Use the information in the table and your own knowledge, to explain why the amphibian does not need to ventilate its lungs when inactive, whereas the mammal must ventilate its lungs all the time. [4]

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3. The photograph shows a single leaf of white clover *(Trifolium repens)*. Each leaf has three leaflets.

Some white clover plants can produce cyanide. Those plants that can produce cyanide are called cyanogenic; those that cannot produce cyanide are called acyanogenic.

The leaves of cyanogenic plants can be damaged by slugs or by ice crystals when exposed to low temperatures. When cell membranes are damaged cyanide is released. Cyanide is toxic to the cells of animals.

(a) State why it is an adaptation for the clover to produce cyanide. [1]

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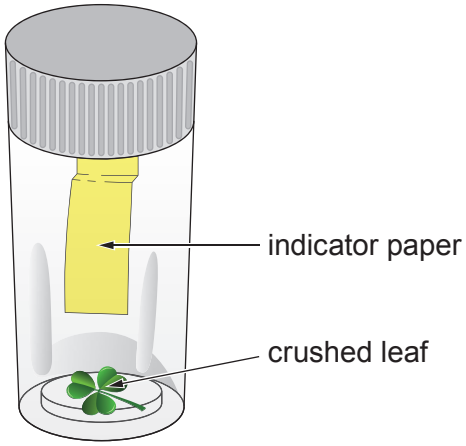
(b) To test different white clover plants for cyanide production, a single leaf from each plant is crushed in a few drops of water at the bottom of separate 50 mm × 15 mm glass tubes. A short slip of indicator paper is suspended in each tube. Each tube is then incubated for 2 hours at 40 °C. If cyanide is released it will turn the indicator paper from yellow to a reddish brown.



(i) Identify **two** controlled variables in this test. [2]

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(ii) Explain why the leaves are crushed before inserting the indicator paper. [1]

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(iii) The indicator paper contains a corrosive chemical. Describe a risk in performing this test and the control measure that should be taken to minimise the risk. [1]

Risk .....

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Control Measure .....

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(c) A researcher performed an investigation to discover if there was a correlation between altitude (distance above sea level) and the percentage of cyanogenic clover in a population.

A large number of sites were sampled at altitudes between 20 m and 240 m above sea level. Each site covered an area of 10 m × 10 m. At each site clover leaves were collected at random. Each leaf was then tested for cyanide production.

(i) Identify the independent and dependent variables in this investigation. [1]

Independent variable: .....

Dependent variable: .....

(ii) Describe a method that could be used at each site to collect clover leaves at random. [3]

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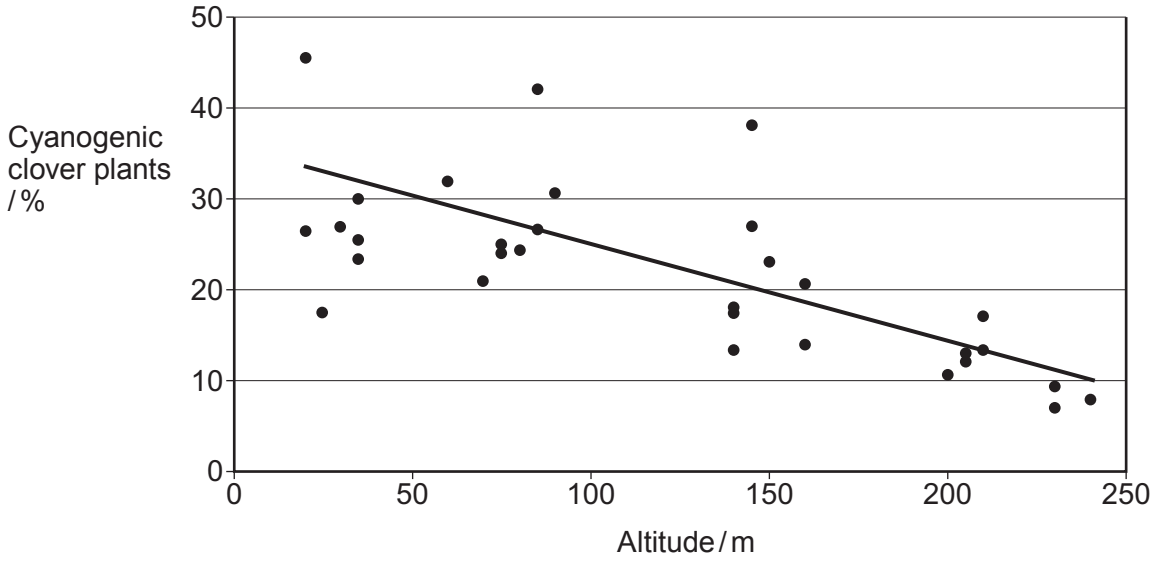
(d) The scatter diagram summarises the results of this investigation.



The researcher claimed that the reason for the change in the percentage of cyanogenic clover plants was due to differences in **environmental temperature**. Was the researcher justified in making this claim? Give a reason for your answer. [1]

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(e) Cyanogenesis in *Trifolium repens* is an example of genetic polymorphism. Explain what is meant by genetic polymorphism. [2]

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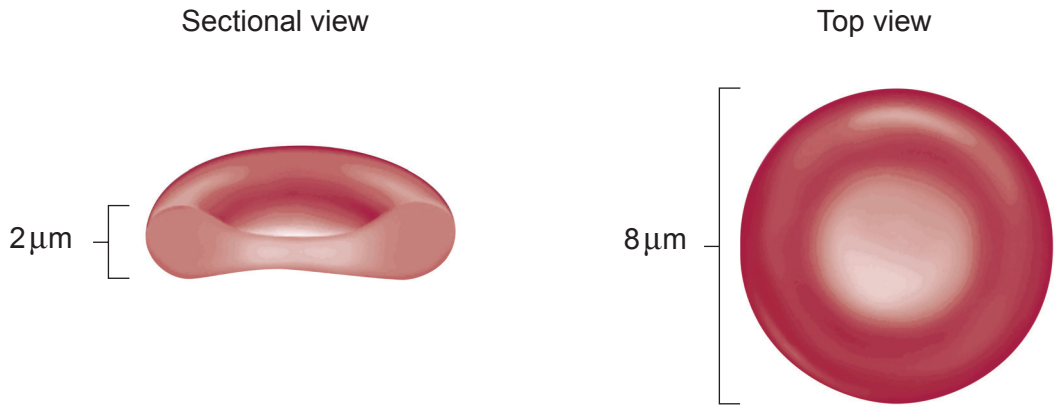
4. The main function of red blood cells (erythrocytes) is to carry oxygen from respiratory surfaces to respiring tissues.

The diagrams illustrate the structure of a red blood cell.



(a) Describe and explain how the structure of a red blood cell is related to its function. [3]

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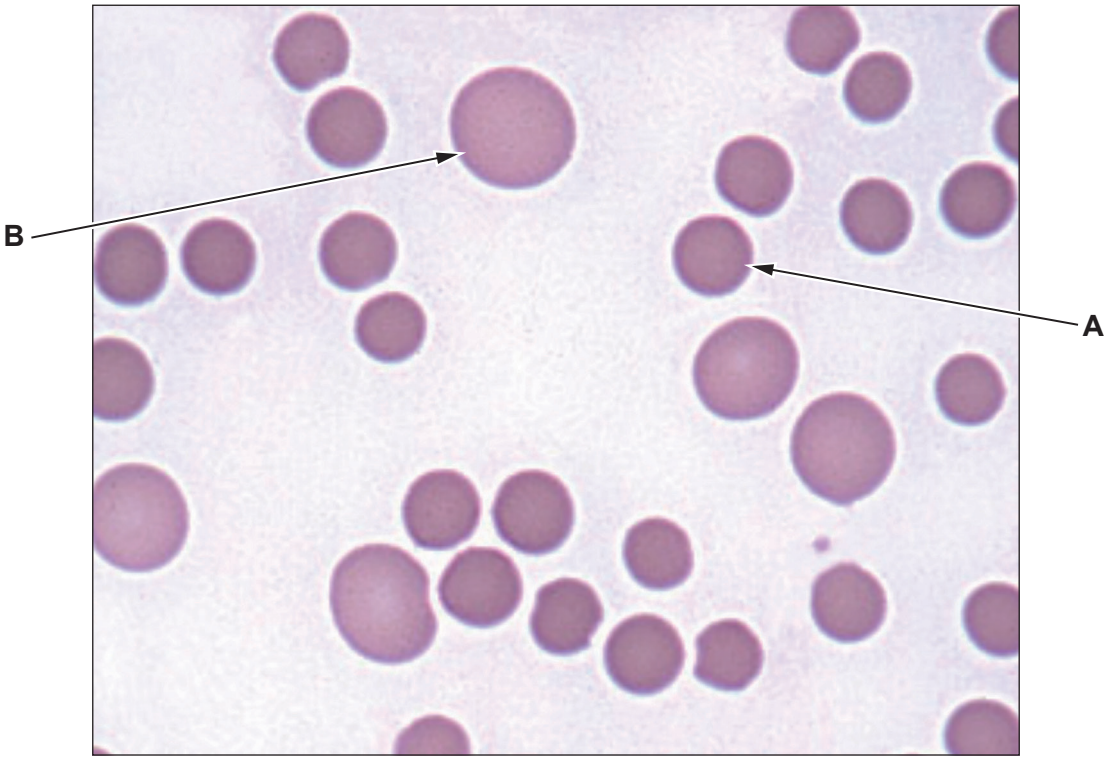
(b) Anaemia may be defined as a decrease in the oxygen carrying capacity of the blood.

Macrocytic anaemia is caused by a dietary deficiency of vitamin B12 resulting in the production of fewer red blood cells than normal. Some of these red blood cells are very large and are called macrocytes.

The photomicrograph shows red blood cells of an individual with macrocytic anaemia.



Cell **A** is a normal red blood cell. It has a diameter of 8 µm. Cell **B** is a macrocyte. Calculate the diameter of cell **B to the nearest micrometre**. [3]

Diameter = ... µm

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(c) A mean red blood cell volume that is higher than normal indicates macrocytic anaemia. The normal range is 80 – 95 μm^3. The mean volume of a red blood cell in μm^3 can be calculated by using the following formula.

$$\text{mean volume of a red blood cell} = \frac{\text{percentage volume of red blood cells in blood}}{\text{red blood cell count (cells per cubic millimetre)}} \times 10^7$$

(i) Calculate the mean volume of a red blood cell for a person with a red blood cell count of 4.5×10^6 cells per cubic millimetre where the percentage volume of red blood cells is 45%. [2]

Mean volume = ... μm^3

(ii) State, with a reason, whether this person has macrocytic anaemia. [1]

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(iii) Using the given information, suggest **two** reasons why macrocytic anaemia would cause a reduction in the oxygen carrying capacity of blood. Explain your answers. [2]

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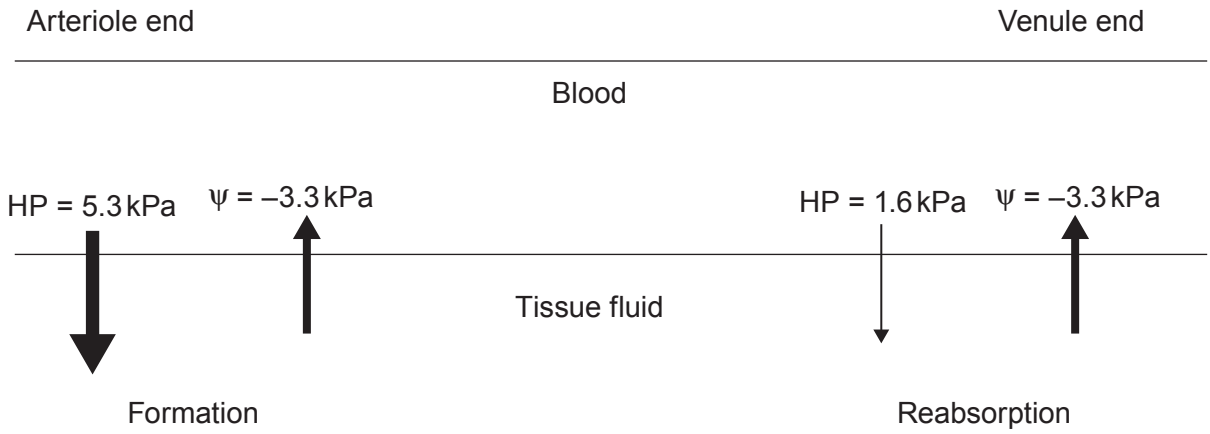
5. Tissue fluid is formed at the arteriole end of a capillary bed and water is reabsorbed at the venule end.

The formation of tissue fluid and reabsorption of water occurs as a result of two opposing forces: the hydrostatic pressure of blood and osmotic pressure. Proteins in the plasma maintain a low water potential in the blood.
The diagram illustrates the differences in hydrostatic pressure (HP) and water potential (ψ) between blood and tissue fluid in a capillary bed.



(a) Use the information in the diagram to calculate the pressure difference that results in:

(i) tissue fluid formation; [1]

..... kPa

(ii) water reabsorption. [1]

..... kPa

(iii) Name the vessel that removes excess tissue fluid. [1]

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(b) Explain why fluid will accumulate in the tissues of a person whose diet is poor in protein. [3]

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6. The photograph shows the skull of a wild boar *(Sus scrofa)*.

(a) Like humans, wild boars are omnivores. From the photograph describe **one** feature of the wild boar's dentition that is typical of a carnivore's dentition and **one** feature that is typical of a herbivore's dentition. For each feature explain how it is suited to the diet of the wild boar.

(i) Carnivore. [1]

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(ii) Herbivore. [1]

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(b) The alimentary canal of a wild boar is very similar to that of a human. **State the region** of the human alimentary canal where the digestion of the following dietary constituents **begins**: [2]

Lipids .....

Starch .....

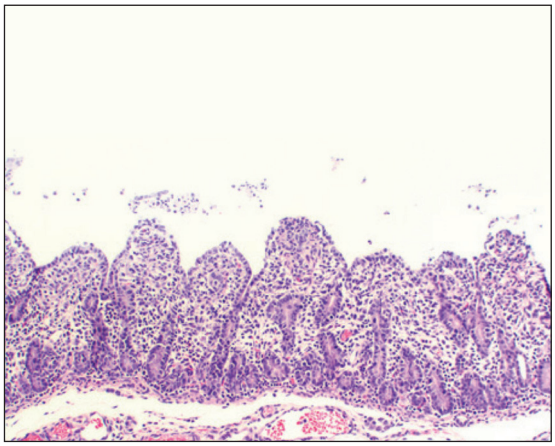
Proteins .....

(c) Porcine epidemic diarrhoea (PED) is a condition that is caused by a virus and leads to severe gastrointestinal disease in wild boars. The virus infects and destroys epithelial cells at the tips of villi in the small intestine. Symptoms include weight loss and diarrhoea.

The photomicrograph shows the lining of the small intestine of a normal wild boar and of a wild boar suffering with PED.

Normal wild boar

Wild boar with PED



With reference to the photomicrographs and your own knowledge, describe and explain how the viral infection causes weight loss and diarrhoea. [5]

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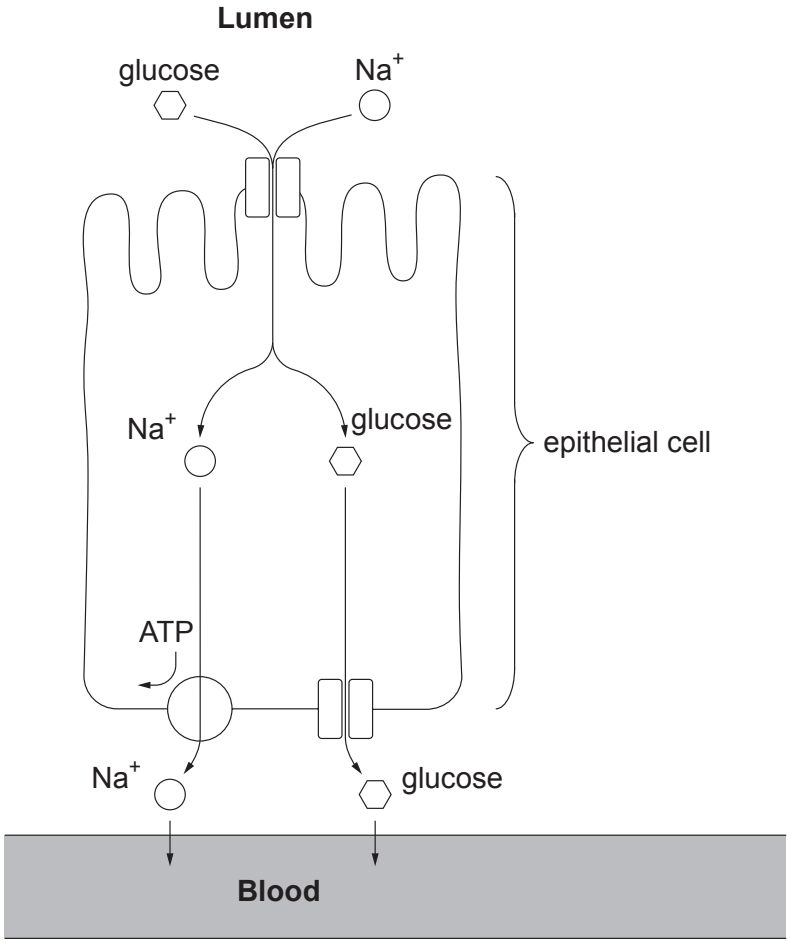
(d) The epithelial cells of villi contain many mitochondria. These supply ATP for the active transport of sodium ions (Na^+) out of epithelial cells and eventually into blood capillaries.

Use the diagram below and your own knowledge to explain how the active transport of sodium ions out of the epithelial cell results in passage of glucose from the lumen of the small intestine, across the epithelium and into the bloodstream. [4]



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7. An investigation was performed to discover the effect of light intensity on the stomatal density of the leaves of coffee plants *(Coffea arabica)*. The drawings below were obtained using the high power objective of a light microscope. **Diagrams 1** and **2** show the number of stomata in the field of view on the lower epidermis for a leaf in full sun and a leaf in shade. Both diagrams are drawn to the same scale.

Diagram 1

Leaf growing in full sun

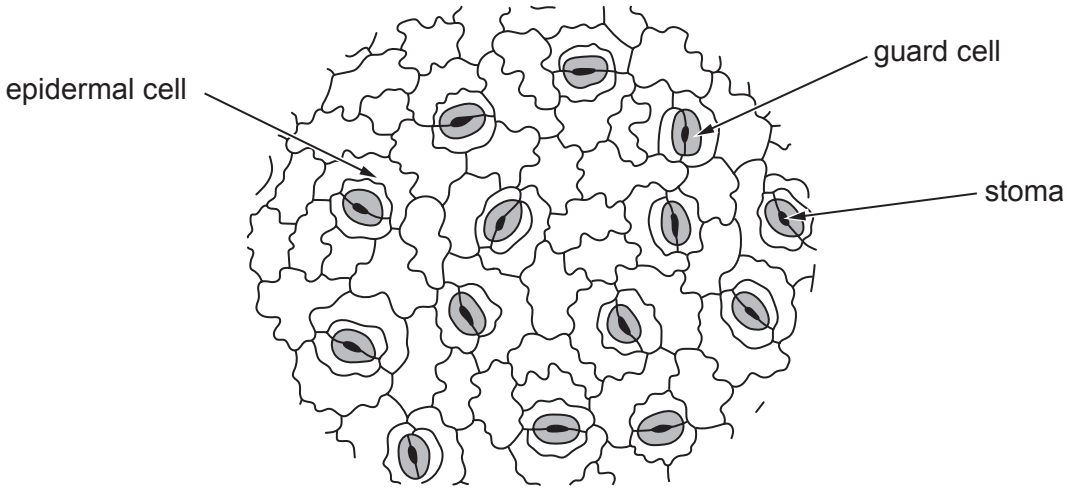
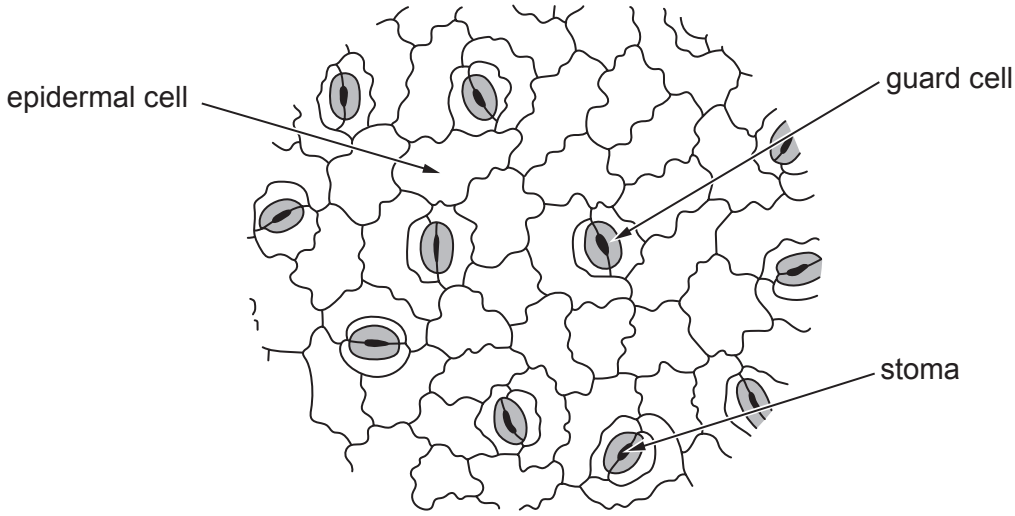


Diagram 2

Leaf growing in shade



(a) With **the exception of shape**, state **two** structural features of guard cells that are different from epidermal cells. [2]

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(b) (i) Use the following information to calculate the number of stomata per mm^2 on the leaf grown in full sun. Show your working in the space provided. **Give your answer to three significant figures**. [4]

Number of stomata = 14

Diameter of field of view = 0.3 mm

Area of a circle = πr^2

r = radius of a circle

π = 3.14

Number of stomata = ... stomata per mm^2

(ii) The stomatal index is the ratio of the number of stomata to the total number of epidermal cells. It is calculated using the following equation.

$$SI = \frac{S}{S + E} \times 100$$

SI = stomatal index.
S = number of stomata per unit area.
E = number of epidermal cells in the same unit area.

Table 1 gives the stomatal indices for the leaf grown in full sun and the leaf grown in shade.

Table 1

	Leaf grown in full sun	Leaf grown in shade
S	14	11
S + E	77	61
SI	18.2	18.0

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For a given species, the stomatal number may vary considerably but the stomatal index is relatively constant. Explain this observation with reference to **Table 1** and **Diagrams 1** and **2**. [2]

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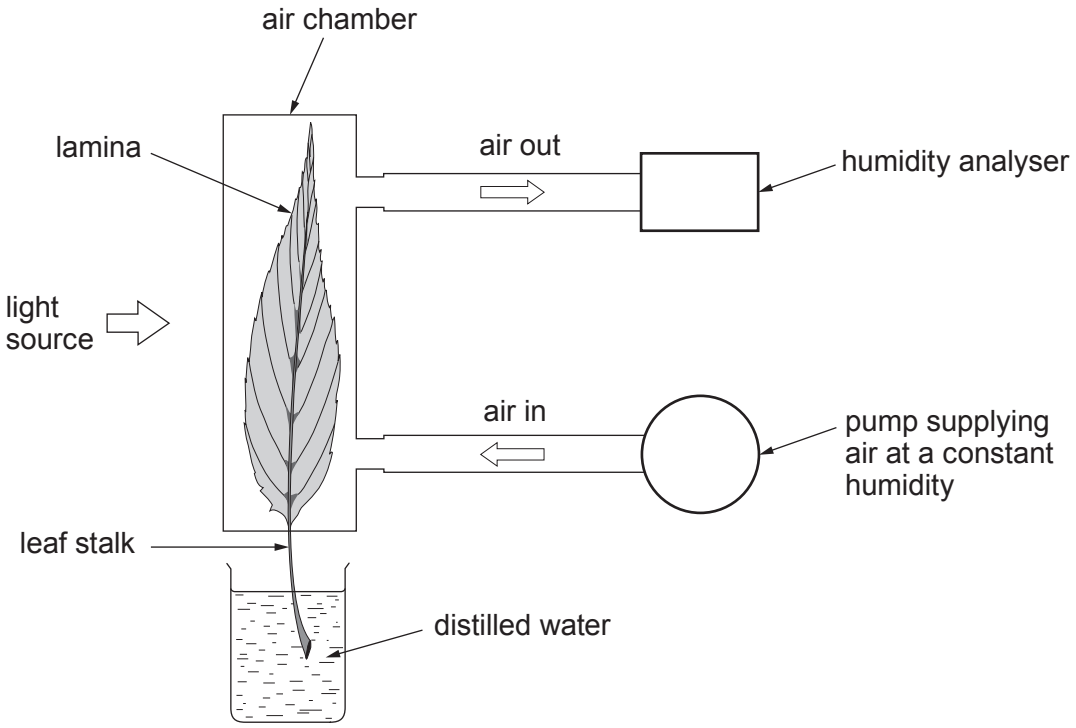
(c) Abscisic acid (ABA) is a plant hormone that is produced in roots in response to soil water shortage. It is then transported to guard cells. An investigation was carried out to determine the effect of ABA on the humidity of air surrounding a bean leaf *(Phaseolus vulgaris)*.

A bean leaf stalk was cut underwater and the leaf inserted into an illuminated, transparent chamber. The lamina of the experimental leaf was held at right angles to the light source. The leaf was supplied with air at a constant humidity. The humidity of the air leaving the chamber was then measured using an analyser. The apparatus used is shown in **Diagram 3**.

Diagram 3



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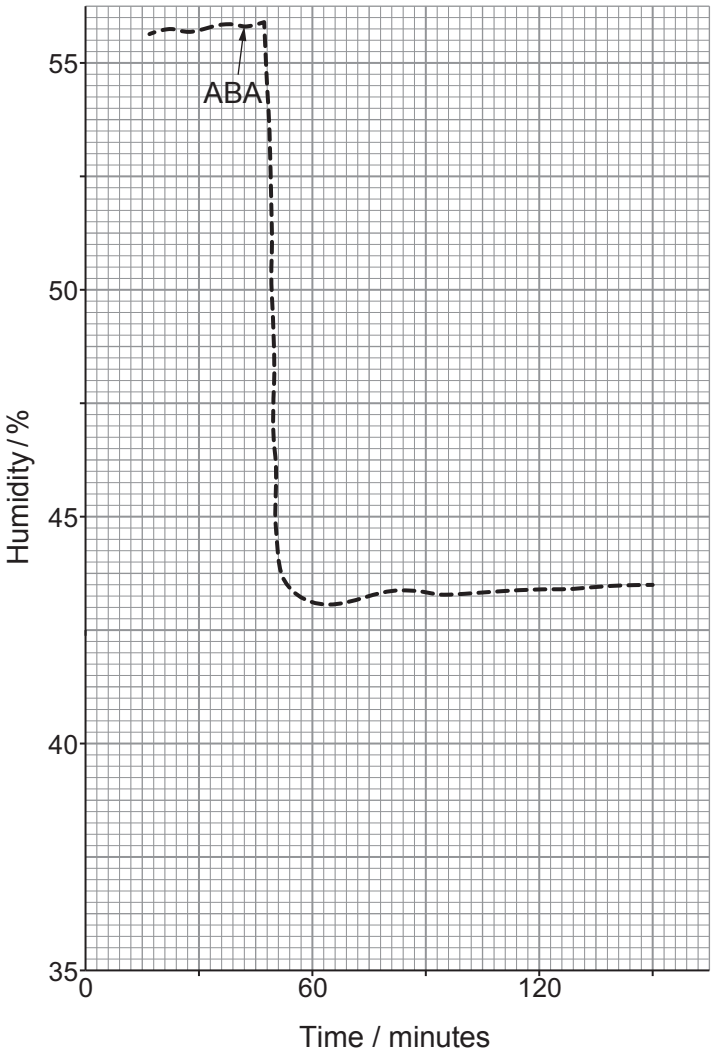
After 40 minutes, ABA was added to the distilled water. The results are shown in **Graph 1**.

Graph 1



(i) Explain why the bean leaf stalk was cut underwater. [2]

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(ii) Describe and explain the change in the humidity of the air leaving the leaf chamber **after** the addition of ABA. Explain how this change benefits the bean plant. [4]

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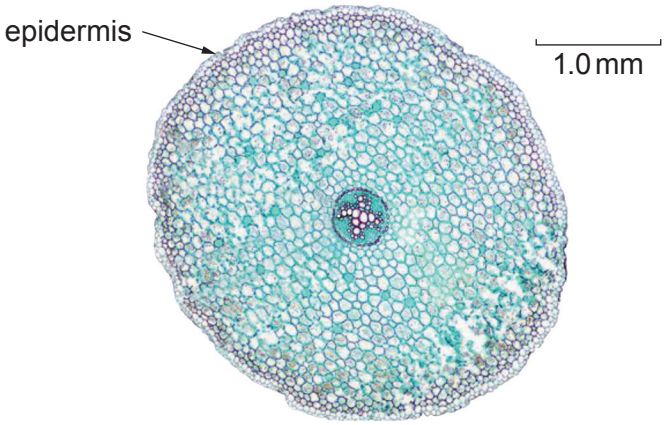
8. Most plants are unable to survive in waterlogged soil because air spaces between soil particles become filled with water.

The photomicrograph shows a transverse section through the root of a dicotyledonous plant.



Describe the pathways by which water passes from the cells of the epidermis across the cortex of the root and then into the vascular tissue of a plant growing in well-drained soil.
Explain why a plant growing in waterlogged soil experiences a reduction in root pressure.

[9 QER]

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