Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

S24-2400U20-1

2400U20-1

THURSDAY, 23 MAY 2024 – 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.	**7**	
2.	**10**	
3.	**12**	
4.	**13**	
5.	**16**	
6.	**13**	
7.	**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 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 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 **7**.

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

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Answer **all** questions.

1. Different theories have been proposed to explain the evolution of the three Domains of life. **Image 1.1** and **Image 1.2** show different phylogenetic trees to explain the relationships between the three Domains.

Image 1.1

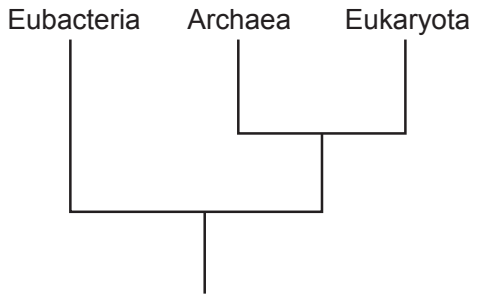
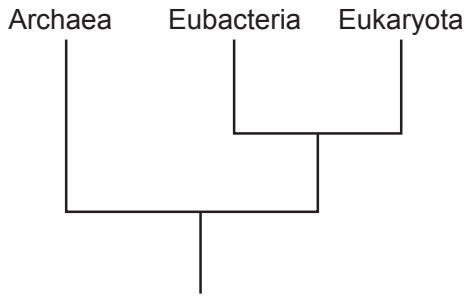


Image 1.2



(a) The last universal common ancestor (LUCA) is the most recent population of organisms from which all organisms now living on Earth have evolved.
Place a cross (×) on **Image 1.1** to show the position of LUCA. [1]

(b) State **two** features found in the cells of organisms in the Domain Eukaryota that are not found in the cells of organisms in the Domains Archaea and Eubacteria. [2]

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(c) Analysis of the nucleotide sequences at specific positions (numbered 1–8) in molecules of ribosomal RNA (rRNA) have been used to provide evidence for the evolution of the three Domains. This is shown in **Table 1.3**.

Table 1.3

Position	Nucleotide sequence	Occurrence in species analysed / %		
		Archaea	Eubacteria	Eukaryota
1	CACUUG	0	>95	0
2	AAACUCAAA	3	100	0
3	AAACUUAAAG	100	0	100
4	CUCAAUG	100	<1	100
5	CAACCUUCG	0	>95	0
6	UCCCUG	>95	0	100
7	UACACACCG	0	>99	100
8	CACACACCG	100	0	0

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(i) It has been concluded that **Image 1.1** provides the most likely explanation for the evolution of the three Domains.

Use **Table 1.3** to identify **one** piece of evidence that supports this decision and **one** piece of evidence that does not support this decision. Explain your answers. [2]

One piece of evidence that supports the decision:

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One piece of evidence that does not support the decision:

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(ii) In this analysis, the rRNA molecules from each domain were extracted from large numbers of different species. Explain why this was necessary. [1]

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(iii) Explain why evidence obtained from biochemical analysis is of more use in assessing the relatedness of organisms than the comparison of morphological features. [1]

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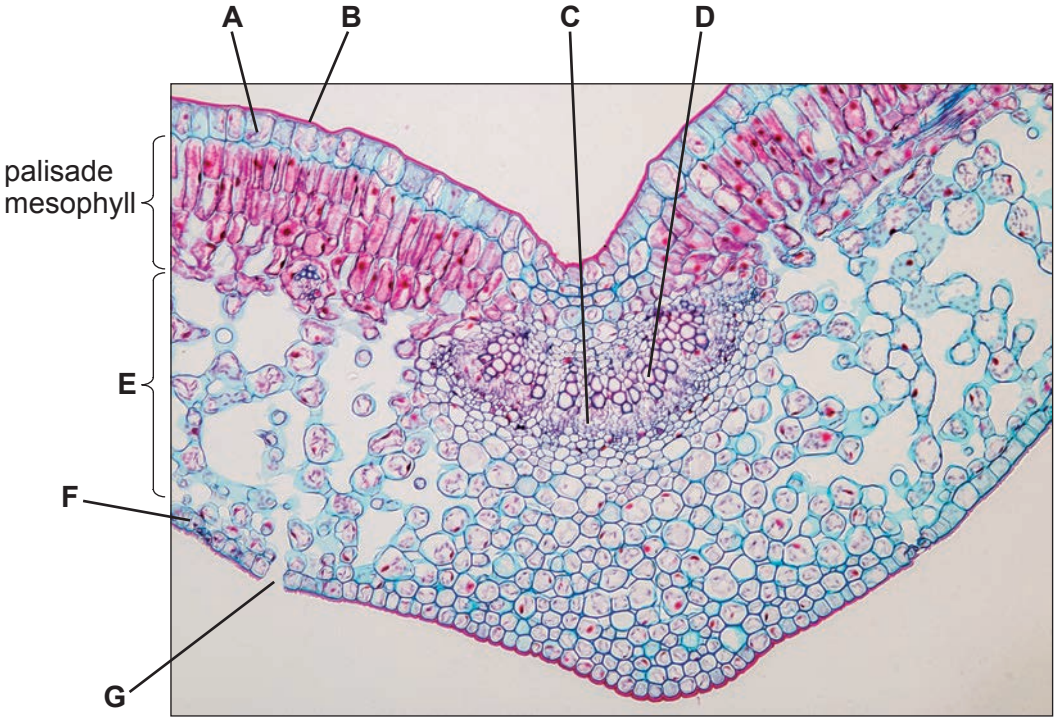
2. Leaves show many adaptations for photosynthesis. **Image 2.1** shows a transverse section through a leaf.

Image 2.1



(a) The palisade mesophyll tissue, shown in **Image 2.1**, is the main site of photosynthesis. Identify and explain **two** adaptations of this **tissue** for photosynthesis. [2]

Adaptation 1 .....

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Adaptation 2 .....

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(b) The chemical equation for photosynthesis is shown below:

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

Use **letters (A–G)** from **Image 2.1** to identify the following:

(i) **Two** structures that allow the **reactants** to reach the palisade mesophyll cells. [1]

....

(ii) **Two** structures that allow the **products** to be moved from the palisade mesophyll cells. [1]

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(c) A student concluded that **Image 2.1** was taken from a leaf of a mesophyte.
State **one** piece of evidence from **Image 2.1** that shows it was **not** taken from a:

(i) hydrophyte; [1]

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(ii) xerophyte. [1]

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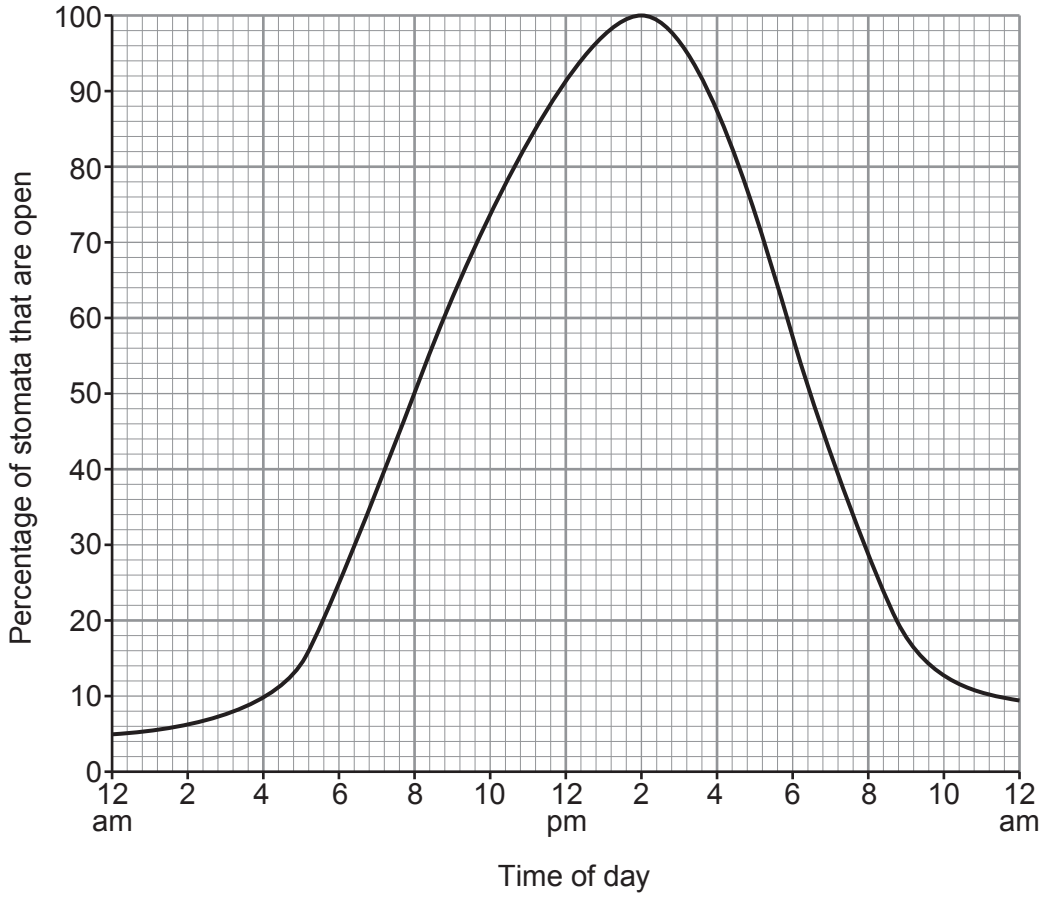
(d) **Graph 2.2** shows the percentage of stomata that are open at different times over a 24-hour period.

Graph 2.2



Describe the pattern of data shown in **Graph 2.2**. Explain the advantage of this to the plant. [4]

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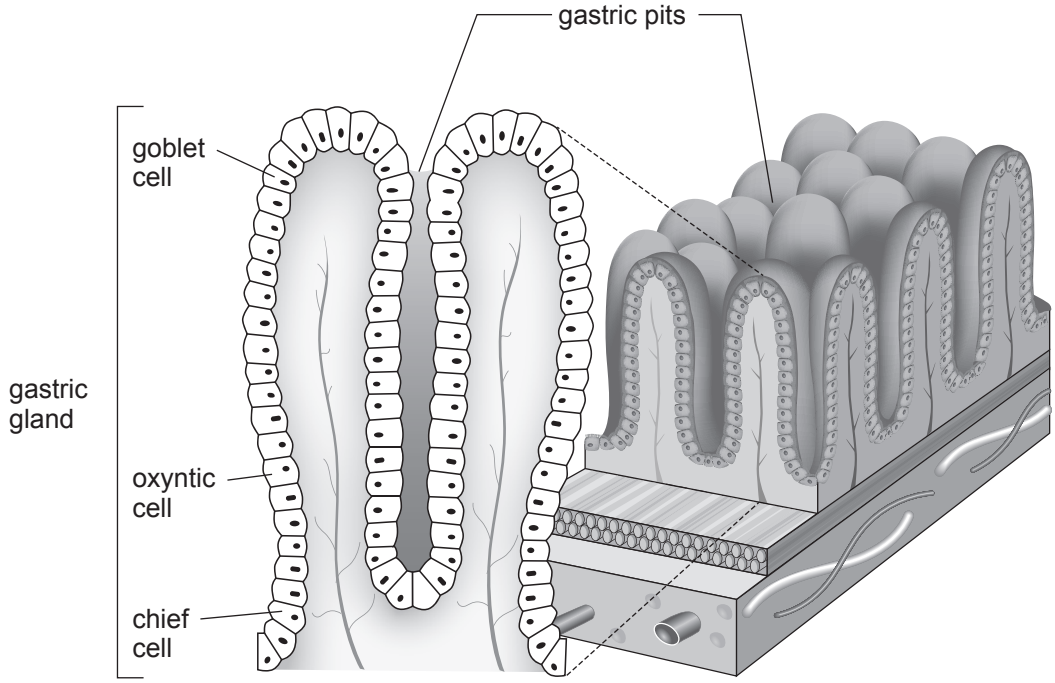
3. Gastric glands are responsible for producing a number of secretions. **Image 3.1** shows a section through the wall of the stomach.

Image 3.1



The chief cells produce and secrete pepsinogen, the inactive form of the endopeptidase pepsin. Oxyntic cells produce and secrete hydrochloric acid.

(a) (i) Explain why it is important that pepsin is produced in an inactive form **and** why it is necessary that hydrochloric acid and pepsinogen are produced by separate cells. [3]

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(ii) Describe the function of the goblet cells. [1]

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(iii) Glands within the wall of the duodenum produce exopeptidases.
Explain the advantage of the stomach producing endopeptidases and the duodenum producing exopeptidases. [2]

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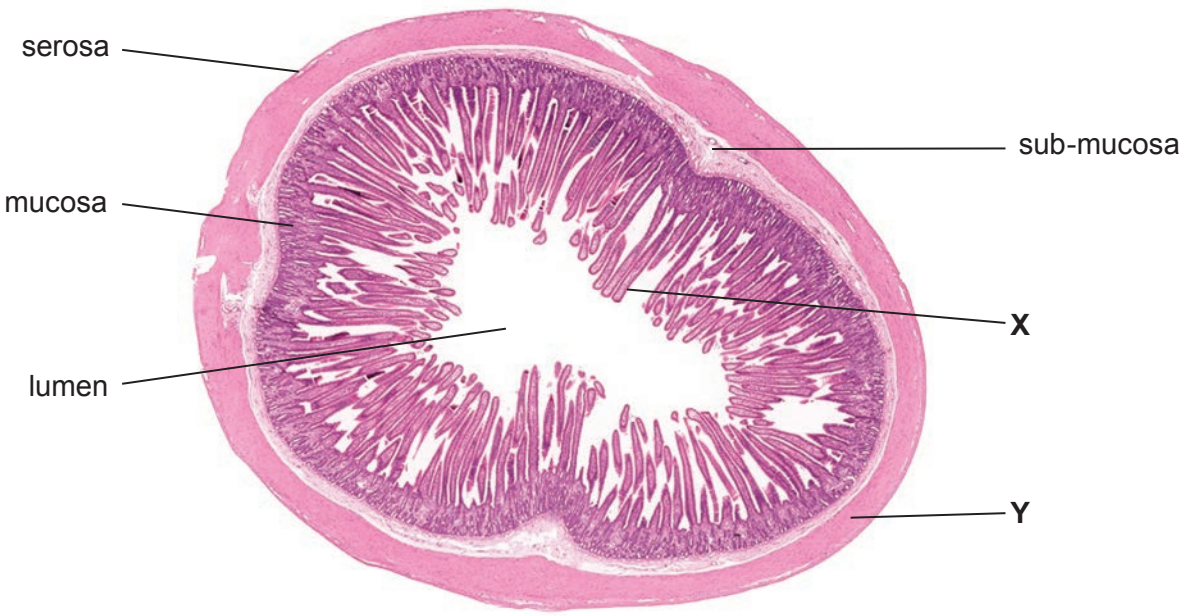
(b) **Image 3.2** shows a transverse section through the small intestine with some of the tissue layers labelled.

Image 3.2



Name the types of **tissue** found at [1]

X .....

Y .....

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(c) Giardiasis is a common intestinal disease in some countries. It is caused by a parasitic protoctistan of the genus *Giardia*. The parasite causes damage to the cells in tissue **X** in **Image 3.2**, which result in shorter villi in the small intestine. The symptoms of infection include diarrhoea and fatigue (tiredness).

(i) State what is meant by the term parasite. [1]

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(ii) Explain how damage to the cells in tissue **X** can result in the symptoms described above. [4]

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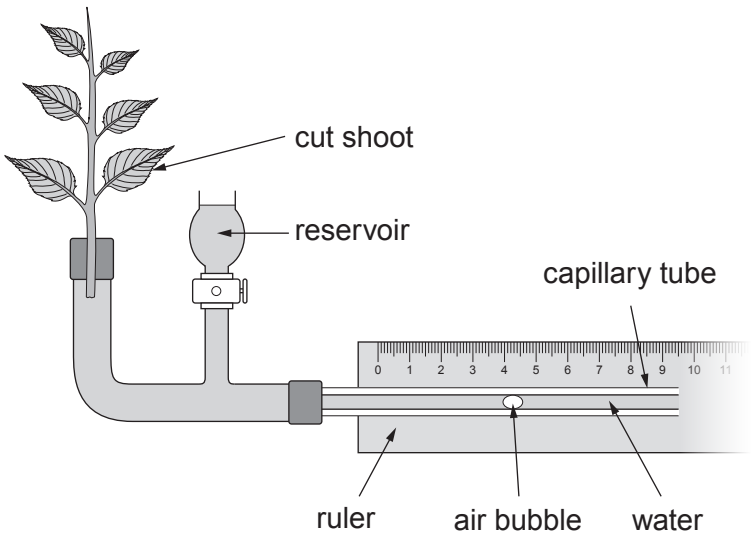
4. A student investigated the effect of wind speed on the rate of transpiration. He set up the apparatus as shown in **Image 4.1**.

Image 4.1



(a) (i) State the name of the apparatus shown in **Image 4.1**. [1]

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(ii) When setting up the apparatus, it is important that air bubbles are prevented from entering the xylem.
Describe how the leafy shoot is prepared and the apparatus assembled to avoid this. [2]

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(iii) State **two environmental** factors that would need to be controlled during this investigation. [1]

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(b) The student then placed a fan at different distances from the apparatus and recorded the time taken for the air bubble to travel 200 mm. The results are shown in **Table 4.2**.

Table 4.2

Distance between the fan and the apparatus / cm	Time taken for the air bubble to travel 200 mm / seconds				Mean rate of water uptake by the leafy shoot / mm^3 min^{-1}
	Trial 1	Trial 2	Trial 3	mean	
20	168	156	132	152	62.0
40	172	166	145	161	58.5
60	184	170	165	173	54.5
80	188	185	179	184	51.2
100	195	191	190	192	.....

(i) I. The internal diameter of the capillary tube was 1 mm. Use the equation below to calculate the volume of water taken up by the shoot when the bubble travels 200 mm. [2]

Volume of a cylinder: $V = \pi r^2 h$

Where
h = distance travelled by the air bubble
π = 3.14
r = radius of capillary tube

Volume = ... mm^3

II. Use your answer to *(b)*(i) part I and the data in **Table 4.2** to calculate the mean rate of water uptake by the shoot at a fan distance of 100 cm. **Give your answer in mm^3 min^{-1} and write your answer in Table 4.2**. [3]

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(ii) Describe and explain the results shown in **Table 4.2**. [3]

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(c) The apparatus shown in **Image 4.1** measures the rate of water uptake.
Give **one** reason why this may not be equal to the rate of water lost in transpiration. [1]

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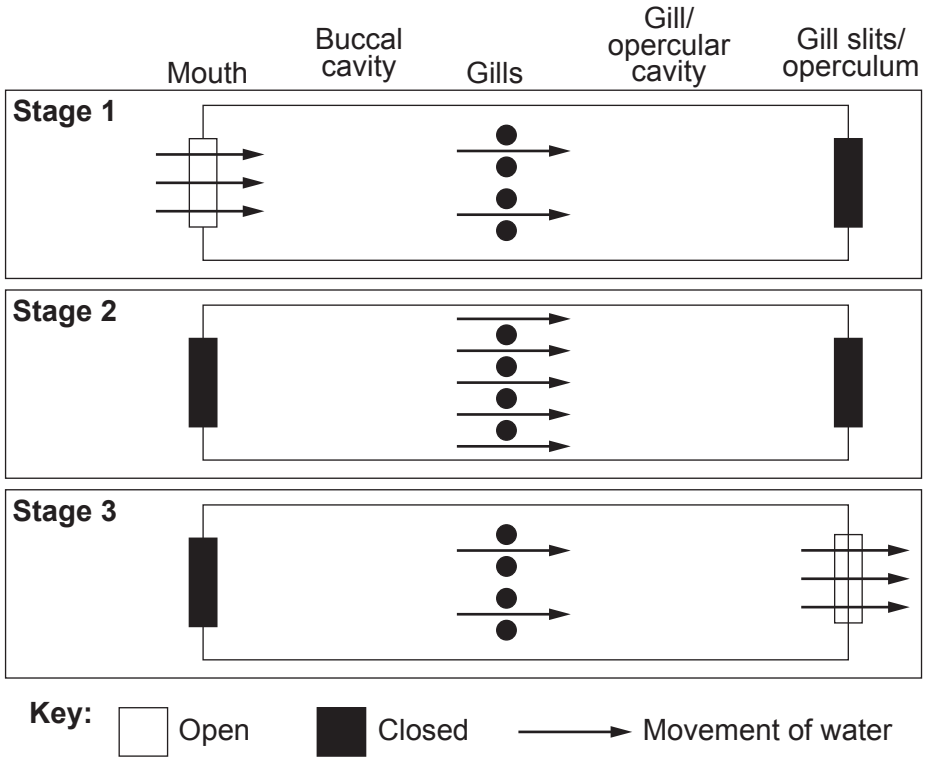
5. Bony fish use a ventilation mechanism to move water over their gills. **Image 5.1** shows three stages during ventilation.

Image 5.1



(a) Use **Image 5.1** and your own knowledge to explain how water is moved across the gills. [4]

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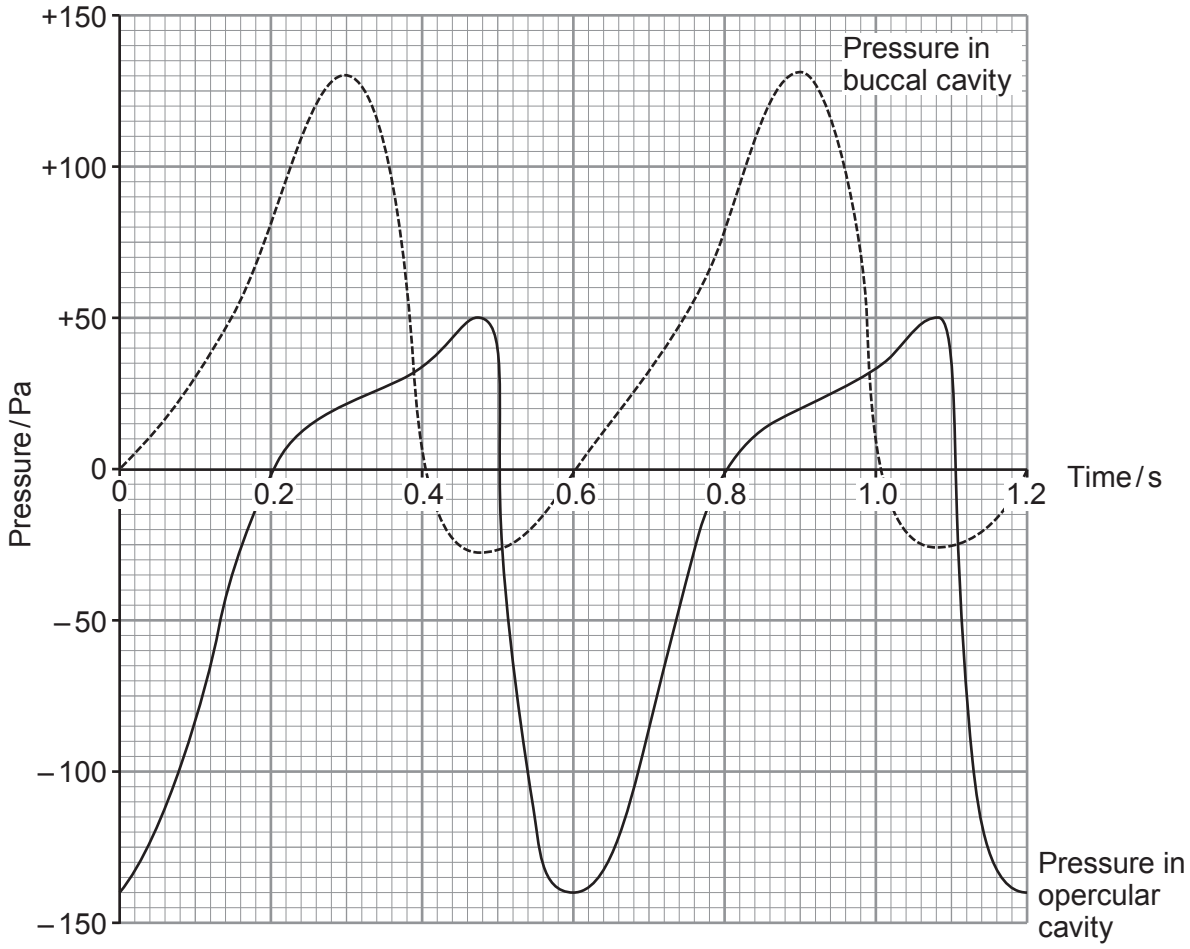
(b) **Graph 5.2** shows the pressure changes in the buccal and opercular cavities during two ventilation cycles.

Graph 5.2



(i) Use **Graph 5.2** to calculate the maximum pressure change within the **opercular cavity**. [1]

Maximum pressure change = ... Pa

(ii) I. Indicate **on Graph 5.2, with an arrow** labelled **B**, a point when water will enter the buccal cavity. [1]

II. Indicate **on Graph 5.2, with an arrow** labelled **G**, a point when water will be flowing over the gills. [1]

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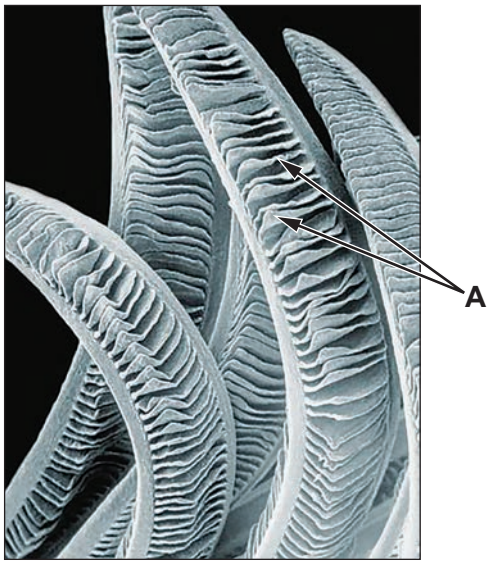
(c) **Image 5.3** is a magnified image of part of a fish's gill.

Image 5.3



(i) State the name of the structures labelled **A** in **Image 5.3**. [1]

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(ii) Use **Image 5.3** to describe and explain **one** adaptation of the gills for gas exchange. [2]

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(iii) The blood flow through the structures labelled **A** is in the opposite direction from the water flowing over the gills. Explain the advantage of this to the fish. [3]

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(d) The Australian Lungfish *(Neoceratodus forsteri)* is one of several species of fish that have evolved simple lungs. The lungs are subdivided into numerous smaller air sacs surrounded by many capillaries. Lungfish are capable of carrying out gas exchange via their gills and lungs.

During the dry season, water levels fall, and the water temperature rises. The concentration of oxygen in the water decreases. During these months the lungfish gulp air from the surface.

Suggest how these adaptations have enabled the lungfish to survive in its environment. [2]

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(e) The structure of the lungs of lungfish are homologous to the lungs of mammals. State what conclusion can be made about the evolutionary relationships between lungfish and mammals. [1]

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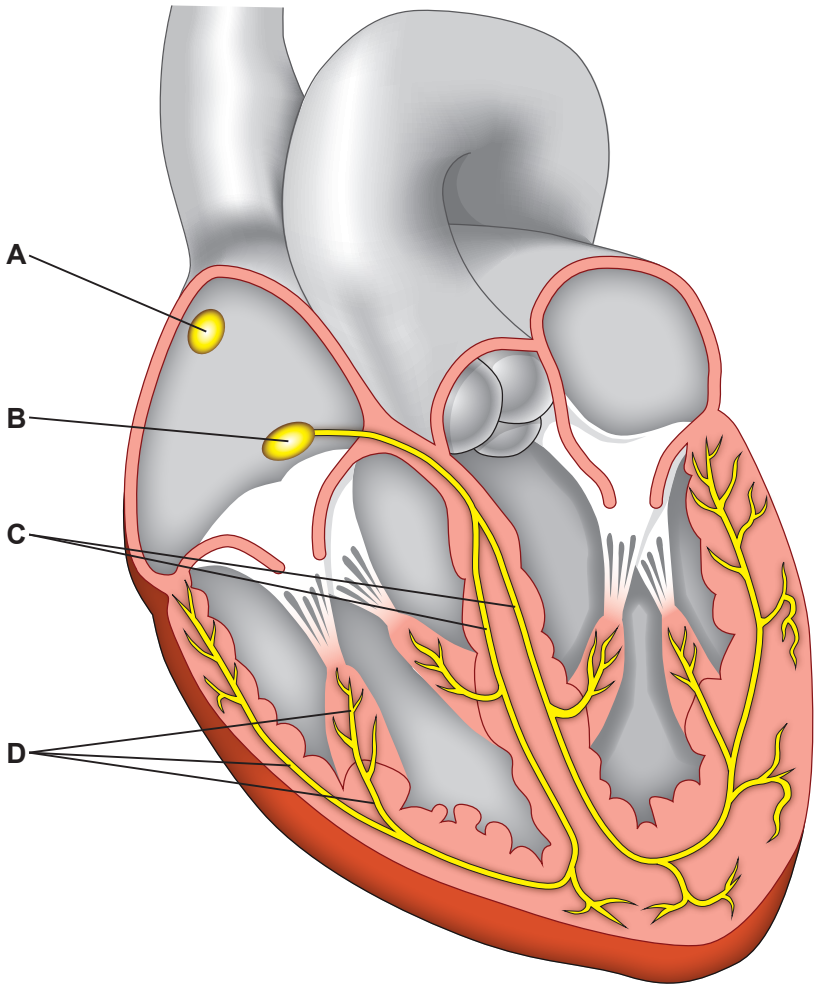
6. The cardiac cycle is controlled by several structures within the heart. **Image 6.1** shows a longitudinal section through the heart.

Image 6.1



(a) (i) Cardiac muscle has the property of being myogenic.
State what is meant by the term myogenic. [1]

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(ii) Use letters (**A–D**) from **Image 6.1** to identify the following structures: [2]

I. the atrio-ventricular node .....

II. the Purkyne fibres .....

III. the sino-atrial node .....

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(iii) Describe and explain the role of structures labelled **A–D** in **Image 6.1** in controlling the cardiac cycle. [4]

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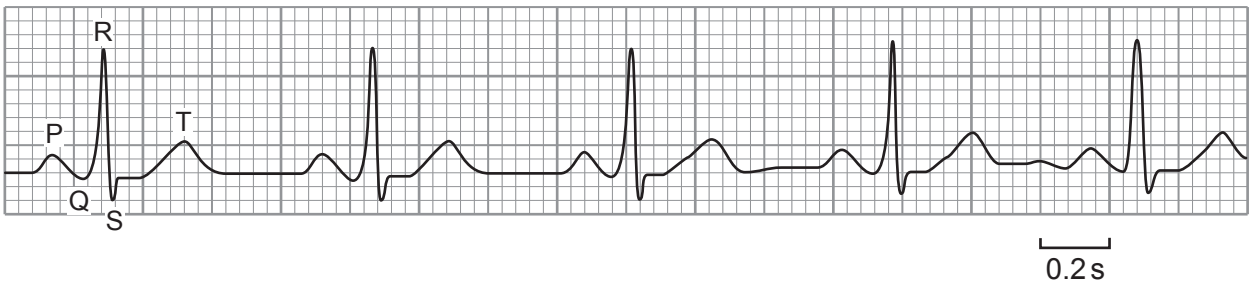
(b) **Image 6.2** shows a normal ECG (electrocardiogram) trace.

Image 6.2



Use **four** cardiac cycles shown on **Image 6.2** to calculate the heart rate of this individual. [2]

Heart rate = ... beats per minute

(c) A heart block is a medical condition which is caused by an obstruction in the electrical conduction system of the heart. These obstructions can either affect the sino-atrial node or the atrio-ventricular node.

Image 6.3 shows an abnormal ECG trace. This was taken from a patient suffering from a heart block.

Image 6.3

(i) **Image 6.3** shows that there is an obstruction at the atrio-ventricular node and not at the sino-atrial node. Explain the evidence for this. [2]

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(ii) Suggest the effect that this obstruction would have on the cardiac cycle. [2]

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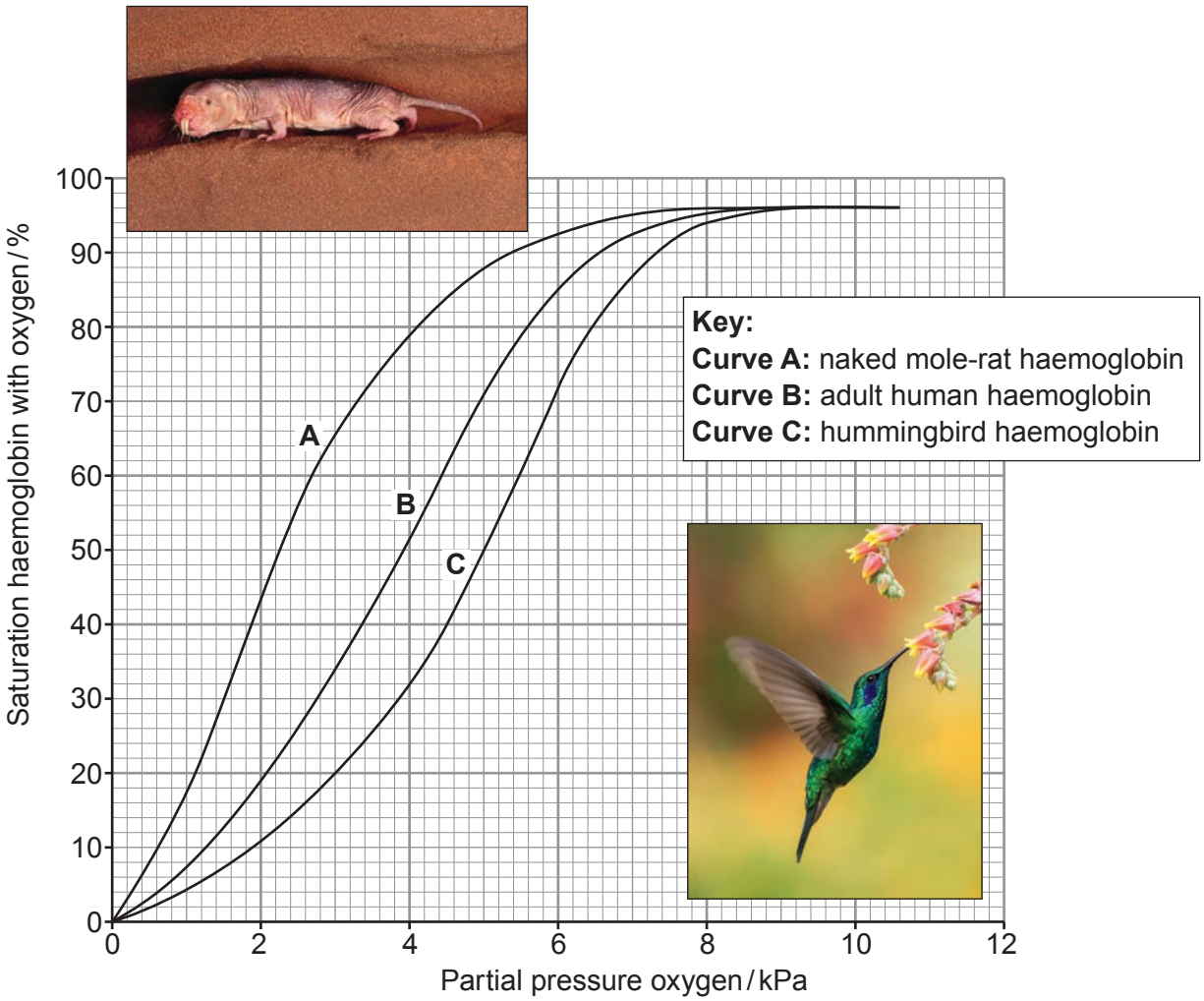
7. **Graph 7** shows the oxygen dissociation curves for the haemoglobin from three different organisms. Haemoglobin **A** is from a naked mole-rat, haemoglobin **B** is from an adult human and haemoglobin **C** is from a hummingbird.

Graph 7



Naked mole-rats live in colonies of up to 80 individuals and spend their entire lives in a maze of poorly ventilated underground tunnels.

Hummingbirds are small birds and their flight muscles account for 30% of their body weight. They can beat their wings up to 200 times per second.

Explain the shape of the oxygen dissociation curve for adult human haemoglobin as shown in **Graph 7.**
Explain the significance of the relative positions of the oxygen dissociation curves for the naked mole-rat haemoglobin and the hummingbird haemoglobin. [9 QER]

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