Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

S23-2400U20-1

2400U20-1

TUESDAY, 23 MAY 2023 – MORNING

BIOLOGY – AS unit 2
Biodiversity and Physiology of Body Systems

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**14**	
3.	**13**	
4.	**12**	
5.	**10**	
6.	**11**	
7.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

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

You may use a pencil for graphs and diagrams only.

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 page(s) 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 **7**.

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

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Answer **all** questions.

1. **Image 1.1** shows a region of lowland heath on the Pembrokeshire coast.

Image 1.1

Heathland is dominated by grasses and shrubs, such as heather and gorse, and supports a very diverse range of wildlife. Grazing by large herbivores, such as sheep and ponies, maintains this habitat. However, if the area is not grazed, it develops into woodland.

Since the 19th century, more than 75% of lowland heaths in the UK have been lost with a resulting loss of biodiversity.

(a) State what is meant by biodiversity. [1]

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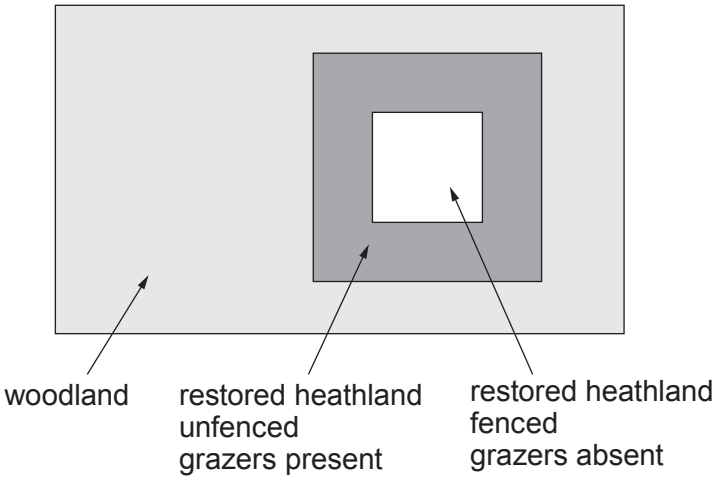
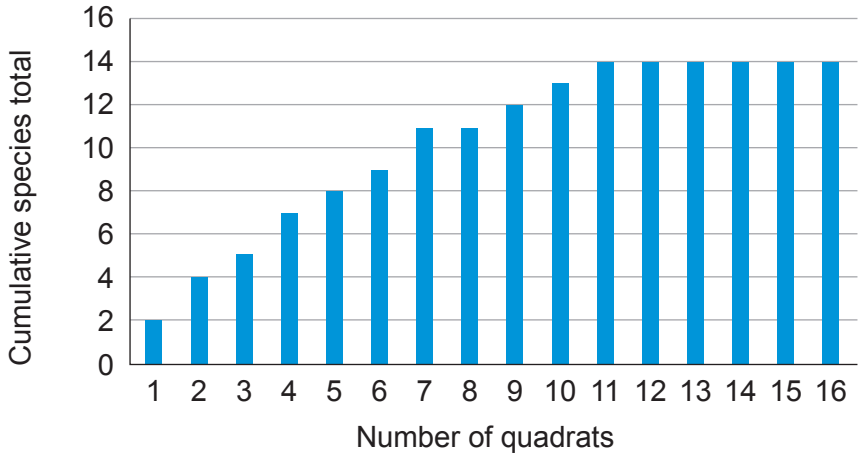
In an investigation, an area of former heathland, which had developed into silver birch woodland, was cleared of trees to restore it to heathland. Within this area, a 50 m × 50 m square was fenced off to prevent the entry of grazing animals. Native ponies and sheep were allowed to graze the remaining area. This is shown in **Image 1.2**.

Image 1.2



The study area was left for **three** years, after which time a conservation group used Simpson's Diversity Index to assess the impact of grazing on the heathland biodiversity. They used 1 m^2 quadrats to sample both the restored heathland and the fenced area within it and recorded which species of plants were present.
Graph 1.3 shows the results of preliminary work to decide how many times to use the quadrat.

Graph 1.3



(b) It was decided to use 11 quadrats at each site. Explain the reasons for this decision. [2]

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(c) **Table 1.4** shows the number of quadrats in which different species of plants were present.

Table 1.4

Common name	Scientific name	Relative height of plant	Number of quadrats in which the species was present	
			Fenced area	Unfenced area
Common bent grass	*Agrostis capillaris*	short	1	7
Sweet vernal grass	*Anthoxanthum odoratum*	short	1	4
Sedge	*Carex pilulifera*	short	1	3
Gorse	*Ulex europaeus*	medium	11	5
Bramble	*Rubus fruticosus*	medium	8	3
Silver birch	*Betula pendula*	tall	10	1
Ling heather	*Calluna vulgaris*	short	1	9
Bell heather	*Erica cinerea*	short	1	8

(i) Name the genus to which bell heather belongs. [1]

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(ii) Explain why the values in the table do not provide information about the actual number of organisms present. [1]

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(iii) The unfenced area had a Simpson's Diversity Index of 0.87.
The results for the fenced area are shown in **Table 1.5**.

Table 1.5

Common name	n	$(n-1)$	$n(n-1)$
Common bent grass	1		
Sweet vernal grass	1		
Sedge	1		
Gorse	11		
Bramble	8		
Silver birch	10		
Ling heather	1		
Bell heather	1		
$N =$		$\sum n(n-1) =$	
$N(N-1) =$			

Calculate the Simpson's Diversity Index for this site. [3]

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

where;
n = the number of quadrats where the species was present
N = the total number of quadrats where species were found
$\sum$ = sum of

D = ...

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(d) Use all the information provided to answer the following questions.

(i) Conclude the effect of grazing on heathland biodiversity. [1]

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(ii) It was found that grazing increased the number of quadrats in which bell heather was found. Suggest an explanation for this. [2]

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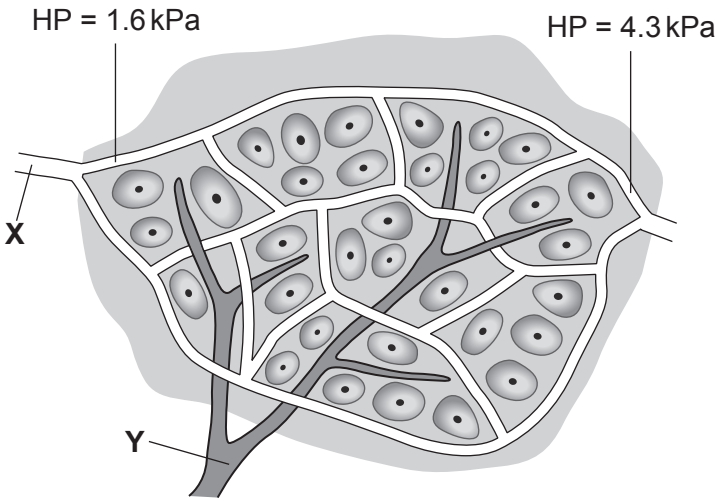
2. **Image 2.1** shows a diagram of the blood supply to the cells of a body tissue.

Image 2.1



HP = hydrostatic pressure

(a) (i) Identify the structures labelled **X** and **Y** in **Image 2.1**. [2]

X .....

Y .....

(ii) **Draw an arrow** on **Image 2.1** to show the direction of blood flow through the capillary network. [1]

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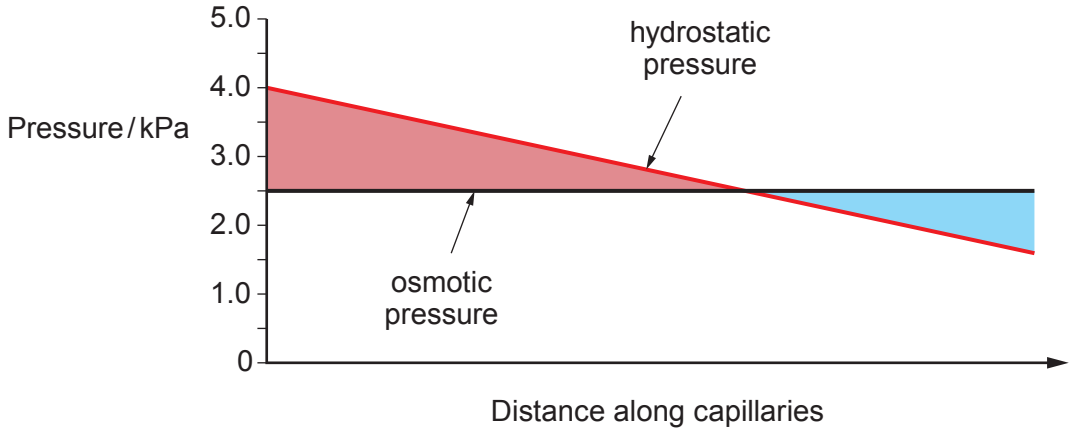
(b) **Graph 2.2** shows the changes in the hydrostatic pressure and osmotic pressure of the blood flowing through the capillaries.

Graph 2.2



(i) Explain why the hydrostatic pressure decreases as the blood travels along the capillaries. [2]

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(ii) Explain why the osmotic pressure remains constant as the blood travels along the capillaries. [2]

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(iii) Use the information provided in **Graph 2.2** to explain why structure **Y** in **Image 2.1** is necessary. [2]

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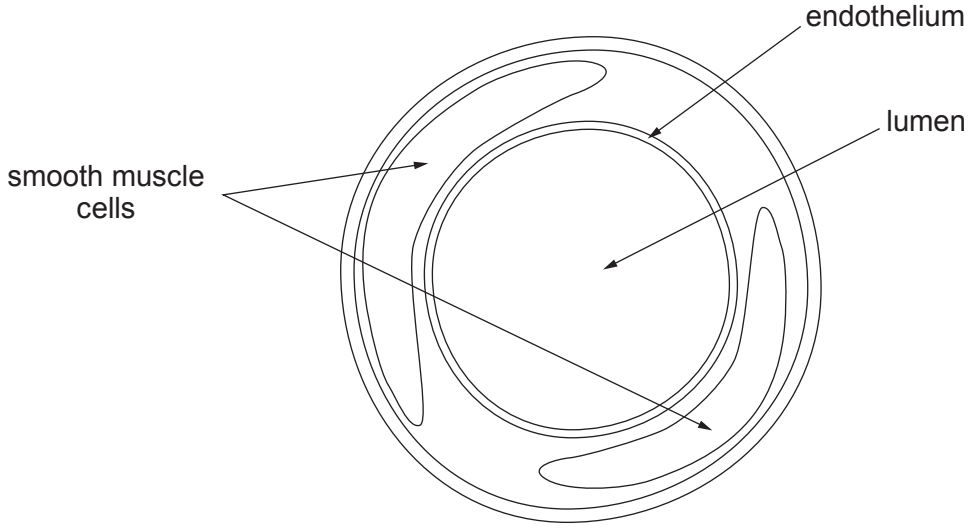
(c) Arterioles are responsible for the regulation of blood flow through a capillary network. **Image 2.3** shows a section through an arteriole.

Image 2.3



Explain how the structure of the wall of the arteriole, shown in **Image 2.3**, can reduce blood flow to a capillary network. [2]

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(d) Arterioles are also responsible for the distribution of blood around the body. **Table 2.4** shows the blood flow in the human body at rest and during vigorous exercise.

Table 2.4

Body structure	Blood flow / $cm^3 min^{-1}$	
	At rest	During vigorous exercise
heart	250	750
kidneys	1200	600
skeletal muscles	1000	125 000
skin	400	1900
stomach & intestines	1400	600
brain	750	750
other	600	400
total	5600	130 000

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(i) Calculate the percentage increase in blood flow to the skin during vigorous exercise. [2]

Percentage = ...

(ii) Suggest the significance of increased blood flow to the skin during exercise. [1]

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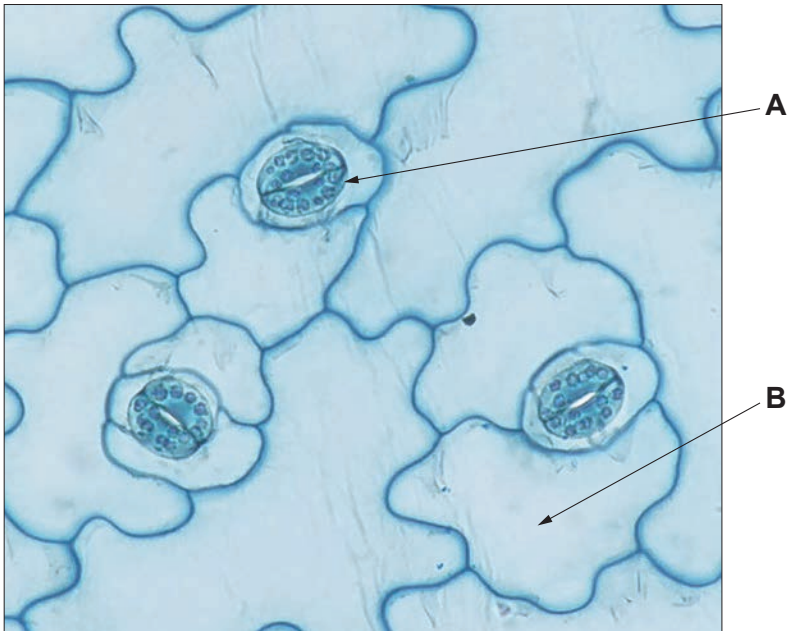
3. **Image 3.1** shows the surface view of stomata found on the lower surface of Kalanchoe *(Kalanchoe sp.)* leaves. Kalanchoe is a xerophyte.

Image 3.1



(a) (i) Identify the cells labelled **A** and **B** in **Image 3.1**. [1]

A .....

B .....

(ii) Describe the mechanism that causes stomata to open. [4]

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(iii) Suggest an advantage to Kalanchoe of being able to close stomata. [1]

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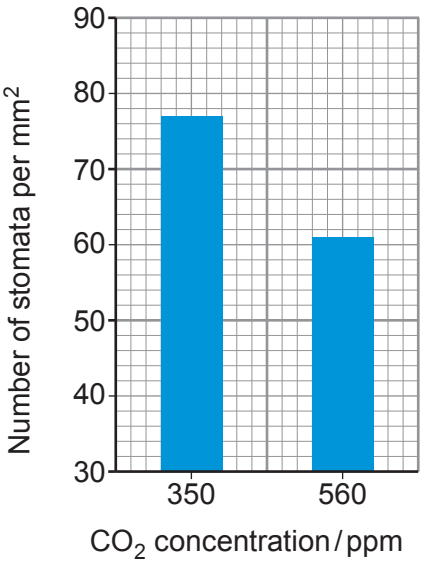
(b) In the 1990s, researchers investigated the effect of CO_2 concentration on stomatal density in a tree species known as *Ginkgo biloba* using the following method:

- One group of 40 young trees were grown in a greenhouse at atmospheric CO_2 concentrations (350 ppm).
- A second group of 40 young trees were grown in a different greenhouse at a higher CO_2 concentration (560 ppm).
- All other conditions were constant for the two groups.
- After three years growth, the mean number of stomata per mm^2 was calculated for both groups of trees.

The results are shown in **Graph 3.2**.

Graph 3.2



(i) State **two** variables that should have been controlled to maintain constant conditions. [1]

I. .....

II. .....

(ii) State **one** conclusion that can be drawn from this investigation. [1]

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(iii) Using your knowledge of the functions of stomata, explain the results of this investigation. [3]

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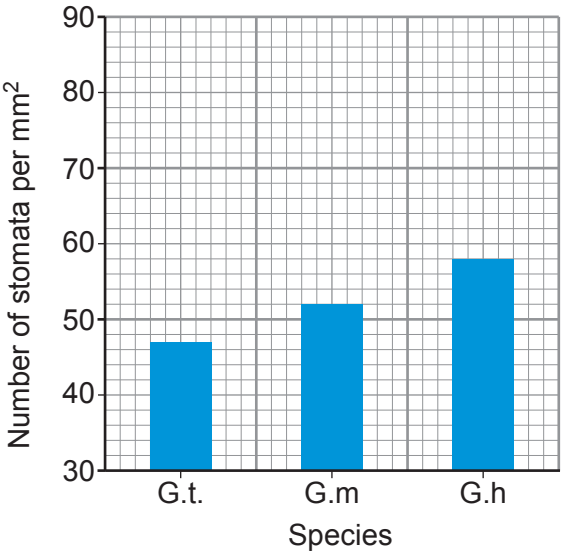
(c) Darwin described *Ginkgo biloba* as a 'living fossil', as fossils of the genus *Ginkgo* have been found in rocks from the Mesozoic era (252 to 66 million years ago). Stomata can be seen on the surface of fossilised leaves. **Graph 3.3** shows the number of stomata per mm^2 from three different species of the genus *Ginkgo*.

Graph 3.3



Key:

Species	Abbreviation	Age of rocks / million years
G. troedssonni	G.t	237 – 200
G. marginatus	G.m	200 – 174
G. huttonii	G.h	174 – 163

Using the information in **Graphs 3.2** and **3.3**, suggest what conclusions could be made about the concentration of CO_2 during the Mesozoic era. [2]

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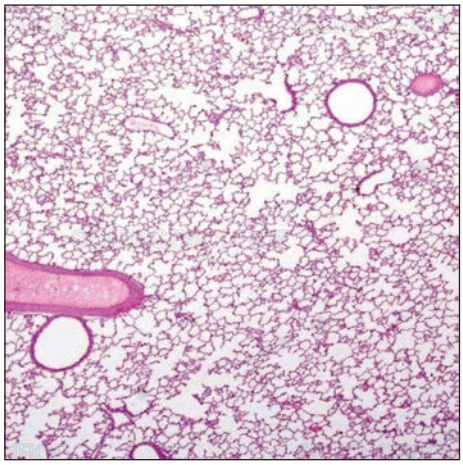
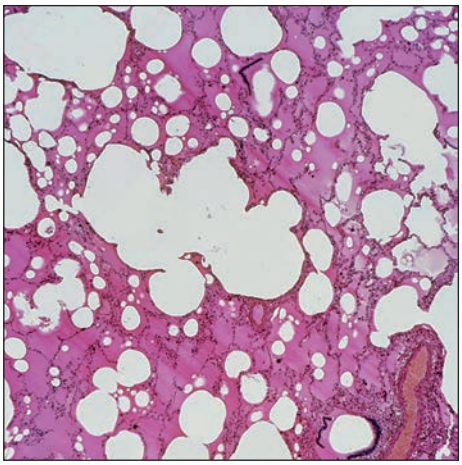
4. Emphysema is a disease of the lungs that results in the breakdown of the walls between adjacent alveoli.

Images 4.1 and **4.2** show sections of lung tissue from an adult with healthy lungs and an adult with emphysema.

Image 4.1 Lung tissue from an adult with healthy lungs	**Image 4.2** Lung tissue from an adult with emphysema
	

(a) (i) Using **Image 4.1** and your own knowledge, describe **and** explain **two** adaptations of the lungs for gas exchange. [2]

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(ii) Using **Image 4.2**, explain why the person with emphysema would have a lower oxygen saturation of haemoglobin than an adult with healthy lungs. [2]

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(b) The health of the lungs can be assessed by using a device called a spirometer, which measures the rate and depth of inspiration and expiration.

(i) Describe the process of inspiration. [4]

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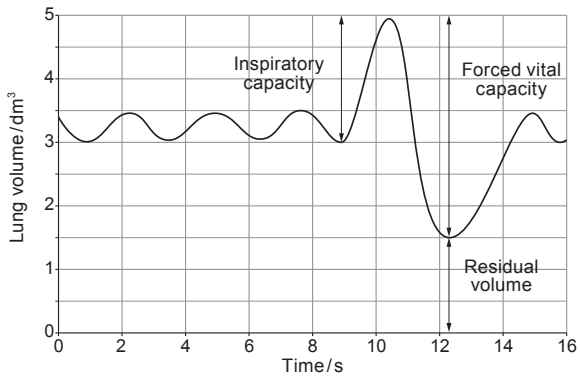
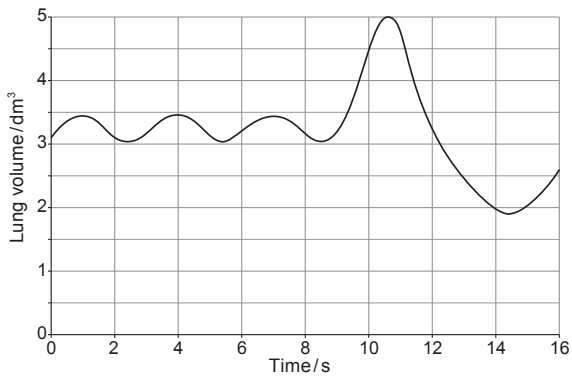
During an investigation an adult with healthy lungs and an adult with emphysema were asked to:

- breathe normally for three breaths
- then to take a very deep breath to fill their lungs, known as a forced inspiration
- then to expire as completely and as rapidly as possible, known as a forced expiration.

Images 4.3 and **4.4** show the spirometry traces produced.

Image 4.3 Spirometry trace from an adult with healthy lungs	**Image 4.4** Spirometry trace from an adult with emphysema
	

Key:

Inspiratory capacity:	Total volume of air that can be taken into the lungs during inspiration.
Forced vital capacity:	Total volume of air that can be forced out of the lungs following a forced inspiration.
Residual volume:	Volume of air that cannot be removed from the lungs.

Emphysema fact file

Emphysema causes the following physical effects on the lungs:

- loss of elastic tissue from the lungs
- thickening of the walls of the bronchioles
- increased mucus production within the bronchioles.

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(ii) **Complete Table 4.5** to state **two** differences between the two spirometry traces in **Images 4.3** and **4.4** and use the information from the fact file to explain these differences. [4]

Table 4.5

Difference	Explanation
.....	.....
.....	.....
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.....	.....
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5. Some heterotrophic organisms are also saprotrophic. Fungi are examples of saprotrophic organisms.

(a) (i) State the meaning of the term heterotrophic organism. [1]

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(ii) Describe the process of saprotrophic nutrition in fungi. [3]

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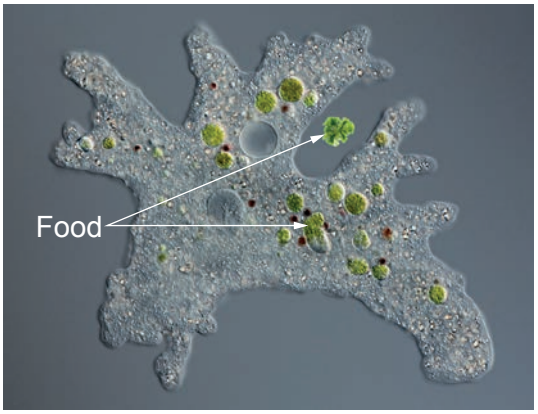
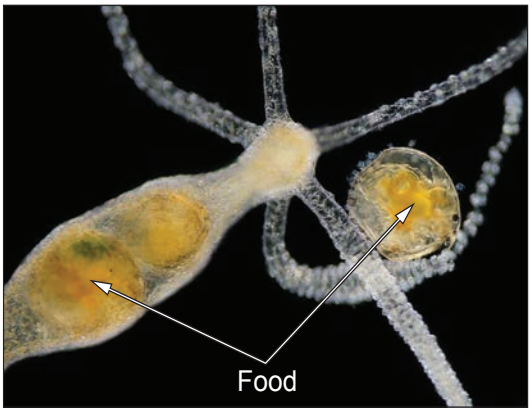
(b) *Amoeba* and *Hydra* are also heterotrophic organisms. **Images 5.1** and **5.2** show *Amoeba* and *Hydra* feeding. The images also show food which has previously been taken into the organisms.

Image 5.1 *Amoeba* feeding	**Image 5.2** *Hydra* feeding
	

Use **Images 5.1**, **5.2** and your knowledge of digestion to describe **one** similarity and **two** differences between the adaptations of *Amoeba* and *Hydra* for obtaining their nutrition. [3]

Similarity:

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Difference I:

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Difference II:

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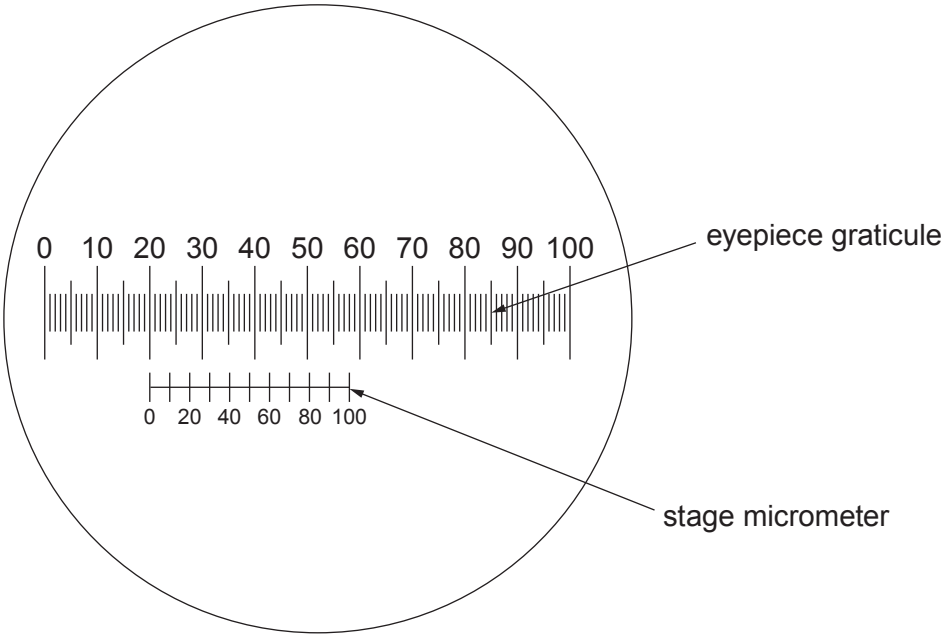
(c) A student used an eyepiece graticule to measure the length of an *Amoeba* on a microscope slide at a magnification of ×40. In order to calculate the actual size of the *Amoeba*, the student had to calibrate the eyepiece graticule. She used a 1 mm stage micrometer slide which had 100 divisions.

Image 5.3 shows the field of view from a microscope with the eyepiece graticule and stage micrometer labelled.

Image 5.3



(i) Use **Image 5.3** to calculate the length of **one** eyepiece unit in micrometres. [2]

One eyepiece unit = ... µm

(ii) The *Amoeba* at ×40 magnification measured 27 eyepiece units (epu). Calculate the actual length of the *Amoeba* in micrometres. [1]

Amoeba length = ... µm

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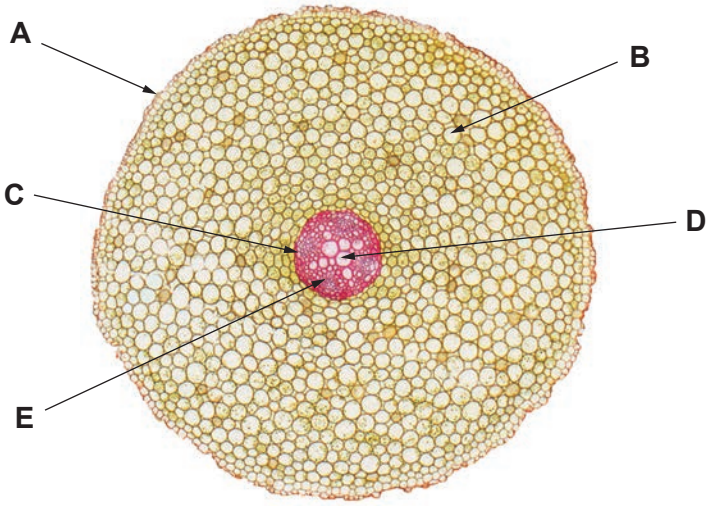
6. **Image 6.1** shows a transverse section through a root.

Image 6.1



(a) Use the **letters** (**A-E**) from **Image 6.1** to identify the following: [2]

I. the tissue responsible for transporting organic solutes .....

II. the tissue where root hair cells are located .....

III. the tissue containing the Casparian strip .....

(b) Water can be transported across the tissue labelled **B** by the apoplast and symplast pathways. Describe these **two** pathways. [2]

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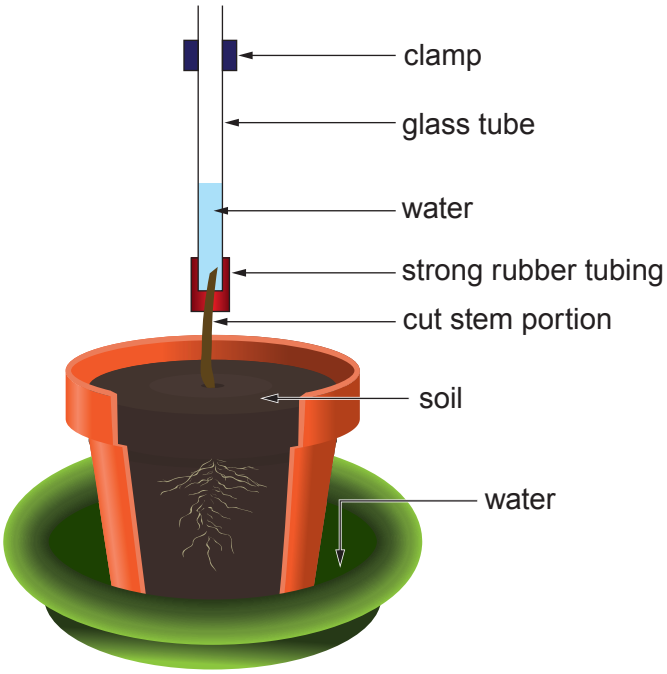
(c) **Image 6.2** shows an experiment to demonstrate root pressure.

Image 6.2



The stem of a well-watered plant is cut 3 cm above the level of the soil. The cut stem is inserted into a glass tube and secured with rubber tubing to ensure a watertight seal. A small volume of water is poured into the glass tube and its level marked.

After several hours the water level in the tube rises.

(i) Explain the role of structure **C**, in **Image 6.1**, in the uptake of water into the xylem vessels and in the generation of root pressure. [4]

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(ii) If the same experiment is repeated with cyanide added to the soil, the water level in the tube remains constant. Explain this observation. [3]

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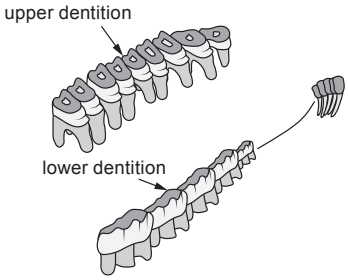
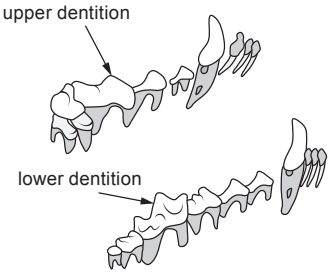
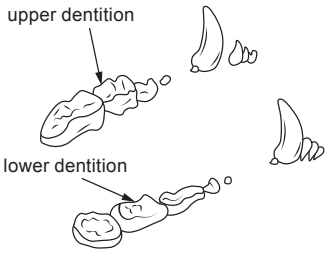
7. **Table 7** shows the skulls from three different mammals. It also provides information regarding their classification, dentition and diet.

Table 7

White-tailed deer	**Grey wolf**	**North American black bear**
Order: Artiodactyla	Order: Carnivora	Order: Carnivora
		
Diet: Plants including grasses, leaves, twigs, fruits and nuts.	**Diet:** Hunt mainly large-hoofed mammals such as deer, elk, bison and moose.	**Diet:** Plants, fruits, nuts, insects, honey, salmon, small mammals. It will occasionally kill small deer.

Describe and explain how the dentition of the white-tailed deer, the grey wolf and North American black bear is adapted to their respective diets. [9 QER]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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