GCE AS/A LEVEL

2400U20 – 1

THURSDAY, 23 MAY 2024 – MORNING

BIOLOGY– AS UNIT 2
BIODIVERSITY AND PHYSIOLOGY
OF BODY SYSTEMS

1 hour 30 minutes plus your additional time allowance

Surname: ______________________________

First name(s): ______________________________

Centre Number: ______________________________

Candidate Number: 2 ______________________________

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	

(Turn over)

ADDITIONAL MATERIALS

A calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

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.

(Turn over)

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.

(Turn over)

Answer ALL questions.

1. Different theories have been proposed to explain the evolution of the three Domains of life. Refer to the IMAGE 1.1 and IMAGE 1.2 in the separate Diagram Booklet. IMAGE 1.1 and IMAGE 1.2 show different phylogenetic trees to explain the relationships between the three Domains.

(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 mark]

continued on the next page . . .

Question 1 continued

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 marks]

(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 in the separate Diagram Booklet.

continued on the next page . . .

Question 1 (c) continued

1. (c) (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.

One piece of evidence that supports the decision:

continued on the next page . . .

Question 1 (c) (i) continued

One piece of evidence that does not support the decision:

[2 marks]

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

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (c) continued

1. (c) (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 mark]

(Total for Question 1 = 7 marks)

(Turn over)

2. Leaves show many adaptations for photosynthesis. Refer to IMAGE 2.1 in the separate Diagram Booklet. IMAGE 2.1 shows a transverse section through a leaf.

(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.

Adaptation 1 ______________________________

____

____

____

____

Adaptation 2 ______________________________

____

____

____

____

[2 marks]

continued on the next page . . .

Question 2 continued

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

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

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.

______________________ and ______________________

[1 mark]

(ii) TWO structures that allow the PRODUCTS to be moved from the palisade mesophyll cells.

______________________ and ______________________

[1 mark]

continued on the next page . . .

Question 2 continued

2. (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:

(i) a hydrophyte;

[1 mark]

(ii) a xerophyte.

[1 mark]

continued on the next page . . .

Question 2 continued

2. (d) Refer to GRAPH 2.2 in the separate Diagram Booklet. GRAPH 2.2 shows the percentage of stomata that are open at different times over a 24 – hour period.

Describe the pattern of data shown in GRAPH 2.2. Explain the advantage of this to the plant.

(Turn over)

[4 marks]

(Total for Question 2 = 10 marks)

3. Refer to IMAGE 3.1 in the separate Diagram Booklet. Gastric glands are responsible for producing a number of secretions. IMAGE 3.1 shows a section through the wall of the stomach.

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.

(Turn over)

[3 marks]

3. (a) (ii) Describe the function of the goblet cells.

[1 mark]

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

(Turn over)

____

____

____

[2 marks]

3. (b) Refer to IMAGE 3.2 in the separate Diagram Booklet. IMAGE 3.2 shows a transverse section through the small intestine with some of the tissue layers labelled.

Name the types of TISSUE found at

X ____

Y ____

[1 mark]

continued on the next page . . .

Question 3 continued

3. (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 mark]

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

(Turn over)

[4 marks]

(Total for Question 3 = 12 marks)

(Turn over)

4. **Refer to IMAGE 4.1 in the separate Diagram Boooklet. A student investigated the effect of wind speed on the rate of transpiration. He set up the apparatus as shown in IMAGE 4.1.**

(a) (i) State the name of the apparatus shown in IMAGE 4.1

[1 mark]

(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.

(Turn over)

[2 marks]

4. (a) (iii) State TWO ENVIRONMENTAL factors that would need to be controlled during this investigation.

[1 mark]

(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 in the separate Diagram Booklet.

continued on the next page . . .

(Turn over)

Question 4 (b) continued

4. (b) (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.

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

Where

h = distance travelled by the air bubble

$\pi = 3 \cdot 14$

r = radius of capillary tube

Volume = ________________ mm^3

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 (b) (i) continued

4. (b) (i) 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.

Space for working

[3 marks]

continued on the next page . . .

(Turn over)

Question 4 (b) continued

4. (b) (ii) Describe and explain the results shown in TABLE 4.2

[3 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

4. (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 mark]

(Total for Question 4 = 13 marks)

(Turn over)

5. **Refer to the IMAGE 5.1 in the separate Diagram Booklet. Bony fish use a ventilation mechanism to move water over their gills. IMAGE 5.1 shows three stages during ventilation.**

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

(Turn over)

____

____

____

[4 marks]

5. (b) Refer to GRAPH 5.2 in the separate Diagram Booklet. GRAPH 5.2 shows the pressure changes in the buccal and opercular cavities during two ventilation cycles.

(i) Use GRAPH 5.2 to calculate the maximum pressure change within the OPERCULAR CAVITY.

Maximum pressure change = ________________ Pa

[1 mark]

(ii) I. Indicate on GRAPH 5.2, WITH AN ARROW labelled B, a point when water will enter the buccal cavity.

[1 mark]

continued on the next page . . .

Question 5 (b) (ii) continued

II. Indicate on GRAPH 5.2, WITH AN ARROW labelled G, a point when water will be flowing over the gills.

[1 mark]

5. (c) Refer to IMAGE 5.3 in the separate Diagram Booklet. IMAGE 5.3 is a magnified image of part of a fish's gill.

(i) State the name of the structures labelled **A** in IMAGE 5.3

____

[1 mark]

(ii) Use IMAGE 5.3 to describe and explain ONE adaptation of the gills for gas exchange.

____

____

____

____

(Turn over)

[2 marks]

5. (c) (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 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

5. (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.

(Turn over)

[2 marks]

5. (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 mark]

(Total for Question 5 = 16 marks)

6. Refer to IMAGE 6.1 in the separate Diagram Booklet. The cardiac cycle is controlled by several structures within the heart. IMAGE 6.1 shows a longitudinal section through the heart.

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

[1 mark]

continued on the next page . . .

Question 6 (a) continued

6. (a) (ii) Use letters (A–D) from IMAGE 6.1 to identify the following structures:

I. the atrio-ventricular node

___

II. the Purkyne fibres

___

III. the sino-atrial node

___

[2 marks]

(iii) Describe and explain the role of structures labelled A – D in IMAGE 6.1 in controlling the cardiac cycle.

___

___

___

___

___

(Turn over)

[4 marks]

continued on the next page . . .

Question 6 continued

6. (b) Refer to the IMAGE 6.2 in the separate Diagram Booklet. IMAGE 6.2 shows a normal ECG (electrocardiogram) trace.

Use FOUR cardiac cycles shown on IMAGE 6.2 to calculate the heart rate of this individual.

Heart rate = ____________________ beats per minute

[2 marks]

continued on the next page . . .

(Turn over)

Question 6 continued

6. (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.

Refer to IMAGE 6.3 in the separate Diagram Booklet. IMAGE 6.3 shows an abnormal ECG trace. This was taken from a patient suffering from a heart block.

continued on the next page . . .

Question 6 (c) continued

6. (c) (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 marks]

continued on the next page . . .

Question 6 (c) continued

6. (c) (ii) Suggest the effect that this obstruction would have on the cardiac cycle.

[2 marks]

(Total for Question 6 = 13 marks)

7. Refer to GRAPH 7 in the separate Diagram Booklet. 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.

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.

continued on the next page . . .

(Turn over)

Question 7 continued

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.

(Turn over)

(Turn over)

(Turn over)

(Turn over)

(Turn over)

[9 QER marks]

(Total for Question 7 = 9 marks)

TOTAL FOR PAPER = 80 MARKS

END OF PAPER

(Turn over)

Question Number	Additional pages, if required. Write the question number(s) in the left – hand margin.

(Turn over)

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(Turn over)

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BIOLOGY − AS UNIT 2
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The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

Diagram Booklet

Surname: ____________________

First name(s): ____________________

Centre Number: ____________________

Candidate Number: 2 ____________________

IMAGE 1.1 and IMAGE 1.2

IMAGE 1.1

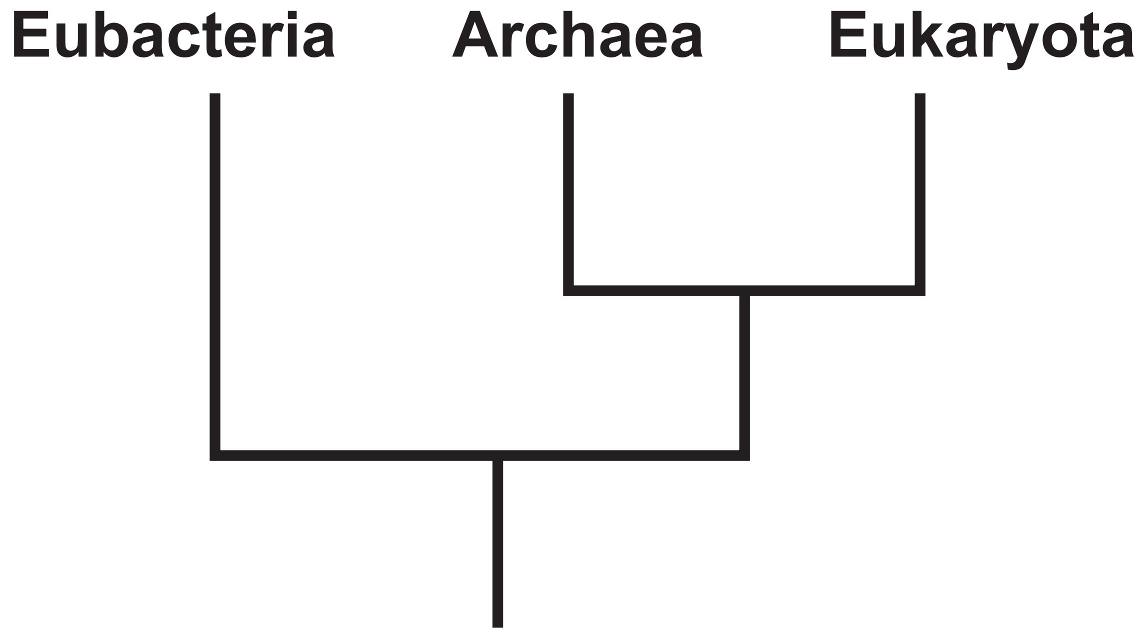


IMAGE 1.2

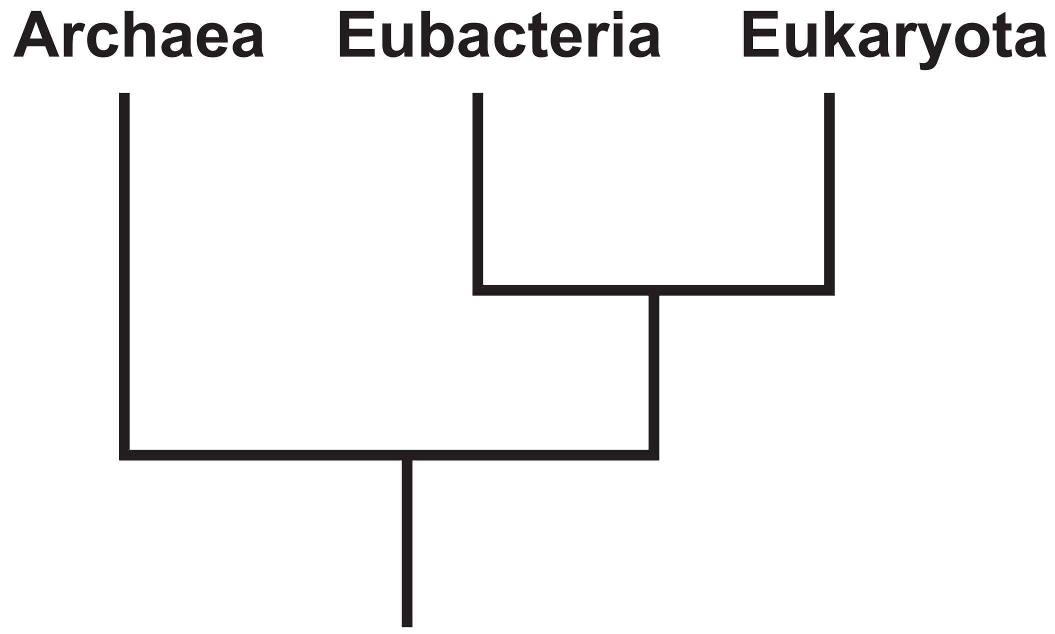
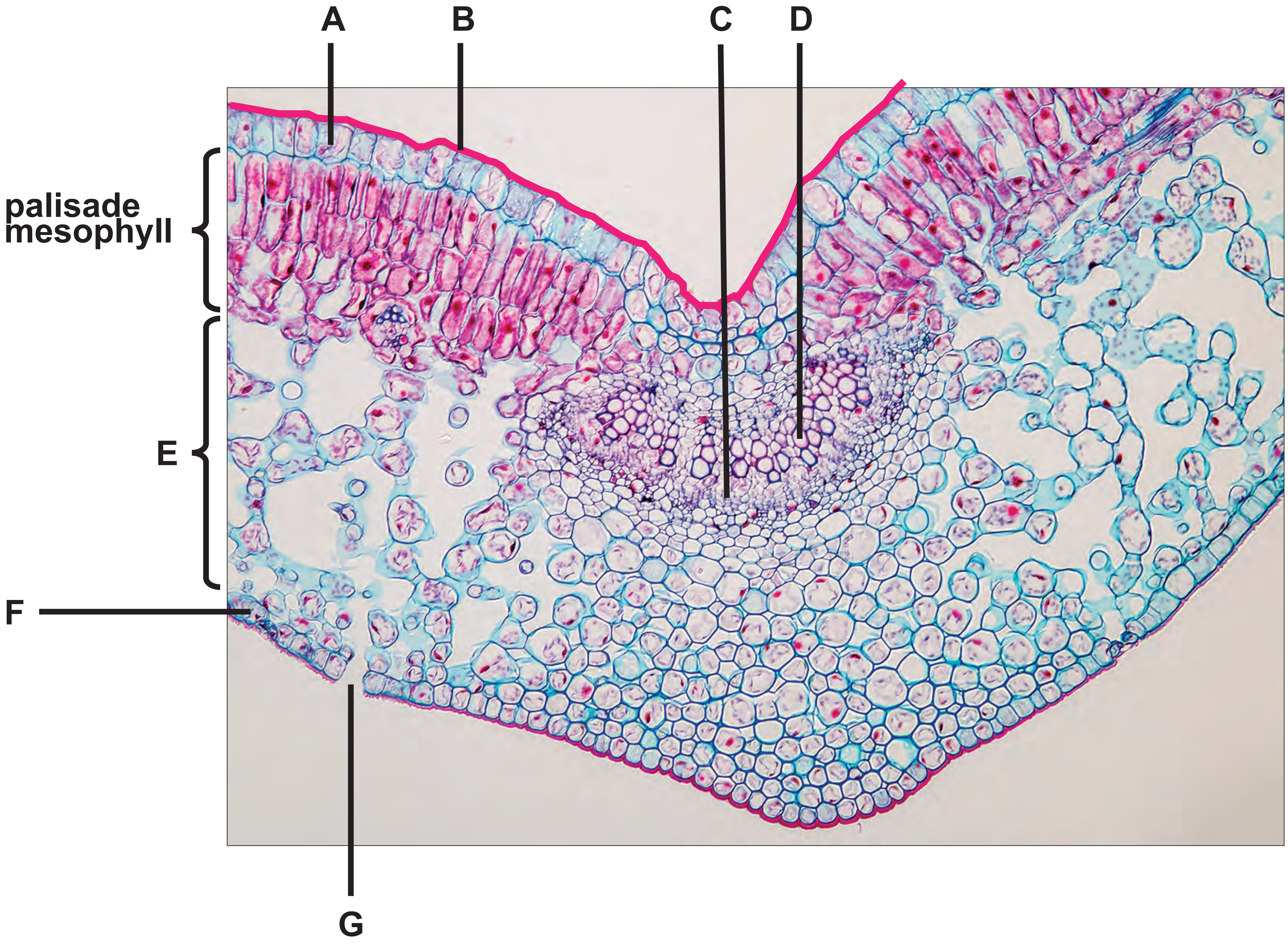


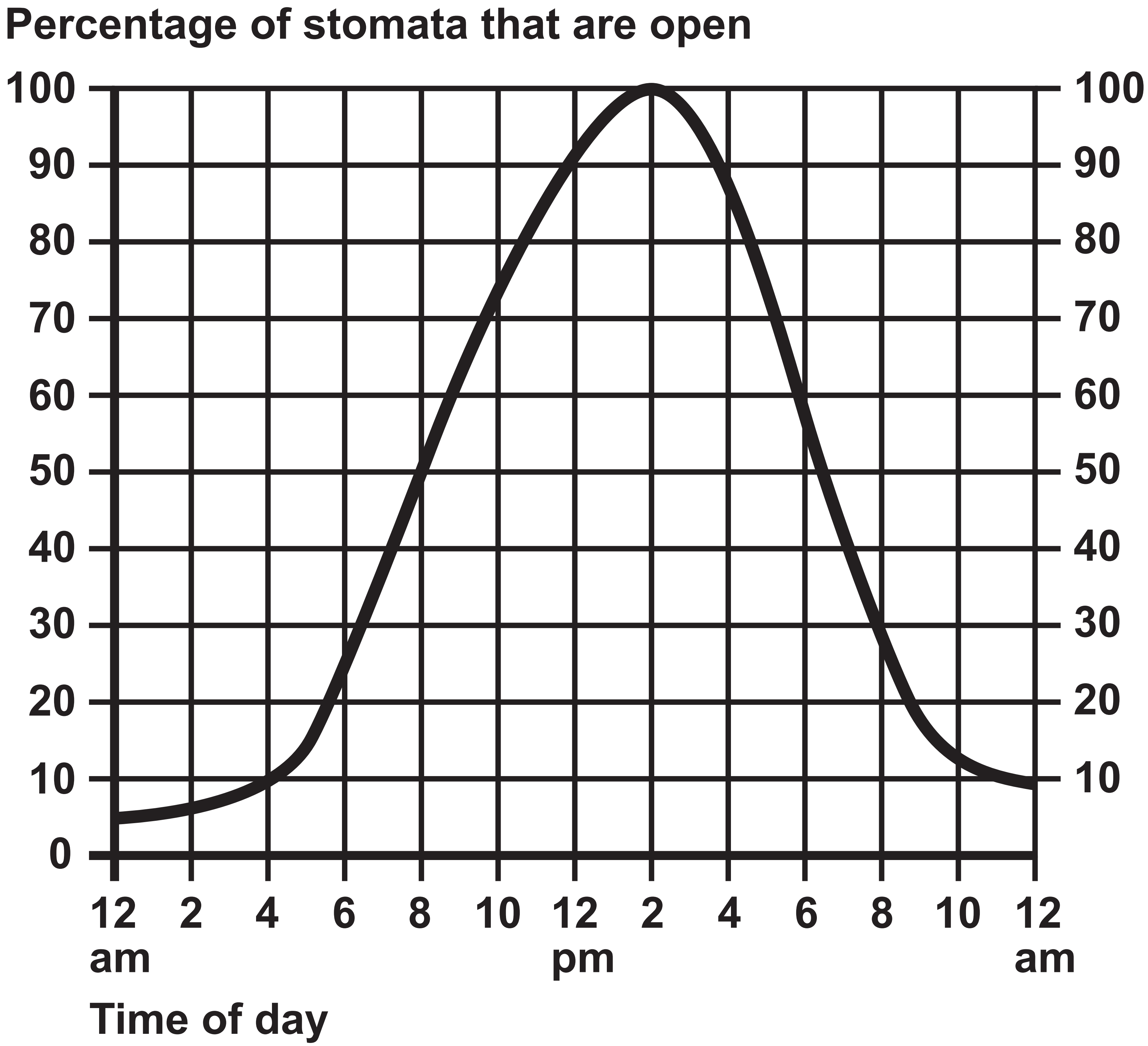
TABLE 1.3

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

IMAGE 2.1



GRAPH 2.2



Percentage of stomata that are open
100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
12 am
2
4
6
8
10
12 pm
2
4
6
8
10
12 am
Time of day

IMAGE 3.1

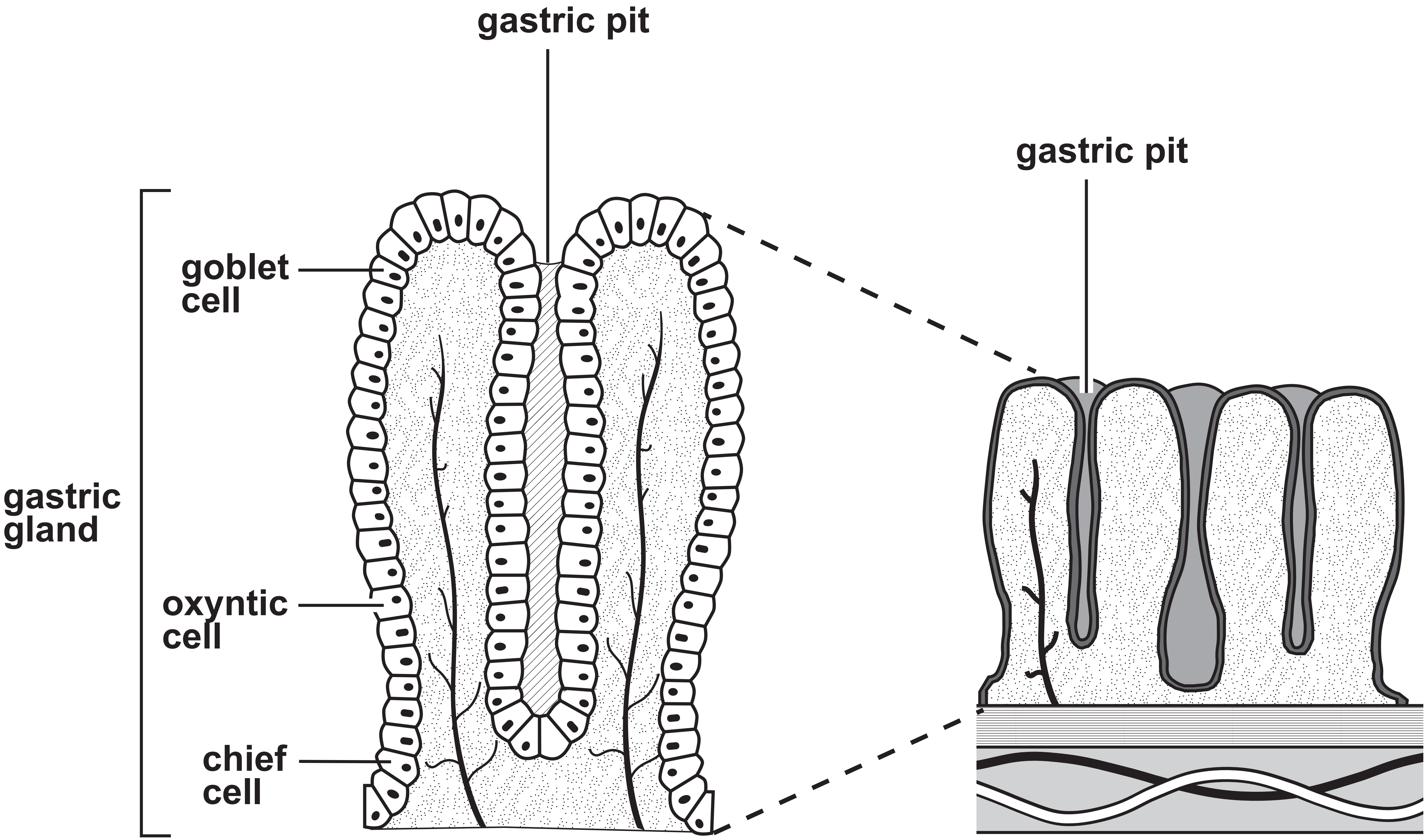

gastric pit
goblet cell
gastric gland
oxyntic cell
chief cell
gastric pit

IMAGE 3.2

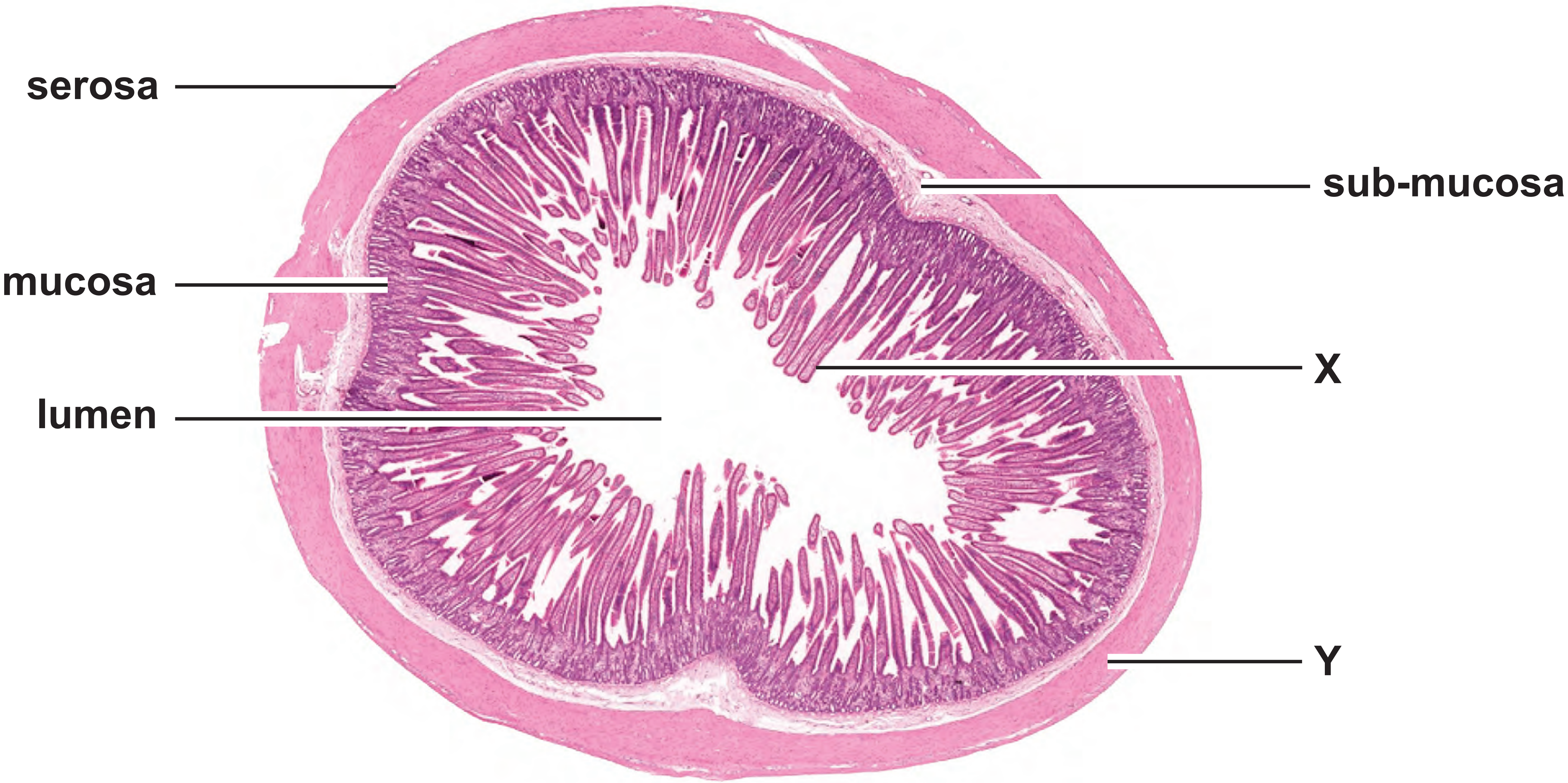


IMAGE 4.1

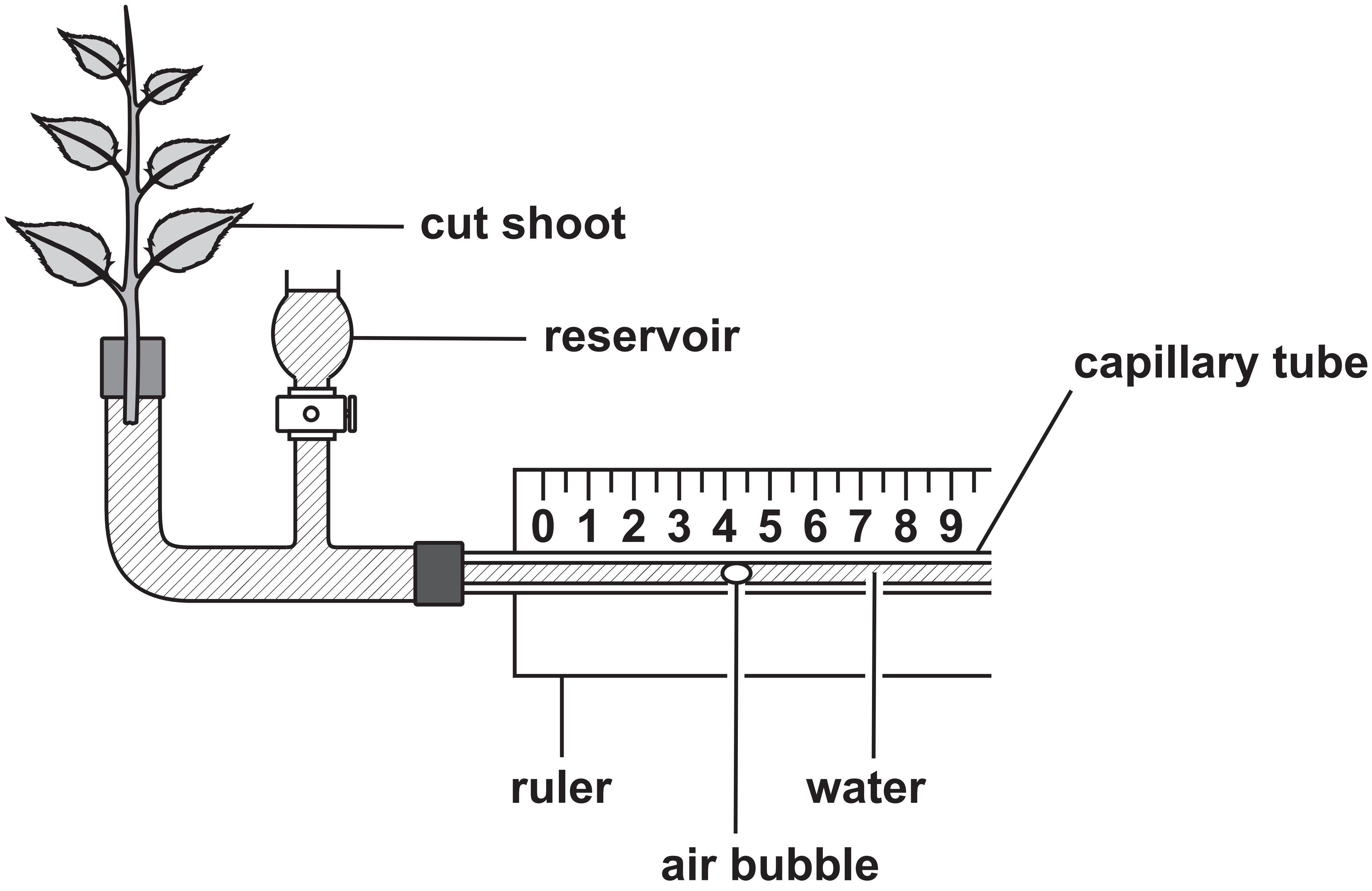
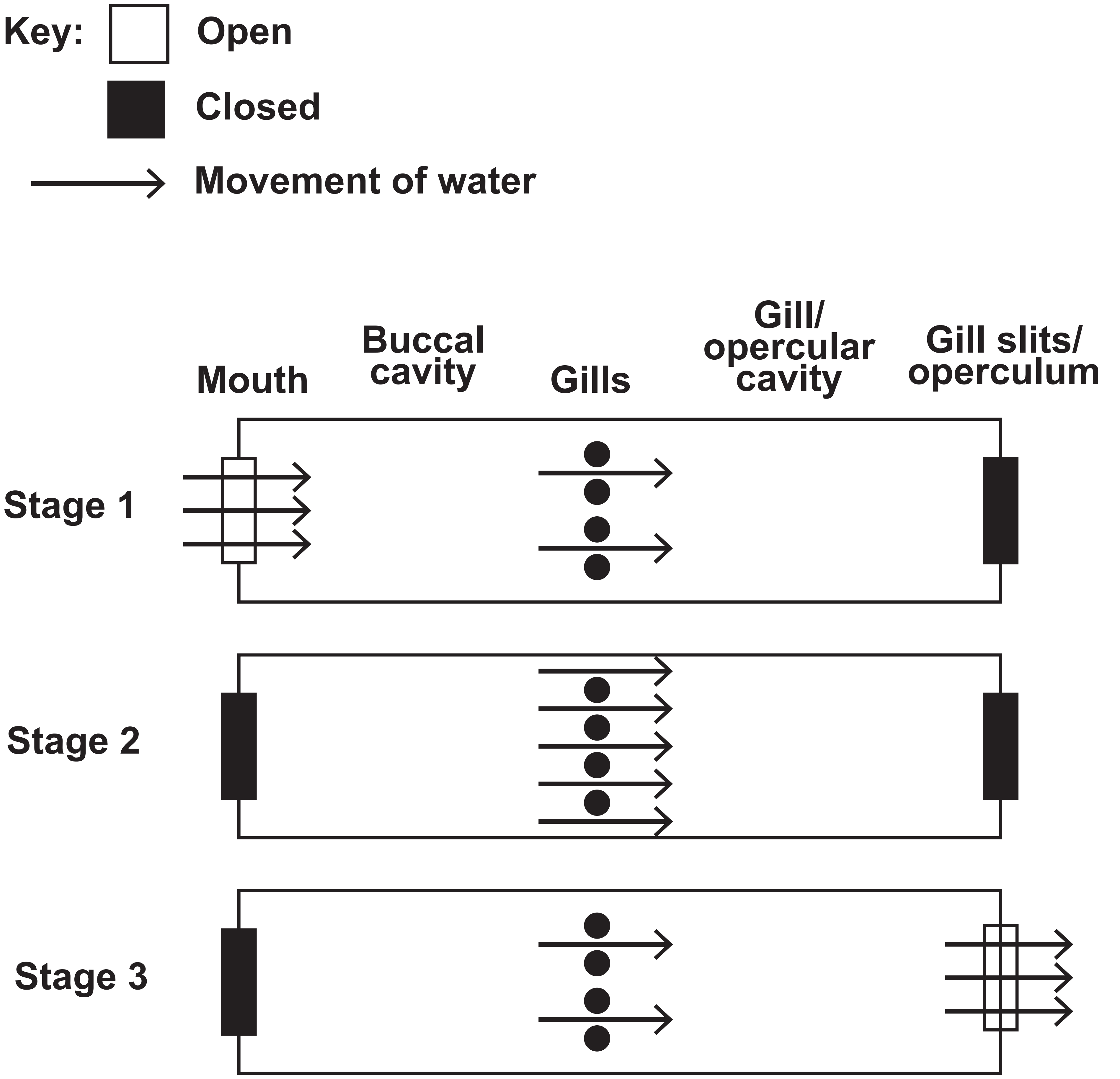

cut shoot
reservoir
capillary tube
0 1 2 3 4 5 6 7 8 9
ruler
water
air bubble

TABLE 4.2

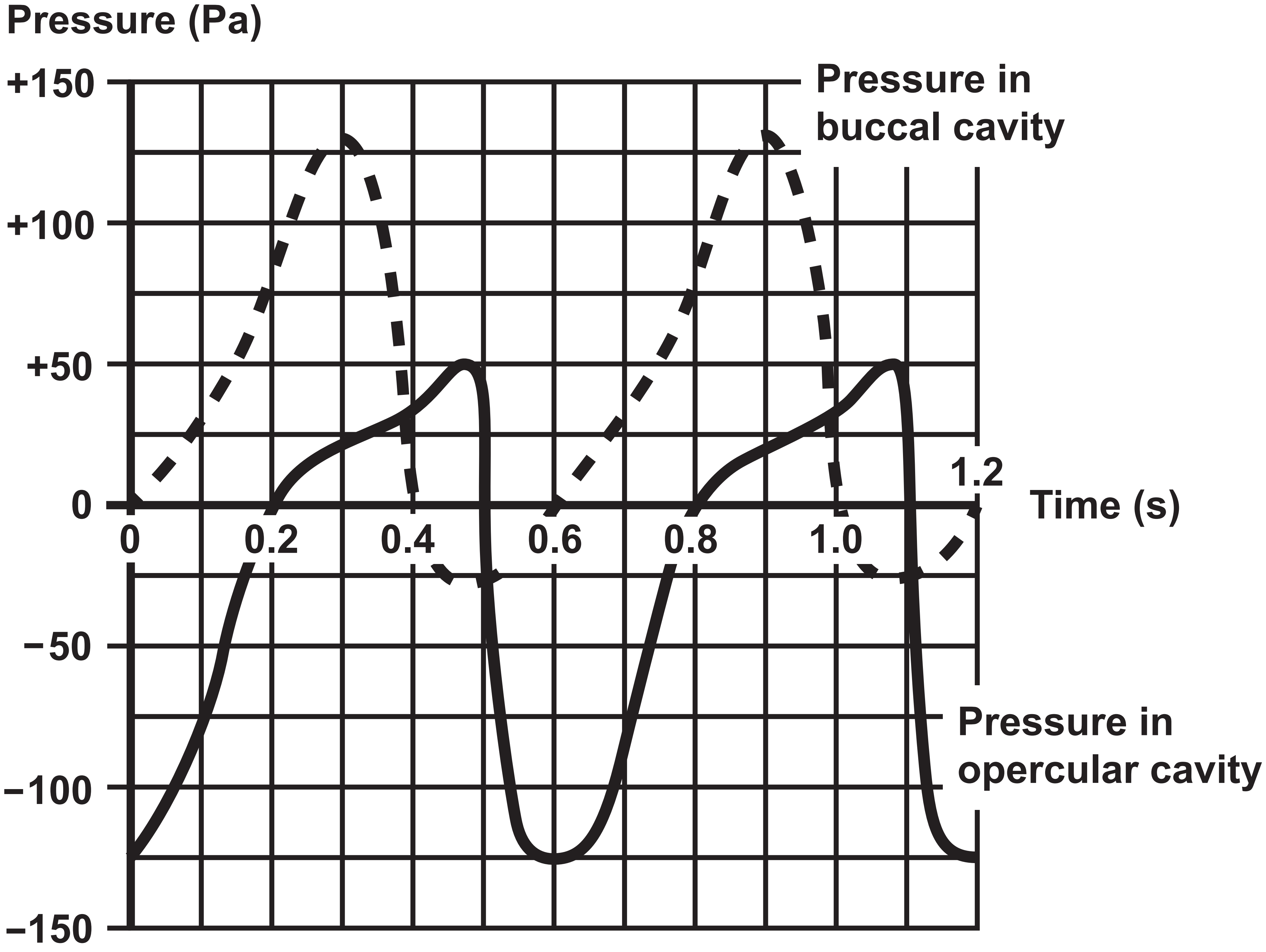
Distance between the fan and the apparatus / cm	Time taken for the air bubble to travel 200 mm / seconds				Mean rate of water uptake by the leafy shoot / $mm^3 min^{-1}$
	Trial 1	Trial 2	Trial 3	mean	
20	168	156	132	152	62•0
40	172	166	145	161	58•5
60	184	170	165	173	54•5
80	188	185	179	184	51•2
100	195	191	190	192	______

IMAGE 5.1



Key:
Open
Closed
Movement of water
Mouth
Buccal cavity
Gills
Gill/ opercular cavity
Gill slits/ operculum
Stage 1
Stage 2
Stage 3

GRAPH 5.2



Pressure (Pa)
+150
+100
+50
0
−50
−100
−150
0
0.2
0.4
0.6
0.8
1.0
1.2
Time (s)
Pressure in buccal cavity
Pressure in opercular cavity

IMAGE 5.3

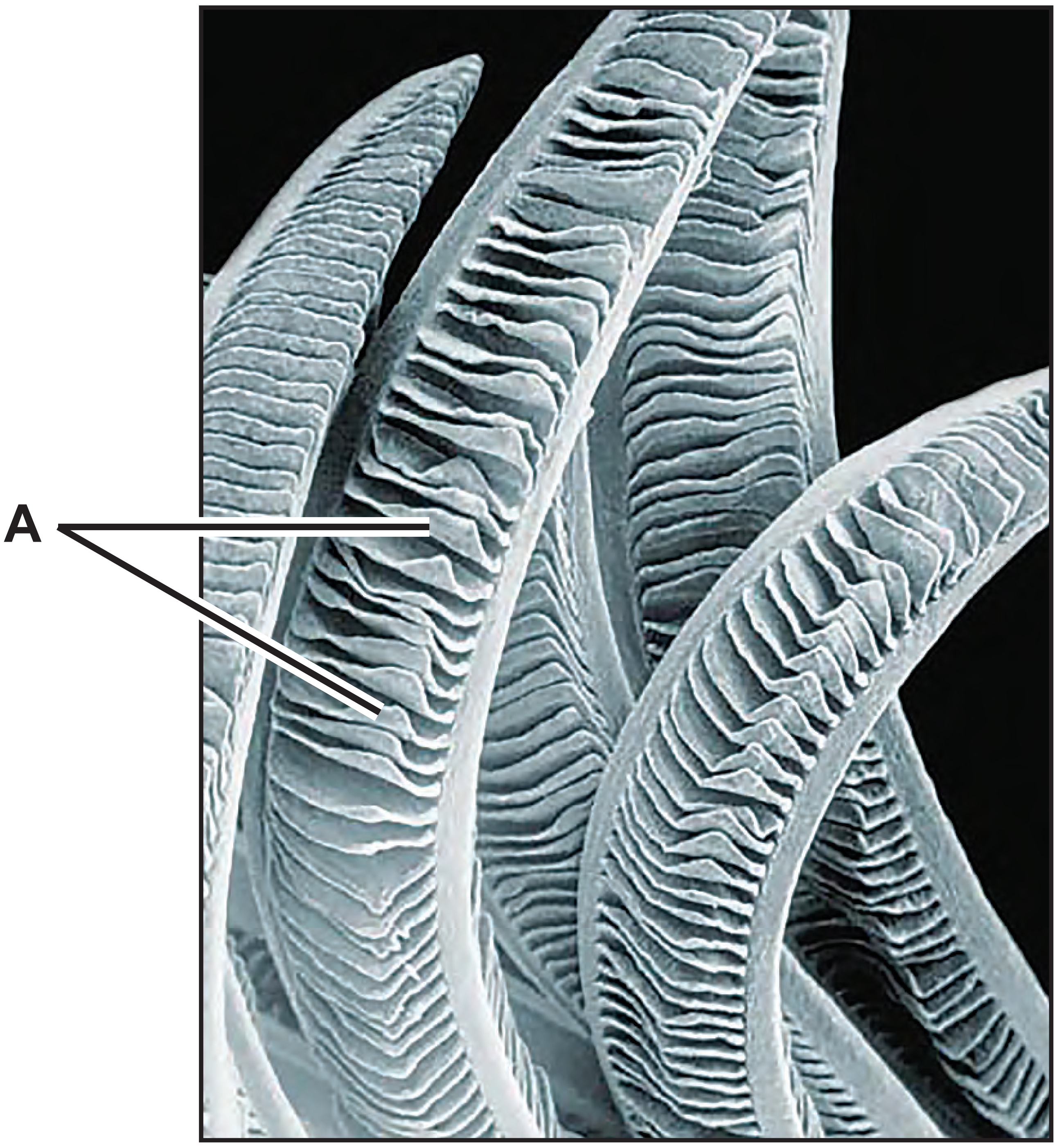


IMAGE 6.1

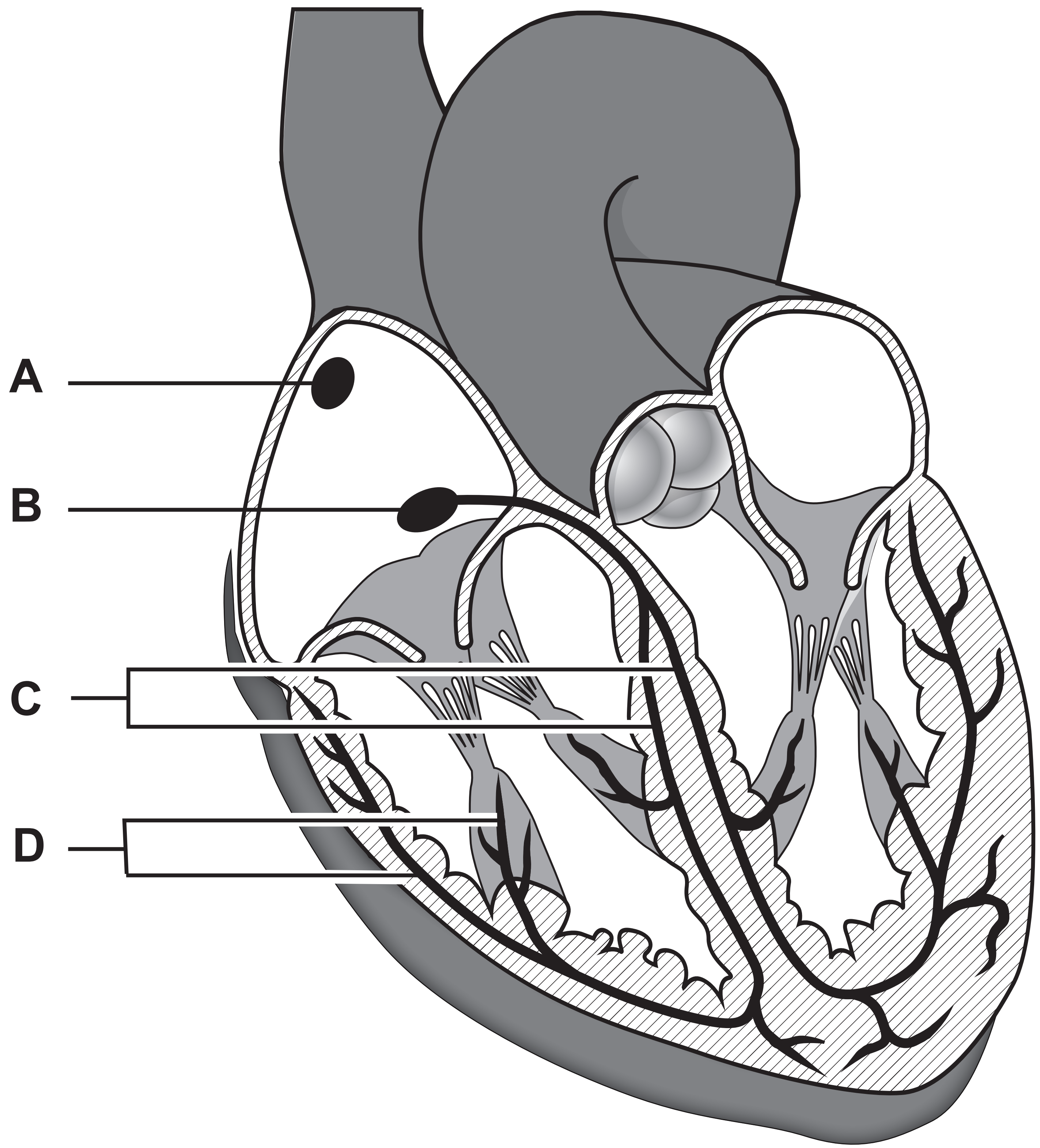


IMAGE 6.2 and IMAGE 6.3

IMAGE 6.2

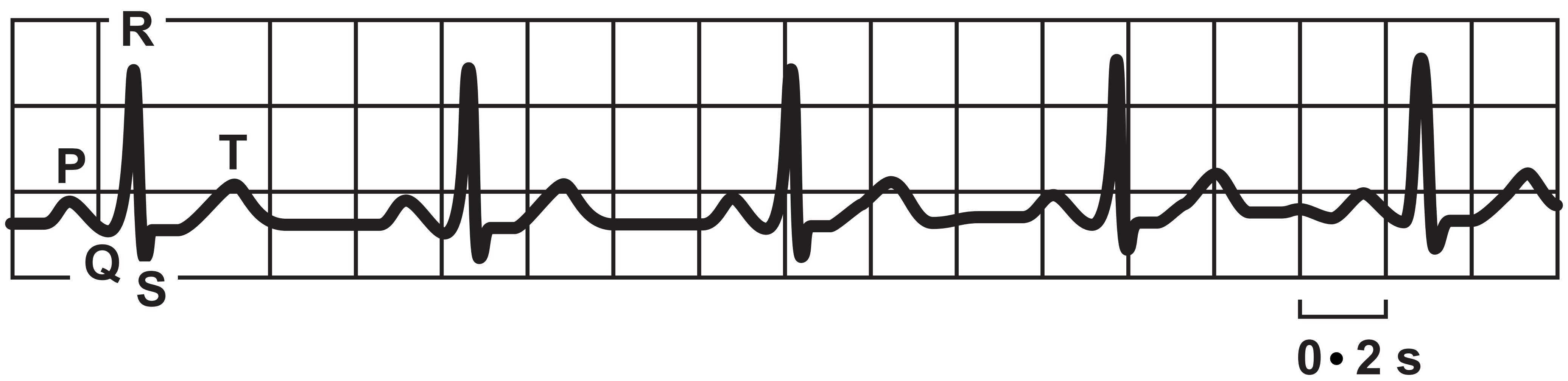
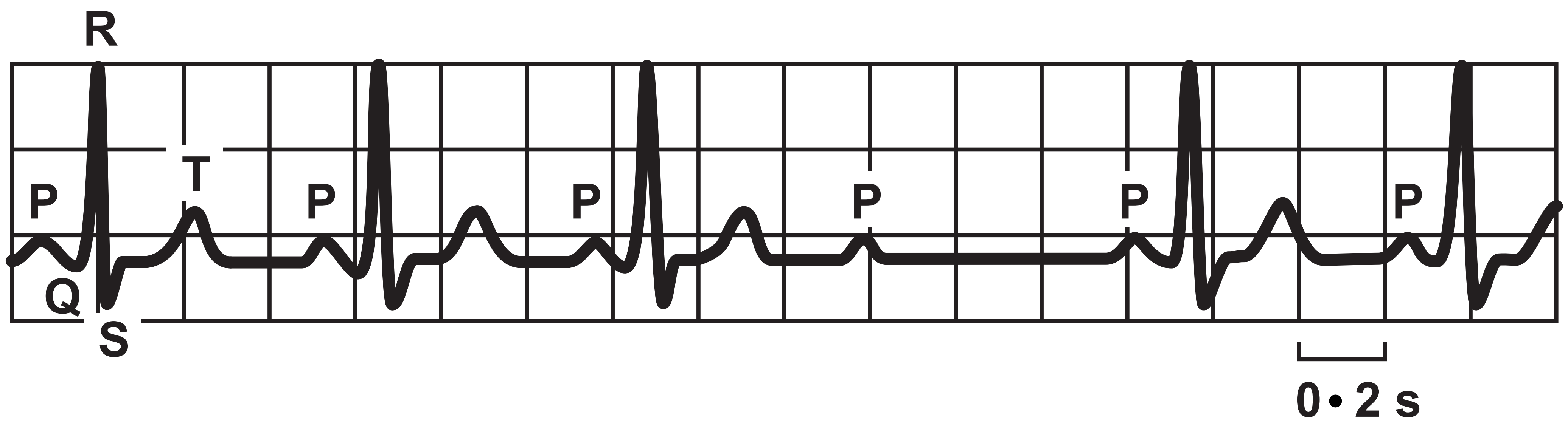


IMAGE 6.3



GRAPH 7

Key: Curve A: naked mole-rat haemoglobin
Curve B: adult human haemoglobin
Curve C: hummingbird haemoglobin